THE MORTALITY OF STEEL FOUNDRY WORKERS: A COHORT STUDY

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SUMMARY

The Mortality of Steel Foundry Workers: A cohort study.

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Patterns of mortality were analysed among 11069 steel foundry workers: all male manual workers who started work in ten British steel foundries between 1946 and 1965 and were employed at least one year. They were followed up for mortality until 1983. Person-years were summed and expected deaths calculated based on England and Wales age and calendar-year specific death rates. Correction factors based on regional differences in mortality were applied. Standardised Mortality Ratios (SMRs) were calculated as ratios of observed to expected deaths and the excess risk was analysed by modelling its relationship with duration of employment using GLIM. A group of 623 immigrants had high loss to follow up and very few deaths and were analysed separately. The vital status of the remaining 10446 workers was established for 96.8% of the cohort. The SMR for all causes is 111 based on 2789 deaths ($p<0.001$). The excess mortality is entirely accounted for by significant excesses of lung cancer, stomach cancer and non-malignant respiratory disease mortality. The excess lung cancer mortality is apparent in the foundry subgroup (SMR = 159, observed/expected = 164/103.3, $p<0.001$) and the fettling shop subgroup (SMR = 172, obs/exp = 86/49.9, $p<0.001$) but not those unexposed to these environments (SMR = 119, obs/exp = 77/64.6). There is no consistent pattern with duration of employment, but the excess is considered as unlikely to be attributable to smoking and, given the consistent findings in other studies is largely attributable to foundry employment. The role of specific exposures in the foundry environment could not be evaluated and the level of risk does not appear to be changing over calendar period. Mortality from non-malignant respiratory disease is significantly raised among the exposed (SMR = 144, obs/exp = 317/219.9, $p<0.001$), being highest for the fettling shop workers (SMR = 172). The risk has been falling over time and no risk is evident for workers who started after 1960, although in this latter group a small excess (obs/exp = 8/5.1) persists for bronchitis, emphysema and asthma. For stomach cancer the excess mortality is restricted to the foundry subgroup (SMR = 192, obs/exp = 52/27.1, $p<0.001$). Correction for regional mortality has little impact on any of these excesses although it removes a significant excess of circulatory disease mortality (the SMR falls from 111 to 98).

Key words: Epidemiology, lung cancer, occupational mortality, respiratory disease, steel foundry.

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I dedicate this thesis to past, current and future foundry workers in the hope that the identification of some of the health hazards they face may help in the alleviation of such risks.

CHAPTER 1 - INTRODUCTION

Metal founding, the production of castings by pouring molten metal into moulds to give the desired shape, is one of the oldest of industries, dating from the Bronze Age, i.e. from about 3000 B.C. The development of founding from the casting of axeheads in open-moulds was quite slow until recent centuries. Iron which required much higher temperatures to melt was not cast until the end of the middle-ages, a technology necessitating both refractory materials and bellows to raise the heat of the furnace. The Chinese had discovered how to cast iron some 1500 years earlier. By the end of the mediaeval period, iron was being cast for cannon, cannon shot and grave slabs; moulding boxes and sand were in use by the sixteenth century.

The widespread adoption of cast iron as an engineering material was allowed by the development of iron smelting, using coke, lime and iron ore in blast furnaces by Abraham Darby in 1709. Steel became widely available after the development of the Bessemer converter in 1856. In 1977 the foundry industry comprised some 1500 foundries and was estimated as employing 81500 in iron foundries, 20300 in steel foundries and 34500 in non-ferrous foundries (Gooding, 1977). The size of the industry has decreased with about 500 ferrous foundries closing between 1955 and 1977.

The moulds have been made of sand, bonded with clay until the middle of the twentieth century when binders based on organic polymer resins or sodium silicate were introduced. Currently a very wide range of different binders is used. One constant feature of the foundry environment has been and remains: silica sand. The effect of mechanical movements, high temperatures, shotblasting and grinding all contribute to the production of respirable silica dust and this was well recognised early this century. For example, Macklin and Middleton in a report published in 1923, reported 23% fibrosis and 6% tuberculosis among 200 steel dressers. Many other reports of high prevalence of fibrosis among foundry workers were published during the 1930s and 1940s and have been reviewed in McLaughlin et al (1950).

In recognition of the risk for steel dressers, the Dust in Steel Foundries committee was established by the Factory Department in the Ministry of Labour in 1943. With employers' and union representatives, it was charged with considering methods of reducing steel foundry workers' exposure to silicaceous dust. An interim report in 1944 led eventually to some legislation banning the use of silica flour as a parting powder as it was recognised as a significant source of high levels of respirable silica dust (The Foundries (Parting Materials) Special Regulations 1950). The Joint Advisory committee on Conditions in Iron Foundries was set up shortly afterwards and prepared a report during 1945 to 1947. (It became known as the Garrett Committee after its chairman, Sir Wilfred Garrett.) This committee (with representation of both employers and trade unions) made recommendations which led to the first general legislation to attempt to regulate conditions in foundries, the Iron and Steel Foundries Regulations of 1953. One of the most important provisions in the regulations was the requirement in Regulation 7 to provide local exhaust ventilation at knockout and dressing, although only "so far as is reasonably practicable".

It was in 1938 that the first report was published suggesting that foundry work may be linked to an excess risk of lung cancer (Turner and Grace, 1938). One suggestive case series and two UK surveys based on analysis of deaths relative to census data were published during the 1950s (McLaughlin and Harding, 1956; Swanston, 1950; Morrison, 1957), but it was not until the late 1970s that the ferrous foundry industry was seriously considered as presenting a lung cancer risk (Palmer and Scott, 1981).

Two cohort studies, one in Finland, one in Canada, both reported statistically significant lung cancer excesses (Koskela et al, 1976; Gibson et al, 1977). However it was a methodologically much weaker study (Lloyd, 1978), but one nevertheless within the British Isles, that increased public awareness in Britain of the potential for lung cancer being associated with the foundry environment and was a factor in the initiation of the present study. The author alleged an association between pollution from a steel foundry and a cluster of lung cancer cases in the neighbouring community.

The study suffered from some methodological weaknesses (discussed in Chapter 2) but posed the question of whether the steel foundry environment presented a carcinogenic risk. If the external pollution was associated with lung cancer risk, then the risk should be higher and easier to detect in the more heavily exposed population spending their working lives in the foundry.

The literature at that time was inadequate to determine whether any particular steel foundry worker population might be expected to be at a higher risk of lung cancer than the general population. Therefore an epidemiological study of steel foundries within the UK was initiated with the intention of answering the following questions:

1. Are steel foundry workers as a whole or any subpopulation of steel foundry workers at a risk of dying of lung cancer different from that of the general population?
2. Are they at excess risk from any other causes of death?
3. If they are at excess risk, how does this risk vary over time?

The study described in this thesis is an analysis of the mortality of workers employed in ten British steel foundries. They have been traced through linkage to health service records and their vital status established, in most cases as of the end of 1983. Five reports have been prepared, based on analyses of the data traced up to the end of 1978 (Fletcher, 1982; Fletcher and Philips, 1983; Fletcher and Ades, 1984; Fletcher, 1985; Fletcher, 1986). The latter three are reproduced in Appendix D. The first was a report to the original sponsors, reproduced in their internal research journal, the second was only published in the form of an abstract.

The next chapter reviews the published literature on ill health and mortality among foundry workers and the past and present environmental exposures in foundries, in particular considering potential carcinogenic effects. In Chapter Three, the study population, the factories included in the study, and the practical data collection and management are described. In Chapter Four, the analytical methods used are described and discussed. In Chapter Five, the results of the analysis of mortality are described. In Chapter Six the results are discussed and evaluated. In Chapter Seven the conclusions and recommendations for further work are presented.

Four appendices contain respectively some detail on the history of each of the foundries included in the study, a description of the raw data used to assemble the cohort in each foundry, detailed tables of the results of the mortality study and three papers already published on this study.

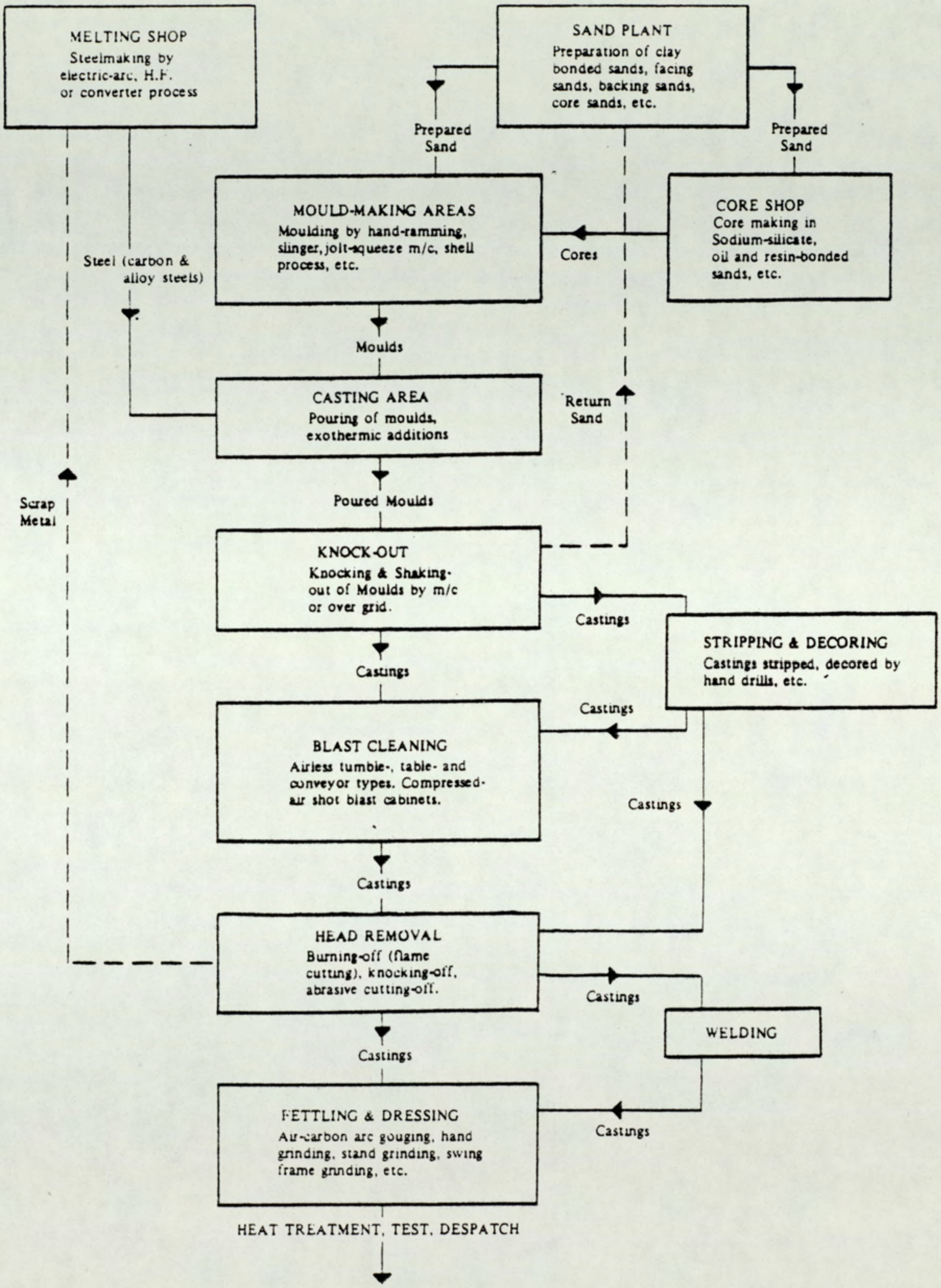
CHAPTER 2 - LITERATURE REVIEW

2.1 Steel foundry processes

The central elements in the production of steel castings, along with some of the terminology employed are illustrated in Figure 2.1, reproduced from Thornton and Lambert (1968). Molten metal of the appropriate composition is carried from the furnace in ladles and poured into the ready assembled moulds and cores. Smaller castings are cast in moulds in metal containers ("boxes"), larger castings in pits in the foundry floor. After the casting has solidified, it is knocked (or lifted) out of the mould and cleaned of adhering sand. Ancillary processes not illustrated in the diagram, include the pattern shop where (usually wooden) patterns are made as shapes in or against which moulds and cores are formed; inspection, where non-destructive testing methods are used for checking the castings for flaws; heat treatment, to improve the mechanical properties of the casting; the machine shop where castings are machined (for example milling smooth surfaces, boring holes and cutting threads); fabrication, often in the same area as the machine shop, meaning the assembly of parts and frequently involving some welding. Maintenance workers including electricians, mechanical fitters, plumbers and welders had, in most study factories their own workshops but tended to spend working time in all work areas. In addition various other jobs exist such as in despatch, driver, boilerman and yard labourer.

Figure 2.1

Steel foundry production processes



(Source: Thornton and Lambert, 1968)

In the study foundries, most of the work in the pattern shops consisted of making wooden patterns, machined and glued together. Thus an important airborne contaminant is wood dust. Some metal patterns were made for shell moulding (described below), and some wax patterns were made for small high precision castings. In this latter process, the pattern is left inside the mould and burnt away during casting.

Exposure to metals and their oxides derives from the types of steel cast, the main division being between low alloy and high alloy (stainless) steels. In broad terms low alloy steel contains less than 8% non-ferrous metals and typically 97-99% iron, 0-3% nickel, 0-4% chromium, 1-3% magnesium and 0.5-1.2% manganese. (NIOSH, 1978). High alloy steels contain more than 8% non-ferrous metals and this category includes a wide variety of compositions: 8-68% nickel, 12-32% chromium, 2-20% manganese, with up to 78% iron (Ibid).

Moulds and cores used for casting metals, are made of sand with some binding agent and other additives. Traditionally they were bound with (moist) clays and termed "greensand moulds", which were either natural sand/clay mixtures or a synthetic mixture of sand and for example bentonite clay. The moulds and cores require curing at elevated temperatures to set. They have organic additives to give a reducing environment around the casting (for a good surface finish) and to allow thermal expansion of the cores and moulds. Such additives have included sawdust, vegetable oils, starches, sour beer, wood pulp, pitch, straw and especially coal dust. Then, in the early part of this century, molasses, linseed oil and flour were used as binders particularly for cores (Woodliffe, 1971). Consumption of greensand was still increasing during the early 1970s and the greensand systems still dominate the high volume small castings market (Ashby, 1974). But greensand additives are changing - coal dust which has long been a major additive is being replaced by coal tar pitch, synthetic and natural asphalts and a wide range of flours, with consequent changes on the fumes produced (Radia, 1977).

From about 1950, organic chemical binder systems have been introduced, and now there is a very wide variety. The main reasons for their introduction have been that they offered higher production rates, better surface-finish, high mould strengths (suitable for intricate shapes) and reduced dependance on skilled labour (Nicholas, 1976). The carbon dioxide/sodium silicate system was the first corebinder to cure cold in the box. Carbon dioxide passed through the mould, causing the sodium silicate to bind the sand. More recently chemical catalysts have been introduced to cure silicate binder. Another inorganic binder of some importance is cement, used particularly in conjunction with machine moulding. Management of one of the foundries (16) in the present study reported that they found it convenient because it required less moulding skill and there was a shortage of moulders in the area.

During the 1970s the use of cold setting chemical binders became increasingly important, with phenolic urethane and furans widely used. There has at the same time been some shift back towards the cleaner silicate systems. According to Nicholas (1976), as a result of environmental concerns, many foundries are taking renewed interest in inorganic binder systems owing to the low level of fume at mixing, moulding and knockout stations, and the comparatively safe working conditions when operating with these materials.

All the moulding systems except one are moulded cold and then either heated or cured chemically to set. The shell moulding system brings loose sand mixed with a phenol/formaldehyde binder and catalyst (normally hexamethylene tetramine) in contact with a heated metal pattern. The heat of the pattern causes a polymerisation and the sand/binder mix forms a "shell" of about 1 cm in thickness in contact with the pattern. The remaining loose sand is shaken off and the mould, now quite rigid, is removed from the pattern. This system is only suitable for quite small castings as it can withstand only limited pressure from the metal. Table 2.1 lists the types of synthetic binder in use and their main constituents (Middleton, 1978).

The approximate dates of introduction of various major binder systems into the UK foundry industry have been estimated by the Health and Safety Executive and are presented in Table 2.2 (Brown, personal communication). Figure 2.2 illustrates both the dates of introduction of some synthetic binders and the rapid growth of their use during the 1950s to 1970s in the USA, a pattern paralleled in the UK.

Table 2.1

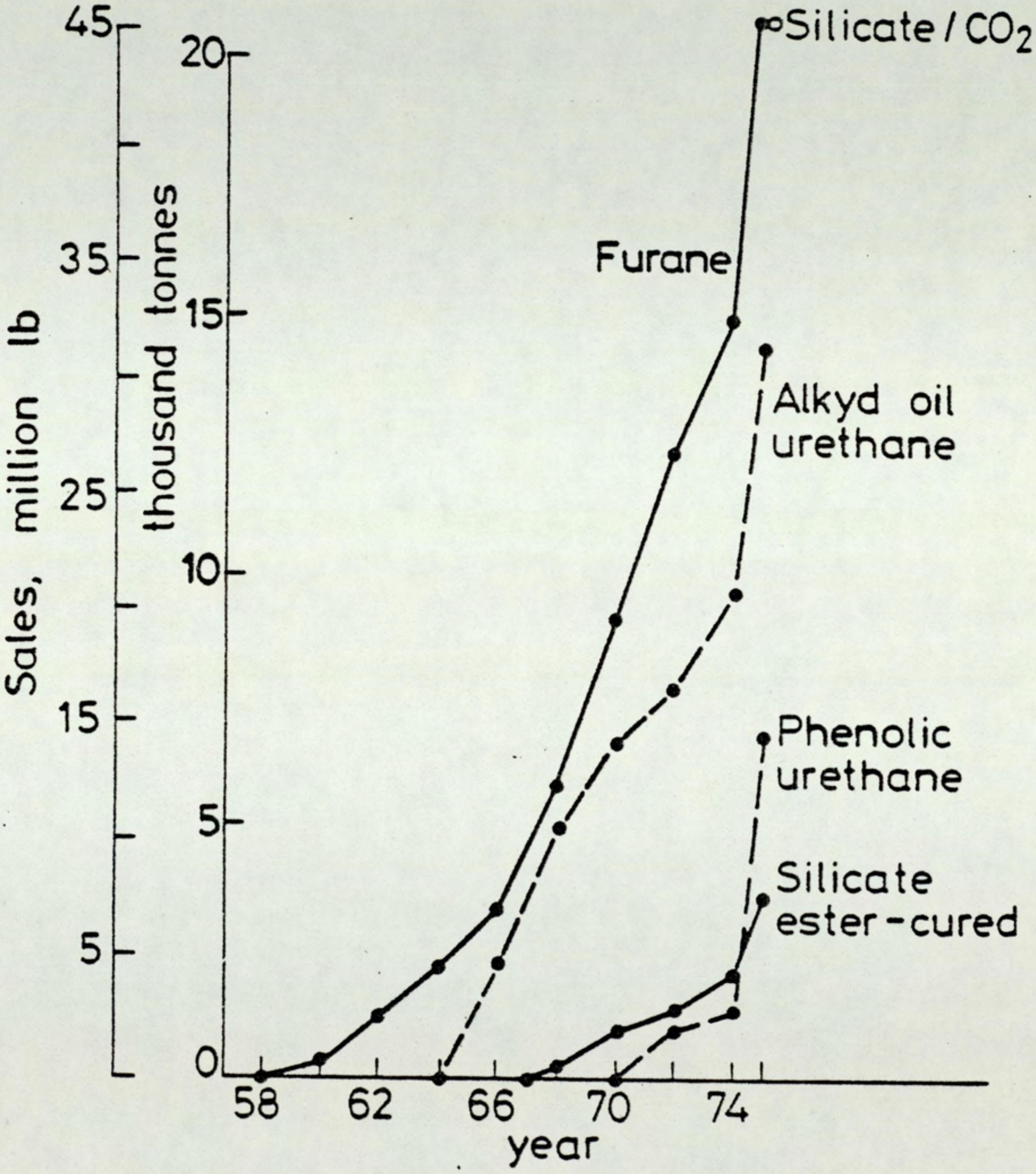
Constituents of synthetic binder systems

Heat curing systems			Cold-setting systems		
Process	Constituents of binders	Hardener	Process	Constituents of binders	Hardener-catalyst
Oven cure	Drying and semi-drying oils Natural and synthetic resins Metallic driers Starch Dextrin	Heat	Alkyd oil/ urethane	Alkyd oil/resin metallic Metallic driers	Methylene diphenyl di-isocyanate (MDI)
			Phenolic/ urethane	Phenol formaldehyde (organic solvent)	MDI (solvent) Pyridine derivatives
Cold set oils	Alkyd oil/resin Metallic driers	Sodium perborate	Furan	Furfuryl alcohol Phenol formaldehyde Formaldehyde Silane	Paratoluene sulphonic acid (PTSA) Xylene sulphonic acid Benzene sulphonic acid Sulphuric acid
Shell	Phenol formaldehyde (Novolak)	Hexamethylene tetramine Paraformal-dehyde, heat	Phenolic cold set	Phenol formaldehyde	Paratoluene sulphonic acid (PTSA)
			Cold box	Phenol formaldehyde	MDI Triethylamine (TEA) Dimethylethylamine(DMEA)
			CO_2 process	Sodium silicate Glucose Dextrose monohydrate Molasses Phenol formaldehyde	Carbon dioxide
			Cold set silicate	Sodium silicate Sugars Synthetic resins	Glycerol, mono, di and triacetates
			Cement	Portland cement	Molasses Calcium chloride

(Source: Middleton, 1978)

Figure 2.2

Sales of cold-setting binders in the USA



(Source: Nicholas, 1976)

Table 2.2

Approximate dates of introduction of synthetic binder systems into the United Kingdom

Shell moulding	1950
Carbon dioxide/sodium silicate	1950
Alkyd resins/linseed oil	1955
Furan	1960
Silicate/Ester	1965
Phenolic/urethane	1970

2.2 Environmental Contaminants

Foundry workers are potentially exposed to a wide range of airborne contaminants. Table 2.3 (from IARC, 1984) lists the potential exposures and their sources in the atmosphere. Many are upper respiratory irritants; silica, cristobalite and tridymite are fibrogenic; a number of materials are potential carcinogens (including chromium and nickel from metal fumes and polynuclear aromatic hydrocarbons and nitrosamines) and carbon monoxide exposure has been associated with heart disease. Reported hygiene evaluations are reviewed in turn, for siliceous dust, fumes from binder chemicals, and polynuclear aromatic compounds.

2.3 Dust measurements

A number of surveys of dust levels in British foundries have been published, however changes in the technology of dust sampling

Table 2.3

Airborne substances found in iron and steel foundries

Material	Principal uses or sources of emission
Common airborne contaminants	
Amines, aliphatic and aromatic* (e.g., hexamethylenetetramine triethylamine; dimethylethylamine, aniline*)	Urethane binders, amine gassing of urethane resins, thermal decomposition of urea, urethane or shell binders
Ammonia	Thermal decomposition of hexamethylenetetramine in shell moulding, decomposition of urea or urethane binders
Bentonite	Foundry sand, refractory materials
Carbon	Coal powder, graphite and soot in foundry sand, coke in cupola melting, core and mould coatings, constituent of ferrous alloys, electrodes in arc melting and gouging
Carbon dioxide	Combustion of carbonaceous materials in foundry sand, cupola melting, fuel combustion in furnaces, ovens, heaters and engines, carbon dioxide gassing of silicate binders, inert gas welding
Carbon monoxide	Combustion of carbonaceous materials in foundry sand, cupola melting, fuel combustion in furnaces, ovens, heaters and engines, flame cutting and welding
Chromite*	Foundry sand, refractory materials
Chromium and chromium oxides*	Steel alloys, melting, pouring, cutting, grinding and welding operations
Chlorinated hydrocarbons* (e.g., 1,1,1-trichloroethane*)	Solvents
Cristobalite	Refractory materials, high-temperature transformation of silicon dioxide
Fluorides*	Melting, slagging and welding
Formaldehyde*	Urea, phenol and furan resins, thermal decomposition of organic materials in core baking and casting
Furfuryl alcohol	Furan resins
Hydrocarbons, aliphatic and aromatic (e.g., benzene, toluene, xylene, naphthalene)	Solvents for binders and paints, pattern resins and glues, core and mould dressings, metal primers, petroleum fuels, thermal decomposition of organic materials in foundry sand
Hydrogen sulphide	Water quenching of furnace slag, thermal decomposition of sulphur compounds in foundry sand
Iron and iron oxides*	Ferrous alloys, melting, pouring, cutting, grinding and welding
Isocyanates* (e.g., 4,4'-methylenediphenyl diisocyanate*)	Urethane resins, thermal decomposition of urethane binders in foundry sands
Lead and lead oxides*	Scrap melting, spray painting operations
Magnesium and magnesium oxide	Inoculation process in production of nodular iron
Manganese and manganese oxides	Ferrous alloys, melting, pouring, cutting, grinding and welding operations
Nickel and nickel oxides*	Steel alloys, melting, pouring, cutting, grinding and welding operations
Nitrogen oxides	Thermal decomposition of urea or urethane binders in foundry sand, flame cutting and welding, internal combustion engines
Olivine	Foundry sand, refractory materials
Phenols (e.g., cresol, phenol, xylenol)	Phenolic binders, thermal decomposition of organic materials in foundry sand
Polynuclear aromatic hydrocarbons*	Coal-tar pitch, thermal decomposition of carbonaceous materials in foundry sand, fuel combustion in furnaces, ovens, heaters and engines
Silica, quartz	Foundry sand, refractory materials, sand blasting
Sulphur dioxide	Combustion of sulphurous fuels, sulphur-dioxide gassing and decomposition of furan resins
Tridymite	Refractory materials, high-temperature, phase transformation of quartz
Vanadium and vanadium oxides	Steel alloying
Zinc and zinc oxides	Scrap melting
Zircon	Foundry sand, refractory materials
Other airborne contaminants	
Acrolein*	Thermal decomposition of vegetable oils in core baking and casting
Alcohols, aliphatic (e.g., isopropanol)	Solvents for binders and paints, carriers for core and mould dressings, components of urethane resins
Asbestos*	Thermal or electrical insulation in furnaces and ovens; coverings, troughs and clothing in pouring areas
Cadmium and cadmium oxide*	Scrap melting
Calcium carbide, calcium carbonate, calcium silicide, calcium oxide	Melting, alloying and slagging
Carbon disulphide	Decomposition of furan resins with sulphonic acid catalysts
Carbonyl disulphide	Decomposition of furan resins with sulphonic acid catalysts
Copper and copper oxides	Scrap melting, arc gouging with coated carbon electrodes
Cyanides (e.g., hydrogen cyanide)	Thermal decomposition of urea or urethane binders, heat treatment of special castings
Esters (e.g. glycerol diacetate, butyl acetate)	Ester-silicate process, foundry solvents
Ethyl silicate	Silicate binders
Ferrochromium, ferromanganese, ferromolybdenum, ferrosilicon, ferrovanadium	Melting and alloying
Methylethylketone peroxide	Sulphur-dioxide gassing process
Nitrogen heterocyclics (e.g., pyridine)	Coal-tar pitch, thermal decomposition of carbonaceous materials in foundry sand
Nitrosamines* (e.g., *N*-nitrosodimethylamine*, *N*-nitrosodiethylamine*)	Reaction of nitrogen oxides with amines in foundry sand
Oxygen heterocyclics (e.g., furan, methylfuran)	Furan resins
Ozone	Inert gas welding
Phosphine	Reaction of water with phosphides in ferroalloys, decomposition of furan binder, furan resins catalysed with phosphoric acid
Phosphoric acid	Catalyst for furan resins
Radon	Zircon sands
Sulphonic acids (e.g., toluene/sulphonic acid)	Catalyst for furan resins
Sulphur heterocyclics (e.g., thiophene)	Decomposition of furan resins
Talc	Core and mould dressings

(Source: IARC, 1984)

make comparison over time rather difficult, at least before the mid 1950s when gravimetric sampling was introduced. Earlier surveys, using particle counting methods such as the Thermal Precipitator, Konimeter, Owen's Jet or Greenburgh-Smith Impinger reported dust levels in the range of 1000-4000 particles per cubic centimetre (ppcc) (Bloor, 1951, Michie and Jowett, 1952). Using a chemical titration method, the percentage of free silica has been estimated as on average 35% and ranging from 11 to 73% (Bloor, 1951).

During 1956-57 the fettling shops in 55 British steel foundries underwent gravimetric dust surveys (Nagelschmidt, 1963). A repeat survey in 1961-64 included 38 of foundries surveyed in 1956-57, and six of these were included in another survey of eight foundries which took place in 1965-67 (Thornton and Lambert, 1968). Thus serial measurements over a decade enable both the levels and time trends in some foundry fettling shop dusts to be compared. Table 2.4, reproduced from Thornton and Lambert, shows the mean respirable dust levels measured in the workroom atmospheres in the three surveys falling by some 40% for both respirable dust and respirable quartz.

Table 2.4

Average respirable dust concentrations in steel foundry fettling shops in three consecutive surveys.

Number of foundries	Average respirable dust concentration, mg/m^3			Average respirable quartz concentration, mg/m^3		
	1956-7	1961-4	1965-7	1956-7	1961-4	1965-7
38	1.81	1.45	-	0.16	0.10	-
6	2.09	1.15	1.26	0.09	0.07	0.05

(Source: Thornton & Lambert, 1968)

Extraction was already being introduced in the early 1950s and McLaughlin et al (1950) reported that this could lead to dramatic improvements. Modification of foundry processes and attention to dust preventive measures in an iron foundry led to reductions of thermal precipitator dust counts from 270-2800 ppcc to 83-285 ppcc and increased the median particle size. The mean percentage of free silica ranged from 4% to 9% in these data with no trend apparent over time. Another survey of steel foundry dust about the same time reported an average quartz concentration of 7% (Sully et al, 1959). The levels of dust and percentage quartz were similar in moulding and fettling areas.

Table 2.5

Average respirable dust concentration in the breathing zones of operators and close vicinities of operations.

Operation	Breathing Zone, mg/m^3	Close Vinicity, mg/m^3
Arc gouging	13.46	6.34
Burning	4.56	2.58
Welding	2.65	1.39
Swing Grinding	2.43	1.71
Hand Fettling	1.80	1.31
Stand Grinding	1.32	0.99
Knocking-out	1.1	0.62

(Source: Thornton & Lambert, 1968)

The most detailed survey was the 1965-67 survey of eight foundries (Thornton and Lambert, 1968). The mean respirable dust concentrations for some operations are shown in Table 2.5 with breathing zone samples ranging from about 1 milligram per cubic meter (mg/m^3) up to 13.46 mg/m^3 for the arc air gouging process. Exposures in the fettling shop and sand mixing area and for crane drivers were generally approximately twofold higher than in foundry and core shop. Quartz and cristobalite were measured in the dust using X-ray diffraction methods, and the overall percentage of quartz was 11% of the breathing zone air samples, and 2.5% for cristobalite. Respirable quartz concentrations by department lay in the range of 0.03 to 0.08 mg/m^3. There was as much as an order of magnitude of variation between foundries. The influence of different factories on the respirable dust levels was investigated using regression methods. They reported that in the core shops, moulding and casting areas, the dust concentration mainly depended on the levels in adjacent areas. In the melting shops and sand plants high dust levels were related to high levels of production per unit area, the absence of local exhaust ventilation and the presence of general extraction (by roof fans). In the fettling shops the efficiency of local exhaust ventilation was the main factor, but also there were high respirable dust levels associated with the production of manganese and stainless steels.

A survey of dust and fume in six steel foundry fettling shops was conducted by the Steel Castings Research and Trade Association (SCRATA) in 1978, and unpublished data give mean breathing zone respirable dust concentrations for several operations as follows: arc air gouging 11.5 mg/m^3, oxyfuel burning 3.3 mg/m, welding 4.3 mg/m3, swing frame grinding 2.7 mg/m^3, pedestal grinding 1.6 mg/m^3, grinding and burning of large castings 8.1 mg/m^3. Comparisons with Table 2.5 show that the respirable dust results are quite similar for most occupations, to the results 10 years earlier. However, the quartz percentage was less than 1% for all processes except the portable grinding and chipping where it was 3% and grinding and burning of large castings where it was 5%. Thus, there is evidence of an improvement with respect to quartz content, but not respirable dust levels. However, the sampling technology has changed (the earlier survey used the British Cast Iron Research Association gravimetric sampler; the 1970s survey used a Simpeds size sampler with a Rotheroe and Mitchell pump). Over the whole period surveyed these data suggest a limited drop in respirable dust levels and a more substantial drop in respirable quartz from the 1950s to the present.

Measurements in a US iron foundry over the period 1950 to 1976, showed little evidence of improvements in dust counts (Mirer et al, 1985). The overall mean was 9.2 million particles per cubic foot (mppcf), very high levels recorded in three individual years (1963, 1965, 1971), otherwise levels fluctuations between 2 and 9 mppcf with no apparent trend. This absence of downward trend, was reported as contradicting the impression of the hygienists who conducted the sampling.

Dust levels reported in other countries appear to have been rather higher than the UK figures cited above. In Finland, nine steel foundries evaluated in 1972-74 yielded mean respirable quartz levels as follows: sand preparation 0.55 mg/m^3, moulding 0.27 mg/m^3, melting 0.19 mg/m^3, furnace repair 5.26 mg/m^3, shakeout 0.42 mg/m^3 and fettling 0.45 mg/m^3 (Siltanen 1976). It is noteworthy that the furnace repair workers were exposed to levels an order of magnitude higher than other workers. Data from the US during the 1970s summarised by Oudiz et al (1983), gave a median respirable dust exposure of 0.90 mg/m^3 and a median percentage of silica of 9.0% (thus the average silica exposure may be estimated as about 0.08 mg/m^3). For the steel foundry subgroup, 54% of the (287) samples exceeded the Occupational Safety and Health Administration (OSHA) permissible exposure levels (PEL) of 10 (% silica + 2) mg/m^3, approximately equal to 0.1 mg/m^3 free silica (Oudiz, 1986).

Several surveys have investigated the effect of foundry size on dust levels. Oudiz et al (1983) reporting the results of OSHA inspections during the 1970s, showed a clear trend of increasing percentage of samples exceeding the PEL, from 32% of foundries employing less than 100 workers to 49% of those employing more than 500. Mirer (1977) using results of a smaller survey of 28 iron foundries, reported similar findings. The percentage of samples exceeding the silica PEL was higher (62%) among the larger foundries in big companies than in the smaller "independent" foundries (45%). A more detailed analysis of the effect of foundry size on dust levels in 51 Finnish iron foundries revealed a complicated picture (Koponen et al, 1976). The dust concentrations increased with foundry size for the sand making and melting areas but decreased with size in moulding, coremaking, knockout and fettling. The authors commented how the larger foundries were more mechanised and had higher productivity, leading to increase dustiness. However, the larger foundries used more ventilation equipment which had succeeded in reducing dust levels in some areas.

Very low levels of asbestos fibres (less than 0.0033 fibres/cm^3) have been measured in air samples in five foundries (Gullickson and Doninger, 1970). These may be due to impurities in the sand used, as chrysotile fibres have been detected in both olivine and chromite sands and amphibole fibres have been detected in samples of chromite sand (Stettler et al, 1981). In general asbestos use in foundries has been limited to asbestos textiles in fireproof gloves and aprons or insulation boards in melting areas (IARC, 1984).

2.4 Exposures associated with the use of binders

Of the materials listed in Table 2.3 a number stand out as having been associated with acute or chronic respiratory disease.

Many of the measurements described below were made during the 1970s. For comparison, some Threshold Limit Values in force in 1976 (from Health and Safety Executive Guidance Note EH 15/76) are as follows: Acrolein 0.25 mg/m^3, Formaldehyde 3 mg/m^3 (ceiling, value), Furfuryl alcohol 20 mg/m^3, Methylene bisphenyl diisocyanate (MDI) 0.2 mg/m^3 (ceiling), Ammonia 18 mg/m^3.

Acrolein, formed by the thermal decomposition of the glycerine which is present in many core oils or as part of the more general pyrolysis of binder constituents, is an intense irritant of the eyes and upper respiratory tract (URT), (ILO, 1983). Formaldehyde, methylene bisphenyl diisocyanate (MDI), amines (dimethylamine, triethylamine, hexamethylenetetramine), ammonia (formed from breakdown of the amines), hydrogen sulphide, sulphur dioxide and furfuryl alcohol are all upper respiratory irritants (NIOSH, 1978). In addition, some of these irritants, especially isocyanates and formaldehyde can induce asthma (Brooks, 1977). Several foundry managers reported that the use of furan binders provoked the most complaints from workers (due apparently to the furfuryl alcohol), especially during warm periods.

Formaldehyde levels have been measured in conjunction with the use of several formaldehyde-containing resin binders. Kay (1974) in a survey of 17 foundries, reported levels of 5 ppm during the packing of urea/formaldehyde and phenol/formaldehyde acid catalysed moulds. In the hot boxed heat-cured system formaldehyde levels reached 10-15 ppm near stacked cores. Thyberg and Jonsson (1976) reported levels of about 1 ppm while mixing cold setting furan resin, and during shellmoulding. Bobrishev (1971) reported levels of approximately 3 ppm adjacent to a coremaker making heat cured phenolic resin bound cores. The author suggested the formaldehyde exposures accounted for a high level of "bronchial disorders" among the coremakers. Eftax et al (1977) reported levels of 0.3 to 1 ppm during the mixing of furan resins. Drasche (1976) reported levels of 0.2 mg/m^3 (approximated 0.15 ppm) during shakeout in a shell moulding foundry. In furan coremaking areas in 10 Finnish foundries, formaldehyde levels ranged from 0.15 to 20 ppm and overaged 2.7 ppm (Virtamo and Tossavainen, 1976). The threshold limit value (in Finland) was 2 ppm during the period of those measurements.

Furfuryl alcohol levels up to 10 ppm have been reported by Kay (1974) during moulding with furan sand. In a survey of coremaking areas in ten foundries in Finland, furfuryl alcohols levels ranged from 0.15 to 40 ppm with a mean of 4.3 ppm (Virtamo and Tossavainen, 1976b). Thyberg and Johnsson (1976) measured 3-6 ppm during furan moulding and only 0.25 ppm during casting. Eftax et al (1977) reported that during mixing 35% of 75 samples exceeding 5 ppm and 20% exceeding 10 ppm.

MDI has been measured in several foundry environments, associated with its use in urethane binder systems. 18 of 200 samples in iron and steel foundries during pouring, cooling and shakeout were in excess of 0.005 ppm MDI. Another study reported MDI levels of 0.002-0.009 mg/m^3 during coremaking and 0.003-0.04 during casting (IARC, 1984), Kay (1974) reported levels of MDI of one half the ceiling value (0.2 ppm) during cooling after casting. Trimethylamine and dimethylethylamine when used as gassing agents in the urethane process led to 12% of samples in 29 ferrous foundries exceeding the threshold limit value of 25 ppm (Toenisketter, 1981). Hexamethylenetetramine catalyst breaks down to ammonia during shellmoulding and the following levels have been reported: a range of 7-25 ppm (Tubich et al, 1960), range of 2-10 ppm (Toenisketter and Schafer, 1977), mean of 15 ppm (Drasche, 1976). A survey of nitrosamines in a broad range of US plants included five foundries and in one of these, using an "amine catalysed sand core process" nitrosamines were detected (Fajen et al, 1982). They measured levels of N-nitrosodiethylamine in the range 0.1 to 0.7 $\mu g/m^3$ and 0.1 $\mu g/m^3$ of N-nitrosodimethylamine.

The primary source of carbon monoxide in steel foundries is from the partial combustion of organic constituents in moulds and cores. This is released during casting and knockout. In addition, carbon monoxide may be produced from cupola furnaces, heat treatment furnaces, welding and flame cutting operations and exhaust from diesel powered vehicles (such as fork lift trucks). In a survey of five Finnish steel foundries, carbon monoxide levels were all less than 20 ppm around the electric furnaces and 18 ppm in the casting areas (Virtamo and Tossavainen, 1976a). The readings ranged from 2.5 to 160 ppm with only 9% exceeding the TLV of 50 ppm. Carbon monoxide levels of 25-600 ppm during the pouring of greensand moulds, 25-400 ppm for resin bonded moulds and 10-75 ppm for shell moulds have been reported (Tubich, 1981).

2.5 Metal fumes

Foundry workers are exposed to metal fumes as metal oxides released during melting, casting, knockout and fettling and metal dust released during fettling and grinding opearations. Compared to the other metals present in the melt, iron is relatively innocuous, with chromium and nickel being potentially the most hazardous for steel foundry workers. Chromium can provoke allergic pulmonary asthma (Brooks, 1977), and various other metals can provoke metal fume fever including zinc, copper, magnesium and cadmium. Chromium in its hexavalent form has been shown to be carcinogenic in animal experiments and studies of chromate producing and chromate pigment industry workers show increased lung cancer risk (IARC, 1980b). In two studies of ferrochromium alloy plants, a study in Norway reported an excess of lung cancer (7 observed, 3.1 expected), one in Sweden a deficit (5 observed, 7.2 expected) (Langard et al, 1980; Axelson et al, 1980). Various nickel compounds are carcinogenic in animal experiments. Nickel refining workers exposed to mixtures of nickel, nickel oxide and nickel subsulphide show increased mortality from lung and nasal cancer (IARC, 1982).

Two studies report systematic measurements of metal fumes in steel foundries. A Finnish survey of 127 foundries included 10 steel foundries (Tossavainen, 1976). Lead was the only metal to frequently exceed TLV values in the foundry atmosphere and copper and zinc were at high levels in the copper alloy foundries, but measurements for all the other metals reported did not exceed the TLVs. In particular, mean exposure to chromium (acid soluble) was (5 $\mu g/m^3$) in the steel foundries using induction furnaces and 6 $\mu g/m^3$ in those using arc furnaces, measured in the air during melting and casting. For nickel the mean values were 10.9 and 2.0 $\mu g/m^3$ respectively. In the iron foundry samples the chromium levels were 3 and 4 $\mu g/m^3$ (induction furnace and cupola cupola) and less than 5$\mu g/m^3$ for nickel. No data was given on differences within the steel group between low and high alloy steels, but the levels were low compared to Finnish TLVs of 1000 $\mu g/m^3$ for each of these two metals.

Mosher (1980) reported levels of chromium and nickel exposure in steel foundries using less than 2% of these metals in their alloys. For chromium the levels were 7.1, 5.4 and 113.8 $\mu g/m^3$ for respectively, furnace tending, ladleman and fettling tasks. The equivalent figures for nickel were 1.6, 2.1 and 190.7 $\mu g/m^3$.

2.6 Polynuclear aromatic hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) comprise a large family of substances present in mineral oils and incomplete combustion products of organic materials including cigarette smoke and the foundry atmosphere from the thermal pyrolysis of organic mould constituents. Benzo(a)pyrene (bp) has often been measured preferentially as a signal PAH as it is universally present, although the quantities of other individual PAHs may be higher. Benzo(a)pyrene and many other PAHs have been demonstrated as carcinogens in animal experiments (IARC, 1983).

The first measurements of PAHS in foundries were published in

Czechoslovakia and bp levels of 0.03-0.12 μg/m^3 before casting, 0.13-0.47 at knockout and 0.38 μg/m^3 in fettling operations were reported (IARC, 1984).

In Canada, Gibson et al (1977) reported levels of the benzene soluble fraction of the total suspended particulate in the range of 0.19 to 0.43 μg/m^3, being highest in the moulding, furnace and fettling areas, and lowest for crane drivers and coremakers. The bp concentrations lay in the range 0.024 to 0.295 μg/m^3, with highest values for moulders. They also detected benzo(k)fluoranthene, benzo(a)anthracene, pyrene and fluoranthene. Verma et al (1982) in a survey of ten foundries, including three steel foundries, reported mean bp exposures of 0.43 μg/m^3 for the steel foundries and 0.94 μg/m^3 for the iron foundries. The levels were lowest for fettlers (0.09 μg/m^3 for all foundries) and highest for shakeout (1.18 μg/m^3). Levels of bp in six Finnish iron foundries averaged 5.1 μg/m^3 for those using coal tar pitch additive and 0.08 μg/m^3 for those using coal powder (Schimberg et al, 1980). For the foundries using coal tar pitch the highest levels reported (12.6 μg/m^3) were for the knockout followed by moulding and casting (2.2 and 2.1 μg/m^3).

By contrast, levels of bp frequently in the range 10-50 and sometimes in excess of 100 or 200 μg/m^3 have been reported in aluminium plants using the pitch-containing Soderberg electrode (IARC, 1984). Published measurements above coke ovens were generally below 10 μg/m^3, but several studies have reported mean levels in the range 20-50 μg/m^3. Both these operations have been associated with increased lung cancer risk (IARC, 1984).

Some experimental work using a standard casting apparatus has compared the PAH content of different types of binder. The range of PAHs identified has been wide with 50 individual chemical species identified by Schimberg et al (1980). Novelli and Rinaldi (1977) compared different organic greensand additives and bp in the fume of after casting. The bp levels were the highest from coal tar pitch and the lowest from vegetable products such as maize starch, wood flour and starch; seacoal gave intermediate emissions. The ratio of the highest to lowest bp concentrations exceeded 1000. Comparable findings were reported by Schimberg et al (1981). The relative difference was present but less pronounced for other PAHs. Work by the Southern Research Institute (1979) compared different types of binder and in the fumes after casting. The highest levels of bp were from greensand (containing sea coal) and dry sand (containing coal tar pitch and sea coal) moulds, with much lower levels (by two to three orders of magnitude) from all the resin moulds except from shell moulds and core oil which were intermediate. The total benzene soluble fraction was highest for greensand fumes, with lower levels (but by less than one order of magnitude) for drysand, core oil, and two types of furan. They estimated the levels of bp in the air if the carbon monoxide effluent levels were normalised to 50 ppm and reported levels of 0.2 $\mu g/m^3$ for greensand and drysand, 0.02 for core oil and shell and 0.005 or less for the other binder systems including sodium silicate ester, urethane, furans and phenol formaldehyde.

2.7 Cohort studies of foundry workers

The first cohort study published comprised as a representative sample of Finnish foundry workers, a cohort of 3,876 men with at least 3 months exposure during 1950-1972 which was followed up to the end of 1973 (Koskela et al., 1976). Mortality was compared to Finnish rates for 1967. The lung cancer Standardised Mortality Ratio (SMR) was 151 (21/13.9) for the whole cohort (not significant), by proportional mortality analysis the Proportional Mortality Ratio (PMR) was 174 (significant at the 5% level). The excess was confined to iron foundries, and there was evidence of an exposure-response relationship. The SMR was 186 for those with 5 or more years' foundry employment and 270 for 5 or more years in iron foundry employment. Analysis by occupational category was hampered by very small numbers. But the "high dust" group (moulders, coremakers and fettlers together) with at least 5 years employment, experienced significantly more lung cancers than expected (8 against 2.9), an SMR of 280. Tola et al. (1979) extended the cohort of iron foundry workers to include 1 year of employment any time between 1918 and 1972 (3425 men). There were 51 lung cancers observed giving an SMR of 145 compared to the Finnish male population ($p<0.05$). The 51 lung cancer deaths were then compared with 153 matched deceased controls from within the cohort. Floor moulders and casters experienced the highest risks and there was a positive association with occupations considered as having the highest exposure to polycyclic aromatic hydrocarbons, though the comparison was not statistically significant. In a more recent and overlapping study of Finnish iron foundry workers, 6415 male workers who started work between 1950 and 1976 were followed up to the end of 1978 with a mean follow-up of

14.6 years (Kurppa et al, 1984). Expected deaths were calculated using Finnish male rates in 1970 and there was an SMR of 127 (47/37.0, $p<0.05$) for lung cancer and 126 (28/22.3) for digestive cancers. The lower risk in this study in comparison to that of Tola et al (1979) may be in part a reflection of the shorter mean follow-up in this population which excluded those entering the cohort prior to 1950.

Gibson et al (1977) in a cohort study of a Canadian steel foundry, which formed part of an integrated steel mill, reported the highest mortality ratios found in any foundry cohort study. The cohort of 1542 workers aged at least 45 and employed or retired in 1967 with at least 5 years' employment was subdivided into "foundry" (439 men) and "non-foundry" groups (1103 men with less than 5 years in the foundry). For the foundry group, the lung cancer mortality ratio was 250 (21/8.40, significant at the 1% level). The SMR of 259 (11/4.25) for those with twenty years experience in foundry work was only slightly higher. The SMR was 66 (11/16.58) for the non-foundry comparison group. Those for the non-foundry group with some but less than 5 years' employment in the foundry department had one observed lung cancer death against 2.45 expected. The results were subdivided by occupational group and though the numbers were small, most categories had raised SMRs and the crane drivers' mortality was significantly higher than expected (4 observed, 0.56 expected). The authors estimated a relative risk of foundry versus non-foundry of 5.01, calculated by stratifying by three groups by age in 1967. The risk appeared to fall with age, being highest (8.77) for those aged 45-54 in 1967. Mortality by other specific causes of death was not presented, although the lung cancer excess accounted for the moderate all cancer excess (SMR = 138) in the foundry group. For cancers other than lung there were 16 observed and 18.35 expected.

A cohort of nearly 59,000 male steelworkers in the USA was defined in 1953 and its mortality has been reported in relation to various causes and occupational subgroups over the years. Redmond et al (1981) analysed the mortality up to 1975 subdivided into (among others) the foundry. Relative to the steelworker population as a whole, the observed deaths from lung cancer were not significantly different from expected. Relative risks of 1.39, 0.99 and 1.30 (none significant) were reported respectively, for those employed in the foundry in 1953, those ever employed in the foundry and those with at least 5 years' experience in the foundry up to 1953 (the observed numbers of deaths were not given). Breslin (1979) reported the results of a similar analysis over the period 1953 to 1970. For the same 3 criteria of cohort definition as above, the relative risks were 1.14 (20/17.7), 1.00 (34/34.0) and 1.16 (23/20.1), being slightly lower than for the longer follow-up among those employed in the foundry in 1953 and those employed at least 5 years. There was a weak association between lung cancer risk and length of employment, the SMR (for deaths up to 1970) being 79 for less than 5 years' foundry employment and 116 for more than 5 years employment. Analysed by three follow-up intervals, the excess was highest in the middle period with a Relative Risk (RR) of 1.61 (for those employed at least 5 years in the foundry). Comparing the results from these two studies suggests that the risk rises again during the period 1971-75, a period 18-22 years from cohort definition. The excess was only apparent for white workers with 2 deaths versus 2.8 expected amongst the non-white cohort. The author did not present data by job category, because the numbers were then too small though they comment that lung cancer among moulders "was not evident" but "excesses of lung cancer were noted among finishing and shakeout". Lerer et al. (1974) reported the lung cancer mortality for foundry crane drivers in the same steelworker population. There were 2 deaths observed and 2.1 expected, for those ever employed as foundry crane drivers relative to all steelworkers, deaths up to 1966. The standard of comparison - the rest of the steelworker population was itself subject to raised lung cancer mortality (SMR = 135 relative to national rates for whites, 169 for non whites, Redmond et al, 1981). Compared to national death rates, the SMR for the foundry workers was 201 (28/13.96), at least for the white workers (data were only presented for the white foundry worker group, though they in fact accounted for the bulk of the foundry worker group). This latter result is significant at the 1% level.

There was a significant excess of cancers of the genitourinary organs (14/7.4 among the whites). This was even larger (RR = 2.40, $p < 0.01$) with the longer follow-up until 1975 (Redmond et al, 1981). Cardiovascular mortality was slightly less than expected (172/187.3). Digestive cancer mortality was close to expected (26/25.2), and nonmalignant respiratory disease mortality less than expected (12/15.5). The figures given are for those with at least 5 years' employment but the other cohort definitions showed similar patterns.

Decoufle and Wood (1979) in a study of a cohort of 2,861 gray iron male foundry workers reported a non-significant excess of respiratory cancer, an SMR of 126 (29/23.1). The cohort comprised all those who had worked at least one month during the years 1938-1967 and was followed up until 1967. Observed and expected deaths were calculated for the same period, therefore the mortality ratio was somewhat diluted by mortality occurring soon after starting work, as is borne out by the low value of the SMR for mortality from all causes: 70 (429/617.2, $p<0.001$). The group which had the longest follow-up between exposure and death comprised those employed before 1938. Results were presented for respiratory cancer deaths among those employed for at least five years prior to 1938: 8 observed, 4.0 expected. Most of this excess derived from the non-white subgroup: 4 observed, 0.9 expected (p less than 0.05), with 4 observed, 3.1 expected among whites. For circulatory diseases there were significant deficits for both whites and non-whites. For non-malignant respiratory disease the SMR was 53 (17/31.9, $p< 0.01$). For digestive cancer the SMR was 90 (30/33.2) for those ever employed, but 189 ($p < 0.05$, 14/7.4) for those employed at least 5 years before 1938.

Egan-Baum et al. (1981) in a proportional mortality study of 2990 deaths between 1971 and 1975 amongst members of the International Molders and Allied Workers' Union in the USA, reported an excess for lung cancer deaths. The eligibility for death benefits stopped in 1961 and they had all been Union members at least 11 years prior to death. For lung cancer, the proportional mortality ratio was 144 (224/155.2)for white males and 176 (39/22.1)for black males both significant at the 1% level. The lung cancer PMRs were highest in the age group 60-64. No subdivision by length of employment was provided, but the relative importance of steel, iron and non-ferrous foundries was assessed. Lung cancer cases and controls (excluding respiratory disease deaths) were selected from those union branches with at least 4 lung cancer deaths. This gave 113 cases and 249 matched controls, but foundry type could only be ascertained for 60% of the cases and 67% of the controls. Among those, 62% of the cases and 50% of the controls worked in iron foundries. Comparing iron against steel and non-ferrous the odds ratio was 2.36 ($p < 0.05$) for those less than 65 and 1.19 for those at least 65. The odds ratios for steel versus non-ferrous were close to unity. The PMR for stomach cancer was 86 (24/27.8), but for non-malignant respiratory disease it was 139 (307/220.2, $p < 0.01$) an excess shared by both racial groups. The heart disease PMRs were 95 and 91 respectively.

In Vienna between 1950 and 1960, 1,630 workers in dusty occupations were registered with an outpatient pulmonary clinic (Neuberger et al. 1982). These people were registered on account of their dusty occupations, as a preventive scheme, and so did not necessarily have dust related diseases already. The occupations covered various occupations in ceramics, glass, stone and metal industries but the largest group worked in foundries (mainly iron foundries). This population was followed until 1980 and expected deaths calculated using Vienna death rates. Overall, the lung cancer SMR was 173 ($p<0.01$, 175 cases). The lung cancer SMR for the foundry worker subgroup was also 173. A comparison group of workers with no exposure to dust was set up, matched on sex, year of birth, domicile and smoking habits. The lung cancer SMR for this latter group was 112 (not significantly different from 100) and so the excess found could not be attributed to smoking. No breakdown by length of employment or length of follow-up was presented, but there is no difference between dusty workers and controls until age 60. As the cohort was restricted to 40 years or over this suggests a latency period in excess of 20 years. A later publication of the same data gives revised estimates of the SMRs apparently because of using age standardisation in the calculation of expected deaths, though still based on the Viennese general population (Neuberger et al, 1986). Foundry workers are not presented separately, though the overall lung cancer risk is still significantly raised, with an SMR of 148 ($p<0.01$, 175 cases). This remains higher than the revised control group SMR of 110. Stomach cancer mortality was also higher with an SMR of 161 ($p<0.01$, 65 cases) and "chronic respiratory disease", SMR = 310 ($p<0.01$, 142 cases). The equivalent control group SMRs were 112 and 111 respectively. The dust exposed group had an SMR of 102 for cardiovascular disease mortality.

Silverstein et al. (1986) reported a proportional mortality analysis of 278 deaths during 1970-1981 among workers with at least 10 years cumulative employment in a US iron foundry. Exposure was classified into finishing foundry, coreroom, mixed exposure jobs and other. Breathing zone air samples taken in the first three of these areas during 1950-76 were in the range 8.8 to 18.8 mppcf (million particles per cubic foot). The percentage of free silica was not given. Proportional mortality was compared with national US deaths. Smoking status was established (ever smoker or non smoker) for 217 out of 221 whites by interviewing coworkers with long-term service. PMRs for white smokers were calculated relative to the proportion of lung cancer deaths reported in a follow-up of smoking US veterans, whose mortality experience had been extrapolated to cover the study period. PMRs were significantly high among the whites for lung cancer (PMR = 148), and nonmalignant respiratory disease (177), but not digestive cancer (107). Among non-whites the only significant excess was for circulatory diseases (PMR = 143, $p < 0.01$). Among whites, the lung cancer PMR was highest in the finishing area (179, $p < 0.05$), but also raised in the foundry (151, not significant (NS), based on 6 cases) and mixed exposures (158, NS, based on 6 cases). Nonmalignant respiratory disease mortality was high in finishing (PMR = 297, $p < 0.001$) and the core room (PMR = 321, $p < 0.01$). Significant PMRs for nonmalignant respiratory disease were present for both smokers (162) and non-smokers (209). For smokers the lung cancer PMR was 159 relative to all US males ($p < 0.05$) and 157 relative to US Veteran Smokers ($p = 0.13$). A two fold excess of lymphopoietic cancers was reported, concentrated in those with no former employment in zinc foundries or coal mining. A case control analysis adjusting for age, smoking habits and previous employment in coal mining or other foundries gave an adjusted odds ratio of 1.4 (95% CI, 0.4-3.5) for finishing versus non-finishing and close to one for each of the other departments. The Odds Ratio (OR) for the same comparison was 3.7 (CI 1.4-10.0) for nonmalignant respiratory disease. No death certificates mentioned silicosis or pneumoconiosis as either underlying or contributing cause of death. A review of X-rays from 19 of 26 nonmalignant respiratory disease deaths found "opacities consistent with silicosis on many of the films", but "their readings were not consistent or reliable enough to reach conclusions about pneumoconiosis in this population". The authors commented that "the lung cancer findings are consistent with a carcinogenic role of silica, other foundry particulates and polycyclic aromatic hydrocarbons, either alone or, more likely in combination."

Sherson and Iversen (1986) conducted a follow-up study of 5,579 male production workers in all Danish iron and steel foundries. These came from two surveys which included X-rays and the collection of detailed work histories: 3650 initially participated in a 1967-1969 survey of all iron and steel foundries and 1929 initially participated in 1972-1974 in a survey of all ferrous and non-ferrous foundries. These were followed up to 1980 with an average follow-up of 10.7 years from being surveyed. Expected deaths were calculated from three reference populations: Danish national reference rates, all economically active males and skilled and unskilled manual workers. The expected deaths in the two latter analyses were derived from a follow-up of a 1970 census population. For all causes the SMR based on 700 deaths was 102, 111 ($p < 0.01$) or 104 corresponding to the three reference populations respectively. For lung cancer the SMR was not significantly raised in any of the three analyses: 115, 117 or 103 (based on 74 deaths). For non-malignant respiratory disease there were 66 deaths giving SMRs of 157, 205 or 180 (all significant, $p < 0.01$). There were 17 deaths from silicosis and even excluding these cases left significant non-malignant respiratory disease SMRs relative to the two economically active referent populations. They also reported a moderate excess of "urogenital cancer" with SMRs of 130, 132, 131 respectively (36 cases, not significant). For all causes, lung and urogenital cancers and non-malignant respiratory disease, the excess was highest in the long employment group (>24.5 years). Job categories were assigned low, medium or high exposure potentials for PAH, dust and carbon monoxide. Cumulative employment in the higher of these categories was not linked to lung and urogenital cancer (pooled together) but the SMRs for non-malignant respiratory disease were highest in the longest employment category for each of these three exposure indices. Within the cohort there were 163 foundry workers with silicosis, though the exact definition they used was not given. Among this group, 8 lung cancers occurred versus 4.5 expected, a non-significant excess. The SMR based on these 8 deaths is 178, quite close to the SMR of 159 among the long employed (24.5 years) group, suggesting that as one would expect, the silicotics are among those with the highest dust exposure.

In 1957, a cross-sectional sample of men in Stavely was identified and Cochrane et al (1980a, 1980b) reported some data on their mortality over the following 20 years. Two age groups were considered, 369 aged 25-34 and 386 aged 55-64 in 1957, and each population was divided into non-dusty, pure mining, pure foundry and "other and mixed". Mortality data were presented as the cumulative percentage who had died in each group. No expected deaths were calculated so that figures are quite difficult to interpret. As only 5.4% (total 20) of the younger cohort had died, only the older cohort is informative. The all cause percentage dead was similar between all four groups (71%, 66%, 71%, 72% respectively). Lung cancer was not presented but for all neoplasms the results were similar (19%, 15%, 17%, 17% respectively) and for non-malignant respiratory disease the foundry group was a little higher (13% 12%, 17%, 13% respectively).

2.8 Case control studies of lung cancer

Decoufle et al. (1977) reported a large retrospective study of cancer patients in a hospital in Buffalo, New York assessing occupation and smoking. The study included 6,434 white males admitted during 1956 to 1965. Relative risks were calculated by occupation and cancer site, the comparison being made with people who had always worked in clerical occupations. The occupational categories of relevance to this review were "furnacemen, smelters and pourers" and "moulders, metal". For furnacemen, the relative risks for those ever employed, those employed for at least 5 years and those employed at least 5 years (adjusted for smoking) were respectively, 1.62, 1.37, 1.34. For moulders the same set of relative risks were 1.60, 1.51, 1.91. None of these values was statistically significant, based as they were on 13 and 16 lung cancer cases respectively in the two ever employed categories. The effects of standardising for smoking made almost no difference to the furnacemen's risk, but the higher (smoking standardised) risk for moulders suggests that they smoked less than the office worker comparison group.

Blot et al (1983) carried out a case control study in two counties in an industrialised area of Eastern Pennsylvania, USA. They identified 360 lung cancer deaths during 1974-77 and selected 360 controls matched on sex, race, age and county from deaths other than from lung cancer, chronic respiratory disease and suicide. Three hundred and forty five cases and 340 controls were interviewed and the data were analysed by usual industry and job category. The steel industry gave the only significant result (OR = 2.2, $p<0.001$, 80 exposed cases). The OR fell to 1.9 after adjusting for smoking and other employment. Within the steel industry the highest odds ratio was for foundry workers/coremakers: 7.1 ($p < 0.05$, 6 cases, 1 referent). This estimate is based on small numbers and has a wide 95% confidence interval (1.2-42.3). The risk was elevated in virtually every job in the steel industry, though non-significantly in most cases.

A case control study conducted in Vienna of 1,580 lung cancer patients, each with two controls, enabled both smoking and occupation to be evaluated (Kunze, 1982). Amongst the 1,580 cases were 197 categorised as "obtaining and working metal", broader than foundrywork, but including foundryworkers. The effect of smoking was pronounced with a relative risk of 8.7 for smokers against non-smokers. However detailed knowledge of the smoking histories enabled smoking to be taken into account when looking at the effect of occupation. A comparison group of "white collar" workers was chosen and compared with the "metal" group. Standardised for age and cigarette consumption (including tar content), the relative risk for lung cancer was 1.5 for the "metal" group compared to the white collar group ($p < 0.10$). There was no clear pattern with length of employment. There was no significant difference in the percentage of smokers amongst the cases drawn from these two occupational groups.

2.9 Occupational mortality data

Turner and Grace (1938) reported their analysis of all deaths among males over 14 years in the Sheffield area during the period

1926-1935. Steel foundry, furnace and blacksmith worker's mortality was compared with professional men in the same area and found to be 89% higher for cancers (158 observed, 402 expected). This was the highest for the various occupational groups considered. For respiratory cancer, there were 126 observed, 54 expected deaths and for stomach cancer, 162 against 81. These excesses derive in part from using a higher social class referent population, which would give relatively low expected deaths for most manual jobs.

Post mortem studies by McLaughlin et al (1950) and McLaughlin and Harding (1956) of 64 and 65 foundryworkers respectively (who had largely died of pneumoconiosis) revealed 4.7% and 15.5% prevalences of lung cancer, respectively. McLaughlin and Harding considered the latter figures "notably higher than the general population of a similar age" and suggested that iron or iron oxide could be a cause for the excess of lung cancer.

Swanston (1950) reported the high mortality for foundry workers reported in the Decennial Supplement on occupational mortality in England and Wales around the 1931 census. Lung cancer mortality was elevated for furnacemen, rollers and skilled assistants (SMR 160, 16 observed deaths); metal moulders and die casters (SMR 193); and iron foundry furnacemen and labourers (SMR 188, 15 deaths). These results were consistent with those of later Registrar General's reports. Morrison (1957) analysed the report of the Registrar General of Scotland for 1949-1953 and reported an SMR of 162 for "moulder"s and 161 for foundry labourers. These two ranked third and fifth respectively in terms of lung cancer SMRs among the occupations considered.

Table 2.6

Mortality from various causes reported in Decennial Supplements of the Censuses of 1951, 1961 and 1971 (* $p<0.05$, ** $p<0.01$, *** $p<0.001$)

Cause of Death	Year of Census 1951 SMR (obs)	1961 SMR (obs)	1971 SMR (obs)
Moulders and Coremakers			
Lung cancer	149*** (186)	160*** (300)	184*** (155)
Stomach cancer	123 (75)	104 (59)	123 (25)
Chronic bronchitis	194*** (200)	186*** (203)	241*** (95)
Pneumoconiosis	200* (12)	480*** (24)	538** (6)
Fettlers (1961 and 1971 only)			
Lung cancer		140*** (134)	129* (70)
Stomach cancer		124 (36)	161 (21)
Chronic bronchitis		126 (72)	164** (42)
Pneumoconiosis		967*** (29)	138 (1)

Table 2.6 summarises the data from the England and Wales decennial supplements of 1951, 1961 and 1971 (Registrar General, 1958; Registrar General, 1971; OPCS, 1978). Deaths are classified by entries in death certificates and expected deaths are calculated from the size of the same occupational category enumerated at the census. For both moulders and coremakers, and to a lesser extent fettlers, the lung cancer SMR is raised. Stomach cancer is only

raised for the fettlers and non-malignant respiratory disease is raised to a more significant degree for moulders. Pneumoconiosis, though the numbers are quite small, has clearly been a problem in both groups. For the 1971 census report, when lung cancer SMRs were standardised for social class the SMR for the moulders was still high (157), and that for fettlers reduced to expectation (105).

Dubrow and Wegman (1983, 1984) carried out an analysis of deaths in Massachusetts during the years 1971-1973. The small number (3 percent) of non-whites was omitted from the analysis, leaving 34879 deaths among white males aged at least 20 for analysis. Occupational categories from the death certificate were categorised into 397 categories. Mortality Odds Ratios (MORs) were calculated, with the referent causes of death being all other causes except cancers and cirrhosis of the liver. The MOR is an age standardised ratio of the exposure odds among the cases versus these referent causes of death. Among the 154 deaths among "foundry workers", there were significant excess MORs of 183 from cancer of the large intestine and rectum based on 18 cases and 663 from tongue cancer based on 4 cases. The MOR of 139 (26 cases) from respiratory system cancer was not statistically significant, and was 126 after adjusting for social class in the analysis. For stomach cancer the MOR was 106 based on 4 cases. By more specific category, respiratory cancer MORS were 146 (17/12) for metal moulders, 164 (5/3) for furnacemen, smeltermen and pourers and 12 (9 cases) for foundry workers not elsewhere classified.

Milham (1976a, 1976b) presented the results of a proportional mortality study of about 300,000 deaths in Washington State during the years 1950-1971. Both cause of death and occupational category came from death certificates and the only relevant category was metal moulders with a respiratory cancer PMR of 135 (12 cases), stomach cancer 166 (11 cases), silicosis 7 cases against less than 0.5 expected and tuberculosis 6 against 2 expected. Petersen and Milham (1980), in a similar analysis of deaths in California over the years 1959-1961, reported a two-fold excess for metal moulders based on deaths from lung cancer. This compared to 13 observed and 8 expected during the equivalent years in the Washington State dataset.

Guralnick (1963) published an occupational mortality analysis for the entire United States, of deaths during 1950 taking occupational codes from death certifiates, and computing SMRs based on the 1950 census population. The total number of deaths was 327,271 in the age range 20-64. For metal molders the lung cancer SMR was 227 ($p < 0.05$, based on 34 deaths), 500 for respiratory disease other than influenza and pneumonia ($p < 0.05$, based on 30 cases), 304 for tuberculosis ($p < 0.05$, 76 cases). No SMR was given for stomach cancer because of small numbers.

Walrath et al (1985) reported the follow-up of 293,958 white men who held active US Government life insurance policies in January 1954. in 1954 and 1957 questionnaires were administered and 84% replied giving information on occupation and smoking habits, thus smoking-specific mortality ratios could be calculated for specific occupational and industry categories, relative to the total cohort. There were in total 107,563 deaths at the end of follow-up in 1970. Most of the cohort were World War I Veterans, mainly white collar or skilled workers. Among 62 metal moulders there were no lung cancer deaths, 0.6 expected, although there was an excess of cardiovascular disease mortality (17/12.0). Among 53 furnacemen, smeltermen and pourers, there was one lung cancer, 0.7 expected, and an excess of cardiovascular mortality (14/8.9). The cohort was also analysed by industry and for the 387 men employed in "other primary iron and steel industries", which includes ferrous foundries, there were 5 lung cancer deaths (6.6 expected), 2 stomach cancer, (1.6 expected) and 11 non malignant respiratory disease (6.4 expected). The cardiovascular disease SMR was 111 based on 94 cases.

2.10 Lung cancer among silicotics

As discussed in the section on respiratory morbidity, a number of jobs in foundries have been associated with an increased risk of fibrosis, variously labelled as pneumoconiosis, silicosis, mixed dust pneumoconiosis or foundry workers' pneumoconiosis. This is defined mainly in terms of X-ray changes but as it is a compensatable disease there is a possibility that a population of "silicotics" (i.e. those registered and receiving some compensation or pension) may be biased towards those with manifest symptoms of respiratory ill health. This would be because either these individuals are most likely to submit an application for compensation if the scheme is not based entirely on routine screening, or because the certifying medical officer takes such symptoms into account when diagnosing pneumoconiosis. Silicosis is primarily an indication of high cumulative silica exposure but for the reasons just stated a population of silicotics may be biased towards those with other respiratory diseases caused by for example occupational exposures to upper respiratory irritants or smoking. In foundries there are several upper respiratory tract irritants including formaldehyde, furfuryl alcohol, pyrolysis fumes and metal oxide fumes. A number of studies have been published recently on the follow-up of silicotic populations and a few of these provide data on lung cancer risk among silicotic foundry workers.

Two mechanised iron foundries in the UK were included in a survey of pneumoconiosis during 1957 and 1958 (HSE 1977). The 235 individuals with pneumoconiosis categories 1 and 2 were followed up for 10 years. Twenty-three were lost to follow up and among the remaining 212, there were 36 deaths versus 27.6 expected based on national rates, an SMR of 130. The SMR was virtually identical in both pneumoconiosis categories 1 and 2. No details on cause specific mortality were given.

Kurppa et al (1986) followed up mortality among 961 diagnosed silicotics in Finland. This represents all silicotics diagnosed from 1935-1977 except 80 who emigrated and 86 with substantial missing data. The population was followed up to 1982 and the all cause SMR was 199, a highly significant excess based on 667 deaths. The SMR for all respiratory diseases, was 704 (165/23.4). For lung cancer there were 80 deaths against 25.6 expected (SMR = 312, 99% CI 230-414). For "steel casting foundries" the SMR was 184 (7/3.8) and for iron foundries it was 225 (11/4.9, $p < 0.05$). By date of entry the risk was higher in the earlier entrants. For iron and steel combined, the lung cancer SMR for entrants 1935-59 was 265 (11/4.2, $p < 0.01$), and for 1960-77 the SMR was 154 (7/4.6, NS).

Westerholm et al (1986) described a follow-up of cases of silicosis diagnosed in Sweden from 1959 to 1977. These comprised 248 cases from mining and quarrying, 428 cases from iron and steel foundries. Non-silicotic controls were taken from the "silica register" of exposed persons, matched to cases on age and date of first silica exposure and occupational category. Each control required a minimum of 5 years exposure to silica. For each of the two groups of silicotics, SMRs relative to the general population and relative risks vis-a-vis the control group were calculated. The overall SMRs did not differ significantly from 100 for either silicotics or controls. For lung cancer mortality among the foundry silicotics, the SMR was 385.

Schuler and Ruttner (1986) analysed lung cancer risks among 2399 deaths of silicotics in Switzerland. A further 60 cases had been excluded because the silicosis was not confirmed at autopsy. Most of these were in mining, tunnelling and quarrying, but there were some foundry workers too (exact numbers were not stated). These cases represent all deaths between 1960 and 1978. PMRs and MORs were calculated. The MORs used all non-pulmonary cancers as referent causes of death. Ratios were also calculated based on any mention of lung cancer on death certificates, but the data summarised here are only those with lung cancer coded as the underlying cause. 40% of the deaths were from non-malignant respiratory disease. Among the lung cancer cases tuberculosis was present in 37% of the miners and 10% of the foundry workers. For all silicotics there were 157 deaths from lung cancer giving a PMR of 85 but a MOR of 241 (p<0.001), a better estimate of risk given the high overall mortality as reported in other silicotic cohorts. For the foundry worker subgroup the PMR was 130 (not significant) and the MOR 392 ($p<0.001$), the highest for all the subpopulations. The authors reported a survey of living silicotics in the 1980s in which the percentage of never smokers does not exceed 10 to 15%. However, they consider that such an excess of smokers would be insufficient to explain the excess risks found.

Puntoni et al (1985) carried out a proportional mortality analysis of 746 deaths among workers compensated for silicosis in the Piedmont region of Italy. Overall the lung cancer PMR was 136 ($p<0.05$, 81 cases) but was 159 (56/35.2, $p<0.05$) for the 457 silicotic foundry workers. There were no data on smoking but as in the previously cited study, given the probably high overall mortality, the PMR understates the risk as measured by for example the SMR.

The relative risks for lung cancer (1.3, 1.8, 2.3, 3.9, 3.9 and 1.6) in the above studies of silicotic foundry workers are of the same order of magnitude as several other studies of silicotics, as follows. An SMR of 302 among 276 silicotics exposed as ceramic, granite, silica brick, quarry and foundry workers in Ontario (Finkelstein et al 1986). An odds ratio of 3.16 for silicotic granite workers in the US (Steenland and Beaumont, 1986). A smoking adjusted odds ratio of 3.8 among silicotic ceramic workers in Italy (Forastiere et al, 1986). A relative risk of 1.4 among all Austrian silicotics (Neuberger et al, 1986). A Standardised Incidence Ratio of 300 among 331 Finnish silicotics (Gudbersson et al, 1984).

2.11 Lung cancer mortality adjacent to foundries

Lloyd and coworkers have published a series of papers on lung cancer mortality in two small Scottish towns attributing excess mortality to pollution from the foundries. In the first short report (Lloyd, 1978), a "dramatic increase" in lung cancer mortality was reported in Armadale for the years 1968-1974. There were 53 lung cancer deaths, with only 10 in the preceding 7 years, however expected deaths were not calculated for these two periods. Much of the excess was derived from an area south-west of the foundry where 15 of the cases lived. Overall nearly a third of the male deaths had been either non-smokers or light smokers (less than 5 cigarettes per day) so the author considered that smoking did not explain the excess. Air pollution was measured and found to be highest in the area south-east of the foundry for pollution from Iron, Manganese, Zinc and Nickel. But there was no excess cluster in that area. The author suggested that during anti-cyclonic weather, the area where the cluster occurred would then receive pollution from the foundry.

The data were subsequently updated and presented in more detail with SMRs being calculated (Lloyd et al, 1985a). However it suffers from the same problems of trying to discern patterns based on small numbers. The lung cancer excess now calculated for 1968-1975 turned out to be an SMR of only 131 (based on 53 cases), which fell to an SMR of 86 during the period 1976-1982. The authors claimed a correlation between lung cancer mortality by area during 1968-1975 and levels of airborne iron, manganese and chromium measured in 1981-1982. Their data, however, contradict this assertion. The highest pollution was in an area close to the foundry to the north and east (correctly reflecting the prevailing south-westerly winds) but the only two areas with any excess mortality were to the west (SMR = 212 based on 16 cases) and to the northwest and fairly distant (SMR = 157, based on 12 cases). The lung cancer SMRs plotted on an annual basis appear to fluctuate fairly constantly between 1951 to 1973 (Lloyd et al, 1985b) not really bearing out their allegation of an "epidemic" in the late 1960s.

Bathgate is another town four miles from Armadale with two ferrous foundries and Lloyd et al (1985c) conducted a similar analysis of mortality and atmospheric pollution. Lung cancer SMRs were close to or less than 100 except for a few years around 1965 when they rose to approximately 120, and in the area judged by them to be most polluted, the SMR was 134 based on 23 deaths. In the part of town classified as less polluted the SMR was 100 (based on 58 deaths). They report that there was no cluster during the preceding years (1960-1965) but give no SMR for this period.

While the apparent parallel rise in the two towns is remarkable, both sets of data are based on very small numbers and the authors appear so eager to show causality between foundry pollution that their inferences appear to exceed the results they themselves present. While such pollution may contribute to an excess risk of lung cancer (Stocks, 1960), given the lack of control of either occupational or smoking related exposures, the lack of historical data on exposure and inconsistency of the excess, their case for a causal relationship is rather weak. If it is such a polluted area as they claim, then the people who will live there will tend to be those who cannot afford to live elsewhere and thus ill health identified as being generally associated with poverty will be confounded with the specific pollution discussed in these papers. There is a strong social class gradient for lung cancer mortality (OPCS, 1978).

In response to the first publication (Lloyd, 1978), the Health and Safety Executive carried out a survey of lung cancer mortality in local authority areas containing steel foundries in England, Wales and Scotland (Werner, 1980). It was carried out as a rapid screening exercise and the crude proportional mortality from lung cancer was presented, standardised by neither age nor sex. They noted the increase in the percentage of lung cancer deaths in Armadale. The percentage rose from 3.7% in 1963-67 to 7.5% in 1973-77, an increase of 103%. This was larger than the equivalent increase in any other local authority area. What is perhaps most impressive is the consistently high proportion of lung cancer deaths in all the areas. The percentage of lung cancer deaths in England and Wales is given as 5.6% during 1973-76. Out of the 75 local authority areas with steel foundries in England and Wales, only three had a percentage less than that and 49 had a percentage more than 1.5 times larger. Assuming that this is not an artefact due to the lack of sex and age standardisation, there is a consistent excess although given the same lack of control of confounding factors as those discussed above in the context of the Lloyd studies, the role of pollution from the steel foundries cannot be evaluated.

2.12 Pneumoconiosis - Introduction

Silicosis has long been recognised as a risk for those in fettling occupations in foundries (Hunter, 1969). Dust, its measurement particularly for silica content, and the means of dust control have been major items of discussion in Joint Standing Committee Reports for the various sectors of the foundry industry. However, the definitions of silicosis and pneumoconiosis vary between authors. Therefore silicosis and pneumoconiosis are defined below and then considered as a disease of foundrywork.

Apart from certain of the smallest divisions, the bronchial passages are lined with a layer of mucus carried upwards and hence outwards by ciliated cells. This "ciliary escalator" serves to remove the largest of the inhaled particles. But those below about 7 microns (um) escape deposition and penetrate to the respiratory bronchioles and alveoli. Mobile scavenging cells, macrophages, are part of the defensive processes by which particles are cleared by, for example, the ciliary escalator or the lymphatic system. However this defence system may not be adequate: if the dust particles are too numerous it may be overwhelmed so that the dust and macrophages accumulate. In the case of dusts which are toxic to macrophages, as is the case with quartz or crystobalite, then the dying macrophages stimulate fibrosis, which results in distortion and later destruction of the alveolar architecture, which may in turn give rise to emphysema.

Dusts are classified as producing either a non-fibrogenic (e.g. iron oxide or alumina) or fibrogenic response (e.g. quartz or asbestos). The term "pneumoconiosis" is sometimes taken to mean both kinds of response, sometimes just the latter, "fibrotic" form. The International Labour Office whose system of X-ray categorisation of pneumoconiosis has been widely adopted, currently defines pneumoconiosis very broadly as the "accumulation of dust in the lungs and tissue reactions to its presence." It also sets out criteria for distinguishing the fibrotic and non-fibrotic types of reaction (ILO, 1983). In the ILO scheme silicosis is a fibrosis, in localised nodules scattered throughout the lungs and caused by silica dust.

As the fibrosis develops, nodules form, about 1-3 mm in diameter. The next stage is that of large amorphous masses of fibrosis, termed progressive massive fibrosis (PMF) because the development of these areas of fibrotic tissue, greater than 1 cm across, may continue after removal from the dust. This is also termed "complicated", as opposed to the "simple" pneumoconiosis in which there is minimal fibrosis. The early stages of fibrosis are usually asymptomatic. Diagnosis rests entirely on radiological evidence and occupational history. Further development leads to progressive exertional dyspnoea. Fibrosis is associated with the risk of further complications: emphysema, tuberculosis and other pulmonary infections. The immediate cause of death for many fibrotics is heart failure. Although some systems, including earlier versions of the ILO categorisation were based on both symptoms and radiographic evidence, the basic categorisation of pneumoconiosis is now radiographic. The 1958 ILO system was purely on X-ray categorisation, coded for linear, small or large opacities, as follows:

L	linear or recticular opacities
1,2,3	increasing number of nodules
A,B,C	increasing size and number of large opacities

The presence or absence of reticulation was found to be difficult to establish in a standardised manner and later it was dropped from the pneumoconiosis classification. Under the auspices of the National Coal Board (Liddel et al 1969), a system of dividing the categories 1,2,3 into 3 subdivisions was established, giving the categories 0/- 0/0 0/1; 1/0 1/1 1/2; 2/1 2/2 2/3; 3/2 3/3 3/4. The system was incorporated into the most recent International Classification (1968) which omits reticulation. Both the 1958 and 1968 systems have a set of symbols for other characteristics of the X-ray picture: shape and size of small opacities, definition of large opacities, emphysema, calcification etc.

All the studies carried out in UK and reviewed below used micronodulation as a minimum criterion of silicosis except McLaughlin et al (1950) and CIFA (1960) who both included reticulation, and Gardner (1954) and the British Steel Founders Association (BSFA) who referred to "X-ray changes consistent with pneumoconiosis" and "silicosis" respectively. At the time of those surveys, reticulation was within the definition of pneumoconiosis, and so it is likely that their prevalence figures included it. However, to be certified for compensation by the Pneumoconiosis Panel, category 2 was normally required.

McLaughlin et al (1950) found no clear relation between pneumoconiosis and cough. Dyspnoea prevalence was higher in the dustier work of fettling, but not considered a "reliable guide to the presence or absence of silicosis". Men with nodulation or massive shadows were usually but not always disabled, and only small proportions of those with reticulation had any disability. The Council of Iron Foundries Associations Survey reported an association between breathlessness and pneumoconiosis category (CIFA, 1960). Gregory (1970) showed over 3 times the prevalence of chronic bronchitis among pneumoconiosis cases compared with the rest, for a population of foundryworkers. A more recent survey found no relation between pneumoconiosis category and lung function (HSE, 1977). Of the two companies investigated in the survey, the workers in one showed an <u>improvement</u> in lung function (FEV and FVC) on average, with increased pneumoconiosis category. In the other, no change occurred with increase in pneumoconiosis category. Three studies of miners have reported positive associations between pneumoconiosis category and respiratory symptoms (Ashford et al, 1970; Rae et al, 1971; Rogan et al, 1973).

2.13 <u>Pneumoconiosis Surveys in the UK</u>

In their 1947 Report, the Joint Advisory Committee on Conditions in Ironfoundries concluded that silicosis was restricted to dressing shop workers, and moulders who were exposed to the dust from siliceous parting powders (Ministry of Labour, 1947). However, a significant number of surveys published before that date had already shown that the risk was present in other occupations.

McLaughlin et al (1950) reviewed the world literature published on foundryworkers' respiratory health up to 1950. Most of the studies presented a figure for the prevalence of "silicosis" or "fibrosis". These surveys were from a wide range of countries and showed fettlers and other metal dressers to be worst affected - up to 66% with silicosis in the German study published in 1933. Moulders and furnace bricklayers suffered up to 30% prevalence. For foundryworkers as a whole prevalences were mainly observed in the range 2 to 10% with a few prevalences above this range. Occupations identified as being at risk were: moulders, fettlers, furnace bricklayers, knockout labourers, labourers, welders, maintenance, smiths and inspectors.

Mclaughlin et al (1950) carried out a survey in 1943 of iron and steel foundryworkers. Nearly three thousand foundrymen in 19 iron and steel foundries were given a radiological and clinical examination. This study remains one of the largest single X-ray surveys of foundryworkers ever carried out. For the study the following X-ray classification scheme was used:

Category I Normal

Category II Early reticulation

Category III Reticulation

Category IV Nodulation and/or massive shadows

According to the authors, categories III and IV roughly corresponded to "silicosis". Reticulation described a network covering the lungs which did not appear to be made of nodules. The results are shown in Table 2.7.

Table 2.7

Percentage prevalence of X-ray changes by type of foundry

Foundry type	Percentage in each X-ray category I	II	III	IV	Number of workers
Iron	76	18	6	1	911
Steel	62	19	16	3	1120
Mixed Iron and Steel	80	14	6	1	736
Total	71	17	10	2	2767

(Source: McLaughlin et al, 1950)

Overall, the prevalence was 12% "silicosis" with the steel foundries prevalence nearly three times that for iron foundries. Taking account of age and length of exposure, the most marked radiographic changes were shown to occur in all occupations in steel fettling shops, especially amongst fettlers, welders and shot blasters. Slightly lower figures were found for the corresponding occupations in iron and mixed iron and steel foundries. Marked radiographic changes were found in all occupations in steel moulding shops and less often in the other foundries, though again small numbers were involved. Pattern and coreshop workers, maintenance and administrative workers showed only slight X-ray changes. Totals for categories III and IV for some occupational groups are shown in Table 2.8.

Table 2.8

Percentage prevalence of silicosis (Categories III and IV) by occupational group and foundry type.

	Foundry Type		
Occupational	Iron	Steel	Mixed
Moulding shop	7	13	8
Fettling shop	12	34	13
Other workers	1	4	1

(Source: McLaughlin et al, 1950)

Most later papers did not include reticulation in their definitions of silicosis, but, Mclaughlin's category III included cases of "reticulo-nodulation", an intermediate state, some of which might have been categorised later as micronodulation. Later improvements in radiological techniques suggest that radiological reticulation is really made up of small nodules (Muir,1974). As part of the same study, a pathological study of the lungs of 64 foundryworkers revealed that four fifths of them had nodular silicosis and one third had "massive silicosis" (equivalent to PMF). In 1953 workers in several iron foundries were surveyed (Gardner, 1954). Each foundry employed between 87 and 158 foundryworkers and 200 workers were surveyed in Stavely and West Bromwich. Prevalences were found of "X-ray changes consistent with pneumoconiosis" among 6.5% in Stavely and 14% in West Bromwich. These figures closely agreed with numbers receiving Disablement Benefit: 4.9% and 14% respectively. Moulders were disproportionately represented in the pneumoconiosis sufferers in the four West Bromwich foundries, and they also retired at a younger age than the moulders in the Stavely foundries.

A survey by the British Steel founders Association (BSFA) was started in 1950 and some of their results were published in the 1961 report of the Joint Standing Committee on Conditions in Steel foundries (Ministry of Labour 1961). The survey of about 77% of the workers in about half of the BSFA member firms showed a 5.1% prevalence of silicosis. Over the 5 year period of the survey the incidence was estimated as 5 per 10,000 per year.

Gregory (1970) reported a survey conducted from 1950 to 1960 in a Sheffield steel foundry. Pneumoconiosis was diagnosed by the presence, on X-ray, of nodulation or large opacities. This was observed in 17.6% of the welders and burners, in whom the X-ray picture was termed siderosis because the disease was asymptomatic. The silicosis prevalence in other occupations was 6.4% in the whole foundry, varying from 2% in the main foundry to 14.7% in the fettling and grinding shops (ex coalminers were excluded from these data). Out of the 90 foundrymen in the survey with pneumoconiosis, 25 had progressive massive fibrosis, a higher proportion (28%) than in other surveys.

McBain et al (1962) reported the results of an X-ray survey of approximately 5800 workers, 98% of the workforce of a group of iron and light alloy foundries. The prevalences of pneumoconiosis amongst men exposed to dust in the iron foundries was 4.8% and slightly lower in the non-ferrous foundry workers. No cases of complicated pneumoconiosis were observed in this study but the prevalence in the non-ferrous foundries was higher than in the previous surveys mentioned in this review. An important finding by

McBain was that iron moulders showed a significant prevalence of pneumoconiosis amongst those with less than 10 years experience. These workers had been moulders only since the Parting Materials Regulations 1950 banned the use of siliceous parting powders, up till then widely considered the cause of silicosis in moulders.

The Council of Iron Foundries Associations conducted in 1958 a survey of the prevalence of pneumoconiosis in small and non-mechanised iron foundries (CIFA, 1960). Workers at 44 foundries, each employing 26-75 foundrymen, were selected, and 88% (1437 workers) were X-rayed. CIFA categorised the X-rays in a manner apparently similar to that used by McLaughlin et al (1950). Although there were very few cases of PMF, there was a high prevalence of pneumoconiosis, with 52% category 1, 20% Category 2 and 3% Category 3+A+B. There was an approximate correspondence with ILO categories, except that Category 1 corresponded to ILO categories 1 + Z + L (Z and L are increased linear and reticular lung markings). The prevalence of at least category 2 pneumoconiosis was overall 22.5% and 30% for fettling and blasting operations, and present in all occupational categories.

The first representative survey of foundryworkers lung disease was carried out in 1964-5 by the Medical Branch of HM Factory Inspectorate (Lloyd Davies, 1971). The study population was a 1 in 40 sample of a random sample of foundries, stratified to proportionally represent the region, size of foundry and type of metal product. Only men aged from 35 to 64 were examined. A comparable population of engineering workers from proximate factories (owned by the same employer if possible) was selected.

The response rate was about 93% of each population, giving about 1800 in each sample. Fettlers (384) were assessed separately from the rest of the foundry floor workers (1396). X-rays for those with no other dust experience were categorised according to the 1958 ILO classification, and the results are shown in Table 2.9. "Fettler" covers the various fettling and dressing shop occupations. "Foundry floor" represents the total non-fettling manual occuptions.

Table 2.9

Percentage prevalence of X-ray results by work area

Work area	X-ray results ILO Category				
	1	2	3	≥1	R
Foundry floor	12.4	1.3	0.3	14.1	19.4
Fettlers	22.9	11.2	0.6	34.6	19.6

(Source: Lloyd Davis, 1971)

R represents dust retention to a degree less than category 1, i.e. increased lung marking insufficient to be described as reticulation. Categorisation was somewhat uncertain because the X-ray readers had difficulty in assigning categories 1 and R, and distinguishing between them. Data were broken down into the foundry groups: iron, steel, non-ferrous and mixed. For foundry floor workers iron and mixed foundries showed the average prevalence as in Table 2.9, non-ferrous slightly less and steel approximately double the average. Fettlers of different metal groups suffered about the same prevalences except for non-ferrous, which had no cases of category 1 or more, out of 12 fettlers. However, in both groups, the numbers of steel and non-ferrous workers with nodulation were small. Overall the prevalence for foundrymen of category 1 or more was 18.5%. The number of workers in each X-ray category was estimated for the national population of foundry workers, giving estimates of 1648 foundry floor and 3341 fettlers with category 2 and above. The 95% confidence interval of the total was 2524 to 7767.

Nickol (1977) summarised two studies of X-rays performed in the Thames foundry in the Ford Motor Company. Overall, the percentage of ironfoundry workers with at least X-ray category 1 fell from 12% in 1964-6 to 3% in 1970-3. Over the same period, the foundry population increased by 56% while workers with X-ray abnormalities fell in number from 380 to 148 over the period, a figure which suggests that the dramatic reduction was achieved by some form of health selection.

All surveys reviewed have been point prevalence studies and this may underestimate the true burden of silicosis. This problem was discussed in the third report of the Sub-Committee on Dust and Fume of the Joint Standing Committee on Health Safety and Welfare in Foundries (Health and Safety Executive, 1977): "Prevalence figures are to be regarded with caution because, particularly in the mechanised section of the industry, there may be more interchange between jobs and more recruiting from other industries than is generally realised."

The latter report included a study of progression of X-ray abnormality between two surveys in 1958 and 1968, amongst the foundryworkers in the survey of McBain et al (1962). Of a population of 2076 iron foundryworkers in two companies in 1958, 238 had X-rays of category 1 or more. By 1968, 40 of these had died (17% of the sample) and 22 more had moved, refused to be examined, or the X-rays for 1958 were unavailable. 178 remained and took part in the 1968 survey. Table 2.10 below shows the mean progression rate for a variety of occupational groups. The progression rate is the proportion of an X-ray category covered in the 10 years. X-rays were read side by side (1958 and 1968 X-rays for each person) and separately (in random order). These two methods gave slightly different results; the figures below are the mean of the two assessments. Only men who had stayed in one job category for the whole ten years are included in each category, and thus those who remained are a fairly selected survivor population.

Table 2.10

Mean progression rates of X-ray category by occupational group.

Figures in brackets are the number of men used to derive the rates.

Occupation	Rate (X-ray category per 10 years)
Knock-out	0.63 (2)
Furnace	0.59 (8)
Fettler	0.44 (24)
Maintenance	0.38 (8)
Other foundry	0.27 (8)
Core shop	0.26 (33)
Moulder	0.24 (17)
Other fettling	0.23 (12)
Sand worker	0.17 (4)

(Source: McBain et al, 1962)

Nevertheless, progression was observed in jobs where dust control methods were in use, which the authors pointed out, might have indicated that the protection was less effective than anticipated, or that dangerous dust is moving into the breathing zone from adjacent dustier areas. Progression was also observed in those specifically engaged in dust producing occupations and amongst those who retired early in the survey period but the numbers were small in both cases.

Gregory (1970) reported progression of all the men with more advanced X-ray changes and about half of those with little or no nodulation when they left the dusty job. This is consistent with current theories of silicosis etiology. Silica is believed to poison macrophages causing their autolysis. Autolysis products then kill further macrophages and so the process continues to some extent, once initiated. This is believed to occur for nodulation as well as the later Progressive Massive Fibrosis. There was limited evidence of progressing simple pneumoconiosis: the rate of progression rose with X-ray category (average of two surveys) but only if the X-rays were read side-by-side. If read separately no such effect was observed. The authors concluded that: "It is quite certain that 'disabling' pneumoconiosis is a comparatively rare condition in the mechanised iron foundries concerned but the indications are that its occasional occurrence may still be expected in the conditions obtained during the period under review." At the time of the second survey, 75 out of 176 were also registered as disabled.

Varying definitions make comparisons of the earlier surveys difficult, and the only possible bases for comparison are the prevalences of what the respective authors termed pneumoconiosis. These are as follows: McLaughlin et al reported 12% (7% and 19% for iron and steel respectively); the BSFA reported 5.1% in steel foundries; Gregory reported 6.4% in a large steel foundry; McBain reported 4.8% and 3.4% for non-previously dust exposed in iron and non-ferrous foundries respectively; Gardner reported 14% and 6.5% for medium sized iron foundries in two different regions and finally the CIFA reported 22.5% in small non-mechanised iron foundries. Workers in larger iron foundries appear to run much less risk of pneumoconiosis than the smaller ones.

Two substantial surveys have been published describing pneumoconiosis in the 1960s. One, a representative sample of those not otherwise dust-exposed, estimated the prevalence of pneumoconiosis category 1 or more as 34.6% of fettlers and 14.1% of other foundry workers (18.5% for both groups combined). The other, within a group of mechanised iron foundries, estimated the progression rate as about one third of an X-ray category for those with at least category 1 to begin with, over a ten year period. The worst affected occupations progressed about half an X-ray category on average over the 10 years (knock-out, furnace men, and fettlers).

Lloyd Davies estimated that approximately 5000 foundryworkers (between 2525 and 7767 at 95% confidence limits) were potentially eligible for industrial injury benefit for pneumoconiosis. These were all currently employed as foundrymen in 1964-5. Benefit was awarded to pneumoconiotic foundry workers from 1956. The cumulative total of foundry workers and dressers in ferrous foundries awarded disability benefit for pneumoconiosis from 1956-1964 is 1750 workers, (a proportion of whom will have died or retired by 1964), well below the estimates of Lloyd Davies (Department of Energy 1963 et seq.).

One survey illustrated the discrepancy between diagnosis and receiving awards (CIFA 1960). Among 65 foundry workers with category 3 or PMF plus those in category 2 with symptoms of disability, letters were sent to their doctors, recommending clinical examinations. Of the 50 who reported to their doctors, 35 were diagnosed after referral as suffering from pneumoconiosis. However, only 19 were submitted to the pneumoconiosis panel and awards were made to 10 of them.

2.14 Respiratory morbidity

Chronic bronchitis is defined in various ways by different authors. Some consider only the presence of cough and sputum, and others have included a history of chest disease, still others made the presence of breathlessness essential. Diagnosis based on the results of the respiratory symptoms questionnaire developed by the Medical Research Council (1960), normally uses the MRC (1965) classification of chronic bronchitis. In outline this has four grades:

Grade 0	No symptoms, less than Grade 1
Grade 1	Cough and phlegm on most days for at least 3 months of at least one year and less than Grade 2.
Grade 2	As Grade 1, <u>plus</u> A history of chest illness keeping subject off work for more than one week in three years and less than Grade 3.
Grade 3	As Grade 2 <u>plus</u> symptoms of breathlessness on moderate exertion (walking on level ground).

Most of the authors quoted here do not grade chronic bronchitis but they each use a definiton that corresponds to one of the above grades. So because different definitions are used, not all the studies are exactly comparable.

As well as diagnosing bronchitis using the subjects' own assessment of cough, sputum production, breathlessness etc., lung function tests can be performed to measure respiratory performance. From breathing hard into a spirometer, two parameters are normally obtained: the Forced Vital Capacity (FVC) or the total volume exhaled, and the Forced Expiratory Volume in one second (FEV_1). Frequently, the FEV_1 is taken as a percentage of FVC, and the result, the FEV%, is a measure of lung resistance, used as an indication of obstructive respiratory disease, a narrowing of bronchioles which increases the resistance to air flow and hence breathing difficulty.

Higgins (1960) reported chronic bronchitis morbidity among foundry workers. From Ministry of Pensions and National Insurance figures for absences from work in 1951, foundryworkers had 6.4 spells of absence (of at least 3 days) from work due to bronchitis per 100 men per year. This compared with the national average of 3.3 and a rate of 8.1 for miners. In a survey of Stavely foundryworkers, Higgins found no significant excess of bronchitis relative to controls. The author's definition of bronchitis was a fairly high index: "persistent sputum and at least one bronchitic chest illness during the past 3 years".

Keatinge et al (1959) compared a group of foundrymen with a control group of wagonbuilders. The foundryworkers showed an excess of bronchitis (20.6% as against 14.9%) but the numbers were small, and the wagon builders averaged twice the annual loss of time due to respiratory illness as compared with the foundrymen.

Lloyd Davies (1971) using the MRC questionnaire (1960) on respiratory symptoms, found no difference between foundry workers and an engineering worker reference group for chronic bronchitis, but reported differences in prevalence of the "sputum chest illness syndrome" - sputum for at least 3 months each year associated with one or more chest illness. Foundryworkers' prevalence was 10.5% compared with 7.2% for controls. But, some ex-foundry workers were in the control group so the difference may be slightly underestimated. There appears to be a dose response for foundry floor workers with 3.2% for 25-29 years exposure rising to 21.1% for

45-49 years exposure, almost twice the corresponding increase for those in the control factories. The same report also revealed effects on lung function - a more rapid decrease with age amongst foundryworkers, relative to controls.

Mikov (1974) in a survey of foundry workers in Yugoslavia, reported a prevalence of 31% chronic bronchitis relative to 10.3% in controls. FEV_1 and FVC were reduced in the foundryworkers relative to the controls, both as overall means, and as percentages substantially less than the normal expected value within each age group.

Karava et al (1976) in Finland found no association between lung function and dust exposure but both dust and smoking were associated with the prevalence of bronchitis amongst foundryworkers. Within non-smokers bronchitis was five times more prevalent for high versus low or medium dust exposure (not significant) and within smokers the rate ratio was 1.9 ($p < 0.01$).

Schoenberg and Mitchell (1975) investigated the effect of phenol and formaldehyde fumes from phenolic resin used as a sand-binder. Although the sample was quite small (63 altogether) chronic airway obstruction characterised by reduced FEV% was significantly more frequent relative to the non-exposed control population. Workers exposed to the fumes also suffered more frequent acute symptoms of cough, sputum production, mucous membrane and respiratory tract irritation, shortness of breath and wheezing/chest tightness. Their exposure was mainly well below the American Threshold Limit Values for phenol (5 ppm) and formaldehyde (2 ppm), except for occasional excursions up to 6 times the TLV, in the case of formaldehyde.

Cockcroft et al (1980) report a case of a foundryworker developing a severe asthma attack a few weeks after starting to work with furan binders. Repeating the exposure provoked the same response and withdrawal led to an abatement of symptoms, although symptoms recurred insidiously when he worked in another foundry, some distance from where furan binders were being used.

Low and Mitchell (1985) carried out a cross-sectional lung function survey in an Australian steel foundry using various binder systems, including furan, isocure, shell, carbon dioxide and oil sand. There was a significant drop in FEV but not FVC in a group of six workers on a semiautomated line, compared to aftercast workers, who themselves were exposed to fumes and dust. Respiratory symptoms were reported most frequently in connection with the shell process, then furan and isocure. Eleven workers had developed a wheeze while working in the foundry, but there was no unexposed comparison group (one out of 17 of the aftercast workers reported a wheeze). They cited a French study which showed an excess of chronic bronchitis and obstructive lung disease in a group of moulders using the Isocure process (polyurethane/MDI and phenol formaldehyde).

Johnson et al (1985) carried out a lung function survey of 78 workers in a Vancouver iron and steel foundry using Pepset binder (MDI, phenol formaldehyde and a pyridine derivative catalyst), with 372 railway workers acting as controls. Various symptoms were significantly more prevalent, including phlegm production, breathlessness and chest tightness. FEV_1, FVC and FEFR (forced expiratory volume in 1 sec., forced vital capacity and forced expiratory flow rate) were all significantly lower in the foundry worker group after adjusting for smoking habits and age.

2.15 Experimental data on foundry fume

No experimental studies of carcinogenicity of foundry fumes have been located. One study of the potential carcinogenicity of foundry sand was negative (Niemeyer et al, 1986). Groups of 50 male Syrian golden hamsters received saline, ferric oxide powder, foundry silica sand, Min-U-Sil (silica sand), or ferric oxide and Min-U-Sil together by intratracheal instillation. Further groups received each of the above treatments combined with 3mg of benzopyrene. There were only two animals with tumours among the four groups treated without benzopyrene (with none in the silica sand group). With benzopyrene, 47% of saline group and between 76% and 90% of the dust groups had respiratory tumours. Thus foundry sand was inert but as with other dusts, silica sand or ferric oxide, increased the carcinogenic response to benzopyrene.

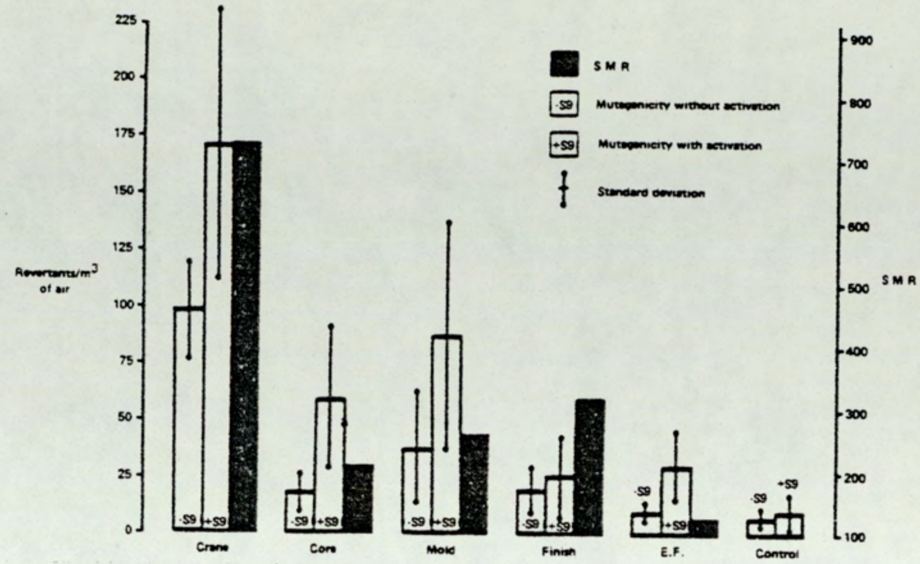
Two groups of investigators have studies the mutagenicity of extracts of foundry fume, in Canada (steel foundry) and Finland (iron foundries).

The Canadian studies consisted in the main of bacterial mutagenicity assays of air samples taken from a steel foundry where a significant risk of lung cancer had been reported (Gibson et al, 1977). Later some experimental work aimed at comparing different binder systems was carried out (McCalla et al, 1983). This was based on the Salmonella test described by Ames (Ames et al, 1975). The test measured the number of revertants of a histidine requiring strain of Salmonella Typhimurium induced by adding extracts of foundry fume. These were then adjusted, by the volume of sampled air to give comparable estimates of mutagenicity in revertants per cubic metre. Some samples were evaluated directly, others after metabolic activation by S-9 extract (a fraction obtained from the liver of Aroclor 1254 induced rats). Samples active without S-9 activation are direct acting mutagens. This assay performs well in detecting powerful organic carcinogenic initiators (e.g., aromatic hydrocarbons, aromatic amines and nitro- and nitroso-compounds). It is less effective with chlorinated aromatic hydrocarbons and carcinogenic hormones and is even less sensitive for inorganic carcinogens except for hexavalent chromium (Rinkus and Legator, 1979; IARC, 1980a). Using different bacterial strains can indicate different mechanisms of action. Both strains TA98 and TA100 were tested and significant mutagenic activity was found only with TA98 (Kaiser et al, 1981). This result suggests that the foundry mutagens induce frame shifts (i.e., deletion or insertion of base-pairs in DNA) and cause few if any single base substitutions.

The correlation between the area in the foundry where the samples were taken, and the degree of mutagenic activity is quite striking. Figure 2.3, reproduced from Gibson et al (1986), illustrates how the highest mutagenic activity (with or without metabolic activation) is in the atmosphere breathed by the crane drivers, for whom the SMR was highest. However, these overall means obscure very high intersample variation in the level of mutagenicity

Figure 2.3

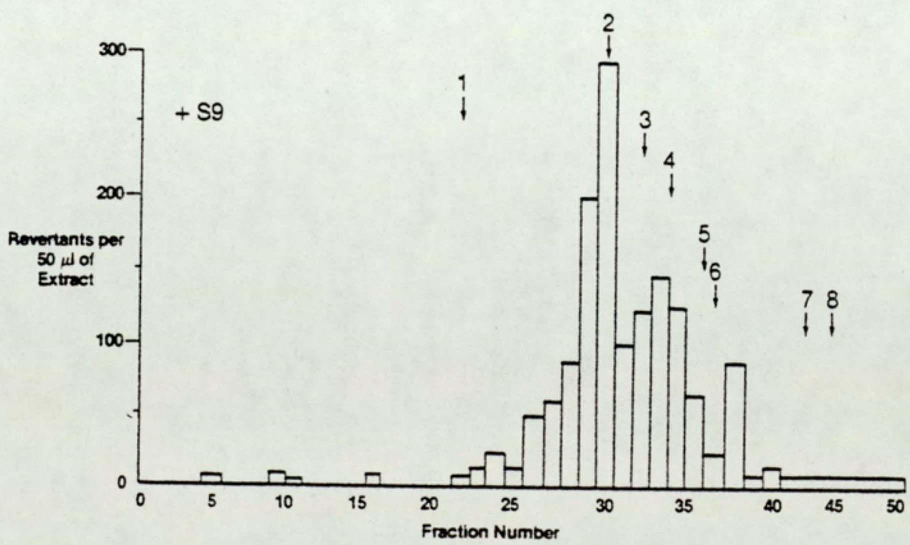
Comparison of area-specific SMRs for lung cancer to mutagenic activity



(Source: Gibson et al, 1986)

Figure 2.4

Mutagenicity of serial elution fractions from HPLC



Mutagenicity of serial elution fractions from HPLC. Arrows indicate where various PAH standards eluted. The arrows identify the following fractions: 1 = toluene, 2 = anthracene 3 = fluoranthene, 4 = pyrene, 5 = triphylene, 6 = benzo (a) anthracene, 7 = benzo(e) pyrene plus perylene, and 8 = benzo (a) pyrene.

(Source: Gibson et al, 1986)

(Bryant and McCalla, 1982). This was considered to reflect the high variability in the atmosphere (the samples were taken over a 2-hour period) due to the batch-process nature of the work with different materials being used at different times.

Because of the known presence of polycyclic aromatic hydrocarbons in the foundry air, attention was initially focused on this class of compounds. Levels of benzopyrene, benzofluoranthene, benzanthracene and a mixture of pyrene and fluoranthene were all identified but the levels were low and did not vary markedly between foundry areas (Gibson et al, 1983). The mutagenicity elution fractions from high pressure liquid chromatography (HPLC) were evaluated and are presented in Figure 2.4, reproduced from Gibson et al (1986). The bulk of the mutagenicity is associated with fractions eluted before PAH carcinogens, such as benzo(a)anthracene or benzo(a)pyrene. Another similar analysis of different elution fractions found that the effect of metabolic activity varied between fractions, with direct acting mutagens predominating only in the more polar fractions (Kaiser et al, 1981). The samples were also fractionated by liquid-liquid extraction into aqueous, acidic, basic and neutral (organic solvent soluble). For some samples the majority of the mutagenic axctivity was found in the neutral fraction, in others it was concentrated in basic fractions and required metabolic activation (Bryant and McCalla, 1982). It was suggested that this material might consist of aromatic amines. Among the hydrocarbon fractions, alkyl (C2,C3,C4) derivatives of phenanthrene and/or anthracene and pyrene and/or fluoranthene have been identified in high mutagenicity fractions (McCalla et al, 1983).

To assess the role of different binders, fume was generated using a standard experimental rig and then tested using the same mutagenicity assay (McCalla et al, 1983). Greensand (with new or recycled sand), oil, clay and cereal, sodium silicate, furan on-bake, kold-set and shell core were tested. In each case except the latter (which was somewhat smaller), an identical 46 kg steel casting was poured and fume collected in a hood over the mould. The levels of mutagenicity were all higher after metabolic activation and the shell-core (phenol-formaldehyde) system generates by far the greatest amount of mutagenicity followed by the conventional oil, clay and cereal system, the sodium silicate system, green sand, furan non-bake and kold set. The range of activity spanned two orders of magnitude with kold-set much lower and shell-core much higher than the bulk of results. Chromatographic analysis of each sample showed quite different spectra between binder types, though no data were presented on levels of specific constituents.

Mutagenic activity of fume samples in two iron foundries using coal tar pitch, were compared in a Finnish study (Skytta et al, 1980). In one of the foundries a high correlation (r = 0.78) was reported between the concentration of bp in the fume samples and the revertants per colony in the Salmonella Typhimurium system. Mutagenicity of urine samples of 12 workers was also compared (Rantanen, 1983). Among the four non-smokers the individual with the highest bp exposure also had the highest numbers of revertants per unit volume of urine, but the pattern among the smokers appeared to be the reverse.

CHAPTER 3 - DATA COLLECTION AND CATEGORISATION

3.1 Selection of the study factories

All SCRATA member foundries were circulated by SCRATA to determine whether they had personnel records going back to 1946 and whether they were willing to cooperate in the study. (One foundry in Scotland was excluded because at the time the foundry had agreed with EMAS that the latter would conduct a mortality study of a similar nature to the present study). From the 47 member foundries, 17 replies were received of which 10 foundries had appropriate records and agreed to cooperate.

Of the 17 who replied, 7 were not included for the following reasons: four foundries were visited and it was established that the records did not go far enough back in time, or there was insufficient detail to allow tracing. In 2 further cases this was established by phone contact and one foundry made clear in their reply their refusal to cooperate and was not contacted further. The 10 foundries which gave a positive response were exclusively larger foundries, thus an attempt was made to make the sample more representative by circulating reminders to the smaller foundries who had not replied. This attempt was however, unsuccessful yielding no more foundries willing to cooperate. Table 3.1 summarises the distribution of all SCRATA members and the study sample foundries by geographical region and by size (in 1977). It is apparent that the sample does not reflect the distribution of all SCRATA member foundries.

These foundries are not a random sample of the steel foundries in Britain since not all steel foundries are members of SCRATA and the sample is weighted by such factors as whether the foundry kept personnel records and was willing to participate in the study. What effect this might have on mortality patterns is not obvious.

Table 3.1

Distribution of SCRATA members and foundries in study by size and region

Area	SCRATA Members	In study
Wales	3	0
Scotland	8	1
North England	9	1
North East	3	0
Yorkshire	13	5
Midlands	7	2
South East	5	1
	48	10

Size

Number of Employees	10-99	100-249	250-400	400-2000
SCRATA member	11	10	13	14
Study members	0	0	7	3

3.2 The foundries in the study

In most of the factories, some personnel were interviewed to build up a history of the technology and products. Unfortunately, because of differing degrees of cooperation, the amount of detail obtained has not been consistent. In one case the factory (no 14) closed down in between data collection and returning to collect information on the factory's history and this information is thus not available. The information collected has been summarised in Appendix A, although the relevant information on types of steel and binders is briefly as follows:

Foundries 10, 11, 13, 15 and 17 had as much of their production, high alloy steel with substantial chromium and nickel content. Foundry 12 mainly produced manganese steel. Foundries 16, 18 and 19 produced mainly low alloy steels.

Foundries 10 and 11 used shell moulding from the 1950s for smaller castings. All foundries apart from 17 and 18 introduced carbon dioxide/sodium silicate from the 1960s. Foundry 18 used furan binders for moulding from the 1960s. Prior to the above binders being introduced foundries 11, 13, 15, 18 and 19 had used claybonded greensand or drysand for moulding. Foundry 16 was unique in using mainly cement as a mould binder and only foundry 17 used phenol formaldehyde resins in large quantities throughout the post-war period. All foundries had used oilsand for cores, progressively replacing it in most instances with sodium silicate corebinders.

3.3 Criteria of cohort definiton

Preliminary investigation of the data in the factories established that quite a high proportion of employees had worked a fairly short period, such as a few days or weeks. Because of limited resources and the intention to include as many foundries as possible in the study, it was decided to limit the inclusion of the shorter term employees. A one year minimum criterion was chosen as it was judged that those individuals would be unlikely to have accumulated sufficient exposure to be of major health significance.

The literature suggested that foundry fume and dust exposures may present a health hazard and it was therefore decided to exclude office workers from the cohort. The records available in the factories were in the main separated into "hourly paid" and "salary", which broadly was equivalent to manual work versus office work. The data collection was limited to hourly paid. Thus office workers were excluded, although foremen and supervisors who were exposed to the foundry and fettling shop environments to an extent were also excluded by this selection. For an internal reference population, less exposed to the dust and fume, other manual workers were selected rather than office workers as the latter may be different in other ways that are related to health status (they are in a different social class category).

A small number of women were employed in the factories, mainly in office jobs and some coremakers. Because the numbers were so few compared to the male employees, it was decided not to include them in the cohort.

During the Second World War, conditions were, according to reports from factory managers, rather different. The products were atypical because of wartime needs. Blackout conditions affected ventilation in ways that were difficult to predict and in any case, would not be representative of conditions after the end of the war and during the period when legislation was introduced to control dust exposure in the foundries. Finally, recruitment into the army meant that the factory workforce was not representative of the post-war workforce. As the primary intention of the study was to establish patterns of mortality related to foundry conditions as relevant as possible to current conditions, it was decided to include only those entering each workforce from 1946 onwards. This provides a follow-up of over 30 years for the earliest cohort members, sufficient to allow occupationally related cancer mortality to become evident. Because cancer was the cause of death of primary interest in this study, very recent employees would have been uninformative because of too short a period of follow-up. For this reason, only entrants up to 1965 were included.

The criteria of inclusion into the cohort were therefore all male hourly paid workers who entered the study factories from 1.1.1946 to 31.12.1965 and reached a cumulative employment of at least one year.

3.4 Data collection

At each factory data were collected by searching the personnel files and taking details of all weekly paid male workers who met the cohort definiton. The data collected consisted of name, address, date of birth, place of birth and full occupational history. Where available the National Health Service (NHS) and National Insurance (NI) numbers were also collected. In some cases medical records were also searched to ensure completeness of the cohort.

In each case where the record sources came from different sites or different cupboards in the same office, this information was coded and marked on the record card to aid in referring back to the original records in case the data extracted needed verifying. The form of each of the companies records is described in Appendix B.

In factories for which part of a company engaged in non-foundry production and for which the employment records could not be distinguished, the foundry departments were selected at the time of data collection. This was possible either because the other department was named (for example Jack manufacture in factory 13) or the department numbers were used to identify work areas (for example to exclude the rolling mill in factory 18).

3.4 Tracing the vital status

Permission had been sought and received from the Office of Population Censuses and Surveys for tracing the members of the study population at the National Health Service Central Register (NHSCR) at Southport. Subsequently equivalent permission was granted for tracing to be carried out at the General Register Office for Scotland (GROS) in Edinburgh and the Department of Health and Social Security (DHSS) national records centre in Newcastle.

Facilities exist at both the NHSCR and the GROS for tracing people who have been resident in England and Wales, and Scotland, respectively and registered with a General Practitioner (GP). When the National Health Service was formed in 1946, it used as its register the register of all British Citizens used for security and rationing purposes during and after the Second World War. Each person who was registered in 1939 or registered with a doctor since has been allocated a unique NHS number. Subsequent events such as registering with a new doctor, changing name, emigrating, dying and, since 1971 having cancer diagnosed, are routinely notified and the record updated at the Register.

The record for members of the study population can be traced at the Registers either in the index by National Health Service number or by full name and date of birth (with home address and date of living there to help discriminate between people with the same name and birthdate). If the tracing is successful, then either the NHSCR or the GROS sends details of the death or emigration, or the individual is "flagged" and if he/she dies or emigrates subsequently then details are sent. If the individual has already been flagged in this study, either because of a clerical error submitting two forms from the same foundry or the same individual being employed in more than one study foundry, then the NHSCR or GROS returns the card as a duplicate. People in Scotland who died prior to 1974 have been removed from their central register.

The GROS has its own death register. The Death Register for the NHSCR is located in Titchfield, and administered by OPCS who when requested by the NHSCR will send a copy of the death certificate coded to the appropriate revision of the International Classification of Disease. The Eighth Revision has been used for all deaths in this study (WHO, 1969).

Name, date of birth and if available, National Insurance number can be sent to the DHSS, who are normally notified of deaths because of claims for DHSS death benefit. They do not however have facilities for flagging, so subsequent death notifications cannot be communicated to researchers after the initial tracing exercise. The DHSS supplies information in the following categories: National Insurance Record does not show death recorded (assumed alive), no trace of NI account (treated as equivalent to no trace on NHSCR) or the date of death and (if grant was claimed) the place where the death grant was claimed. Knowing the date and place of death, the entry in the death register can be traced and a copy of the death certificate supplied by OPCS or GROS.

3.6 Data management

The form used for collecting the data for each member of the cohort is shown in Figure 3.1. The reverse side has details of the occupational history. It was designed so that it formed the basic record for this project but to avoid unecessary clerical work the front side could be photocopied for sending direct to the NHSCR and

Figure 3.1

Form used for data collection

Foundry Study
Safety & Hygiene Department Aston University

NHS Number	Date of Birth	Day / Month / Year [ ][ ] [ ][ ] [ ][ ]	1 - 6
Surname	Sex M = 1 F = 2	[ ]	7
Forenames	Identity	[ ][ ][ ][ ][ ][1]	8 - 13
Maiden name (if applic.)	Foundry	[ ][ ]	14 - 15
Address	Area	[ ][ ]	16 - 17
....	Date of Death	[ ][ ][ ][ ][ ][ ]	18 - 23
....	Emigration	[ ][ ][ ][ ][ ][ ]	24 - 29
Year address valid	Cause of Death	[ ][ ][ ][ ]	30 - 33
Place of birth	Social Class	[ ]	34
Foundry			
NI Number			
OPCS Use			

OCCUPATIONAL HISTORY **NUMBER OF ENTRIES** [ ] 35

Description of Job or LEFT	Date of Starting (Day / Month / Year)	Code	
....	[ ][ ] [ ][ ] [ ][ ]	[ ][ ]	36 - 43
....	[ ][ ] [ ][ ] [ ][ ]	[ ][ ]	44 - 51
....	[ ][ ] [ ][ ] [ ][ ]	[ ][ ]	52 - 59
....	[ ][ ] [ ][ ] [ ][ ]	[ ][ ]	60 - 67
....	[ ][ ] [ ][ ] [ ][ ]	[ ][ ]	68 - 75

If occupational history continued, tick here ____

GROS, and it was laid out in such a way that the coded information could be read directly by punch card operators.

At several of the factories, employment records included details of National Registration Numbers (ie National Health Service Numbers) for workers starting in the 1946-1952 period before National Registration Numbers were abolished, and this number was entered onto the record. For each male in the employment records eligible for inclusion in the cohort the full name, date of birth, last known address and date the address was valid was taken from the employment records and the place of birth and the National Insurance number if available. The factory code was entered on the card. If the employment records contained a record of death the date was also entered onto the record card to aid tracing.

The card as originally designed contained spaces for coding the geographical area and the social class of the individual. However as the geographical area of employment can be defined by the foundry code in the analysis and the social class is defined by the occupational categories, these categories were redundant and were used for vital status and race respectively. Each individual was thus coded as follows: The cohort was restricted to males and so all cards are coded 1 in column 7: "sex". Each individual was assigned a unique identity number, in numerical order by alphabetical order within factory. Each of the ten study factories was assigned a unique code number from 10 to 19.

The vital status (marked "area" on the card) was 11 for those alive, which could readily be amended to the other codes depending on the information received from the tracing exercise: 77 for untraced, 44 for emigrated and 99 for died. The date of death or emigration was entered where appropriate and the four digit ICD code for the cause of death was entered if known. The race code (marked social class on the card) could not be based on any categorisation of the workers by place of birth or ethnic group as such data were not collected by the factories. However, men from the Asian subcontinent and African Asians can be recognised by their names with a fair degree of sensitivity and specificity. Carribean immigrants of which there were a fair number in foundries 11 and 14 (though much less than "Asians") cannot be distinguished from people of British and Irish descent by their names. In addition, at least one of the foundries employed a substantial minority of Arabs whose predominantly Muslim names were indistinguishable from names of Pakistani descent. The names judged as most likely of Indian, Pakistani or Arab origin have been coded "5" in column 34, the remainder are coded "1".

Copies of the front of all cards were sent to the NHSCR for the 9 factories in England and Wales. The following action was taken in response to the various categories of reply from the NHSCR:

If the NHSCR could not identify the individual on their registers the copy of the card would be returned as "No trace". The failure to trace may have been because of some difference in the name or date or birth on their records and in the factory records or because they are not on the register. For some individuals the register returned them as "insufficient information" to allow tracing. In this case they were treated in the same way as individuals returned as "no trace". For each of the untraced individuals the factory records were checked for errors in data collection and if errors were found, the amended record was returned to the NHSCR. If the personal details had been correctly transcribed from the foundry employment records, then the details were sent to the DHSS on an agreed form. After the DHSS has returned the forms, each individual could be coded as alive, dead or still untraced. The cards were marked appropriately and the computer files edited. For some individuals the NHSCR later traced the cohort member who is then flagged by them and can be amended back to alive in the files.

For those who have left the country the forms are returned marked "embarked", the vital status was recoded, the date of emigration inserted and the computer file edited. For some members the NHSCR later send notification that the person who left the country has returned in which case files were amended back to status alive.

For notifications of deaths, the date and cause of death were entered into the files. For causes where the fourth digit was "X", the fourth digit (col 33) was entered as zero. For causes of death from accidents, poisoning and violence (ICD 8000-9999), the E code (the external cause) was used for the coding, not the N code (nature of injury).

For a number of individuals, a date of death was available but not the cause of death. This may have been because the date of death supplied by the DHSS was not traced on the Death Register, or the date of death was known but the individual was known to have died abroad and thus the cause is unknown. Alternatively, the company records indicated that the individual died in service but the death could not be traced by the NHSCR. In these cases, the cause of death was unknown and he contributes to the observed deaths for deaths from all causes, but is not included in the cause-specific analysis. The cause of death was coded 7969 (8th Revision) the code for deaths from unknown cause.

Some cards were returned as duplicates and the record of the individual already sent was sought out by going through the card indexes for all the foundries, starting with those geographically nearest. If the duplicate was found in the same foundry population, the occupational histories were checked, aggregated together on one card and the extra card removed from the file and edited out of the computer file. If the duplicate was found in another foundry and this was the case in 24 cases, then a card was made up consisting of the complete occupational history and the foundry code recoded as follows: 20 (10+18), 21 (11+18), 22 (16+18), 23 (11+12). The mortality of this small group was no different from that of the foundries in which they had worked and so for ease of analysis, these 24 were assigned (with all their work history) to the factory in which they worked the longest.

For Scotland, the tracing exercise was exactly equivalent for the English cohort with one exception. For 156 individuals there was the full name and NI number, the age at start and date of start, but no date of birth or NHS number. These were sent to the DHSS as the primary means of tracing and if found to be alive subsequently sent to the GROS for flagging, or if dead the death certificate was obtained from the GROS. Two individuals had neither date of birth, NHS number or NI number and were deleted from the cohort for having insufficient details for tracing.

3.7 Categorisation of occupations

Personnel officers and supervisors were interviewed in each foundry to gain precise descriptions of the work performed by workers in each of the occupational titles occurring in the employment records. From this information appropriate occupational categories were compiled and the titles covered by each category are summarised in Table 3.2. It would have been desirable to subdivide some of the categories, for example ladlemen and furnacemen but this was not done because it was not possible in some foundries to separate these two functions. Some of the occupational categories were not completely distinct. Thus in some factories dressers spent part of their time arc air burning rather than there being a separate occupation of arc air burning. For the same reason shellmoulders and coremakers have been amalgamated into all moulders and coremakers. In some foundries, jobtitles were used which differed from those listed in Table 3.2 and these have been listed in Appendix B under the description for each foundry.

Table 3.2:

Titles used for categorising occupational histories

Code	Category	Specific occupational titles
	FOUNDRY	
1	Sand preparation	Sand miller, sand plant service labourer, millman mixer
2	Moulding	Moulder, coremaker, closer, machine moulder, pinlift
3	Shell moulding	Shell coremaker, closer, flame dryer, corestove attendant
4	Furnace	Furnaceman, 2nd hand, 3rd hand, spareman, scrapman, ladleman, teemer, caster, ingot man, cupola loader, labourer (steel plant)
5	Furnace repair	Furnace fettler, patcher, furnace bricklayer, furnace fitter's mate, furnace serviceman
6	Centrifugal casting	Spinner, spinning operator, puller out, single end shanker
7	Foundry cranes	Cranedriver, mobile crane driver
8	Labourers etc.	Foundry labourer, fork lift driver, slinger, degreaser's labourer, steel carrier
9	Knockout	knocker out, knockout labourer, gridman
10	Mixed and other in foundry	Alloy storekeeper, descaler, die inspector, chip crusher
	FETTLING SHOP	
11	Fettling	Fettler, grinder, finisher, dresser, chipper
12	Blasting	Shot blaster, hydroblaster, wheelabrator
13	Burning and welding	Burner, welder, cutter, powder washer, oxycutter,
14	Arc air	Arc air burner, arc air gouger
15	Heat treatment	Heat treatment furnaceman, loader, stove attendant (heat treatment), heat treatment labourer
16	Fettling shop cranes	Crane driver
17	Labourers etc.	Labourer, service labourer, fork lift driver, press operator assistant, link wrapper, setter's assistant
18	Mixed and other in fettling shop	Blacksmith, dressing shop inspector, setter, stamper, checker, blacksmith striker

Table 3.2 (Contd.)

Code	Category	Range of occupational titles
	OTHERS	
19	Pattern making	Pattern maker
20	Pattern shop labourers	Pattern labourer, pattern storeman, labourer, pattern stores, pattern checker
21	Inspection	Checker, inspector, machinist (inspection, labourer (crack detection), marker off, pressure test, test press assistant
22	Machining	Turner, machinist, driller, machine shop fitter, miller, borer
23	Machine shop labourers etc.	Labourer, fork lift driver, crane driver, machine shop storekeeper, inspector
24	Welding	Machine shop welder, maintenance welder
25	Maintenance	Maintenance fitter, electrician, joiner, blacksmith, pipe fitter
26	Maintenance mates	Fitter's mate, maintenance craftsman's mate, greaser, belt attendant
27	Other work outside foundry and fettling shop	Yard labourer, lorry driver, storekeeper, yard bricklayer, despatch labourer, boilerman, tackle shop, assistant blower house attendant
28	Precision melter	
29	Precision checker	
30	Precision fettler	

For the analysis by individual occupational title, three different approaches were used, two involving the unique assignment of individuals to either the job category held for the longest period or the first job category held. The other approach involved the allocation of individuals to any job held for at least one year, as many subjects had been in more than one job category (three individuals reached the maximum count of spending at least one year in five different categories). The three analyses gave very similar results and only the analysis by main job category is presented in the body of the report, results of the other two approaches being presented in Appendix C.

Many analyses are carried out on aggregations of individual job histories, the most simple being a dichotomous categorisation into "exposed" (ever employed in foundry or fettling shop jobs, maintenance or precision foundry jobs viz, categories 1-18, 25-26, 28-30) and "unexposed" (only employed in jobs other than exposed: pattern shop, machine shop, inspection, viz 19-23).

Within the exposed, three more homogeneous subgroups were defined (only employed in foundry jobs, only fettling shop, only maintenance) this left a relatively small group who had been employed in more than one of the other work area groups.

To investigate the effects of specific contaminants attempts were made to aggregate jobs by common exposure. One method (Fletcher, 1986) was to consider those workers who had been employed in jobs directly handling silica sand or directly generating siliceous dust (sand preparation, moulding and coremaking, furnace repair, knockout, shotblasters and dressers, viz categories 1, 2, 3, 5, 9, 11, 12) and this has been termed the silica exposed group. SCRATA was asked to categorise jobs associated with relatively high dust or fume exposure and the following groupings were provided. High dust exposure comprised moulders, furnace repair, foundry cranedriver, knockout, fettler, shotblaster, burner, crane driver, labourer in fettling shop and pattern maker (categories 2, 5, 7, 9, 11, 12, 13, 14, 16, 17, 19). High fume exposure comprised furnacemen, foundry crane drivers, fettlers, burners, crane drivers and labourers in the fettling shop, heat treatment furnacemen, and maintenance welders (categories 4, 7, 11, 13-17, 24). For each of the analyses of these three subgroups by duration of employment, only the cumulative employment within the categories specified was utilised.

3.8 Quality control

For most of the foundry populations the quality of the raw data determined the quality of the data in the cohort. In several factories the cohort was assembled from several sources of data: wages and personnel records (factory 11), personnel and medical records (factory 12), both ledgers of starters and leavers and employment record cards (factories 12 and 19) and multiple employment records (factories 15 and 16). The cross checking inherent in using several sources of data helped reduce transcription errors as well as improve completeness. As explained in the section on record management, the system of tracing through the NHSCR helps identify some errors in the data. If an individual has been entered twice onto record cards this is detected (although most such duplicates had already been found by alphabeticising the raw data). Similarly many untraced individuals were not traceable because of errors in the date of birth or a misspelt name. The errors were (unless the error was in the raw data at the factory) resolved by revisiting the factory and checking the files.

After entry into the computer, a programme was written which performed a number of logical checks on the data to identify impossible and unlikely combinations of dates, and that the job codes, factory codes, vital status codes, etc. all fell within the ranges of permitted values. The factory records were checked for all individuals who started work apparently outside the age range 15-64 or who started outside the period 1946-1965. In addition the following logical checks were performed:

Date of birth before all other dates.

Employment history in correct chronological order.

Date of emigration, death or loss to follow up after end of employment history.

3.9 Description of data

The final cohort after applying the inclusion criteria and tracing comprised 11069 individuals whose vital status at 31.12.83 is shown in Table 3.3. Of the total, 26.6% had died and 1.7% were untraced and 2.3% had emigrated; a total of 4% with vital status unknown. This overall figure of 4% is adequate not to undermine confidence in the results and compares well with other published studies. However, the success of tracing is heterogeneous by ethnic group. For the immigrant worker subgroup of 623 individuals 16.7% had unknown vital status, of which 9.3% were untraced (Table 3.4). This is unacceptably high and it was therefore decided to separate this group in the analysis and to concentrate the analysis on the remainder, those for whom the trace rate is more satisfactory. The vital status of this group, excluding immigrant workers is shown in Table 3.5, and only 3.2% are lost to follow up, 1.2% through being untraced and 2.0% emigrated. The different trace rates by factory reflect in the main the different levels of quality in the data, with only 2 out of 525 individuals in factory 15 being untraced, but

16 out of 698 in factory 17.

In Table 3.6, the 623 immigrant workers are presented subdivided by factory and main job category. Over one third are in one category, (8) the foundry labourers and another 24% are split between fettling shop and machine shop labourers. Thus they were largely employed in the unskilled jobs in these factories.

By contrast, in Table 3.7, for the rest of the cohort (and all subsequent tables refer to this group) only 17% worked in the same three labouring categories. The largest categories, with just over 10% in each are 1, 8, 11 and 22, the moulders, foundry labourers, fettlers and machinists. The proportions varied between factory, but it is evident that all factories showed a wide range of job titles, reflecting the detail given in the employment records. There were some exceptions however. Only three factories employed the centrifugal casting method (job category 6). Three factories did not distinguish knockout (category 9), the job being carried out by foundry labourers in these factories. Only four factories separated arc air burning (14) from fettling and welding (13) in the job titles. Finally, only one foundry (10) had a precision welding shop and 25 cohort members had had one of the three jobs in the precision foundry as their main occupational category.

In Table 3.8, the cohort is shown subdivided by work area and factory. Most people did not work in more than one area, as shown by the low percentages in the mixed category. The largest category is the foundry, and while the pattern shop/machine shop/inspection/-yard group varies between factory, all factories contribute to this reference group, although only 7% of the factory 15 population is in this group. The foundry itself accounts for between 23% and 51% of the population by factory.

Table 3.9 presents the distribution by 5 year cohort of entry, which is overall fairly even, with slightly more than a quarter (28.8%) in the second group and 21.1% in the most recent entry cohort. There is more variation by individual factory, the most dramatic divergence from the norm being the low recruitment in the late 1950s for factory 17.

Table 3.10 presents the distribution of the study population by age at entry and factory. 29% started under the age of 24 and a further 33.8% between 25 and 34. For the youngest age groups the percentage varies over a narrow range: 20% to 38% by factory, a remarkable stability in the distribution.

Table 3.11 and 3.12 presents the distribution of person-years of the population by factory and time since first exposure for the exposed and unexposed respectively. The total of 188 749 person years for 7883 exposed workers gives an average of 23.9 years of follow-up since first exposure. For the unexposed, the 2563 workers averaged 23.3 years since first exposure.

Table 3.3

Population by vital status and factory

Factory code	Vital status									
	Numbers					Percent				
	Total	Alive	Deceased	Untraced	Emigrated	Total	Alive	Deceased	Untraced	Emigrated
10	880	541	283	24	32	100.0%	61.5%	32.2%	2.7%	3.6%
11	1406	1009	349	19	29	100.0%	71.8%	24.8%	1.4%	2.1%
12	394	269	99	14	12	100.0%	68.3%	25.1%	3.6%	3.0%
13	559	437	98	9	15	100.0%	78.2%	17.5%	1.6%	2.7%
14	2202	1537	627	13	25	100.0%	69.8%	28.5%	0.6%	1.1%
15	525	366	146	2	11	100.0%	69.7%	27.8%	0.4%	2.1%
16	1175	886	258	15	16	100.0%	75.4%	22.0%	1.3%	1.4%
17	698	467	202	16	13	100.0%	66.9%	28.9%	2.3%	1.9%
18	2335	1533	670	67	65	100.0%	65.7%	28.7%	2.9%	2.8%
19	895	643	211	8	33	100.0%	71.8%	23.6%	0.9%	3.7%
Total	11069	7688	2943	187	251	100.0%	69.5%	26.6%	1.7%	2.3%

Table 3.4

Population by vital status and factory - immigrant workers

Factory code	Vital status									
	Total					Percent				
	Total	Alive	Deceased	Untraced	Emigrated	Total	Alive	Deceased	Untraced	Emigrated
10	111	83	8	13	7	100.0%	74.8%	7.2%	11.7%	6.3%
11	266	228	11	9	18	100.0%	85.7%	4.1%	3.4%	6.8%
12	69	49	7	8	5	100.0%	71.0%	10.1%	11.6%	7.2%
13	–	–	–	–	–	–	–	–	–	–
14	34	29	2	2	1	100.0%	85.3%	5.9%	5.9%	2.9%
15	–	–	–	–	–	–	–	–	–	–
16	1	1	–	–	–	100.0%	100.0%	–	–	–
17	–	–	–	–	–	–	–	–	–	–
18	142	96	5	26	15	100.0%	67.6%	3.5%	18.3%	10.6%
19	–	–	–	–	–	–	–	–	–	–
Total	623	486	33	58	46	100.0%	78.0%	5.3%	9.3%	7.4%

Table 3.5

Population by vital status and factory excluding immigrant workers

Factory code	Vital status									
	Total					Percent				
	Total	Alive	Deceased	Untraced	Emigrated	Total	Alive	Deceased	Untraced	Emigrated
10	769	458	275	11	25	100.0%	59.6%	35.8%	1.4%	3.3%
11	1140	781	338	10	11	100.0%	68.5%	29.6%	0.9%	1.0%
12	325	220	92	6	7	100.0%	67.7%	28.3%	1.8%	2.2%
13	559	437	98	9	15	100.0%	78.2%	17.5%	1.6%	2.7%
14	2168	1508	625	11	24	100.0%	69.6%	28.8%	0.5%	1.1%
15	525	366	146	2	11	100.0%	69.7%	27.8%	0.4%	2.1%
16	1174	885	258	15	16	100.0%	75.4%	22.0%	1.3%	1.4%
17	698	467	202	16	13	100.0%	66.9%	28.9%	2.3%	1.9%
18	2193	1437	665	41	50	100.0%	65.5%	30.3%	1.9%	2.3%
19	895	643	211	8	33	100.0%	71.8%	23.6%	0.9%	3.7%
Total	10446	7202	2910	129	205	100.0%	68.9%	27.9%	1.2%	2.0%

Table 3.6

Population by main job category and factory - immigrant workers

	Factory Code										
	10	11	12	13	14	15	16	17	18	19	Total	Per-cent
Job code												
1	1	19	–	–	2	–	–	–	3	–	25	4.0%
2	1	10	–	–	1	–	–	–	–	–	12	1.9%
3	–	6	–	–	–	–	–	–	–	–	6	1.0%
4	8	21	1	–	–	–	–	–	2	–	32	5.1%
5	–	–	–	–	–	–	–	–	9	–	9	1.4%
6	9	–	–	–	–	–	–	–	–	–	9	1.4%
7	9	5	–	–	11	–	–	–	2	–	27	4.3%
8	30	96	51	–	12	–	–	–	28	–	217	34.8%
9	3	8	–	–	7	–	–	–	–	–	18	2.9%
10	10	2	1	–	–	–	–	–	–	–	13	2.1%
11	1	4	1	–	–	–	–	–	23	–	29	4.7%
12	–	1	2	–	–	–	–	–	–	–	3	0.5%
13	–	–	–	–	–	–	–	–	–	–	–	–
14	–	7	–	–	–	–	–	–	–	–	7	1.1%
15	1	13	–	–	–	–	–	–	–	–	14	2.2%
16	–	3	–	–	–	–	–	–	3	–	6	1.0%
17	2	59	10	–	–	–	–	–	13	–	84	13.5%
18	–	1	–	–	–	–	–	–	1	–	2	0.3%
19	–	–	–	–	–	–	–	–	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–
21	–	6	2	–	–	–	–	–	–	–	8	1.3%
22	4	–	–	–	–	–	1	–	3	–	8	1.3%
23	13	–	–	–	1	–	–	–	53	–	67	10.8%
24	–	–	–	–	–	–	–	–	–	–	–	–
25	1	1	–	–	–	–	–	–	1	–	3	0.5%
26	2	–	–	–	–	–	–	–	1	–	3	0.5%
27	3	4	1	–	–	–	–	–	–	–	8	1.3%
28	4	–	–	–	–	–	–	–	–	–	4	0.6%
29	–	–	–	–	–	–	–	–	–	–	–	–
30	9	–	–	–	–	–	–	–	–	–	9	1.4%
Total	111	266	69	–	34	–	1	–	142	–	623	100.0%

Table 3.7

Population by main job category and factory - excluding immigrant workers

	Factory Code											
Job code	10	11	12	13	14	15	16	17	18	19	Total	Per-cent
1	-	9	8	4	76	7	33	9	9	7	162	1.6%
2	31	133	40	85	242	53	204	81	139	149	1157	11.1%
3	-	15	-	-	-	-	15	8	-	-	38	0.4%
4	81	51	24	27	136	16	53	79	127	13	607	5.8%
5	-	46	14	1	34	1	1	4	355	1	457	4.4%
6	94	-	-	-	-	-	10	23	-	-	127	1.2%
7	26	24	7	8	124	7	90	12	27	3	328	3.1%
8	96	131	73	99	249	123	89	60	115	46	1081	10.3%
9	11	5	5	-	48	-	42	10	-	12	133	1.3%
10	36	12	8	6	1	3	3	2	4	3	78	0.7%
11	30	171	21	43	188	152	134	56	240	73	1108	10.6%
12	5	5	-	7	68	23	42	2	12	16	180	1.7%
13	2	51	14	34	132	39	43	13	83	42	453	4.3%
14	-	1	-	-	23	1	-	-	-	14	39	0.4%
15	22	14	-	4	26	6	14	7	10	2	105	1.0%
16	1	25	1	2	72	5	-	-	6	3	115	1.1%
17	4	47	11	14	71	15	1	-	41	30	234	2.2%
18	5	16	1	7	20	4	5	-	40	4	102	1.0%
19	11	50	11	39	64	10	23	8	83	23	322	3.1%
20	3	20	6	4	29	3	14	4	5	4	92	0.9%
21	12	54	9	17	52	5	29	24	17	35	254	2.4%
22	163	3	10	76	193	9	71	134	323	272	1254	12.0%
23	23	-	2	6	39	1	5	32	366	43	517	4.9%
24	-	6	-	1	10	-	41	-	29	8	95	0.9%
25	53	147	21	44	104	23	93	72	83	50	690	6.6%
26	20	50	5	5	85	2	45	40	67	14	333	3.2%
27	15	54	34	26	82	17	74	18	12	28	360	3.4%
28	13	-	-	-	-	-	-	-	-	-	13	0.1%
29	5	-	-	-	-	-	-	-	-	-	5	0.0%
30	7	-	-	-	-	-	-	-	-	-	7	0.1%
Total	769	1140	325	559	2168	525	1174	698	2193	895	10446	100.0%

Table 3.8

Population by work area and factory

	Work area							Total
	Foundry	Fettling	Foundry & fettling	Patt-mach-insp-yard	Maint-enance	Mixed	Precision	
Numbers								
Factory								
10	355	59	8	218	69	36	24	769
11	410	314	19	173	200	24	–	1140
12	166	40	9	67	23	20	–	325
13	194	77	38	157	47	46	–	559
14	840	513	87	414	183	131	–	2168
15	193	232	23	37	25	15	–	525
16	468	191	54	166	152	143	–	1174
17	228	50	27	187	97	109	–	698
18	743	401	31	764	173	81	–	2193
19	213	160	22	380	62	58	–	895
Total	3810	2037	318	2563	1031	663	24	10446
Percent								
Factory								
10	46.2%	7.7%	1.0%	28.3%	9.0%	4.7%	3.1%	100.0%
11	36.0%	27.5%	1.7%	15.2%	17.5%	2.1%	–	100.0%
12	51.1%	12.3%	2.8%	20.6%	7.1%	6.2%	–	100.0%
13	34.7%	13.8%	6.8%	28.1%	8.4%	8.2%	–	100.0%
14	38.7%	23.7%	4.0%	19.1%	8.4%	6.0%	–	100.0%
15	36.8%	44.2%	4.4%	7.0%	4.8%	2.9%	–	100.0%
16	39.9%	16.3%	4.6%	14.1%	12.9%	12.2%	–	100.0%
17	32.7%	7.2%	3.9%	26.8%	13.9%	15.6%	–	100.0%
18	33.9%	18.3%	1.4%	34.8%	7.9%	3.7%	–	100.0%
19	23.8%	17.9%	2.5%	42.5%	6.9%	6.5%	–	100.0%
Total	36.5%	19.5%	3.0%	24.5%	9.9%	6.3%	0.2%	100.0%

Table 3.9

Population by date of entry and factory

	Year of entry				Total
	1946-50	1951-55	1956-60	1961-65	
Numbers					
Factory					
10	240	250	158	121	769
11	231	326	374	209	1140
12	113	63	73	76	325
13	99	161	154	145	559
14	434	670	552	512	2168
15	157	174	83	111	525
16	386	245	231	312	1174
17	220	278	63	137	698
18	572	614	654	353	2193
19	171	232	269	223	895
Total	2623	3013	2611	2199	10446
Percent					
Factory					
10	31.2%	32.5%	20.5%	15.7%	100.0%
11	20.3%	28.6%	32.8%	18.3%	100.0%
12	34.8%	19.4%	22.5%	23.4%	100.0%
13	17.7%	28.8%	27.5%	25.9%	100.0%
14	20.0%	30.9%	25.5%	23.6%	100.0%
15	29.9%	33.1%	15.8%	21.1%	100.0%
16	32.9%	20.9%	19.7%	26.6%	100.0%
17	31.5%	39.8%	9.0%	19.6%	100.0%
18	26.1%	28.0%	29.8%	16.1%	100.0%
19	19.1%	25.9%	30.1%	24.9%	100.0%
Total	25.1%	28.8%	25.0%	21.1%	100.0%

Table 3.10

Population by age at entry and factory

	Age at entry						Total
	15–24	25–34	35–44	45–54	55–64	65+	
Numbers							
Factory							
10	154	249	201	110	49	6	769
11	228	430	284	154	42	2	1140
12	118	88	48	47	22	1	325
13	212	169	111	53	14	–	559
14	507	827	499	274	54	–	2168
15	166	167	118	56	18	–	525
16	451	405	193	93	23	8	1174
17	199	236	163	78	21	1	698
18	660	691	415	292	132	2	2193
19	339	267	155	103	27	1	895
Total	3034	3529	2187	1260	402	21	10446
Percent							
Factory							
10	20.0%	32.4%	26.1%	14.3%	6.4%	0.8%	100.0%
11	20.0%	37.7%	24.9%	13.5%	3.7%	0.2%	100.0%
12	36.3%	27.1%	14.8%	14.5%	6.8%	0.3%	100.0%
13	37.9%	30.2%	19.9%	9.5%	2.5%	–	100.0%
14	23.4%	38.1%	23.0%	12.6%	2.5%	–	100.0%
15	31.6%	31.8%	22.5%	10.7%	3.4%	–	100.0%
16	38.4%	34.5%	16.4%	7.9%	2.0%	0.7%	100.0%
17	28.5%	33.8%	23.4%	11.2%	3.0%	0.1%	100.0%
18	30.1%	31.5%	18.9%	13.3%	6.0%	0.1%	100.0%
19	37.9%	29.8%	17.3%	11.5%	3.0%	0.1%	100.0%
Total	29.0%	33.8%	20.9%	12.1%	3.8%	0.2%	100.0%

Table 3.11

Numbers and person-years in exposed cohort by factory and years since first exposure

Factory	Numbers	Years since first exposure 1 - 9	10 - 19	20 - 29	30 +	Total
10	551	4700	4614	2662	584	12560
11	967	8432	8633	4982	862	22909
12	258	2248	2282	1375	349	6253
13	402	3352	3504	1972	374	9201
14	1754	15318	15662	9239	1595	41815
15	488	4167	4441	2870	614	12091
16	1008	8902	9297	5723	1721	25642
17	511	4418	4482	2910	719	12530
18	1429	12222	12458	7849	1535	34064
19	515	4488	4534	2312	348	11683
Total	7883	68248	69908	41893	8700	188749

Table 3.12

Numbers and person-years in unexposed cohort by factory and years since first exposure

Factory	Numbers	Years since first exposure 1 - 9	10 - 19	20 - 29	30 +	Total
10	218	1866	1907	1424	328	5525
11	173	1508	1501	745	88	3842
12	67	552	536	298	62	1447
13	157	1390	1488	909	146	3934
14	414	3635	3727	1856	248	9466
15	37	316	321	189	77	903
16	166	1426	1459	795	174	3854
17	187	1561	1625	1091	253	4530
18	764	6482	6218	3715	800	17215
19	380	3300	3377	1911	316	8905
Total	2563	22036	22159	12934	2493	59621

CHAPTER 4 - ANALYTICAL METHODS

4.1 Calculation of observed and expected deaths

The aim of this study is to evaluate whether the mortality experience of foundry workers is unusual. The chosen method of comparison is to produce an age standardised estimate of the cause-specific mortality risk compared to the general population. The advantages and disadvantages of this approach are discussed in Chapter 6. This chapter describes the methods used to calculate expected numbers of deaths, Standardised Mortality Ratios, the testing of their significance and the modelling of observed and expected deaths in regression equations. The method of regional adjustment is described and discussed.

While the risk may vary over age groups and it is important to investigate whether this is the case, an overall estimate of relative risk is useful both for summarising the risk of foundry work and for comparing with other findings. Death rates in the general population vary over both calendar year and age. This is evident in Table 4.1 which illustrates the death rates from lung cancer for same age and calendar year groups used in the calculation of expected deaths in this study. For oldest age groups, the rate has been increasing sharply and clearly the death rates increase with increasing age.

Table 4.1

Sample of England and Wales death rates (per 100,000 per year) from lung cancer (rounded to nearest integer)

Age group	Calendar years 1961-65	1960-70	1971-75
15-19	-	-	-
20-24	1	-	-
25-29	1	1	1
30-34	3	2	2
35-39	9	7	6
40-44	22	21	17
45-49	56	52	50
50-54	123	115	106
55-59	230	221	207
60-64	368	372	353
65-69	486	529	516
70-74	501	625	681
75-79	460	599	726
80+	299	440	549

Death rates in the study population may be computed for the same cells and compared, but that requires the simultaneous comparison of dozens of figures. The crude rates are not comparable and direct and indirect standardisation can be used to produce an age standardised estimate of the mortality in the study population compared to the general population (Hill, 1977). In direct standardisation, the weighted sum of the stratum-specific death rates is calculated, and the directly standardised rates weighted on the same calendar year and age distribution (eg the general population) are directly comparable. The ratio of the rate in the study group to the reference (usually expressed as a percentage) is the Comparative Mortality Figure. The main disadvantage of this method, which makes it virtually unused in occupational cohort studies, is that the small numbers of deaths per stratum makes the directly standardised rate unstable (Symons and Taulbee, 1981).

Indirect standardisation, where the death rates in the general population (which are based on large numbers and thus relatively stable) are standardised to the age and calendar year distribution of the study population, is generally chosen for occupational cohort studies. Thus the age distribution of the population at entry or at one point in time does not adequately reflect the dynamic change in the size and age structure of the study population over time. An individual entering the study by starting work in one of the foundries at age 32 and leaving the study by dying at age 51 only passes through a limited number of age groups in the study. He also only passes through a limited number of calendar periods within the study period of 1946 to 1983. The appropriate distribution is calculated by summing the "person-years at risk" (PYAR) contributed by each individual to each age/time stratum (for example age 35-40 during 1966-70), over the whole study population (Berry, 1983). The concept of "risk" used here is that the individual is at risk of dying and the risk of dying in a given stratum (or cell) rises with the length of time he passes in that cell. The risk of a death from among the population occurring in that cell rises with the number of the population who spend some of their time in that cell. For the population, the risk of a death in that cell is proportional to the accumulated person-years in that cell and a death rate for that age and calendar group would be the observed number of deaths divided by the person-years. Death rates calculated in this manner could be used to compute age specific death rates.

To calculate indirectly standardised mortality ratios, for each age/calendar year cell, the accumulated person-years are multiplied by the reference rate to give an expected number of deaths. These may be compared cell by cell with the observed, but are usually summed over all cells and then the ratio of the observed to the expected (often expressed as a percentage) is the Standardised Mortality Ratio (SMR). This is an age-standardised estimate of the risk of dying in the study population compared to the reference population, the weighting being the person-years distribution of the study population over age and time. Other factors such as race and sex may be included if the population has such subgroups and appropriate reference rates are available, but in this study only males are included and the foreign-born workers are largely excluded.

The SMR is thus defined as follows:

$$SMR = 100 \times \frac{O}{E} = 100 \times \frac{\sum O_j}{\sum R_j n_j}$$

Where O = Observed deaths

E = Expected deaths

O_j = Observed deaths per stratum

R_j = Reference rate per stratum

n_j = Person-years per stratum

Table 4.2 gives for the foundry subgroup and for the cells equivalent to the cells in Table 4.1, the person-years, expected lung cancer deaths and observed lung cancer deaths, and the total observed and expected for each calendar period. Such calculations have been performed for subgroups of the population defined by occupational history and age or date at entry. The observed and

Table 4.2

Worked example of calculating person years at risk (PYAR), expected deaths (Exp) and standardised mortality ratio (SMR).

Age Group	Obs	PYAR	Exp	Obs	PYAR	Exp	Obs	PYAR	Exp
15-19	0	273	-	0	88	-	-	-	-
20-24	0	741	-	0	654	-	0	93	-
25-29	0	1405	-	0	1232	-	0	671	-
30-34	0	1868	.1	0	1814	-	0	1235	-
34-39	1	2485	.2	0	2141	.2	0	1825	.1
40-44	1	2616	.6	0	2712	.6	2	2108	.4
45-49	1	1972	1.1	2	2862	1.5	1	2653	1.3
50-54	2	1575	1.9	10	2028	2.3	4	2705	2.9
55-59	2	1135	2.6	6	1556	3.4	5	1854	3.8
60-64	0	643	2.4	11	1063	4.0	4	1387	4.9
65-69	3	29	1.4	2	575	3.0	6	875	4.5
70-74	1	102	.5	4	211	1.3	5	21	2.9
75-79	0	59	.3	1	66	.4	1	116	.8
80+	0	8	-	0	44	.2	2	61	.3
Total	11	15169	11.1	36	17010	16.9	30	16004	22.0

$$SMR = 100 \times \frac{\text{Total Observed}}{\text{Total Expected}} = 77 / 50.0 \times 100 = 154$$

expected deaths have been presented subdivided by length of time since first exposure.

The programme used to perform the calculations of observed and expected deaths and SMRs, is the "Manyears" (now more appropriately named "personyears") programme written by Julian Peto and revised by Michel Coleman (Coleman et al, 1986). Subroutines were written to select specific subgroups of the population and using the steering file required by the programme, output defined by subgroup, age, calendar period, time from first exposure and cause of death can be specified.

Each individual contributes person-years during the period during which he would have contributed an observed death had he died and in the age/calendar year cell to which the observed death would have been assigned. Each individual has worked a minimum of one year in this cohort thus he starts to contribute person-years when he achieves one year of cumulative employment (because if he had died with less than one year of employment he would not have been in the cohort). He contributes person-years into the appropriate cells until he dies, is lost to follow-up or the end of the study period (31.12.83). The date of loss to follow-up is for those who have emigrated, the date of emigration, for those who were untraced, the date of finishing employment, because in each case a death that may have occurred after either of those dates would not have been included as an observed death.

Analysis of subgroups of the population by work area or date of entry is relatively simple because subjects were uniquely assigned to each subgroup but for duration of employment, the calculation is more complicated because individuals contribute person-years to more than one group. Following the same reasoning as above for allocation of person-years, individuals are dynamically allocated to the duration of employment group to which they would contribute the observed death had they died. Put another way, for a given employment group, they contribute to the denominator of the SMR (person-years and expected deaths) for as long as they would contribute to the numerator in that group, had they died. Thus the individual who works for a single period of 11 years and then leaves, contributes four person-years from the beginning of his second year of employment to the end of his fourth, to the first duration of employment category (1-4 years). He contributes 5 persons-years to the second duration category, from the beginning of his fifth year of employment to the end of this ninth (5-9 years employment). He then contributes the rest of his person-years (until death, loss to follow-up, or the end of the study) to the 10-14 years' employment category. If his employment had been discontinuous, it may have taken more than 10 years since first employment to accumulate 10 years of employment, and it is on the date at which 10 years of employment has been accumulated that he transfers from one group to the next. The method chosen for correctly analysing by duration of employment has been to create computer files, with for each subject a series of dates for when 1, 5, 10, 15 and 20 years of employment were reached. Subroutines for the Manyears programme were then written to allocate the person years following the above rules.

4.2 Statistical testing and estimation

For testing the deviation of a number of events from expectation, where events occur in a large population given a low individual probability of the event happening, the appropriate probability distribution is the Poisson distribution. If one assumes that the expected deaths are without error (because they are based on sufficiently large numbers, relative to the size of the cohort), then the Poisson distribution is appropriate for describing the distribution of observed death (Armitage, 1971). Thus where O exceeds E the probability of O deaths where E were expected is given as the probability of O or more deaths in a Poisson distribution of mean and variance equal to E. These probabilities have been calculated, and the results in the table indicate whether the conventional values of 0.05, 0.01 or 0.001 have been reached as measures of the significance of departures of observed from expected values. In fact twice the above probability has been calculated to give a two tailed test of divergence from the expected value. In some tables, confidence intervals of the calculated SMR are shown. These are derived from calculating the 95% confidence limits of the mean of the Poisson distributed observation O, then calculating the upper and lower confidence intervals for the SMR as the ratio of the above limits over the expected deaths.

In some cases a test for trend has been applied by calculating the following statistic (Armitage, 1955). It assumes a Poisson distribution and is distributed as a chi-squared with one degree of freedom under the null hypothesis of no difference:

$$X^2 = \frac{\sum_j (O_j - E_j^*)}{\sum_j j^2 E_j^* - (\sum_j j E_j^*)^2 / \sum O_j}$$

Each summation is summed for j = 1 to J, the number of levels. O_j = observed, $E_j^* = E_j \times O/E$, where O/E is overall SMR, and E_j = expected.

4.3 Correction for regional differences in mortality

Death rates by standard region were available for a limited period (from 1966). Rather than either, only present regionally calculated SMRs for a restricted period of the study, or extrapolate these rates too far back to be justifiable, they were used to derive correction factors. Over the calendar periods where there was a correspondence between available regional rates and national rates (1966-1978) expected deaths by factory were calculated using both these sets of rates.

In tables 4.3 to 4.8, the effects of using region-specific mortality reference rates are shown for the six cause of death categories for which such

rates were available, for the calendar periods for which they were available. In each case the expected deaths are shown calculated by the two rates and the ratio of the locally calculated expecteds to the nationally calculated expected deaths is also shown. In most cases these exceed one, because the foundries are generally located in areas of higher than average mortality. The data is subdivided by foundry and exposed/unexposed. The SMRs for the data aggregated over foundry and calendar period are given at the foot of the table.

For mortality from all causes (Table 4.3) the overall SMR is reduced by some 9% for both exposed and unexposed. The largest decrease is for factory 19, located in Scotland where the rates are some 23% higher than the national (in fact England and Wales) rates used. The only factory for which the SMR is lower after correction for regions is 13, in South-East England, although the difference is negligible for factory 17 in the East Midlands. It is interesting to note that the correction factor varies between the 5 factories (10, 11, 12, 16 and 18) in the Yorkshire and Humberside region though not by a great deal - over the range 1.077 to 1.113 for the whole time period. This reflects different age distributions of the cohorts in each factory.

The ratios of local to national expecteds is quite constant over the three calendar periods, considering the total aggregated over foundry, varying by only 0.01. For most foundries it remains fairly constant, varying seldom by more than 0.05 between periods, except in two cases. For foundry 13, there is a marked decreasing trend where expected deaths change from being higher calculated locally than nationally, to the contrary. The ratio of expecteds falls by some 13% for the exposed group. In the opposite sense, for factory 15, the correction factor rises by a factor of some 14% from the earliest to the most recent of the three calendar periods.

For several specific cause categories factory 15 shows the least stability in the ratio between the expecteds calculated nationally and locally: for stomach cancer, lung cancer, non-malignant respiratory diseases, but not circulatory diseases. For the data across factory, the circulatory disease results show the least stability, reflecting the convergence over time of the nationally and locally calculated expected deaths.

The SMRs for lung and stomach cancer amongst the exposed are reduced from 167 to 157 and 174 to 161 respectively by applying regional rates. For the unexposed the SMRs for both these causes remain a little less than 100. For non-malignant respiratory disease the effect is more pronounced, reducing the SMR for the exposed from 152 to 131 and for the unexposed from 109 to 97. For circulatory diseases, the slight but significant excess of mortality evident for both subcohorts is reduced in the regional calculations to SMR of just under 100 in both cases.

The regional rates are not available for the whole study period and to estimate the effect of performing such calculations, regional correction factors have been derived for each of the foundry populations. These factors are the overall (exposed plus unexposed) ratio of locally to nationally calculated expecteds, and are the figures used for regional correction of the results of the analysis of mortality in this study (last column in Tables 4.3 to 4.8).

The period (1966-1978) over which these comparison calculations have been made includes 53% of the expected deaths from all causes and 54% of the expected lung cancer cases, and as the regions are large, the rates are quite stable. However correction factors based on smaller areas might be more preferable as the aim is to make a comparison with a population which in all respects other than employment in these foundries is quite similar.

Mortality by geographical area during 1969-1973 was published as one of the 1971 Census Decennial Supplement publications (OPCS, 1978). In Tables 4.10-4.12, the correction factors calculated using regional reference rates expressed as a percentage are compared to 1969-1973 SMRs for the 9 factories in England. The SMRs are for all ages relative to the England and Wales national mortality. Three different levels of aggregation have been used, and there are shown in Table 4.9. First the same Standard Regions as were used for the reference rates and secondly the County Borough (CB) and Administrative County (AC) level. Four of the factories fall in "County Boroughs": Leeds (11), Walsall (14) and Sheffield (10 and 18). Five of the foundries are in "Administrative Counties", essentially the county after subtracting the larger cities or "County Boroughs". The five towns involved: Scunthorpe (12), Braintree (13), Guisborough (15), Penistone (16) and Sutton-in-Ashfield (17) are all of quite limited size, but it may be more appropriate to choose the "urban aggregate" sub-category of the administrative county. This is done in the third, most detailed level of correction factor.

In some analyses, the data have been grouped by their location in towns with a potential for previous employment in the foundry industry. According to Hunter (1969), steel foundries are concentrated in Sheffield, Lancashire, Middlesborough, South Wales and the Clyde side. Iron foundries are concentrated in Falkirk, Birmingham and the Black Country. In addition, Leeds is a large city with a wide variety of industry including other foundries and Scunthorpe is a town with large steel-making capacity. Thus the larger towns with a higher potential for other foundry/steel industry employment are considered Sheffield (Factories 10 and 18), Leeds (11), Scunthorpe (12) and Walsall (14). The others are considered as smaller towns with less potential for other foundry employment Braintree (12), Guisborough (15), Penistone (16), Sutton in Ashfield (17) and Leven (19). This distinction has its limitations because two of these latter towns are located fairly near foundry areas, Guisborough being seven miles from Middlesborough and Penistone is 14 miles from Sheffield.

4.4 GLIM modelling of observed and expected deaths

For the analysis of the population by calculation of SMRs, it is practicable to inspect tables of results showing SMRs distributed by two factors (for example date of entry and length of follow-up) however it is not practicable to look at more than 2 variables simultaneously by stratification and visual inspection of different strata. By modelling the results one can both evaluate several factors simultaneously and perform formal tests of significance (by comparing the "goodness of fit" of different models) of individual factors while controlling for other factors.

The models used have been multiplicative models using an assumption of Poisson variability of observed deaths, which can be conveniently fitted using maximum likelihood methods using the
- General Linear Interaction Modelling
programme GLIM/(Baker and Nelder, 1977). The deviation of the observed deaths from the expected involves a linear predictor and a

(Poisson) error. By using the log link function in GLIM, the logarithm of the observed deaths is the dependent variable in a linear regression equation. By declaring the logarithm of the expected deaths in each stratum as an OFFSET, the linear predictor then consists of a constant and a vector of variates and the coefficients to be estimated:

$$\text{Log}\ (O_j) = \text{Log}\ (E_j) + a + \underset{\sim}{b}\cdot\underset{\sim}{z}_j$$

O_j = observed deaths, E_j = expected, $\underset{\sim}{z}_j$ = vector of covariables such as date of entry group, length of employment, interactions, etc and $\underset{\sim}{b}$ a vector of coefficients to be estimated as well as a. A covariable may be categorical, for example four levels of date of entry (0, 1, 2, 3) where the different values for parameters b are estimated for each level relative to the zero category, or ordinal, for example length of employment (5, 10, 15 years) where one b parameter is estimated as the increase in log(O) per unit increase in that covariable.

The equation may be rewritten as:

$$O_j/E_j = \exp\ (a + \underset{\sim}{b}\cdot\underset{\sim}{z}_j),$$

from which it is obvious that exp(a) is the SMR when all the covariables are zero, and each value of b represents the log relative risk of that level of the covariable compared to the referent category for that covariable.

The goodness of fit of the model may be estimated from the "deviance" which is lower, the better the fit. The deviance G^2 derives from a comparison of observed (O) and fitted ($\hat{O}$) values as follows:

$$G^2 = 2\sum d \log(\hat{O}_j/O_j) + (\hat{O}_j-O_j)$$

This expression is summed over both cells and covariable strata. The degrees of freedom of G^2 which is distributed approximately chi-squared, depend on the number of cells of data and is reduced each time an addition variable is fitted. For testing significance of the parameter associated with a factor(s) one should fit nested models and evaluate the difference in deviance from adding terms to a model. This difference is distributed as a chisquared (under the null hypothesis of no effect) the degrees of freedom being the reduction in degrees of freedom of the deviance achieved by adding the term(s). For example, using the data on lung cancer presented in Table 5.18, fitting length of employment as a variable with 4 levels, reduces the deviance in the simplest model (only a is estimated) by 3.5. This is compared to the value of chisquared on 3 degrees of freedom, and thus length of employment is not significant.

The lack of significance of this parameter may also be gauged by dividing the estimates of the parameter b by its standard error and comparing the result to a standard normal distribution. The standardised normal deviates in that example are all quite low (1.1, 1.3, - 0.5), none statistically significant. For clarity, results are presented as relative risks (the exponential of the parameter b in the above equation).

Table 4.3

Comparison of expected deaths derived from national and regional reference rates

Mortality from all causes (000-999)

Fac-tory	Period	Exposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Unexposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exposed + Unexposed Exp(Reg)/ Exp(Nat)
10	1966-70	44	32.55	34.99	1.075	8	7.83	8.43	1.076	
	1971-75	48	35.95	38.67	1.076	12	11.27	12.65	1.122	
	1976-78	28	22.84	24.58	1.076	4	9.09	9.95	1.095	
	1966-78	120	91.35	98.24	1.076	24	28.19	31.03	1.101	1.081
11	1966-70	53	37.99	41.67	1.097	5	7.47	8.17	1.094	
	1971-75	62	49.86	54.27	1.088	7	11.05	12.36	1.119	
	1976-78	34	35.37	39.07	1.105	9	8.12	9.11	1.122	
	1966-78	149	123.22	135.00	1.096	21	26.64	29.65	1.113	1.099
12	1966-70	12	11.04	11.95	1.082	3	2.28	2.44	1.071	
	1971-75	13	14.72	16.71	1.135	4	2.90	3.26	1.125	
	1976-78	10	9.98	10.81	1.084	1	2.30	2.52	1.095	
	1966-78	35	35.74	39.47	1.105	8	7.48	8.22	1.099	1.104
13	1966-70	16	12.59	13.18	1.047	3	4.19	4.27	1.018	
	1971-75	17	17.91	17.28	0.965	3	6.31	6.01	0.952	
	1976-78	9	12.89	11.69	0.907	2	4.84	4.47	0.925	
	1966-78	42	43.38	42.16	0.972	8	15.34	14.74	0.962	0.969
14	1966-70	77	64.47	70.29	1.090	13	13.97	14.93	1.068	
	1971-75	121	87.57	95.01	1.085	16	19.24	20.86	1.084	
	1976-78	89	63.19	68.99	1.092	9	14.02	14.89	1.062	
	1966-78	287	215.24	234.29	1.089	38	47.24	50.68	1.073	1.086
15	1966-70	25	20.51	21.83	1.064	2	1.56	1.75	1.123	
	1971-75	30	25.54	30.31	1.187	3	1.92	2.15	1.121	
	1976-78	15	18.25	22.18	1.215	0	1.31	1.62	1.239	
	1966-78	70	64.30	74.32	1.156	5	4.78	5.52	1.154	1.156
16	1966-70	25	32.06	35.32	1.102	4	5.52	5.94	1.077	
	1971-75	39	46.82	51.91	1.109	9	7.63	8.59	1.125	
	1976-78	32	34.96	39.30	1.124	3	5.67	6.24	1.101	
	1966-78	96	113.84	126.53	1.111	16	18.82	20.77	1.104	1.110
17	1966-70	25	21.44	21.09	0.984	6	7.41	7.49	1.010	
	1971-75	36	27.73	28.70	1.035	10	9.24	9.52	1.030	
	1976-78	17	19.09	19.05	0.998	8	6.65	6.38	0.959	
	1966-78	78	68.26	68.84	1.009	24	23.30	23.38	1.004	1.007
18	1966-70	70	50.36	54.99	1.092	57	39.20	42.95	1.096	
	1971-75	77	65.83	72.01	1.094	49	43.96	47.09	1.071	
	1976-78	53	46.56	50.68	1.089	37	27.63	29.84	1.080	
	1966-78	200	162.75	177.68	1.092	143	110.79	119.88	1.082	1.088
19	1966-70	16	18.50	22.78	1.232	7	10.81	13.23	1.223	
	1971-75	36	22.58	27.17	1.203	14	14.16	17.48	1.234	
	1976-78	20	14.12	17.55	1.242	9	10.51	12.97	1.234	
	1966-78	72	55.20	67.50	1.223	30	35.49	43.67	1.231	1.226
Tot.	1966-70	363	301.51	328.09	1.088	108	100.25	109.60	1.093	
	1971-75	479	394.51	432.05	1.095	127	127.67	139.96	1.096	
	1976-78	307	277.25	303.90	1.096	82	90.14	98.00	1.087	
	1966-78	1149	973.26	1064.04	1.093	317	318.05	347.55	1.093	
SMRs for totals:			118	108			100	91		

Table 4.4

Comparison of expected deaths derived from national and regional reference rates

Mortality from all neoplasms (140-209)

		Exposed:				Unexposed:				Exposed + Unexposed
Factory	Period	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exp(Reg)/ Exp(Nat)
10	1966-70	15	7.82	8.05	1.029	3	2.10	2.15	1.024	
	1971-75	14	8.93	9.19	1.029	4	3.02	3.19	1.055	
	1976-78	10	5.96	6.16	1.034	1	2.44	2.52	1.032	
	1966-78	39	22.71	23.40	1.030	8	7.56	7.85	1.039	1.032
11	1966-70	27	9.82	10.28	1.047	1	2.00	2.10	1.051	
	1971-75	23	13.14	13.61	1.036	3	2.93	2.99	1.022	
	1976-78	11	9.59	10.02	1.045	3	2.13	2.24	1.050	
	1966-78	61	32.54	33.90	1.042	7	7.06	7.33	1.039	1.041
12	1966-70	4	2.84	2.91	1.023	1	0.60	0.61	1.003	
	1971-75	1	3.79	3.95	1.040	2	0.77	0.81	1.052	
	1976-78	3	2.60	2.65	1.022	1	0.61	0.63	1.029	
	1966-78	8	9.23	9.51	1.030	4	1.99	2.05	1.031	1.030
13	1966-70	1	3.19	3.23	1.013	1	1.10	1.11	1.001	
	1971-75	4	4.49	4.53	1.009	0	1.68	1.70	1.009	
	1976-78	1	3.29	3.21	0.977	0	1.31	1.26	0.962	
	1966-78	6	10.97	10.97	1.001	1	4.10	4.06	0.992	0.998
14	1966-70	17	17.13	18.64	1.088	1	3.63	3.83	1.055	
	1971-75	41	23.48	25.28	1.077	4	5.00	5.36	1.073	
	1976-78	33	17.35	18.69	1.078	1	3.71	3.86	1.039	
	1966-78	91	57.96	62.62	1.080	6	12.34	13.05	1.058	1.076
15	1966-70	5	5.32	5.82	1.095	0	0.42	0.48	1.128	
	1971-75	8	6.80	7.70	1.132	0	0.52	0.56	1.079	
	1976-78	1	4.93	5.82	1.181	0	0.36	0.44	1.230	
	1966-78	14	17.04	19.33	1.135	0	1.30	1.48	1.136	1.135
16	1966-70	8	8.42	8.86	1.052	0	1.42	1.46	1.025	
	1971-75	8	12.46	12.98	1.042	1	1.97	2.08	1.056	
	1976-78	13	9.56	10.06	1.052	1	1.46	1.52	1.042	
	1966-78	29	30.45	31.91	1.048	2	4.85	5.06	1.043	1.047
17	1966-70	7	5.52	5.20	0.941	2	1.85	1.75	0.950	
	1971-75	4	7.29	7.07	0.971	2	2.35	2.29	0.975	
	1976-78	6	5.15	4.89	0.950	2	1.70	1.60	0.943	
	1966-78	17	17.96	17.16	0.956	6	5.89	5.64	0.958	0.956
18	1966-70	20	12.99	13.61	1.048	12	9.54	9.80	1.028	
	1971-75	18	17.29	18.06	1.045	14	10.59	10.79	1.020	
	1976-78	14	12.70	13.26	1.044	8	6.83	7.06	1.033	
	1966-78	52	42.98	44.93	1.045	34	26.95	27.66	1.026	1.038
19	1966-70	3	4.58	5.34	1.166	0	2.76	3.22	1.168	
	1971-75	14	5.68	6.43	1.130	3	3.73	4.24	1.138	
	1976-78	5	3.79	4.31	1.138	1	2.79	3.16	1.132	
	1966-78	22	14.05	16.07	1.144	4	9.28	10.63	1.145	1.145
Tot.	1966-70	107	77.62	81.93	1.056	21	25.42	26.50	1.043	
	1971-75	135	103.35	108.80	1.053	33	32.55	34.02	1.045	
	1976-78	97	74.92	79.09	1.056	18	23.35	24.29	1.040	
	1966-78	339	255.89	269.81	1.054	72	81.32	84.81	1.043	
SMRs for totals:			132	126			89	85		

Table 4.5

Comparison of expected deaths derived from national and regional reference rates

Mortality from cancers of the trachea, bronchus and lung (162)

Fac-tory	Period	Exposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Unexposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exposed + Unexposed Exp(Reg)/ Exp(Nat)
10	1966-70	8	3.26	3.35	1.030	2	0.91	0.94	1.032	
	1971-75	7	3.75	3.92	1.046	2	1.30	1.40	1.073	
	1976-78	2	2.48	2.60	1.048	1	1.02	1.06	1.042	
	1966-78	17	9.49	9.88	1.041	5	3.23	3.40	1.052	1.044
11	1966-70	12	4.18	4.41	1.055	1	0.87	0.92	1.057	
	1971-75	15	5.62	5.94	1.058	0	1.26	1.29	1.018	
	1976-78	6	4.02	4.24	1.055	1	0.89	0.94	1.055	
	1966-78	33	13.82	14.60	1.056	2	3.02	3.14	1.040	1.053
12	1966-70	2	1.22	1.24	1.020	0	0.26	0.26	0.989	
	1971-75	0	1.61	1.67	1.039	0	0.33	0.35	1.060	
	1976-78	3	1.07	1.10	1.028	1	0.25	0.26	1.035	
	1966-78	5	3.89	4.01	1.030	1	0.85	0.88	1.031	1.030
13	1966-70	0	1.31	1.34	1.027	1	0.47	0.47	1.004	
	1971-75	0	1.84	1.88	1.017	0	0.71	0.73	1.021	
	1976-78	0	1.33	1.32	0.992	0	0.54	0.52	0.965	
	1966-78	0	4.48	4.54	1.012	1	1.72	1.72	0.999	1.009
14	1966-70	9	7.37	8.07	1.095	0	1.54	1.62	1.053	
	1971-75	26	10.11	10.92	1.080	1	2.11	2.26	1.073	
	1976-78	19	7.31	8.13	1.113	0	1.52	1.62	1.065	
	1966-78	54	24.79	27.11	1.094	1	5.17	5.50	1.065	1.089
15	1966-70	3	2.28	2.51	1.104	0	0.19	0.21	1.127	
	1971-75	6	2.92	3.45	1.180	0	0.23	0.25	1.123	
	1976-78	0	2.06	2.57	1.247	0	0.15	0.20	1.307	
	1966-78	9	7.26	8.53	1.175	0	0.57	0.67	1.174	1.175
16	1966-70	4	3.57	3.81	1.068	0	0.60	0.62	1.035	
	1971-75	3	5.31	5.64	1.062	0	0.82	0.88	1.073	
	1976-78	9	4.00	4.24	1.060	0	0.59	0.63	1.057	
	1966-78	16	12.88	13.69	1.063	0	2.01	2.13	1.057	1.062
17	1966-70	6	2.35	2.16	0.920	2	0.76	0.70	0.921	
	1971-75	1	3.12	2.89	0.929	2	0.98	0.92	0.934	
	1976-78	3	2.16	2.01	0.930	1	0.69	0.65	0.934	
	1966-78	10	7.63	7.07	0.927	5	2.43	2.26	0.930	0.927
18	1966-70	10	5.49	5.82	1.061	7	3.98	4.05	1.016	
	1971-75	10	7.36	7.88	1.071	7	4.34	4.48	1.032	
	1976-78	7	5.32	5.64	1.059	2	2.74	2.88	1.050	
	1966-78	27	18.17	19.34	1.064	16	11.07	11.40	1.031	1.052
19	1966-70	2	1.88	2.23	1.188	0	1.15	1.38	1.200	
	1971-75	4	2.35	2.76	1.178	2	1.56	1.85	1.184	
	1976-78	4	1.55	1.85	1.191	0	1.14	1.35	1.186	
	1966-78	10	5.78	6.85	1.185	2	3.85	4.58	1.189	1.187
Tot.	1966-70	56	32.89	34.96	1.063	13	10.73	11.16	1.041	
	1971-75	72	43.99	46.96	1.068	14	13.65	14.40	1.055	
	1976-78	53	31.31	33.71	1.076	6	9.55	10.11	1.059	
	1966-78	181	108.19	115.62	1.069	33	33.92	35.68	1.052	
SMRs for totals:			167	157			97	92		

Table 4.6

Comparison of expected deaths derived from national and regional reference rates

Mortality from cancer of the stomach (151)

Factory	Period	Exposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Unexposed: Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exposed + Unexposed Exp(Reg)/ Exp(Nat)
10	1966-70	1	0.93	0.95	1.018	0	0.24	0.24	1.008	
	1971-75	3	0.96	1.02	1.059	1	0.32	0.35	1.097	
	1976-78	2	0.59	0.63	1.075	0	0.24	0.25	1.071	
	1966-78	6	2.48	2.60	1.048	1	0.80	0.85	1.063	1.051
11	1966-70	4	1.12	1.16	1.037	0	0.23	0.24	1.035	
	1971-75	2	1.39	1.49	1.067	0	0.31	0.33	1.051	
	1976-78	1	0.93	1.02	1.090	0	0.21	0.23	1.095	
	1966-78	7	3.45	3.66	1.063	0	0.76	0.80	1.058	1.062
12	1966-70	1	0.33	0.33	1.009	0	0.07	0.07	1.000	
	1971-75	0	0.41	0.44	1.073	1	0.08	0.09	1.096	
	1976-78	0	0.26	0.27	1.062	0	0.06	0.06	1.066	
	1966-78	1	1.00	1.05	1.050	1	0.21	0.22	1.056	1.051
13	1966-70	0	0.36	0.32	0.894	0	0.12	0.11	0.893	
	1971-75	1	0.47	0.43	0.923	0	0.18	0.16	0.926	
	1976-78	0	0.31	0.29	0.911	0	0.13	0.11	0.897	
	1966-78	1	1.14	1.04	0.910	0	0.42	0.38	0.905	0.909
14	1966-70	2	1.94	2.17	1.120	0	0.41	0.45	1.083	
	1971-75	5	2.48	2.78	1.121	0	0.53	0.59	1.115	
	1976-78	4	1.68	1.89	1.123	0	0.36	0.39	1.080	
	1966-78	11	6.09	6.84	1.122	0	1.31	1.43	1.095	1.117
15	1966-70	1	0.61	0.82	1.343	0	0.05	0.06	1.286	
	1971-75	1	0.72	0.91	1.258	0	0.06	0.07	1.196	
	1976-78	0	0.48	0.58	1.212	0	0.04	0.04	1.222	
	1966-78	2	1.82	2.32	1.275	0	0.14	0.17	1.234	1.272
16	1966-70	1	0.94	0.98	1.039	0	0.16	0.16	1.006	
	1971-75	2	1.31	1.40	1.074	0	0.21	0.22	1.087	
	1976-78	2	0.92	1.01	1.103	0	0.14	0.15	1.085	
	1966-78	5	3.17	3.40	1.072	0	0.51	0.54	1.063	1.071
17	1966-70	0	0.64	0.60	0.945	0	0.21	0.20	0.953	
	1971-75	0	0.78	0.77	0.987	0	0.25	0.25	1.004	
	1976-78	0	0.50	0.52	1.036	0	0.16	0.17	1.024	
	1966-78	0	1.92	1.89	0.986	0	0.63	0.62	0.992	0.987
18	1966-70	6	1.47	1.52	1.035	2	1.13	1.15	1.017	
	1971-75	3	1.82	1.96	1.074	1	1.15	1.21	1.053	
	1976-78	2	1.23	1.34	1.092	2	0.67	0.72	1.076	
	1966-78	11	4.52	4.82	1.066	5	2.95	3.08	1.044	1.058
19	1966-70	0	0.53	0.57	1.078	0	0.31	0.34	1.097	
	1971-75	3	0.60	0.65	1.082	0	0.39	0.42	1.093	
	1976-78	0	0.36	0.41	1.144	0	0.27	0.30	1.143	
	1966-78	3	1.49	1.63	1.095	0	0.96	1.07	1.108	1.100
Tot.	1966-70	16	8.86	9.42	1.063	2	2.93	3.02	1.029	
	1971-75	20	10.94	11.84	1.083	3	3.47	3.70	1.066	
	1976-78	11	7.26	7.97	1.097	2	2.28	2.45	1.075	
	1966-78	47	27.07	29.24	1.080	7	8.68	9.17	1.056	
SMRs for totals:			174	161			81	76		

Table 4.7

Comparison of expected deaths derived from national and regional reference rates

Mortality from diseases of the respiratory system (460-519)

		Exposed:				Unexposed:				Exposed + Unexposed
Factory	Period	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exp(Reg)/ Exp(Nat)
10	1966-70	12	4.62	5.13	1.111	0	0.90	1.03	1.140	
	1971-75	5	4.75	5.23	1.100	0	1.26	1.51	1.201	
	1976-78	4	2.99	3.32	1.112	0	1.10	1.29	1.175	
	1966-78	21	12.36	13.68	1.107	0	3.26	3.83	1.175	1.121
11	1966-70	9	4.68	5.43	1.160	1	0.92	1.06	1.148	
	1971-75	8	5.73	6.49	1.131	0	1.33	1.61	1.213	
	1976-78	2	4.10	4.87	1.188	1	1.05	1.26	1.208	
	1966-78	19	14.51	16.78	1.157	2	3.30	3.93	1.193	1.163
12	1966-70	3	1.45	1.65	1.134	1	0.29	0.32	1.122	
	1971-75	3	1.87	2.26	1.213	0	0.34	0.41	1.204	
	1976-78	0	1.29	1.49	1.148	0	0.29	0.34	1.170	
	1966-78	6	4.61	5.39	1.170	1	0.91	1.07	1.168	1.170
13	1966-70	2	1.52	1.47	0.969	0	0.46	0.43	0.922	
	1971-75	3	2.15	2.08	0.970	0	0.68	0.62	0.910	
	1976-78	3	1.61	1.38	0.860	0	0.54	0.50	0.922	
	1966-78	8	5.27	4.94	0.936	0	1.68	1.54	0.917	0.932
14	1966-70	15	7.53	9.40	1.248	2	1.72	2.08	1.213	
	1971-75	24	9.63	12.13	1.259	1	2.26	2.80	1.237	
	1976-78	13	7.05	9.14	1.296	2	1.69	2.10	1.244	
	1966-78	52	24.22	30.67	1.266	5	5.67	6.98	1.232	1.260
15	1966-70	2	2.61	3.08	1.180	1	0.19	0.24	1.266	
	1971-75	3	2.97	3.88	1.307	0	0.22	0.27	1.227	
	1976-78	7	2.17	2.95	1.360	0	0.15	0.20	1.358	
	1966-78	12	7.75	9.91	1.279	1	0.56	0.71	1.277	1.279
16	1966-70	3	3.66	4.32	1.180	0	0.67	0.76	1.134	
	1971-75	9	5.15	6.06	1.177	2	0.90	1.07	1.188	
	1976-78	4	3.89	4.86	1.248	0	0.72	0.85	1.175	
	1966-78	16	12.71	15.24	1.200	2	2.29	2.68	1.168	1.195
17	1966-70	4	2.73	2.86	1.046	0	0.96	1.05	1.086	
	1971-75	6	3.28	3.59	1.096	0	1.11	1.20	1.075	
	1976-78	2	2.26	2.28	1.012	2	0.85	0.78	0.915	
	1966-78	12	8.26	8.73	1.056	2	2.93	3.03	1.033	1.050
18	1966-70	7	6.03	6.96	1.154	16	5.63	6.43	1.141	
	1971-75	11	7.40	8.44	1.140	6	6.08	6.63	1.090	
	1976-78	6	5.19	5.96	1.149	8	3.91	4.38	1.119	
	1966-78	24	18.62	21.35	1.147	30	15.63	17.43	1.115	1.132
19	1966-70	2	2.40	2.42	1.011	0	1.29	1.30	1.009	
	1971-75	2	2.73	2.57	0.944	1	1.55	1.56	1.008	
	1976-78	1	1.58	1.73	1.091	0	1.20	1.28	1.069	
	1966-78	5	6.71	6.72	1.003	1	4.04	4.14	1.026	1.011
Tot.	1966-70	59	37.22	42.71	1.147	21	13.04	14.70	1.127	
	1971-75	74	45.66	52.74	1.155	10	15.74	17.68	1.123	
	1976-78	42	32.13	37.98	1.182	13	11.49	12.98	1.129	
	1966-78	175	115.01	133.42	1.160	44	40.26	45.35	1.126	
SMRs for totals:			152	131			109	97		

Table 4.8

Comparison of expected deaths derived from national and regional reference rates

Mortality from diseases of the circulatory system(390-458)

		Exposed:				Unexposed:				Exposed + Unexposed
Fac-tory	Period	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Obs.	Exp. (Nat.)	Exp. (Reg.)	Exp(Reg)/ Exp(Nat)	Exp(Reg)/ Exp(Nat)
10	1966-70	13	14.88	17.62	1.184	5	3.45	4.01	1.164	
	1971-75	24	18.50	20.42	1.104	6	5.72	6.62	1.158	
	1976-78	13	11.72	12.92	1.103	3	4.66	5.23	1.124	
	1966-78	50	45.10	50.97	1.130	14	13.82	15.87	1.148	1.134
11	1966-70	15	16.88	20.15	1.194	3	3.30	3.92	1.186	
	1971-75	24	25.27	28.34	1.121	4	5.60	6.49	1.159	
	1976-78	18	18.08	20.53	1.135	5	4.16	4.79	1.153	
	1966-78	57	60.24	69.02	1.146	12	13.06	15.19	1.164	1.149
12	1966-70	5	4.87	5.78	1.186	0	0.99	1.16	1.173	
	1971-75	6	7.44	8.76	1.176	1	1.45	1.69	1.164	
	1976-78	6	5.08	5.66	1.114	0	1.17	1.32	1.126	
	1966-78	17	17.39	20.19	1.161	1	3.61	4.17	1.154	1.160
13	1966-70	10	5.49	5.66	1.031	2	1.76	1.77	1.005	
	1971-75	7	9.05	8.49	0.939	3	3.11	2.88	0.926	
	1976-78	5	6.55	5.75	0.878	1	2.43	2.18	0.895	
	1966-78	22	21.09	19.90	0.944	6	7.30	6.82	0.935	0.941
14	1966-70	35	28.41	32.53	1.145	9	6.04	6.86	1.136	
	1971-75	43	44.25	46.93	1.060	11	9.63	10.25	1.064	
	1976-78	38	32.30	34.28	1.061	5	7.11	7.35	1.035	
	1966-78	116	104.97	113.74	1.084	25	22.78	24.47	1.074	1.082
15	1966-70	15	9.06	11.18	1.234	1	0.68	0.88	1.283	
	1971-75	16	12.86	15.39	1.196	3	0.96	1.08	1.126	
	1976-78	7	9.30	11.20	1.205	0	0.67	0.82	1.228	
	1966-78	38	31.22	37.78	1.210	4	2.31	2.78	1.201	1.209
16	1966-70	13	13.90	16.59	1.194	3	2.39	2.81	1.173	
	1971-75	18	23.46	26.90	1.147	4	3.83	4.46	1.163	
	1976-78	12	17.76	20.52	1.156	2	2.88	3.25	1.131	
	1966-78	43	55.11	64.01	1.161	9	9.10	10.52	1.156	1.161
17	1966-70	11	9.55	10.26	1.075	4	3.31	3.68	1.113	
	1971-75	25	14.08	14.63	1.039	8	4.70	4.82	1.025	
	1976-78	8	9.76	10.01	1.026	3	3.40	3.35	0.985	
	1966-78	44	33.38	34.90	1.046	15	11.41	11.85	1.039	1.044
18	1966-70	34	22.24	26.37	1.186	24	17.60	21.40	1.215	
	1971-75	40	33.28	37.48	1.126	22	22.48	24.76	1.101	
	1976-78	29	23.75	26.57	1.119	18	14.07	15.57	1.107	
	1966-78	103	79.26	90.42	1.141	64	54.15	61.73	1.140	1.140
19	1966-70	8	8.11	11.37	1.402	6	4.62	6.33	1.369	
	1971-75	16	11.35	14.28	1.258	7	7.00	9.00	1.285	
	1976-78	10	7.14	9.00	1.260	6	5.29	6.63	1.252	
	1966-78	34	26.60	34.65	1.302	19	16.92	21.96	1.298	1.301
Tot.	1966-70	159	133.38	157.50	1.181	57	44.15	52.81	1.196	
	1971-75	219	199.54	221.62	1.111	69	64.49	72.04	1.117	
	1976-78	146	141.44	156.45	1.106	43	45.83	50.50	1.102	
	1966-78	524	474.37	535.56	1.129	169	154.46	175.35	1.135	
SMRs for totals:			110	98			109	96		

Table 4.9
Geographical Areas for which local reference correction factors have been derived

Foundry	Town/City containing foundry	1966-78 Ref Rates Region	England and Wales Supplement 1969-73 Region	County	Subcounty
10	Sheffield	Yorkshire & Humberside	Yorkshire & Humberside	Sheffield CB	Sheffield CB
18	Sheffield	"	"	"	"
11	Leeds	"	"	Leeds CB	Leeds CB
12	Scunthorpe	"	"	Lincolnshire (Parts of Lindsey) AC	Lincolnshire (Parts of Lindsey) Urban Aggregate
16	Penistone	"	"	Yorkshire West AC Aggregate	Yorkshire West Riding Urban
13	Braintree	South East	South East	Essex AC	Essex Urban Aggregate
14	Walsall	West Midlands	West Midlands	Walsall CB	Walsall CB
15	Guisborough	North	North	Yorkshire, North Riding AC	Yorkshire, North Riding Urban Aggregate
17	Sutton in Ashfield	East Midlands	East Midlands	Nottinghamshire AC	Nottinghamshire Urban Aggregate
19	Leven	Scotland	-	-	-

Abbreviations: CB County Borough
AC Administrative County

Table 4.10
SMRs by factory (exposed and unexposed) and corresponding SMR by geographical area. Mortality from all causes.

Foundry code	Cohort SMRs Exposed	Unexposed	Correction factor (1966-1978)	SMRs (1969-73) Region	County	Subcounty
10	122	82	108	105	105	105
11	114	97	110	105	108	108
12	105	113	110	105	97	104
13	93	59	97	93	91	93
14	125	93	109	104	114	114
15	106	108	116	109	97	103
16	95	110	111	105	103	105
17	106	97	101	98	96	98
18	115	122	109	105	105	105
19	123	107	123	N/A	N/A	N/A

Table 4.11

SMRs by foundry (exposed and unexposed) and corresponding SMR by geographical area. Mortality from lung cancer

Foundry code	Cohort SMRs Exposed	Cohort SMRs Unexposed	Correction factor (1966-1978)	SMRs (1969-73) Region	County	Subcounty
10	202	163	104	101	127	127
11	188	76*	105	101	126	126
12	152	57*	103	101	80	89
13	35*	61*	101	105	95	101
14	205	42*	109	101	119	119
15	117	0*	118	108	82	93
16	122	163*	106	101	85	88
17	95	208	93	90	87	89
18	129	134	105	101	127	127
19	146	149	119	N/A	N/A	N/A

*based on less than 10 deaths

Table 4.12

SMRs by foundry (exposed and unexposed) and corresponding SMR by geographical area. Mortality from non-malignant respiratory disease

Foundry code	Cohort SMRs Exposed	Unexposed	Correction factor (1966-1978)	SMRs (1969-73) Region	County	Subcounty
10	165	30*	112	107	107	107
11	116	97*	116	107	106	106
12	103	130*	117	107	78	90
13	104	29*	93	93	85	90
14	206	114	126	113	162	162
15	141	92*	128	108	75	74
16	124	116*	120	107	106	109
17	156	123*	105	99	102	106
18	125	195	113	107	107	107
19	82	25*	101	N/A	N/A	N/A

*based on less than 10 deaths

CHAPTER 5 - MORTALITY RESULTS

5.1 Introduction

In Appendix C, 243 detailed tables present the results of the mortality analysis by various subdivisions of cause, job category, work area, exposure category, duration of follow up and employment, age at death and entry, date of entry and date of terminating. Standardised Mortality Ratios (SMRs) are presented relative to national rates and regional (and in some cases subcounty level) correction factors have been applied to the results. Most of the SMRs are for the cause of death categories of primary interest. The results summarised in this section are a selection relevant to an undertanding of the overall excess mortality and mortality from lung cancer, stomach cancer, non-malignant respiratory disease and circulatory disease with most emphasis being given to the lung cancer results.

The subcohort of cohort members identified from their surnames as of immigrant origin, has a significant deficit of mortality, 31 observed against 77.3 expected deaths. This deficit is present in virtually all cause of death categories and is most marked for malignant neoplasms (2/19.9). There were no lung cancer deaths, 7.8 expected in this group. The mortality by detailed cause is presented in Appendix C, Table 1.

Because of the high rate of loss to follow-up which in turn explains the significant deficit of deaths, these workers have been excluded from the bulk of the analysis. Thus the remaining cohort members are not entirely representative, but because of their more complete follow-up than if this subgroup were to remain included, the validity of the results has been improved.

5.2 Overall mortality

Table 5.1 presents the mortality by detailed cause for the entire cohort (after excluding the 623 immigrant workers). For 26 deaths the cause is unknown, in the main because the death was identified in National Insurance records but no death certificate could be traced in the Office of Population Censuses and Surveys records. This represents less than one percent of the deaths and is unlikely to be concentrated in particular cause categories and thus the cause-specific SMRs are probably not underestimated to any important degree by these 26 with unknown cause.

Overall, there is significant excess mortality for this cohort with an SMR of 111 (2789/2507) relative to national rates. This excess derives in the main from significant excesses of cancers of the lung and stomach, and diseases of both the respiratory and circulatory systems, and each of these four categories of cause of death are reported in detail below.

The significant deficit for the remainder category is hard to interpret. This category consists of mainly the following cause of death groups: infective and parasitic diseases, endocrine, nutritional and metabolic diseases, diseases of the nervous system and sense organs and diseases of the genito-urinary system. The deficit is present in all factory and work area subgroups of the population with more than very few expected deaths.

In Table 5.2 the all causes mortality is presented, subdivided by work area and follow-up. The overall SMR of 111 is significant at the 0.1% level but is reduced to 102 (non-significant) by applying the regional correction. Applying the correction factor for subcounty mortality has slightly less effect, reducing the SMR for the exposed workers together from 113 to 106, compared to 104 after the regional correction. The SMR is rather high for an industrial cohort and even for the first 10 years since first employment the SMR of 98 is not as low as one might expect (although it is 90 after applying the regional correction). The SMR in the first 10 years is low for the fettling (SMR = 73) and maintenance (SMR = 85) subcohorts only.

By individual factory cohort (Table 5.3) all but factories 17 and 18 show low SMRs in the early follow-up for the exposed and these two also show a high SMR in the early follow-up for the unexposed (along with factory 10, located in the same city as factory 18). For both these factories the SMR tends to fall with time since first exposure, a rather unusual pattern. The high initial SMR is not explained by the general risk in these two towns, as the SMR (during 1969-73) is 98 for the town containing factory 17 and 105 for factory 18.

The excess overall mortality is entirely accounted for by neoplastic, respiratory and circulatory diseases, and these more specific categories are analysed in more detail.

5.3 Malignant neoplasms

Table 5.4 presents the mortality from all malignant neoplasms by work area and years since first exposure. An excess is present in both the foundry and fettling shop populations, with no increase since time from first employment in the foundry, but in the fettling group the first follow-up period shows a low SMR. A 40% excess mortality is present in 3 out of 4 follow-up groups for the foundry subcohort and regional correction has little impact. As was evident in Table 5.1, the overall excess mortality from malignant neoplasms (121 deaths) is entirely accounted for by an excess of lung cancer (123 excess deaths) and stomach cancers (30 excess deaths), however there are some other excesses of interest. These include buccal cavity and pharynx among foundry workers (6/3.7), laryngeal cancer among fettling shop workers (5/1.1), rectal cancer among moulders (6/2.5) and shotblasters (2/0.5) and bladder cancer among foundry labourers (5/3.3), fettlers (2/0.7) and shotblasters (2/0.4).

By individual occupational categories all those with an excess for all cancers have the absolute excess accounted for by lung and stomach cancer excesses with the notable exception of those whose main job was furnacemen/caster. For all neoplasms they have a significant SMR of 170 (62/36.4) an excess of 25.6 deaths, 12.6 of which came from lung cancer (28/15.4) and 4.1 of which came from stomach cancer (8/3.9). This left 26/17.1 for the remaining cancers with excesses for several sites; buccal cavity (2/0.5), small intestine (6/2.2, p< 0.05), prostate (3/1.3), bone cancer (1/0.3) liver cancer (1/0.3), and nasal cavities (2/0.1). For nasal cavities this is the only excess in the whole cohort as the overall mortality was 4 observed versus 1.5 expected (with no cases, 0.04 expected in the pattern shop).

There were in total 3 deaths from pleural mesothelioma (ICD code 163). This represents a crude rate of 1.1 deaths per 100,000 person-years, compared to a crude rate of 0.4 per 100,000 for 15-64 year olds during 1970-72 (OPCS, 1978), although the crude rate has increased since then. Thus it would appear that these three cases represent a slight but not substantial excess over expected numbers.

5.4 Lung cancer

The largest contribution to the excess mortality of this cohort comes from cancers of the trachea, bronchus and lung (henceforth refered to as lung cancer) and the mortality for this cause by work area and follow-up is shown in Table 5.5. The SMRs are lower for the first 10 years since first employment (except for the foundry subgroup) and both the foundry and fettling shop groups show significant excess mortality both before and after regional correction. The unexposed group show a SMR of 119 and the SMRs for the foundry and fettling shop are both significantly ($p < 0.05$) higher than the unexposed group's SMR.

Subdivided by main occupational category (Table 5.6), it is evident that the excess mortality is distributed across many occupational categories, being statistically significant in several categories with larger numbers of observed and expected deaths. In the foundry, every category (except shellmoulders with only 0.9 expected deaths) shows an excess, with SMRs ranging from 133 to 193. In the fettling shop every job is in excess, with SMRs ranging from 113 to 245. The precision foundry workers also show an excess (3/0.7).

Thus the risk already identified in the foundry and fettling shop does not appear to be concentrated in any particular occupations although it is somewhat higher for furnacemen, casters and furnace repairmen in the foundry and fettlers and heat treatment loaders in the fettling shop. Outside the foundry and fettling shop, the machine shop workers, both skilled machinists and labourers show an approximate 50% excess of lung cancer, the maintenance fitters' mates, (effectively labourers) show a significant excess and the other categories show mainly a deficit.

Welders and burners occurred in three situations: In the fettling shop (burning off headers and risers, burning off adhered sand and repairing castings), as maintenance welders and fabricating and repairing in the machine shop. Aggregating all welders and burners together, there were 14 lung cancers observed against 10.1 expected: an SMR of 139, (not significant).

The unexposed, while relatively unexposed to the foundry environment are clearly at some risk of lung cancer themselves in the machine shop environment and there is an excess among unskilled maintenance workers, who do spend some of their time in the foundry/fettling shop areas.

For the exposed group, it is apparent from Table 5.7 that their mortality varies between factories quite markedly and that the regional correction factors only reduce that variation very slightly. Virtually all the excess comes from 3 factories: 10, 11 and 14, and in none of these three is there any increase of SMR with time since first employment. The overall tendency to increase with time since first employment derives from all the other factories, each of which showing moderate, non-significant excesses, except factory 13 which shows a marked deficit (3/8.6).

Table 5.8 presents the lung cancer mortality by age at death for various causes. Apart from the quite high figure for 35-44 years, which is based on rather small numbers, the risk is quite constant over the various age groups. The confidence intervals are also shown in this table and the lung cancer SMR of 154 is clearly quite stable (95% interval 137 to 172), after regional correction the SMR is 145 with a confidence interval of 130 to 162.

Table 5.9 presents the lung cancer mortality for the exposed workers by duration of employment and factory. Pooled together, the mortality rises for the first three periods and then falls again. For the 3 factories (10, 11 and 14) with significant overall excesses, there is even less pattern with no increase evident over the first 3 periods. Only considering the mortality at least 10 or at least 20 years since first employment still shows no factory-specific pattern of increasing risk with duration of employment. The following three Tables (5.10, 5.11 and 5.12) present the mortality by duration and follow-up for those only employed in the foundry, fettling shop and maintenance occupations respectively. For the foundry subcohort, the risk does not rise uniformly although the highest SMR is in the 20 or more years' employment category. In the fettling shop the risk rises with the first three employment periods, due mainly to a cluster in the 10-14 years employment and 10-19 years follow-up group. For the maintenance workers there is no overall excess, and there is a suggestion of a tendency for the SMR to fall with increasing duration of employment. By comparison, Table 5.13 shows the results by duration of employment for the unexposed subcohort which suggests a slight tendency for the risk to increase with duration of employment, but there is not a significant trend, (X_1^2 = 0.2).

Table 5.14 shows the lung cancer mortality by cumulative employment in each of the three categories, dust exposed, fume exposed and silica exposed, as defined in Chapter 3. Because only some of each individual's employment history may be used to calculate the cumulative exposure, some people are exposed for less than one year although employed at least one year in total. The SMR is highest in the 10-14 years' employment period in each case, and for none of these three categories of exposure does a test for trend with increasing exposure yield a significant result.

Table 5.15 presents the lung cancer mortality by cumulative duration of employment for exposed and unexposed workers in small towns and large towns. For the small towns the overall risk is higher for the unexposed who also show the highest mortality for the longest employment periods, though the numbers are small. There is however no trend with duration of employment. For the large towns, there is no excess for the unexposed and there is a substantial excess for the exposed, as is to be expected as they include factories 10, 11 and 14 (in Sheffield, Leeds and Walsall respectively). There is no increase with duration of employment, and neither only considering long periods of follow-up, nor excluding factory 14 which dominates this set of data, reveals a pattern with duration.

Table 5.16 presents the lung cancer mortality by age at entry into the study factories for the exposed population. Over the 3 age groups which account for the bulk of the exposure (25-54), the risk is fairly constant and does not increase with time since first exposure. For the starters under 25 who would have had little if any previous employment in foundries there were few cases, but an excess 30 or more years since first exposure. Within each of the other age at start groups, the risk hardly changes by duration of follow-up.

Table 5.17 presents the lung cancer mortality data by date of entry. Later entry cohorts are less informative because of limited follow-up but within each cohort there appears to be a tendency for the risk to increase with time since first exposure. The SMR of 141 is a little lower for the first entry cohort, but high SMRs are evident for the first three entry cohorts. Mortality results analysed by date of exit are presented in Appendix C but are similar to the results by entry cohort with little change of SMR by date of exit group).

No clear patterns of lung cancer mortality have emerged when analysed by various time-related parameters: duration of employment, time since first exposure, age at entry and date of entry. However it is conceivable that these interact in ways which obscure the effect of one parameter when considered in isolation. Using GLIM, three parameters (age at entry, length of employment and date of entry) have been fitted, for the exposed subcohort to the pattern of lung cancer mortality, as both categorical and ordinal variables as follows:

Date of Entry	1946-50	1951-55	1956-60	1961-65
Categorical	ENT(1)	ENT(2)	ENT(3)	ENT(4)
Ordinal (ENTV)	0	1	2	3
Length of Employment	1-4	5-9	10-14	15+ years
Categorical	LEN(1)	LEN(2)	LEN(3)	LEN(4)
Ordinal (LENV)	0	1	2	3
Age at Entry	< 35	35-44	45-54	55+ years
Categorical	AGE(1)	AGE(2)	AGE(3)	AGE(4)
Ordinal (AGEV)	0	1	2	3

Within each categorical variable, the earliest, shortest or youngest category is the referent group. Separate parameters of the relative risk are estimated for each of the 3 categories relative to the referent category. When fitted as an ordinal variable, the relative risk of each unit increase in the variable is estimated e.g. for date of entry a five year increase in the date of start.

In Table 5.18 the results are presented for several models. The first model is without any variables and then each variable is fitted separately. For no model is the reduction in goodness of fit suggestive of a good fit. Only one of the parameters when added reduces the deviance to any extent and that is the length of employment fitted as a categorical variable, which rises over the first 3 groups and then falls again (see Table 5.9), however the fit remains quite poor ($X_3^2 = 3.5$). In Table 5.19, the effect is shown of adding each ordinal variable to a model already containing the other two as categorical variables. For simplicity only the relative risk estimates for the ordinal variables are shown, as the estimates for the categorical variables are barely different from the results fitted separately. In none of these models does adding the ordinal variable substantially improve the goodness of fit.

Results have already been published describing the fitting with GLIM of the lung cancer mortality results up to December 1978 (Fletcher and Ades 1984, reproduced in Appendix D). Considering only mortality from at least 10 years since first employment, both the fettling shop and foundry were reported as exhibiting trends of increasing mortality with duration of employment. A comparison group comprising all those employed outside the foundry and fettling shop showed a negative relationship with duration. None of these gradients were significantly different from zero but the foundry and fettling shop groups both showed a significant positive slope relative to the remainder. A similar analysis was repeated on the data followed up to the end of 1983 with some refinements. The population was divided into four groups: the cleaner reference group used throughout these analyses, those only employed in the foundry, those only employed in the fettling shop and the remainder (maintenance, mixed employment and precision foundry workers). Furthermore in this analysis additional potential confounders (age, date of entry and size of town) were fitted, although in fact they made virtually no difference to the fit of exposure group and duration of employment. Table 5.20 presents the results of fitting various models to the data. For the ordinal length of employment variable, the mean number of years in each of 6 duration categories (rounded to the nearest integer) has been used, divided by 10. Thus the estimate from the fit is the relative risk of each additional 10 years employment and the relative risk of the occupational category is the "risk at entry" i.e. the risk at zero years employment. The 4 exposure groups are unexposed (Ref), Foundry (Fou) Fettling Shop (Fet) and Maintenance and Mixed (Rem).

The best improvement of fit derives from the differences in risk between exposure groups (model 2 versus model 1, $X_3^2 = 8.6$, $p < 0.05$). The value of 1.20 for the reference category is directly equivalent to the SMR (120) for this group. The Relative Risks (RR) for the other groups represent the ratio of SMRs, thus the risk of 1.56 for the fettling is equivalent to an SMR of 1.56 x 120. The standardised normal deviate is 2.7 and therefore the fettling shop risk is significantly ($p < 0.01$) raised compared to the unexposed. The RR for the foundry is of borderline significance (SND = 1.8). Overall there is no relationship with duration of employment (the relative risk for LEN is 1.0 in model 5 and the deviances in models 5 and 2 are identical), but if all the cohort is constrained to have the same risk at entry (model 3), the reference and remainder groups have negative slopes and the foundry and fettling shop positive slopes (non significant). Thus in this artificial situation, the foundry and fettling groups have a positive slope relative to the reference category (RR for 10 years 1.22 and 1.33 respectively). However if different risks at entry are allowed (model 4) both foundry and fettling shops have very slight positive gradients, close to that of the referent category. Thus nearly all the variation is in the overall difference in risk between exposed and unexposed rather than differences in the relationship with duration of employment. The fairly strong negative slope for the remainder category in Model 4 derives mainly from the pattern of mortality among maintenance workers, for whom the excess is concentrated in short term workers (Table 5.12).

5.5 Stomach cancer

The mortality from stomach cancer, while significant overall (SMR = 143) is concentrated almost entirely in the foundry itself as is evident in Table 5.21. The highest mortality is in the second follow-up period and regional correction has negligible impact. There are a few excess cases in the early follow-up in the fettling and maintenance groups and a significant cluster (5/1.6) more than 30 years since first employment in the unexposed group, but in terms of absolute excess, 25 out of 30 excess cases are in the foundry subcohort. The mortality is a little higher in the younger age groups i.e. less than 55 years (Table 5.8). In the non-exposed there is a slight excess for inspection (4/2.0) but a significant excess for pattern shop labourers (4/0.9), Table 5.22. The excess is present in several foundry occupations but is highest for moulders (SMR = 209), furnacemen (205), furnace repair (364) and "other foundry jobs" (363), with the absolute excess coming mainly from moulders and furnace repairmen.

Subdivided by factory (Table 5.23) the factory (18) which contributes most of the excess also exhibits moderate excesses of stomach cancer mortality (based on smaller numbers) in each of the other work areas. There is an excess of stomach cancer mortality in six out of ten of the factories' foundry subcohorts. The foundry subcohort shows no evidence however of a relationship with duration of employment (Table 5.24), with most of the excess being concentrated in the less than five years employment period (30/14.3). The SMR falls from 212 ($p < 0.001$) for those employed less than 5 years to 169 ($p < 0.05$) for those employed at least 5 years. The grouping of occupations by dust, fume or silica exposure (Table 5.25) gives the strongest overall effect for the silica category, but with a significant decreasing trend ($X_1^2 = 5.6$) from 1-4 years to 20+ years exposure. The same pattern with significant overall excess but decreasing trend is present for the dust exposed group and there is little evidence of an excess for the fume group.

Table 5.26 presents the stomach cancer mortality by cohort of entry and a similar pattern to that for lung cancer is apparent with slightly higher SMRs for the two central entry cohorts.

5.6 Non-malignant respiratory disease

Overall, (Table 5.1) the bulk of the excess mortality from non-malignant respiratory disease (416/298.0, SMR = 140) is due to an excess mortality from bronchitis, emphysema and asthma (referred to as bronchitis) (241/147.0), although there is a moderate, non significant excess of pneumonia (125/105.9). This latter cause reaches a significant excess (SMR = 164, $p < 0.05$, 28/17.1) in the fettling shop subcohort.

There were 4 deaths from silicosis (ICD = 515), all in the foundry: one sandmiller, one centrifugal caster, one labourer and one knockout gridman. The crude rate overall for the cohort is thus 1.5 per 100,000 persons years. This compares to a crude rate for England and Wales of 2.2 per 100,000 for men aged 15-74 during 1970-72 (OPCS, 1978). Although coded as infectious diseases, not respiratory disease, tuberculosis is considered here. There were two cases of silicotuberculosis, (ICD = 010) one sand miller, one machine shop labourer, and twelve cases of pulmonary tuberculosis (ICD = 011 - 012) with nine in the foundry (a sandmiller, a furnaceman, two in furnace repair, a crane driver and four labourers) and three outside: (a machinist, a maintenance fitter's mate and a yard labourer). The crude rate for these 14 deaths together was 5.4/100.000 compared to 3.3 for the 1970-72 figures (OPCS, 1978).

Table 5.27 presents the respiratory disease mortality by work area and factory. The largest excess is in the fettling shop (SMR = 172) an excess shared by all but two of the factories, although factory 14 contributes the most of the absolute excess. There is a moderate excess in the foundry group coming from factories 10, 14 and 17 and an excess based on smaller numbers (for most factories) in the mixed and other occupations group. For factory 18 the highest SMR (197) is in the unexposed group. The effect of regional correction is more pronounced than for lung cancer, removing approximately half of the excess mortality as compared to the SMRs calculated from national reference rates.

Within the foundry there are significant excesses for labourers and sandmillers, and non-significant excesses for furnacemen, casters, furnace repair and knockout (table 5.28). In the fettling shop there are significant excesses for fettlers, welders, cranedrivers and labourers. The machine shop welders also show an excess (all welders together, SMR = 193, $p < 0.05$). There is a risk for labourers almost wherever they are: foundry (SMR = 164), fettling shop (196), machine shop (197), fitters' mates (155), although pattern shop labourers show a deficit, based on small numbers (2/4.14).

Table 5.29 presents the same analysis for bronchitis, and for most but not all of the categories with high respiratory disease mortality, the SMR for bronchitis is even higher. The most extreme example is for shotblasters the six respiratory disease deaths being all bronchitis deaths. The SMRs are respectively 125 and 246. By age at death (Table 5.8) the highest SMRs are in the 55-65 year old group for all respiratory disease and 55-74 for bronchitis.

Table 5.30 presents the respiratory disease mortality for various subcohorts of the population by duration of employment. None of the groups show any patterns with increasing duration. In general, the subcohorts with a high overall mortality (exposed, fettling, dust, fume) show a high SMR in most length categories. The unexposed have a high SMR for the shortest category. The foundry subcohort shows a suggestion of an increase with length, by virtue of the high SMR in the 15-19 years employment category, however there is no significant trend. For bronchitis as noted above, the

SMRs tend to be consistently higher than for respiratory diseases as a whole (Table 5.31). In virtually all analyses, the 20+ employment group shows a low SMR, however for several groups there is a suggestion of an increasing tendency up to the 15-19 years' employment group (this pattern is evident for the exposed, fettling and maintenance groups and both the dust and silica exposure groups). For the foundry and fume exposed groups the SMRs are rather constant up to the 15-19 years group.

The analysis by size of town and exposure group for all respiratory diseases is presented in Table 5.32. The SMRs are raised for the large town group for both exposed and unexposed. Neither show an overall trend but the longer term (15-19 years) workers show raised SMRs for the exposed and the shortest employment period is the only significant excess in the unexposed. For the small town group, the unexposed show a significant decrease ($X_1^2 = 3.85$) in SMR with length of employment.

Table 5.33 presents the respiratory disease mortality by age of starting employment and the bulk of the excess comes from the 35-54 age group (and a similar pattern is evident for the bronchitis data).

For both respiratory disease and bronchitis mortality, there is an unmistakable pattern from the analysis by cohort of entry (Tables 5.34 and 5.35). For both, there is a significant ($p < 0.01$) trend of decreasing SMR with 5 year date of entry cohort falling from 174 to 101 for respiratory disease and from 209 to 92 for bronchitis. For the unexposed, smaller numbers lead to fluctuations, but there is essentially little variation between entry cohorts for respiratory disease and increase from the earliest group for bronchitis (Tables 5.36 and 5.37), although the overall bronchitis SMR is significantly raised among the unexposed and similar in magnitude to that of the exposed.

In Table 5.38 results of fitting date and age at entry and duration of employment variables to the exposed cohort are presented for respiratory disease mortality. It is apparent that the date of entry variable is the only one that gives a good fit to the data with a chi-squared of 7.6 on one degree of freedom if fitted as an ordinal variable ($p < 0.01$). Length of employment is non-significantly but negatively related to the relative risk.

Although the fitting of more than one variable simultaneously (Table 5.39) changes slightly the magnitude of the parameter estimates, their standardised normal deviates, and the chisquared test of fit for each ordinal variable, the effect is not very marked. Date of entry remains the only one of these three variables that is related to changes of risk, in this case a marked reduction over time.

5.1 Circulatory disease

The overall SMR for mortality from diseases of the circulatory system, is not very large (110), but is significantly elevated, the contribution coming from cerebrovascular disease and the remainder category, for which more detailed reference rates were not available (Table 5.1). Table 5.40 presents the mortality by work area and factory. Overall the regional correction removes the excess, giving an SMR of 98 and for regional corrected SMRs, the only excess by work area is a non-significant SMR of 119 for the mixed and other category. By factory, the higher SMRs are in the regions where the regional circulatory disease mortality is higher: after correction most SMRs are close to or less than 100. The significant major excess is a cluster of cases in the mixed occupations in factory 18 (24/13.1).

Analysed by main occupational category (Table 5.41) only two categories show significant excesses, the machinists and machine shop labourers and in both cases, much of the excess comes from cerebrovascular disease mortality (SMRs = 144 (21/14.6) and 151 (32/21.1) respectively). There are moderate excesses for sand millers (SMR = 139) and fettling shop welder/burners (SMR = 128) although there is a deficit (3/5.0) for machine shop and maintenance welders. There is no excess evident for moulders, furnacemen/casters or heat treatment loaders - all of whom have the potential for high carbon monoxide exposure.

By age at death (Table 5.8), the excess mortality is concentrated in the younger (less than 55 years) age groups, and a similar pattern is evident by age at entry (Table 5.42). The highest SMR is for the 25-34 year old entrants although the SMR of 116 is reduced to 103 by regional correction. By time since first exposure the SMR is about 10 points lower for the first period, evident in all categories but the 35-44 year old entrants.

Table 5.43 presents the circulatory disease mortality by duration for several work areas. For the exposed overall and for the foundry, fettling shop and maintenance groups, the highest SMR is to be found in the 10-14 years' employment group, but there are no trends with duration. By date of entry (Table 5.44) the excess appears entirely located in the first entry cohort.

Table 5.1

Mortality by detailed cause

Total cohort

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	2789	2507.03	111	(107-115)
ALL MALIGNANT NEOPLASMS (140-209)	767	646.35	119	(110-127)
Buccal cavity & pharynx (140-149)	8	9.64	83	(36-164)
Oesophagus (150)	15	18.16	83	(46-136)
Stomach (151)	101	70.45	143	(117-174)
Intestine, except rectum (152-153)	34	40.01	85	(59-119)
Rectum (154)	32	29.58	108	(74-153)
Larynx (161)	7	6.21	113	(45-232)
Trachea, bronchus and lung (162)	393	269.80	146	(132-161)
Bone (170)	1	3.12	32	(1-179)
Prostate (185)	20	26.53	75	(46-116)
Bladder (188)	25	22.50	111	(72-164)
Leukaemia (204-207)	13	15.88	82	(44-140)
Other Lymph. & haemato. (200-203,208-209)	23	25.10	92	(58-137)
Other malignant neoplasms	95	109.58	87	(70-106)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	10	7.74	129	(62-238)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	1281	1160.28	110	(104-117)
Ischaemic heart disease (410-414)	819	808.86	101	(94-108)
Cerebrovascular disease (430-438)	248	206.16	120	(106-136)
Other diseases of the circulatory system	214	145.26	147	(128-168)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	416	297.97	140	(127-154)
Acute infections (460-466)	0	5.03	0	(0-73)
Influenza (470-474)	12	8.98	134	(69-233)
Pneumonia (480-486)	125	105.86	118	(98-141)
Bronchitis, emphysema & asthma (490-493)	241	147.03	164	(144-186)
Other diseases of the respiratory system	38	31.06	122	(87-168)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	59	66.30	89	(68-115)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	127	133.09	95	(80-114)
Industrial type (E916-E921,E923-E928)	6	10.10	59	(22-129)
Suicide (E950-E959)	23	37.58	61	(39-92)
Other violent causes	98	85.41	115	(93-140)
OTHER KNOWN CAUSES	103	195.31	53	(43-64)
CAUSE UNKNOWN	26			

Table 5.2

Mortality from all causes (000-999)
by years since first exposure and work area

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	175/161.5	392/323.1	384/359.7	136/116.9	1087/961.2
	108	121***	107	116	113***
	(99)	(111*)	(98)	(107)	(103)
Fettling	52/70.78	215/152.9	210/176.3	62/51.64	539/451.6
	73*	141***	119*	120	119***
	(66**)	(127***)	(108)	(109)	(108)
Mainten.	34/39.78	95/84.43	90/88.12	24/30.20	243/242.5
	85	113	102	79	100
	(79)	(103)	(94)	(73)	(92)
Mix/oth.	34/34.19	82/73.70	112/91.37	44/32.63	272/231.9
	99	111	123*	135	117*
	(92)	(103)	(113)	(125)	(108)
Unexp.	122/118.0	248/217.8	206/220.5	72/63.44	648/619.8
	103	114*	93	114	105
	(94)	(104)	(85*)	(104)	(95)
Total	417/424.3	1032/852.0	1002/936.0	338/294.8	2789/2507.0
	98	121***	107*	115*	111***
	(90*)	(111**)	(98)	(105)	(102)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.3

Mortality from all causes (000-999)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	30/34.61	90/65.72	79/57.35	19/20.29	218/178.0
	87	137**	138**	94	122**
	(80)	(127*)	(128*)	(87)	(113)
11	38/39.70	108/85.28	107/92.61	25/25.48	278/243.1
	96	127*	116	98	114*
	(87)	(115)	(105)	(89)	(104)
12	11/12.49	28/23.88	23/23.92	11/8.91	73/69.21
	88	117	96	124	105
	(80)	(107)	(87)	(112)	(96)
13	11/13.47	34/28.47	25/31.97	6/8.15	76/82.06
	82	119	78	74	93
	(84)	(123)	(81)	(76)	(95)
14	67/64.61	186/139.7	201/163.3	61/45.47	515/413.0
	104	133***	123**	134*	125***
	(95)	(122**)	(113)	(123)	(114**)
15	13/17.74	44/39.42	53/50.75	23/16.98	133/124.9
	73	112	104	135	106
	(63)	(96)	(90)	(117)	(92)
16	18/31.61	62/63.35	77/80.99	51/42.19	208/218.1
	57*	98	95	121	95
	(51**)	(88)	(86)	(109)	(86*)
17	24/18.93	47/41.98	53/54.22	19/19.68	143/134.8
	127	112	98	97	106
	(126)	(111)	(97)	(96)	(105)
18	65/53.46	140/105.5	124/123.6	40/37.09	369/319.6
	122	133**	100	108	115**
	(112)	(122*)	(92)	(99)	(106)
19	18/19.67	45/40.89	54/36.76	11/7.09	128/104.4
	91	110	147**	155	123*
	(74)	(89)	(119)	(126)	(100)
Total	295/306.3	784/634.2	796/715.4	266/231.3	2141/1887.2
	96	124***	111**	115*	113***
	(88*)	(113***)	(102)	(105)	(104)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.4

Mortality from all malignant neoplasms (140-209)
by years since first exposure and work area

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	55/39.16	117/82.42	110/94.11	45/31.41	327/247.1
	140*	142***	117	143*	132***
	(133*)	(135**)	(111)	(136)	(126***)
Fettling	11/17.02	61/39.95	55/47.59	19/14.42	146/119.0
	65	153**	116	132	123*
	(60)	(143**)	(108)	(124)	(115)
Mainten.	9/9.73	29/22.01	25/23.24	7/7.73	70/62.71
	92	132	108	91	112
	(89)	(126)	(103)	(87)	(107)
Mix/oth.	6/8.29	26/19.35	23/24.68	5/9.04	60/61.37
	72	134	93	55	98
	(69)	(129)	(89)	(53)	(94)
Unexp.	28/29.00	63/55.33	49/55.26	24/16.61	164/156.2
	97	114	89	144	105
	(92)	(108)	(84)	(138)	(100)
Total	109/103.2	296/219.1	262/244.9	100/79.21	767/646.3
	106	135***	107	126*	119***
	(100)	(128***)	(102)	(120)	(113**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.5

Mortality from cancers of the trachea, bronchus and lung (162) by years since first exposure and work area

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	26/15.72	54/34.79	59/39.64	25/13.12	164/103.3
	165*	155**	149**	191**	159***
	(156*)	(146*)	(140*)	(180**)	(150***)
Fettling	5/6.65	34/16.88	34/20.26	13/6.12	86/49.91
	75	201***	168**	212*	172***
	(69)	(186**)	(155*)	(197*)	(159***)
Mainten.	4/3.94	11/9.32	13/9.77	4/3.16	32/26.19
	102	118	133	127	122
	(97)	(112)	(126)	(120)	(116)
Mix/oth.	3/3.29	15/8.23	14/10.53	2/3.83	34/25.89
	91	182*	133	52	131
	(87)	(173)	(126)	(50)	(125)
Unexp.	14/11.93	27/23.15	25/22.63	11/6.84	77/64.55
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)
Total	52/41.52	141/92.38	145/102.8	55/33.07	393/269.8
	125	153***	141***	166***	146***
	(118)	(143***)	(133**)	(157**)	(137***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.6

Main occupational category

Mortality from cancers of the trachea, bronchus and lung (162)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	7	5.22	134	(54-276)
2 Moulder	30	22.62	133	(89-189)
3 Shell moulder	0	0.94	0	(0-390)
4 Furnaceman/caster	28	15.41	182	(121-263)
5 Furnace repair	23	12.71	181	(115-272)
6 Centrifugal caster	7	3.63	193	(78-398)
7 Cranedriver, foundry	12	8.35	144	(74-251)
8 Labourer, foundry	58	37.01	157	(119-203)
9 Knockout gridman	6	3.98	151	(55-328)
10 Other foundry jobs	5	2.83	177	(57-412)
11 Fettler	47	24.97	188	(138-250)
12 Shotblaster	8	5.15	155	(67-306)
13 Welder/burner	11	8.43	130	(65-233)
14 Arc air burner	1	0.51	198	(5-1101)
15 Heat treatment loader	8	3.27	245	(106-482)
16 Cranedriver, fettling	5	3.28	152	(50-356)
17 Labourer, fettling shop	9	7.99	113	(52-214)
18 Other fettling shop jobs	6	3.42	176	(64-382)
19 Pattern maker	5	3.49	143	(47-334)
20 Labourer, pattern shop	2	3.35	60	(7-216)
21 Inspection	6	7.63	79	(29-171)
22 Machinist	34	22.27	153	(106-213)
23 Labourer, machine shop	31	21.25	146	(99-207)
24 Welder: m/c shop, maint.	2	1.18	170	(21-614)
25 Maintenance fitter	13	16.02	81	(43-139)
26 Maintenance fitters mate	20	10.92	183	(112-283)
27 Yard lab., lorry driver	6	13.16	46	(17-99)
28 Precision foundry worker	2	0.48	418	(51-1508)
29 Precision inspection	0	0.17	0	(0-2132)
30 Precision fettler	1	0.19	541	(14-3012)
Total	393	269.80	146	(132-161)

Table 5.7

Mortality from cancers of the trachea, bronchus and lung (162)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	6/3.41 176 (169)	13/6.66 195* (188)	11/6.17 178 (172)	7/2.05 342* (329*)	37/18.28 202*** (195***)
11	8/3.87 207 (197)	21/9.42 223** (212**)	18/10.35 174* (166)	3/2.92 103 (98)	50/26.55 188*** (179***)
12	0/1.19 0 (0)	3/2.49 121 (117)	5/2.57 195 (189)	3/0.99 302 (293)	11/7.24 152 (148)
13	0/1.30 0 (0)	1/3.05 33 (32)	1/3.29 30 (30)	1/0.92 109 (108)	3/8.55 35 (35)
14	14/6.44 218* (200*)	31/15.98 194** (178**)	39/18.89 206*** (189***)	11/5.13 214* (197)	95/46.44 205*** (188***)
15	0/1.71 0 (0)	4/4.37 92 (78)	8/5.72 140 (119)	4/1.88 213 (180)	16/13.68 117 (99)
16	2/2.83 71 (67)	10/6.73 149 (140)	9/9.33 96 (91)	8/4.95 162 (153)	29/23.83 122 (115)
17	1/1.80 56 (60)	7/4.61 152 (163)	4/6.17 65 (70)	2/2.22 90 (97)	14/14.79 95 (102)
18	6/5.15 117 (111)	19/11.60 164 (156)	16/13.82 116 (110)	4/4.33 92 (88)	45/34.90 129 (123)
19	1/1.91 52 (44)	5/4.33 115 (97)	9/3.90 231* (194)	1/0.85 118 (99)	16/10.98 146 (122)
Total	38/29.60 128 (121)	114/69.23 165*** (155***)	120/80.20 150*** (141***)	44/26.23 168** (158**)	316/205.2 154*** (145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.8

Mortality by age at death (exposed) and cause

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Age group:

-34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
Mortality from all causes (000-999)						
32/45.69	138/122.3	413/358.4	733/627.9	626/535.6	199/197.3	2141/1887.2
70	113	115	117	117	101	113
(48-99)	(95-133)	(104-127)	(108-126)	(108-126)	(87-116)	(109-118)
Mortality from all malignant neoplasms (140-209)						
2/6.87	35/26.45	114/95.56	228/183.6	181/141.4	43/36.26	603/490.2
29	132	119	124	128	119	123
(4-105)	(92-184)	(98-143)	(109-141)	(110-148)	(86-160)	(113-133)
Mortality from cancers of the trachea, bronchus and lung (162)						
1/0.76	15/7.29	65/39.72	124/84.44	91/60.73	20/12.30	316/205.2
131	206	164	147	150	163	154
(3-731)	(115-339)	(126-209)	(122-175)	(121-184)	(99-251)	(137-172)
Mortality from cancer of the stomach (151)						
0/0.36	5/2.71	19/10.36	29/19.86	23/16.02	5/3.94	81/53.25
0	185	183	146	144	127	152
(0-1028)	(60-431)	(110-286)	(98-210)	(91-215)	(41-296)	(121-189)
Mortality from diseases of the respiratory system (460-519)						
3/2.45	9/7.78	40/28.16	108/66.46	111/75.45	46/39.62	317/219.9
122	116	142	162	147	116	144
(25-357)	(53-220)	(101-193)	(133-196)	(121-177)	(85-155)	(129-161)
Mortality from bronchitis, emphysema & asthma (490-493)						
2/0.40	2/2.49	18/14.05	64/38.33	71/39.50	23/14.30	180/109.1
500	80	128	167	180	161	165
(61-1806)	(10-290)	(76-202)	(129-213)	(140-227)	(102-241)	(142-191)
Mortality from diseases of the circulatory system (390-458)						
6/5.87	52/41.93	204/164.8	321/297.7	285/264.2	98/100.1	966/874.6
102	124	124	108	108	98	110
(38-222)	(93-163)	(107-142)	(96-120)	(96-121)	(79-119)	(104-118)

Table 5.9

Factory by length of employment (exposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	23/10.03 229*** (220**)	9/3.80 237* (228*)	1/2.33 43 (41)	0/1.35 0 (0)	4/0.76 524* (503*)	37/18.28 202*** (195***)
11	27/15.00 180** (171*)	7/4.30 163 (155)	8/3.00 267* (254*)	3/2.02 148 (141)	5/2.22 225 (215)	50/26.55 188*** (179***)
12	4/3.43 116 (113)	3/1.42 211 (205)	2/1.40 143 (139)	1/0.50 200 (194)	1/0.48 207 (201)	11/7.24 152 (148)
13	2/4.13 48 (48)	0/1.84 0 (0)	0/0.88 0 (0)	1/0.68 148 (147)	0/1.02 0 (0)	3/8.55 35 (35)
14	37/18.34 202*** (185***)	22/10.01 220** (202**)	16/6.44 249** (228**)	13/5.52 236** (216*)	7/6.13 114 (105)	95/46.44 205*** (188***)
15	4/5.32 75 (64)	5/3.51 142 (121)	4/1.99 201 (170)	1/1.11 90 (76)	2/1.74 115 (97)	16/13.68 117 (99)
16	10/9.37 107 (101)	4/4.94 81 (76)	4/2.74 146 (138)	5/2.30 217 (205)	6/4.48 134 (126)	29/23.83 122 (115)
17	4/6.34 63 (68)	7/2.76 254* (273*)	2/1.85 108 (116)	0/1.49 0 (0)	1/2.36 42 (45)	14/14.80 95 (102)
18	19/18.09 105 (100)	11/6.42 171 (163)	10/4.51 222* (211*)	2/3.11 64 (61)	3/2.77 108 (103)	45/34.90 129 (123)
19	9/5.07 177 (149)	3/2.32 129 (109)	2/1.73 116 (97)	0/0.91 0 (0)	2/0.95 210 (177)	16/10.98 146 (122)
Total	139/95.14 146*** (138***)	71/41.31 172*** (161***)	49/26.87 182*** (171***)	26/19.00 137 (129)	31/22.92 135 (127)	316/205.2 154*** (145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.10

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (foundry subcohort)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	17/10.45 163 (153)	20/16.61 120 (113)	29/19.44 149 (141)	14/6.12 229** (216*)	80/52.62 152*** (143**)
5-9 yrs	9/5.27 171 (160)	17/6.34 268*** (252**)	8/5.93 135 (127)	1/2.15 47 (44)	35/19.68 178** (167**)
10-14 yr	0/0.00 - -	11/7.75 142 (133)	6/4.11 146 (137)	2/1.29 155 (145)	19/13.15 144 (135)
15-19 yr	0/0.00 - -	6/4.09 147 (138)	6/3.52 171 (161)	1/0.84 119 (114)	13/8.45 154 (145)
20+ yrs	0/0.00 - -	0/0.00 - -	10/6.64 151 (142)	7/2.72 257* (244)	17/9.36 182* (172*)
Total	26/15.71 165* (156*)	54/34.79 155** (146*)	59/39.64 149** (140*)	25/13.11 191** (180**)	164/103.3 159*** (150***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.11

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (fettling subcohort)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	5/4.07	10/7.41	14/8.90	5/2.55	34/22.92
	123	135	157	196	148*
	(113)	(125)	(146)	(184)	(138)
5-9 yrs	0/2.58	4/3.19	8/3.31	5/0.89	17/9.97
	0	125	242*	559**	171
	(0)	(115)	(222)	(511**)	(157)
10-14 yr	0/0.00	16/3.69	3/1.76	0/0.42	19/5.86
	-	433***	171	0	324***
	-	(399***)	(157)	(0)	(298***)
15-19 yr	0/0.00	4/2.59	2/1.86	0/0.34	6/4.79
	-	154	107	0	125
	-	(142)	(99)	(0)	(115)
20+ yrs	0/0.00	0/0.00	7/4.44	3/1.92	10/6.36
	-	-	158	156	157
	-	-	(146)	(144)	(145)
Total	5/6.65	34/16.88	34/20.26	13/6.12	86/49.91
	75	201***	168**	212*	172***
	(69)	(186**)	(155*)	(197*)	(159***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.12

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (maintenance subcohort)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	3/2.44 123 (118)	5/4.05 124 (119)	5/4.30 116 (112)	2/1.18 170 (164)	15/11.97 125 (121)
5-9 yrs	1/1.49 67 (63)	4/1.90 211 (200)	6/1.79 335* (317*)	0/0.63 0 (0)	11/5.81 189 (179)
10-14 yr	0/0.00 - -	1/2.28 44 (41)	1/0.91 109 (102)	1/0.25 408 (387)	3/3.44 87 (81)
15-19 yr	0/0.00 - -	1/1.10 91 (85)	0/0.93 0 (0)	0/0.23 0 (0)	1/2.26 44 (41)
20+ yrs	0/0.00 - -	0/0.00 - -	1/1.83 55 (51)	1/0.88 114 (107)	2/2.71 74 (69)
Total	4/3.94 102 (97)	11/9.33 118 (112)	13/9.76 133 (126)	4/3.16 127 (120)	32/26.19 122 (116)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.13

Mortality from cancers of the trachea, bronchus and lung (162) by years since first exposure and length of employment (unexposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	7/7.43	11/9.38	10/9.36	5/2.73	33/28.89
	94	117	107	183	114
	(89)	(110)	(101)	(173)	(108)
5-9 yrs	7/4.50	4/4.61	5/3.68	0/1.18	16/13.97
	156	87	136	0	115
	(146)	(82)	(128)	(0)	(108)
10-14 yr	0/0.00	9/6.20	4/3.01	2/0.70	15/9.91
	-	145	133	285	151
	-	(136)	(124)	(266)	(142)
15-19 yr	0/0.00	3/2.97	1/2.54	0/0.59	4/6.11
	-	101	39	0	65
	-	(95)	(37)	(0)	(62)
20+ yrs	0/0.00	0/0.00	5/4.05	4/1.64	9/5.68
	-	-	124	245	158
	-	-	(116)	(231)	(149)
Total	14/11.93	27/23.15	25/22.63	11/6.84	77/64.56
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.14

Mortality from cancers of the trachea, bronchus and lung (162)
by length of employment within exposure category

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Years employed:

	<1 yr	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
Dust exposed							
	6/4.48	65/53.01	35/21.80	31/12.79	14/9.91	20/11.70	171/113.7
	134	123	161*	242***	141	171*	150***
	(127)	(115)	(150*)	(225***)	(132)	(160)	(141***)
Fume exposed							
	5/3.81	55/36.85	22/16.08	23/9.73	14/7.69	16/8.88	135/83.03
	131	149**	137	236***	182	180*	163***
	(125)	(140*)	(127)	(221**)	(170)	(168)	(152***)
Silica exposed							
	4/4.12	47/40.42	32/16.28	21/8.84	13/7.25	14/8.79	131/85.70
	97	116	197***	238***	179	159	153***
	(92)	(109)	(184**)	(220**)	(167)	(149)	(143***)

Table 5.15

Mortality from cancers of the trachea, bronchus and lung (162) by town size (exposed and unexposed) and length of employment

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Length of employment

1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
"small towns", exposed					
29/30.23 96 (90)	19/15.36 124 (115)	12/9.20 130 (121)	7/6.49 108 (101)	11/10.56 104 (98)	78/71.84 109 (101)
"small towns", unexposed					
13/9.13 142 (132)	5/3.97 126 (117)	3/3.40 88 (81)	4/1.72 233 (223)	4/2.00 200 (189)	29/20.21 143 (133)
"large towns", exposed					
110/64.91 169*** (160***)	52/25.96 200*** (188***)	37/17.67 209*** (197***)	19/12.51 152 (143)	20/12.36 162 (151)	238/133.4 178*** (168***)
"large towns", unexposed					
20/19.76 101 (96)	11/10.00 110 (104)	12/6.51 184 (174)	0/4.39 0* (0*)	5/3.69 136 (128)	48/44.34 108 (102)

Table 5.16

Mortality from cancers of the trachea, bronchus and lung (162) by years since first exposure and age at entry (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.23	0/1.34	5/4.54	6/3.49	11/9.61
	0	0	110	172	114
	(0)	(0)	(104)	(163)	(108)
25-34	3/1.82	17/9.76	38/24.22	22/12.74	80/48.54
	165	174*	157*	173*	165***
	(154)	(163)	(147*)	(163*)	(155***)
35-44	13/7.02	41/24.41	46/32.73	14/8.31	114/72.46
	185	168**	141*	168	157***
	(174)	(158**)	(132)	(159)	(148***)
45-54	19/13.11	39/25.97	27/16.82	2/1.56	87/57.46
	145	150*	161*	128	151***
	(136)	(141*)	(151)	(121)	(142**)
55-64	3/6.63	16/7.21	4/1.77	0/0.13	23/15.73
	45	222**	226	0	146
	(42)	(208*)	(211)	(0)	(137)
65+	0/0.78	1/0.54	0/0.12	0/0.00	1/1.44
	0	186	0	-	70
	(0)	(177)	(0)	-	(66)
Total	38/29.60	114/69.23	120/80.20	44/26.23	316/205.2
	128	165***	150***	168**	154***
	(121)	(155***)	(141***)	(158**)	(145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.17

Mortality from cancers of the trachea, bronchus and lung (162) by years since first exposure and entry cohort (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	8/6.33	23/16.64	38/29.38	35/21.39	104/73.75
	126	138	129	164**	141**
	(119)	(130)	(122)	(154*)	(133**)
1951-55	12/9.70	39/23.25	60/35.67	9/4.83	120/73.46
	124	168**	168***	186	163***
	(116)	(158**)	(158**)	(176)	(154***)
1956-60	10/7.49	33/17.43	20/13.82	0/0.00	63/38.75
	133	189**	145	-	163***
	(125)	(177**)	(135)	-	(152**)
1961-65	8/6.07	19/11.89	2/1.32	0/0.00	29/19.28
	132	160	152	-	150*
	(124)	(150)	(142)	-	(141)
Total	38/29.60	114/69.23	120/80.20	44/26.23	316/205.2
	128	165***	150***	168**	154***
	(121)	(155***)	(141***)	(158**)	(145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.18

Results of modelling with GLIM the lung cancer mortality in the exposed cohort. Relative Risk (Standardised Normal Deviate of regression estimate)

Model	1	1+ENT	1+ENTV	1+LEN	1+LENV	1+AGE	1+AGEV
Deviance	88.7	87.2	88.2	85.2	88.7	88.3	88.5
DF	59	56	58	56	58	56	58
Chi-squared		1.4	0.5	3.5	0.0	0.3	0.2
ENT(2)		1.16 (1.1)					
ENT(3)		1.15 (0.8)					
ENT(4)		1.07 (0.3)					
ENTV			1.04 (0.7)				
LEN(2)				1.18 (1.1)			
LEN(3)				1.25 (1.3)			
LEN(4)				0.93 (-0.5)			
LENV					1.00 (0.0)		
AGE(2)						1.01 (0.0)	
AGE(3)						0.97 (-0.2)	
AGE(4)						0.89 (-0.5)	
AGEV							0.97 (-0.5)

Table 5.19

Results of modelling with GLIM the lung cancer mortality in the exposed cohort. Relative risk (Standardised Normal Deviate of regression estimate)

Model	Deviance	DF	X^2	ENTV	LENV	AGEV
1+AGE+LEN	84.4	53				
1+AGE+LEN+ENTV	83.8	52	0.6	1.05 (0.74)		
1+AGE+ENT	86.7	53				
1+AGE+ENT+LENV	86.7	52	0.0		1.00 (0.02)	
1+ENT+LEN	83.9	53				
1+ENT+LEN+AGEV	82.9	52	1.0			0.94 (-1.01)

Table 5.20

Results of modelling with GLIM the lung cancer mortality (at least 10 years since first exposure) by work area and length of employment.

Model	Deviance	DF	REF	FOU	FET	REM	REF.LEN	FOU.LEN	FET.LEN	REM.LEN
1 1	180.4	159								
2 1+OCC	171.8	156	1.20 (1.4)	1.32 (1.8)	1.56 (2.7)	1.10 (0.5)				
3 1+OCC.LEN	172.6	155	1.52 (5.1)				0.86 (-1.1)	1.05 (0.5)	1.14 (1.3)	0.82 (-1.6)
4 OCC+OCC.LEN	168.7	152	1.13 (0.6)	1.32 (1.1)	1.62 (1.9)	1.50 (1.4)	1.06 (0.3)	1.06 (0.5)	1.02 (0.1)	0.8 (-1.6)
5 OCC+LEN	171.8	155	1.21 (1.3)	1.31 (1.8)	1.57 (2.1)	1.10 (0.5)				

Table 5.21

Mortality from cancer of the stomach (151)
by years since first exposure and work area

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	8/5.20	24/9.44	16/9.53	4/2.97	52/27.14
	154	254***	168	135	192***
	(144)	(237***)	(156)	(125)	(178***)
Fettling	4/2.18	7/4.46	2/4.75	0/1.36	13/12.74
	184	157	42	0	102
	(167)	(142)	(38)	(0)	(92)
Mainten.	1/1.24	6/2.46	2/2.35	0/0.73	9/6.78
	81	244	85	0	133
	(76)	(230)	(80)	(0)	(125)
Mix/oth.	1/1.07	3/2.18	3/2.48	0/0.85	7/6.59
	93	137	121	0	106
	(88)	(130)	(114)	(0)	(100)
Unexp.	5/3.83	6/6.26	4/5.56	5/1.56	20/17.21
	131	96	72	320*	116
	(123)	(90)	(68)	(301)	(109)
Total	19/13.52	46/24.79	27/24.67	9/7.47	101/70.45
	141	186***	109	120	143***
	(131)	(173***)	(102)	(112)	(133**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.22

Main occupational category

Mortality from cancer of the stomach (151)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	2	1.33	151	(18-545)
2 Moulder	12	5.74	209	(108-365)
3 Shell moulder	0	0.24	0	(0-1556)
4 Furnaceman/caster	8	3.90	205	(89-404)
5 Furnace repair	12	3.29	364	(188-637)
6 Centrifugal caster	1	0.96	104	(3-577)
7 Cranedriver, foundry	3	2.09	143	(30-419)
8 Labourer, foundry	12	10.12	119	(61-207)
9 Knockout gridman	2	1.06	189	(23-683)
10 Other foundry jobs	3	0.83	363	(75-1060)
11 Fettler	4	6.24	64	(17-164)
12 Shotblaster	2	1.29	155	(19-560)
13 Welder/burner	3	2.07	145	(30-424)
14 Arc air burner	0	0.12	0	(0-3024)
15 Heat treatment loader	0	0.82	0	(0-447)
16 Cranedriver, fettling	1	0.84	120	(3-666)
17 Labourer, fettling shop	3	2.24	134	(28-391)
18 Other fettling shop jobs	1	0.88	114	(3-632)
19 Pattern maker	1	0.90	111	(3-621)
20 Labourer, pattern shop	4	0.89	447	(122-1146)
21 Inspection	4	2.00	200	(54-511)
22 Machinist	6	5.55	108	(40-235)
23 Labourer, machine shop	7	6.12	114	(46-236)
24 Welder: m/c shop, maint.	0	0.28	0	(0-1313)
25 Maintenance fitter	5	4.14	121	(39-282)
26 Maintenance fitters mate	4	2.85	140	(38-359)
27 Yard lab., lorry driver	1	3.45	29	(1-162)
28 Precision foundry worker	0	0.12	0	(0-3074)
29 Precision inspection	0	0.05	0	(0-7685)
30 Precision fettler	0	0.04	0	(0-8384)
Total	101	70.45	143	(117-174)

Table 5.23

Factory by work area

Mortality from cancer of the stomach (151)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	9/3.36	1/0.50	0/0.73	0/0.51	2/1.55	12/6.65
	268*	202	0	0	129	181
	(255*)	(192)	(0)	(0)	(123)	(172)
11	4/3.15	2/2.41	4/1.11	1/0.24	0/1.35	11/8.26
	127	83	362	410	0	133
	(120)	(78)	(341)	(387)	(0)	(126)
12	1/1.37	0/0.26	0/0.14	0/0.19	2/0.49	3/2.45
	73	0	0	0	411	123
	(70)	(0)	(0)	(0)	(391)	(117)
13	2/1.15	0/0.28	0/0.33	0/0.44	0/0.82	2/3.02
	174	0	0	0	0	66
	(191)	(0)	(0)	(0)	(0)	(73)
14	10/6.12	2/2.98	2/1.25	1/1.41	2/2.44	17/14.21
	163	67	160	71	82	120
	(146)	(60)	(143)	(63)	(73)	(107)
15	1/1.24	2/1.96	0/0.19	0/0.18	1/0.27	4/3.84
	81	102	0	0	368	104
	(63)	(80)	(0)	(0)	(289)	(82)
16	3/2.88	0/0.92	1/0.92	4/1.25	0/0.95	8/6.91
	104	0	109	321	0	116
	(97)	(0)	(102)	(300)	(0)	(108)
17	1/1.58	0/0.43	0/0.77	0/1.08	0/1.29	1/5.15
	63	0	0	0	0	19
	(64)	(0)	(0)	(0)	(0)	(20)
18	18/4.96	5/2.22	2/0.98	1/0.86	9/6.14	35/15.15
	363***	225	205	117	146	231***
	(343***)	(213)	(194)	(110)	(138)	(218***)
19	3/1.33	1/0.77	0/0.37	0/0.43	4/1.90	8/4.80
	226	129	0	0	210	166
	(205)	(118)	(0)	(0)	(191)	(151)
Total	52/27.14	13/12.74	9/6.78	7/6.59	20/17.21	101/70.45
	192***	102	133	106	116	143***
	(178***)	(92)	(125)	(100)	(109)	(133**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.24

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (foundry subcohort)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	7/3.56 197 (184)	13/4.54 286** (267**)	8/4.65 172 (160)	2/1.38 145 (135)	30/14.13 212*** (198***)
5-9 yrs	1/1.64 61 (57)	3/1.76 171 (159)	4/1.43 280 (260)	1/0.49 206 (189)	9/5.31 169 (157)
10-14 yr	0/0.00 - -	6/2.12 284* (263)	1/1.06 95 (88)	1/0.30 330 (303)	8/3.47 230 (214)
15-19 yr	0/0.00 - -	2/1.02 196 (182)	1/0.87 115 (108)	0/0.20 0 (0)	3/2.09 144 (134)
20+ yrs	0/0.00 - -	0/0.00 - -	2/1.53 131 (122)	0/0.61 0 (0)	2/2.13 94 (87)
Total	8/5.20 154 (144)	24/9.44 254*** (237***)	16/9.53 168 (156)	4/2.97 135 (125)	52/27.14 192*** (178***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.25

Mortality from cancer of the stomach (151)
by length of employment within exposure category

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Years employed:

	<1 yr	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
Dust exposed							
	0/1.24	26/13.83	11/5.73	4/3.26	2/2.40	0/2.61	43/29.06
	0	188**	192	123	83	0	148*
	(0)	(174*)	(176)	(113)	(76)	(0)	(137)
Fume exposed							
	1/1.03	14/9.54	7/4.22	4/2.48	0/1.85	0/1.98	26/21.10
	97	147	166	161	0	0	123
	(90)	(135)	(152)	(148)	(0)	(0)	(113)
Silica exposed							
	0/1.12	24/10.49	7/4.25	3/2.23	2/1.76	0/1.97	36/21.82
	0	229***	165	134	114	0	165**
	(0)	(212**)	(151)	(123)	(105)	(0)	(152*)

Table 5.26

Mortality from cancer of the stomach (151)
by years since first exposure and entry cohort (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	6/2.58 233 (216)	9/5.15 175 (162)	11/7.31 150 (139)	2/4.81 42 (39)	28/19.84 141 (131)
1951-55	3/3.33 90 (84)	16/6.31 254** (235**)	9/8.34 108 (100)	2/1.10 181 (168)	30/19.09 157* (146)
1956-60	3/2.20 137 (127)	10/4.32 232* (216*)	3/3.16 95 (88)	0/0.00 - -	16/9.67 165 (154)
1961-65	2/1.59 126 (117)	5/2.76 181 (168)	0/0.30 0 (0)	0/0.00 - -	7/4.65 151 (140)
Total	14/9.69 144 (134)	40/18.54 216*** (200***)	23/19.11 120 (112)	4/5.91 68 (63)	81/53.24 152*** (141**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.27

Factory by work area

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Group:

Factory	Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	27/15.87	4/1.88	5/3.80	3/2.04	2/6.46	41/30.05
	170*	213	132	147	31	136
	(152*)	(190)	(118)	(131)	(28*)	(122)
11	12/13.18	15/10.42	6/4.12	0/0.82	6/6.09	39/34.62
	91	144	145	0	99	113
	(79)	(124)	(125)	(0)	(85)	(97)
12	6/6.21	2/1.18	0/0.66	1/0.68	3/2.19	12/10.93
	97	169	0	146	137	110
	(83)	(144)	(0)	(125)	(117)	(94)
13	7/5.31	1/1.03	0/1.34	2/1.92	1/3.39	11/12.99
	132	97	0	104	29	85
	(142)	(105)	(0)	(112)	(32)	(91)
14	45/24.54	30/11.28	7/4.82	13/5.48	12/10.50	107/56.62
	183***	266***	145	237**	114	189***
	(146*)	(211***)	(115)	(188*)	(91)	(150***)
15	6/5.42	12/7.98	1/0.93	2/0.61	1/1.08	22/16.03
	111	150	108	326	92	137
	(87)	(117)	(84)	(254)	(72)	(107)
16	12/11.94	6/3.29	6/4.11	6/4.75	5/4.31	35/28.41
	100	182	146	126	116	123
	(84)	(152)	(122)	(105)	(97)	(103)
17	14/6.64	1/1.72	2/3.41	8/4.29	7/5.71	32/21.78
	211*	58	59	186	123	147*
	(201*)	(55)	(56)	(177)	(117)	(140)
18	22/21.00	13/8.05	4/3.71	6/3.25	60/30.40	105/66.42
	105	161	108	185	197***	158***
	(93)	(143)	(95)	(163)	(175***)	(140**)
19	5/5.62	2/3.08	0/1.68	3/1.85	2/7.90	12/20.12
	89	65	0	162	25*	60
	(88)	(64)	(0)	(160)	(25*)	(59)
Total	156/115.7	86/49.91	31/28.59	44/25.70	99/78.04	416/298.0
	135***	172***	108	171**	127*	140***
	(117)	(146**)	(95)	(150*)	(112)	(121***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.28

Main occupational category

Mortality from diseases of the respiratory system (460-519)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	11	5.10	216	(108-386)
2 Moulder	19	22.89	83	(50-130)
3 Shell moulder	0	0.94	0	(0-394)
4 Furnaceman/caster	23	14.91	154	(98-232)
5 Furnace repair	18	13.19	136	(81-216)
6 Centrifugal caster	7	4.00	175	(70-361)
7 Cranedriver, foundry	7	8.25	85	(34-175)
8 Labourer, foundry	77	47.09	164	(129-204)
9 Knockout gridman	6	4.51	133	(49-290)
10 Other foundry jobs	4	4.25	94	(26-241)
11 Fettler	37	22.84	162	(114-223)
12 Shotblaster	6	4.81	125	(46-272)
13 Welder/burner	14	7.48	187	(102-314)
14 Arc air burner	0	0.42	0	(0-878)
15 Heat treatment loader	3	3.21	94	(19-273)
16 Cranedriver, fettling	12	3.26	368	(190-642)
17 Labourer, fettling shop	21	10.72	196	(121-299)
18 Other fettling shop jobs	4	3.77	106	(29-272)
19 Pattern maker	4	3.58	112	(30-286)
20 Labourer, pattern shop	2	4.14	48	(6-175)
21 Inspection	11	9.30	118	(59-212)
22 Machinist	17	20.68	82	(48-132)
23 Labourer, machine shop	62	31.44	197	(151-253)
24 Welder: m/c shop, maint.	3	0.92	327	(67-956)
25 Maintenance fitter	14	17.37	81	(44-135)
26 Maintenance fitters mate	19	12.27	155	(93-242)
27 Yard lab., lorry driver	15	15.84	95	(53-156)
28 Precision foundry worker	0	0.43	0	(0-868)
29 Precision inspection	0	0.24	0	(0-1543)
30 Precision fettler	0	0.15	0	(0-2476)
Total	416	297.97	140	(127-154)

Table 5.29

Main occupational category

Mortality from bronchitis, emphysema & asthma (490-493)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	7	2.63	266	(107-549)
2 Moulder	12	11.08	108	(56-189)
3 Shell moulder	0	0.46	0	(0-797)
4 Furnaceman/caster	14	7.51	187	(102-313)
5 Furnace repair	8	6.65	120	(52-237)
6 Centrifugal caster	3	1.98	151	(31-442)
7 Cranedriver, foundry	4	4.02	99	(27-255)
8 Labourer, foundry	50	23.35	214	(159-282)
9 Knockout gridman	1	2.20	45	(1-253)
10 Other foundry jobs	3	2.03	147	(30-431)
11 Fettler	20	11.45	175	(107-270)
12 Shotblaster	6	2.44	246	(90-536)
13 Welder/burner	7	3.63	193	(78-398)
14 Arc air burner	0	0.20	0	(0-1835)
15 Heat treatment loader	2	1.64	122	(15-439)
16 Cranedriver, fettling	5	1.68	297	(97-694)
17 Labourer, fettling shop	9	5.22	172	(79-327)
18 Other fettling shop jobs	3	1.90	158	(33-462)
19 Pattern maker	2	1.62	124	(15-447)
20 Labourer, pattern shop	2	2.06	97	(12-351)
21 Inspection	5	4.49	111	(36-260)
22 Machinist	10	10.14	99	(47-181)
23 Labourer, machine shop	35	15.34	228	(159-317)
24 Welder: m/c shop, maint.	1	0.43	231	(6-1287)
25 Maintenance fitter	6	8.46	71	(26-154)
26 Maintenance fitters mate	14	6.19	226	(124-380)
27 Yard lab., lorry driver	12	7.80	154	(80-269)
28 Precision foundry worker	0	0.23	0	(0-1611)
29 Precision inspection	0	0.13	0	(0-2860)
30 Precision fettler	0	0.08	0	(0-4854)
Total	241	147.03	164	(144-186)

Table 5.30

Mortality from diseases of the respiratory system (460-519)
by length of employment within exposure category

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Years employed:	<1 yr	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
Exposed							
		144/102.2	67/47.17	46/31.37	37/19.99	23/19.19	317/219.9
		141***	142**	147*	185***	120	144***
		(122*)	(123)	(126)	(158*)	(102)	(124***)
Foundry							
		82/59.55	30/22.27	20/16.83	16/8.91	8/8.17	156/115.7
		138**	135	119	180*	98	135***
		(119)	(116)	(103)	(156)	(84)	(117)
Fettling							
		40/23.03	16/10.99	13/6.24	10/4.58	7/5.07	86/49.91
		174**	146	208*	218*	138	172***
		(149*)	(123)	(174)	(183)	(115)	(146**)
Maintenance							
		13/12.61	7/7.35	3/3.51	6/2.89	2/2.23	31/28.59
		103	95	85	208	90	108
		(91)	(83)	(75)	(177)	(77)	(95)
Unexposed							
		53/34.12	20/18.56	14/13.45	8/7.21	4/4.70	99/78.04
		155**	108	104	111	85	127*
		(139*)	(94)	(92)	(97)	(75)	(112)
Dust exposed							
	8/4.30	73/54.80	35/23.31	23/13.30	17/9.72	10/9.16	166/114.6
	186	133*	150*	173*	175*	109	145***
	(159)	(116)	(129)	(148)	(150)	(92)	(125**)
Fume exposed							
	3/3.74	61/36.52	25/16.71	19/10.20	9/7.45	11/7.23	128/81.84
	80	167***	150	186*	121	152	156***
	(69)	(144**)	(127)	(159)	(101)	(128)	(134**)
Silica exposed							
	11/3.97	50/41.45	24/16.80	13/8.71	14/7.02	8/7.01	120/84.95
	277**	121	143	149	200*	114	141***
	(238*)	(104)	(123)	(128)	(172)	(97)	(122*)

Table 5.31

Mortality from bronchitis, emphysema and asthma (490-493)
by length of employment within exposure category

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR

	<1 yr	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
Exposed							
		85/50.30 169***	38/23.62 161**	28/15.59 180**	22/10.04 219**	7/9.52 74	180/109.1 165***
Foundry							
		51/29.16 175***	16/11.27 142	14/8.14 172	7/4.56 153	3/4.05 74	91/57.17 159***
Fettling							
		24/11.47 209**	9/5.47 165	6/3.15 191	7/2.32 302*	2/2.50 80	48/24.91 193***
Maintenance							
		8/6.24 128	3/3.58 84	3/1.85 162	4/1.33 301	1/1.11 90	19/14.10 135
Unexposed							
		31/16.76 185**	13/9.02 144	9/6.38 141	5/3.50 143	3/2.32 129	61/37.97 161***
Dust exposed							
	5/2.07 242	38/26.81 142*	15/11.49 131	14/6.63 211*	10/4.90 204	3/4.54 66	85/56.43 151***
Fume exposed							
	1/1.82 55	33/18.04 183**	15/8.40 179	9/5.12 176	6/3.76 160	3/3.54 85	67/40.67 165***
Silica exposed							
	5/1.92 260	29/20.38 142	12/8.41 143	8/4.39 182	9/3.57 252*	1/3.49 29	64/42.17 152**

Table 5.32

Mortality from diseases of the respiratory system (460-519) by town size (exposed and unexposed) and length of employment

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Length of employment: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
"small towns", exposed					
43/31.84 135 (121)	19/18.84 101 (90)	12/10.89 110 (98)	11/6.61 166 (147)	11/8.75 126 (111)	96/76.94 125* (111)
"small towns", unexposed					
10/9.48 106 (101)	4/4.54 88 (82)	1/4.76 21 (20)	1/1.95 51 (49)	0/1.67 0 (0)	16/22.39 71 (68)
"large towns", exposed					
101/70.36 144*** (123)	48/28.33 169*** (143*)	34/20.48 166** (140)	26/13.38 194** (164*)	12/10.44 115 (96)	221/143.0 155*** (131***)
"large towns", unexposed					
43/24.64 174** (152*)	16/14.03 114 (98)	13/8.69 150 (128)	7/5.26 133 (113)	4/3.03 132 (113)	83/55.65 149*** (129*)

Table 5.33

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and age at entry (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	2/1.05	5/1.85	2/3.04	2/1.91	11/7.85
	190	271	66	105	140
	(165)	(234)	(57)	(91)	(121)
25-34	2/2.65	7/7.53	24/15.25	13/8.99	46/34.41
	75	93	157*	145	134
	(65)	(80)	(135)	(124)	(115)
35-44	6/6.14	31/18.56	54/29.34	12/11.22	103/65.26
	98	167*	184***	107	158***
	(84)	(144)	(158**)	(92)	(135**)
45-54	20/12.46	44/28.22	45/28.34	9/5.51	118/74.55
	160	156**	159**	163	158***
	(139)	(135)	(137)	(139)	(136**)
55-64	6/9.35	19/14.49	11/8.20	0/0.71	36/32.76
	64	131	134	0	110
	(56)	(115)	(120)	(0)	(97)
65+	1/1.64	1/2.73	1/0.73	0/0.00	3/5.10
	61	37	137	-	59
	(52)	(32)	(121)	-	(51)
Total	37/33.30	107/73.38	137/84.90	36/28.34	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.34

Mortality from diseases of the respiratory system (460-519) by years since first exposure and entry cohort (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	11/8.54	42/20.00	62/32.67	31/22.89	146/84.09
	129	210***	190***	135	174***
	(112)	(182***)	(163***)	(116)	(149***)
1951-55	14/11.19	30/25.45	57/37.30	5/5.46	106/79.39
	125	118	153**	92	134**
	(109)	(102)	(132)	(79)	(115)
1956-60	9/7.65	21/17.21	17/13.79	0/0.00	47/38.65
	118	122	123	-	122
	(102)	(106)	(107)	-	(106)
1961-65	3/5.93	14/10.72	1/1.14	0/0.00	18/17.79
	51	131	88	-	101
	(43)	(112)	(77)	-	(87)
Total	37/33.30	107/73.38	137/84.90	36/28.35	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.35

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and entry cohort (exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	7/4.15 169	29/11.13 261***	37/16.83 220***	14/9.43 148	87/41.54 209***
1951-55	9/5.80 155	23/14.53 158*	26/17.26 151	2/2.20 91	60/39.80 151**
1956-60	4/4.13 97	10/9.10 110	11/5.81 189	0/0.00 -	25/19.04 131
1961-65	0/3.23 0	8/4.97 161	0/0.49 0	0/0.00 -	8/8.69 92
Total	20/17.31 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.36

Mortality from diseases of the respiratory system (460-519) by years since first exposure and entry cohort (unexposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	11/3.13 352*** (313**)	6/6.10 98 (87)	9/10.54 85 (76)	9/6.58 137 (121)	35/26.34 133 (118)
1951-55	7/4.43 158 (141)	12/9.41 128 (114)	15/13.09 115 (103)	2/1.62 124 (113)	36/28.54 126 (113)
1956-60	6/3.09 194 (170)	5/5.32 94 (83)	4/4.39 91 (80)	0/0.00 - -	15/12.80 117 (103)
1961-65	3/3.17 95 (82)	8/6.09 131 (113)	2/1.10 183 (158)	0/0.00 - -	13/10.35 126 (108)
Total	27/13.83 195** (172*)	31/26.92 115 (101)	30/29.10 103 (92)	11/8.19 134 (120)	99/78.04 127* (112)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.37

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and entry cohort (unexposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	5/1.61 311*	3/3.45 87	5/5.10 98	3/2.59 116	16/12.75 126
1951-55	5/2.42 207	11/5.28 208*	9/5.48 164	0/0.60 0	25/13.77 182**
1956-60	6/1.74 345*	2/2.86 70	4/1.78 225	0/0.00 -	12/6.38 188
1961-65	2/1.82 110	5/2.83 177	1/0.41 246	0/0.00 -	8/5.07 158
Total	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.97 161***

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Table 5.38

Results of modelling with GLIM the non-malignant respiratory disease mortality in the exposed cohort. Relative Risk (Standardised normal deviate of the regression estimates)

Model	1	1+ENT	1+ENTV	1+LEN	1+LENV	1+AGE	1+AGEV
Deviance	131.1	122.9	123.5	130.5	131.0	127.5	131.0
DF	119	116	118	116	118	116	118
Chisquared		8.2	7.6	0.6	0.1	3.6	0.1
ENT(2)		0.80 (2.0)					
ENT(3)		0.74 (2.1)					
ENT(4)		0.67 (2.1)					
ENTV			0.86 (-2.7)				
LEN(2)				0.92 (-0.7)			
LEN(3)				0.93 (-0.5)			
LEN(4)				0.97 (-0.2)			
LEN					0.99 (-0.3)		
AGE(2)						1.16 (1.0)	
AGE(3)						1.18 (1.2)	
AGE(4)						0.94 (-0.4)	
AGEV							0.99 (-0.2)

Table 5.39

Results of fitting variables with GLIM to the non-malignant respiratory disease mortality in the exposed cohort. Relative Risk (Standardised normal deviate of the regression estimates)

Model	Deviance	DF	X^2	ENTV	LENV	AGEV
1+AGE+LEN	126.8	113				
1+AGE+LEN+ENTV	118.4	112	8.4	0.85 (-2.8)		
1+AGE+ENT	118.53	113				
1+AGE+ENT+LENV	117.57	112	1.0		0.96 (-1.0)	
1+ENT+LEN	122.1	113				
1+ENT+LEN+AGEV	122.0	112	0.1			1.02 (0.4)

Table 5.40

Factory by work area

Mortality from diseases of the circulatory system(390-458)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	57/54.12 105 (93)	7/7.47 94 (83)	11/12.32 89 (79)	9/8.22 110 (97)	24/26.15 92 (81)	108/108.3 100 (88)
11	52/50.92 102 (89)	35/39.47 89 (77)	25/18.33 136 (119)	4/4.13 97 (84)	24/23.02 104 (91)	140/135.9 103 (90)
12	21/22.02 95 (82)	6/4.31 139 (120)	5/2.41 207 (179)	5/3.03 165 (142)	7/7.63 92 (79)	44/39.40 112 (96)
13	17/19.99 85 (90)	8/4.97 161 (171)	5/5.47 91 (97)	9/7.81 115 (123)	11/14.03 78 (83)	50/52.27 96 (102)
14	110/99.58 110 (102)	48/49.32 97 (90)	25/20.39 123 (114)	25/23.35 107 (99)	48/41.13 117 (108)	256/233.8 110 (101)
15	29/20.04 145 (120)	32/31.43 102 (84)	2/3.17 63 (52)	6/2.94 204 (169)	6/4.29 140 (116)	75/61.87 121 (100)
16	43/49.28 87 (75)	21/16.02 131 (113)	9/15.57 58 (50*)	25/20.63 121 (104)	18/16.48 109 (94)	116/118.0 98 (85)
17	24/25.83 93 (89)	10/6.89 145 (140)	13/12.49 104 (100)	24/17.07 141 (135)	21/21.44 98 (94)	92/83.72 110 (106)
18	91/81.77 111 (98)	46/36.90 125 (109)	19/16.12 118 (103)	24/13.06 184** (161*)	119/99.73 119 (105)	299/247.6 121** (106)
19	29/21.34 136 (105)	22/12.87 171* (131)	2/6.30 32 (24*)	11/7.28 151 (116)	37/31.76 116 (90)	101/79.55 127* (98)
Total	473/444.9 106 (94)	235/209.7 112 (98)	116/112.6 103 (92)	142/107.5 132** (119)	315/285.7 110 (97)	1281/1160.3 110*** (98)

Group: Foundry, Fettling, Mainten., Mix/oth., Unexp.

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.41

Main occupational category

Mortality from diseases of the circulatory system(390-458)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	29	20.82	139	(93-200)
2 Moulder	105	98.03	107	(88-130)
3 Shell moulder	4	3.95	101	(28-259)
4 Furnaceman/caster	65	63.35	103	(79-131)
5 Furnace repair	61	52.72	116	(88-149)
6 Centrifugal caster	11	15.60	71	(35-126)
7 Cranedriver, foundry	28	35.63	79	(52-114)
8 Labourer, foundry	180	162.77	111	(95-128)
9 Knockout gridman	21	17.36	121	(75-185)
10 Other foundry jobs	10	13.61	73	(35-135)
11 Fettler	122	103.28	118	(98-141)
12 Shotblaster	24	20.97	114	(73-170)
13 Welder/burner	46	35.92	128	(94-171)
14 Arc air burner	4	2.26	177	(48-454)
15 Heat treatment loader	13	13.18	99	(53-169)
16 Cranedriver, fettling	14	13.35	105	(57-176)
17 Labourer, fettling shop	41	36.25	113	(81-153)
18 Other fettling shop jobs	13	14.29	91	(48-156)
19 Pattern maker	18	16.33	110	(65-174)
20 Labourer, pattern shop	14	14.51	96	(53-162)
21 Inspection	33	33.86	97	(67-137)
22 Machinist	114	93.99	121	(100-146)
23 Labourer, machine shop	119	97.56	122	(101-146)
24 Welder: m/c shop, maint.	3	5.01	60	(12-175)
25 Maintenance fitter	75	69.62	108	(85-135)
26 Maintenance fitters mate	49	46.06	106	(79-141)
27 Yard lab., lorry driver	61	56.67	108	(82-138)
28 Precision foundry worker	3	1.78	168	(35-492)
29 Precision inspection	1	0.78	128	(3-711)
30 Precision fettler	0	0.74	0	(0-497)
Total	1281	1160.28	110	(104-117)

Table 5.42

Mortality from diseases of the circulatory system(390-458) by years since first exposure and age at entry (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	1/2.01	18/9.82	30/25.69	13/15.41	62/52.93
	50	183*	117	84	117
	(44)	(162)	(103)	(75)	(104)
25-34	11/9.88	63/47.56	114/100.2	52/49.61	240/207.3
	111	132*	114	105	116*
	(99)	(118)	(101)	(93)	(103)
35-44	32/25.02	95/86.59	125/128.7	58/39.82	310/280.1
	128	110	97	146**	111
	(114)	(98)	(86)	(129)	(98)
45-54	37/38.92	123/96.07	78/88.13	15/12.83	253/235.9
	95	128**	89	117	107
	(84)	(113)	(78*)	(103)	(95)
55-64	19/24.25	51/40.00	23/19.95	1/1.47	94/85.66
	78	128	115	68	110
	(69)	(112)	(103)	(62)	(97)
65+	2/4.43	4/6.66	1/1.63	0/0.00	7/12.71
	45	60	62	-	55
	(39)	(53)	(54)	-	(48*)
Total	102/104.5	354/286.7	371/364.3	139/119.1	966/874.6
	98	123***	102	117	110**
	(86)	(109)	(90)	(103)	(98)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Table 5.43

Mortality from diseases of the circulatory system (390-458)
by length of employment within exposure category

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Years employed: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
Exposed					
446/404.6 110* (98)	193/175.9 110 (97)	149/117.1 127** (113)	75/81.74 92 (82)	103/95.29 108 (96)	966/874.6 110** (98)
Foundry					
236/227.4 104 (92)	88/82.92 106 (95)	71/59.21 120 (106)	39/35.97 108 (96)	39/39.36 99 (89)	473/444.9 106 (94)
Fettling					
108/95.65 113 (99)	54/42.27 128 (112)	33/25.20 131 (115)	11/20.30 54* (48**)	29/26.25 110 (97)	235/209.7 112 (98)
Maintenance					
58/50.59 115 (103)	17/25.90 66 (58*)	20/14.20 141 (123)	11/10.64 103 (92)	10/11.24 89 (79)	116/112.6 103 (92)
Unexposed					
138/124.8 111 (97)	77/62.85 123 (108)	45/46.50 97 (85)	32/27.55 116 (105)	23/23.98 96 (86)	315/285.7 110 (97)

Table 5.44

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and entry cohort (exposed)

SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	27/21.37	83/62.63	140/132.2	124/96.76	374/313.0
	126	133*	106	128**	119***
	(112)	(117)	(94)	(114)	(106)
1951-55	32/31.67	114/93.06	167/161.7	15/22.38	328/308.8
	101	123*	103	67	106
	(90)	(109)	(92)	(60*)	(95)
1956-60	23/26.45	89/76.76	62/64.34	0/0.00	174/167.6
	87	116	96	-	104
	(77)	(102)	(85)	-	(92)
1961-65	20/25.00	68/54.23	2/6.02	0/0.00	90/85.25
	80	125	33	-	106
	(71)	(111)	(30)	-	(94)
Total	102/104.5	354/286.7	371/364.3	139/119.1	966/874.6
	98	123***	102	117	110**
	(86)	(109)	(90)	(103)	(98)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

CHAPTER 6 - DISCUSSION

6.1 Introduction

In this chapter the results of the analysis are discussed and evaluated in the light of previous work. First however a number of general issues related to the validity of the data are considered - the exclusion from the analysis of immigrant workers, the validity of death certificates, the choice of reference population, survival and the healthy worker effect and the lack of comparability of SMRs.

6.2 Immigrant workers

Those workers identified as probably being of immigrant origin were excluded from the analysis because of their high proportion of loss to follow-up and very low mortality ratio. Although this method of identifying immigrant workers by their surname rather than place of birth is not ideal because some immigrants will have been missed and some non-immigrants will have been wrongly excluded, it has been reported as a more reliable method of identifying a person of Asian ethnic origin than using country of birth (Sillitoe, 1978). The method appears to have been fairly successful because it identified a group with markedly different characteristics (high loss to follow-up). Analysis by place of birth, of mortality in 1970-1972 in England and Wales using 1971 census data resulted in an all-cause

SMR of 98 for males born on the Indian subcontinent (Marmot et al., 1984). The lack of any deficit in that study would suggest that the low SMR in this study cannot be attributed to non-comparibility of reference rates. Therefore one can assume that in the current study, over half the deaths in this subgroup have occurred in the 14% of individuals lost to follow-up or emigrated. The lowest mortality was found for malignant neoplasms, a set of diseases of old age and thus even more represented among those re-emigrated or otherwise lost to follow-up. From the point of view of evaluating the effects of the foundry environment, it is unfortunate that this group has such poor follow-up. This group tended to work in the less skilled jobs associated with higher mortality from lung cancer and non-malignant respiratory disease. Because of their poor follow-up including them would have led to underestimates of the risk.

6.3 The validity of death certificates

The underlying cause of death as given on the death certificate has been used in this study, as is the practice in most studies of mortality. This is directly comparable to the source of underlying cause of death used for compiling the reference rates for mortality and therefore the two populations should be comparable in this respect unless there have been any systematic differences in either the autopsy rate or certifying practice. The autopsy rate among deaths in the present study is unknown. The rate lay between 20 and 30% in England and Wales during 1958-1972 (Waldron and

Vickerstaff, 1975). It may be the case that physicians, being aware of the occupation of the foundry workers in this study may be influenced in the choice of the causes of death given. In spite of the data from previous Registrar-Generals' reports, it is only recently that the literature has suggested that lung cancer is associated with foundry work (Palmer and Scott, 1981) so for that cause there is no reason to suppose that the cause of death assignment may have been influenced by knowledge of the decedents's occupation. In fact it has been the widely held view that silicosis and silica do not predispose to cancer (Hunter, 1969). Given that silica exposure was the most widely recognised hazard in foundries, an occupational cause for a foundry worker's lung cancer would not have been an obvious link for a clinician to make. As is discussed below in the section on non-malignant respiratory disease, the rather small number of deaths from silicosis and silicotuberculosis suggests a reluctance rather than predilection to choose the one well-known risk of silica-exposed jobs in the foundry when certifying cause of death. The assignment of underlying cause may be subject to some regional variation but this is unlikely to seriously bias the comparability by cause of death for this population.

However the accuracy of death certification per se, if poor, can prejudice the results by decreasing the reliability of the results, especially for subgroups of the populations where inferences may be drawn on quite small numbers of deaths. A number of authors have addressed this issue, both in the UK and abroad. A series of 6 studies in the US and Scandinavia has compared the cause of death given on the death certificate by the clinician, completed prior to autopsy, with the underlying cause of death determined by autopsy. One study considered 2734 deaths during 1955-1965 (Bauer and Robbins, 1972) and the other, smaller series were all of deaths during the 1970s (Engel et al, 1980; Britton, 1974; Schottenfeld et al, 1982; Goldman et al, 1983; Kircher et al, 1985). The agreements considering major ICD category (17 groups) between autopsy and certificate data were in each study respectively 88%, 81%, 82%, 85%, 78% and 71%. There was in general a further 10-20% disagreement between more specific disease categories within those causes of death which were consistent within major category.

Studies in the UK have compared underlying cause of death given before and after autopsy and suggest in general, even poorer consistency than the figures cited above. The largest, a series of 9501 deaths in 75 hospitals in England and Wales during six months in 1959 reported only 45.3% agreement on the underlying cause of death (Heasman and Lipworth, 1966). The authors note that the agreement is better if the causes are aggregated into broader cause of death groupings, but do not give data which would allow direct comparison with the figures cited above. They note that the overall proportions for many causes of death are similar whichever set of diagnoses is selected - that there is misclassification rather than a systematic underdiagnosis of conditions, although some conditions such as brain cancer, chronic bronchitis and lung cancer were less frequent among the clinicans' diagnoses than the diagnoses of the pathologists. These two aspects are well illustrated with cancer of the lung, bronchus and trachea (ICD 7th Revision: 162-163). Of 534 cases assigned by the pathologist, only 268 (50%) were similarly classified. However another 182 cases coded differently by the pathologist were coded as lung cancer by the clinicians, giving 450 lung cancers in total according to the clinicians (84% of the pathologists' count).

In a more recent study of 1152 hospital autopsies (during 1975-77 in Scotland) clinical and pathological underlying causes only agreed by major cause groupings in 61% of the sample (Cameron and McGoogan, 1981). Again, as in all the studies discussed here, the overall proportions are similar according to both clinicians and pathologists, but the low level of consistency leads the authors to state: "In our experience, statistics from death certificates are so inaccurate that they are unsuitable for use in research and planning". They, in common with other authors (Kircher et al, 1985) advocate the increased use of autopsy data for assigning underlying causes of death. However for the present, the routinely available data are widely used and considered as a useful source of data for monitoring chronic diseases in occupational groups (OPCS, 1978).

Selikoff et al (1979) in their study of asbestos insulation workers supplemented death certificate data and derived a "best estimate" of the underlying cause of death, increasing the number of observed lung cancers and mesotheliomas relative to the death certifications. They then compared these revised estimates with the expected deaths, an inappropriate comparison as the reference population's deaths had not been subject to the same review. Such use of revised data could however be a useful approach for overcoming unreliability of death certificate data for internal comparisons and dose response analyses.

The high degree of consistency between the lung cancer mortality risks in other studies of foundry workers is evidence of the practical validity of using death certificate data. However random misclassification of cause of death, as with random misclassification of exposure will tend to bias the computed risk estimate towards unity (Kleinbaum et al, 1982).

To illustrate this phenomenon, data on sensitivity and specificity from Cameron and McGoogan (1981) have been applied to mortality from all malignant neoplasms in the present study using corrections for misclassification from Kleinbaum et al (1982).

There were 603 deaths from malignant neoplasms in the exposed cohort. To estimate the effect of misclassification a comparison group was hypothesized, the same size as the study population, with the number of cancer cases such as to give the observed SMR of 123. Time and age are ignored to simplify the model. The figures are shown below:

	Cohort	Reference Population
Cancer deaths	a = 603	b = 490
Non-Cancer	c = 7786	d = 7899
Total	8389	8389

Rate Ratio (RR) = (603/8389) / (490/8389) = 1.23

If the same degree of miscertification as happened in the Scottish study had taken place in this study, then of the 490 referent deaths from cancer, 72 would have been from another cause and a further 78 would have been discovered among deaths certified as from other causes. This represents a sensitivity ("true" cases correctly certified) of 418/496 = 0.843. The hypothetical cohort of unexposed comprises 8389 individuals, of whom all but 496 did not "in fact" die of cancer, although of these non-cancer cases, 72 were certified as having died of cancer. Thus the specificity ("true" non-cases correctly identified is (8389-496-72)/(8389-496) = 0.991.

One can estimate what would have been the pattern of mortality in the absence of misclassification errors by correcting the values of a,b,c, and d. In this example such a recalculation would represent the pattern of mortality had all causes of deaths in both the foundry and reference population been determined by autopsy.

The equations (derived from Kleinbaum et al, 1982) are as follows, with a, b, c and d as above, and using a sensitivity (s) of 0.843 and a specificity (t) of 0.991:

Corrected a = (t.a-(1-t).c)/(s+t-1)

= (0.991 x 603 - 0.009 x 7786)/(0.843+0.991-1) = 632.5

" b = (t.b-(1-t).d)/(s+t-1) = 497.0

" c = (s.c-(1-s).a)/(s+t-1) = 7756.5

" d = (s.d-(1-s).b)/(s+t-1) = 7892.0

Corrected RR: $\dfrac{632.5}{497.0} = 1.273$

The effect of misclassification is thus a relatively slight underestimation of the risk, although the effect might be much more pronounced for more specific groupings of causes of death where the sensitivities are poorer. For example, using figures for lung cancer derived from Heasman and Lipworth's earlier survey, the sensitivity would be 0.502 and the specificity 0.990, calculated in the same manner as in the above example. The adjusted relative Risk would then be 1.92 instead of 1.54 (SMR = 154). Thus the measured Relative Risk is reduced by a substantially larger factor from the "true" risk than for a broader cause of death grouping.

From this example it is clear that the inaccuracies in death certification make a risk more difficult to demonstrate because risk ratios end up closer to unity. Conversely the risks that are identified may well reflect even higher true risks than the magnitude of those measured. The degree of this effect lies between a few percent up to some 40% but would appear sufficiently small not to invalidate the use of these data as suggested by Cameron and McGoogan.

6.4 Choice of reference population

Given that the death certification procedure is equivalent in the study population and general comparison population (albeit subject to some inaccuracy) are the two populations comparable? Ideally, to investigate the effects of foundry work, the referent population should be identical in all respects other than working in a foundry. However, this is not the case and an extensive literature has developed around the discussion of this problem of comparability. Much of it has hinged around the concept of the "Healthy Worker Effect", in reference to the fact that the foundry worker population could not have included the sections of the population who are not fit enough to work, although these individuals contribute to the national death statistics and suffer a higher mortality than the employed population (McMichael et al, 1974). This is elegantly shown in the Longitudinal Study - a follow up from the 1971 census of a 1% sample of the population of England and Wales (Fox and Goldblatt, 1982). For all men aged 15-64 employed during the week before the April 1971 census, the Standardised Mortality Ratio (SMR) is 86 during 1971-75, relative to the entire population. This low SMR is balanced by high SMRs for those seeking work (SMR = 130) off work, sick (323), retired (153) and permanently sick (392). The effect was becoming less pronounced as time progressed from the census, with the SMR for those employed rising from 80 in 1971 to 89 in 1975.

The tendency of the mortality in employed groups to be lower than the national reference populations has been observed in numerous industrial cohort studies (Wang and Miettenen, 1982) and can be thought of as having several components (Fox and Collier, 1976). Consider a population of workers hired at a particular point in time. Those too unhealthy to take up employment (especially if it is physically demanding) will be excluded, thus the newly hired population is already selected. As time progresses, some of these individuals will leave for reasons of ill-health (both related to and independent of their working conditions), leaving a healthier "survivor" population. On the other hand as the whole cohort is followed forward in time, the effects of the health selection will wear off. The (employed) census population as described above will have been subject to both health selection at initial employment and the "survivor effect". The "healthy worker effect" wears off after a period of some years. Fox and Collier (1976) suggested 15 years. From the Longitudinal Study data the SMR rises almost linearly by year of death and so one can extrapolate and estimate approximately when the SMR for employed persons would approach 100. This appears to take some seven years for all causes, four years for malignant neoplasms, ten years for non-malignant respiratory disease and six years for circulatory disease. (Of course one would not necessarily expect the SMRs to reach 100 because the employed population will always remain a little different from a reference population as the latter group includes those who could never work, and probably retains mortality rates higher than the average. However this effect should be small.) Therefore the healthy worker effect should be fairly negligible in a study of over 30 years follow-up from first exposure and to a large extent can be avoided by considering mortality after the first 10 years of follow-up.

Another source of non-comparability to the national population is that the cohort is drawn from a limited number of geographical areas, however this has been considered in the analysis by applying correction factors to the results. By including a correction for geographical area, one is correcting for local factors which may affect health such as differences in social class composition (which tend to be minimal (OPCS, 1978), general atmospheric pollution, smoking habits (Saracci, 1984) and other social and dietary habits. Such corrections are considered appropriate in occupational cohort studies and are frequently performed (MRC, 1984). One drawback is that in many situations actual rates are not available and so global corrections are made on the basis of SMRs derived from published statistics, usually an SMR based on a different age structure to that of the cohort under study. If the rates are available they may be available for only a limited time period or rates based on such small numbers for the less frequent causes of death that they are unstable. While it may be tempting to use reference rates or correction factors based on smaller geographical areas to maximise comparability, there is also a danger of over-correction because the employed population one is investigating (or the study population plus other similar populations) represents a sufficient proportion of the local population to affect the overall mortality.

For the present study, regionally based mortality rates were not available for the whole time period, but they have been used to derive a more appropriate correction factor than that provided by the SMR for the region. The calculated regional correction factor is based on a longer period of time than any single published SMR and more importantly, the factor derives from applying the regional mortality rates to the actual age distribution of person-years for each factory cohort. Further it was the only way to apply a correction for the Scottish factory as no summary statistics by region are published for the whole of Great Britain. For all causes, lung cancer and non-malignant respiratory disease, the regional correction factors as a ratio of SMRs calculated from the ratio of regionally to nationally derived SMRs are a little higher than the equivalent regional SMRs for 1969-73 (compared to the national average of 100). In a few instances - particularly Walsall (Factory 14) for all three causes and Sheffield and Leeds (Factories 10, 11, 18) for all causes and lung cancer - the local area (county or subcounty) gave the highest SMRs, however these may suffer from the problem described above, of being rather influenced by significant steel industry and foundry employment in the area.

On balance the regional population constitutes a better reference population than the national, but by applying fixed correction factors, independent of age and time, the true regionally based SMRs are being crudely estimated. For this reason, most results present SMRs with and without regional adjustment and attention is drawn to them where they diverge. The effect is most marked for circulatory disease mortality where most of the highly significant excesses were removed by applying the regional correction factors.

In addition to differences in mortality between individual occupational categories, there are consistent differences between social class categories (OPCS, 1978). The social classes as defined by the Registrar-General are V (Unskilled), IV (Semi-skilled), IIIM (Skilled manual), IIIN (Skilled non-manual), II (Intermediate) and I (Professional), and the mortality from most causes of death exhibits a gradient from low mortality in Social class I to high mortality in social class V. For example, in 1970-72, the all cause SMR for social class V is 127 and 77 for social class I (OPCS, 1978). The present study population comprises manual workers only and is thus drawn from social classes IIIM, IV and V. For those social class categories the SMRs for lung cancer during 1970-72 were 118, 123 and 143 respectively. Some of the excess mortality for social classes III to V is related to occupational exposures and thus to control for social class would to an extent be controlling for the factor under study. However much of the excess is related to factors unrelated to specific occupations: Fox and Adelstein (1978) reported that 82% of the between-occupation-order variance is removed by social class standardisation, suggesting some common "way of life" factors as playing a role. Although there may be some occupational factors tending to be shared by much of each social class, the drop in variance is impressive.

Thus it would appear that the national (or even regional) reference population is not comparable for two contradictory reasons. It provides expected deaths that may be too high because of the healthy worker effect and too low because of social class non-comparability. The tendency of these two factors to act in opposite directions, at least over a short period of follow-up is well illustrated by the study of foundry workers' mortality conducted by Sherson and Iversen (1986).

In addition to the Danish general population, they used two sources of reference rates derived from a follow-up from the Danish census of 1970. These were all economically active males (to compensate for the healthy worker effect) and skilled and unskilled manual workers (to compensate for economic activity and social class). Relative to the three reference populations the SMRs for all causes were respectively 102, 112 and 104, for respiratory disease 157, 205 and 180, and for lung cancer 115, 117 and 103 respectively. Thus for all causes the two factors cancel each other out whereas for respiratory disease health selection outweighs social class, the reverse being the case for lung cancer where the social class correction tends to remove the overall excess. Much of the social class gradient in lung cancer mortality is related to differential smoking habits by social class (OPCS, 1978). The issue of smoking is addressed in the discussion of the lung cancer results. However for all cause mortality it would appear that using reference rates derived from the general population offers a reasonable compromise for dealing with social class and health selection factors, although not ideal because the health selection factors change over time, whereas the social class categorisation remains somewhat fixed.

6.5 Internal analyses and health selection

Given the drawbacks outlined above inherent in the use of external reference rates for risk estimation, then internal comparisons are clearly more desirable - comprising comparisons of the mortality of exposed versus unexposed, or investigations of dose related changes in risk. In this study there is a group who are not exposed directly to the foundry environment, comprising those employed in the pattern shop, inspection shop, machine shop and outside in the yard or driving lorries. Each factory contributes to this group, though to differing degrees and they have been used as a reference group in two ways. Firstly in a descriptive way to see if the pattern of SMRs in this group appears to differ on visual inspection from that of the exposed group (or some more specifically defined exposed group) when subdivided by various time, age and work area parameters. Secondly in an analytical way where some formal tests of the difference in the SMRs between the foundry and fettling shop populations have been made with respect to the unexposed referent group.

The investigation of dose-related changes in risk is more problematic. The foundry environment is mixed, and while there is a clear association to be expected between cumulative dose of silica and silicosis risk, for non-malignant respiratory disease in general and even more so for lung cancer, no specific risk factor has been identified. No dose-response analyses can be conducted because no detailed measurements to allow individual dose estimation to for example silica, total fume, polycyclic aromatic hydrocarbons or metal fumes, have been made.

Length of employment is therefore the only measure available approximating to cumulative dose, and may give a very distorted estimate because of changes in exposure over time. Apart from the qualitative changes in the foundry environment that have taken place, in Chapter 2 evidence was presented for respirable silica dust levels having fallen over time and the quality, availability and use of personal protective devices have all improved over time, according to the foundry managements. The replacement of pitch and sea coal in greensand moulds, and the replacement of greensand moulding by synthetic resins have led to lower levels of polycyclic aromatic hydrocarbons, although other exposures have increased. Stratifying by date of start, helps to mitigate the problem of exposure levels changing over time in the analyses by length of employment. However the problem still remains that cumulative employment does not equal cumulative dose, as a short period at a high dose may result in a dose exceeding that for other longer term workers. This is a problem in pooling workers exposed to different exposures at one point in time as well as over the decades covered by this study. In the absence of historical hygiene data, the best approach is to subdivide the population into relatively homogeneous subgroups by job title.

The use of the length of employment as a surrogate for the unknown dose is further complicated by the "survivor effect" alluded to in the preceding section. This phenomenon is a process of turnover of the sick more rapidly than the healthy, leaving a healthier survivor population whose subsequent mortality one might expect to be more favourable than the (on average unhealthier) shorter term employees. The low respiratory disease mortality in the present study in the group employed more than 20 years, probably reflects in part the survivor effect as it includes disproportionately the individuals employed during the initial data collection. This pattern can emerge in the absence of an occupational risk. If there were an occupational risk in addition, then the two effects would act in opposite directions and whether or not an increase in mortality by length of occupation is apparent, will depend on the relative strength of these two effects. The more physically demanding the work, the stronger one would anticipate the survivor effect to be. The survivor effect would be expected to act differently for different categories of disease. In the Longitudinal Study, the strength of the healthy worker effect and its persistence over time was increasingly strong for malignant neoplasm, circulatory disease and respiratory disease mortality. For cancer, where the latent period may last as long as 40 years between first exposure and manifest disease, one would expect little effect directly of the carcinogenic exposure leading to tumour and health selection. However if the exposure that leads to cancer also leads to some morbidity, especially disabling morbidity, then the above selection process may operate and lead to an obscuring of the exposure response relationship.

This is well illustrated by asbestos, a cause of both lung cancer and non-malignant respiratory disease. A number of studies have shown quite high risks in relatively short-term employment groups (Doll and Peto, 1985). For example the study of Rochdale asbestos textile factory workers recently reported by Peto et al. (1985). The risk was virtually the same for those employed less than one year, as it was for the 20 or more years group (observed 1.4 to 1.5 times expected respectively). A survey of Canadian miners of vermiculite contaminated with tremolite (an asbestos-like mineral) included both employed and ex-employees (McDonald et al, 1986). Their findings illustrate the health selection effect, for the prevalence of small opacities and pleural thickening was higher for past employees as compared to current employees in spite of virtually identical estimated cumulative fibre dose among those aged 60 and over. That this may be reflected in results from cohort studies is suggested by Fox and Collier (1976) who in their study of PVC workers found higher mortality in most major cause categories among those who had left versus current employees with 15 years cumulative employment.

As part of the large study of Finnish foundry workers, Koskela et al (1978) investigated the health status and reasons for termination among foundry workers and ex-foundry workers in Finland. Most of the reasons for leaving were not directly health related (low pay, poor conditions, physically demanding and uninteresting work), but their self evaluated health status was worse in several aspects than workers currently employed at the time of the survey.

The percentages of those who "felt in poor health", the proportion with a low scaled rating of "work capacity" and the proportion complaining of chest pains all suggested worse health among exfoundry workers. For chronic respiratory disease the prevalence was higher among 55-64 year olds for the leavers who had accumulated more than five years' employment (35%) compared to the current employees in the same age group (13%), but there was no significant difference. The clearest evidence of health selection came from the significantly more rapid termination rate in the "dusty occupations" compared to other occupations. In the present study as in other studies of foundry workers, the same population has excess risk of both malignant and non-malignant lung disease. Therefore it may be that turnover from job categories because of early effects on respiratory morbidity has the effect of flattening the duration response relationship for both these causes of death. In addition, the low respiratory disease mortality in the present study in the group employed more than 20 years, probably reflects in part the survivor effect as it includes disproportionately the individuals employed during the initial data collection.

6.6 Comparability of SMRs

Notwithstanding the above effects of health selection having the potential to obscure relationships with employment duration, it is still legitimate to search for such relationships in the search of a causal association. Many tables are devoted to tabulations of different subsets of the data in the search for such patterns. However SMRs are indirectly standardised rates (i.e. each one standardised on its own distribution of person-years by age and calendar-year strata), and therefore in a formal sense they are not comparable unless the risk is constant over the age and calendar year strata or the age distributions are identical (Greenland, 1982). While in the comparison of two different groups (for example "exposed" versus "unexposed") the age distributions may be very similar, in the analysis by length of occupation, duration of follow-up or date at entry, the age composition of the person-years in each SMR of necessity changes over strata. Two methods are available for overcoming this problem. One is to restandardise mortality ratios for comparison to one standard age distribution and then make a formal comparison, such as a trend test (Ranstam, 1984). In fact the potential for bias in such comparisons is frequently overestimated and adjustment in this way usually makes negligible difference to the pattern of results. A simpler method of taking into account the varying age distribution across strata is to include age in the model fitted to the data. This has been done in two different ways when investigating the effects of duration of employment and date of entry - considering age at entry and age at death. In both cases it makes scant difference to the fit of the parameters of interest. Thus, in general, the patterns of SMRs in the data presented here fairly reflect the differences or lack of differences across the strata by which the data have been subdivided.

6.7 Cancer mortality

The major excess mortality from lung cancer derives from significant excesses of lung and stomach cancer discussed below. There were small excesses of other respiratory tract cancers (buccal cavity and pharynx among the foundry group and laryngeal cancer among the fettling shop workers) but these were not significant and such excesses have not been reported before. The furnacemen were a group with cancers in excess for several sites in addition to lung and stomach, most notably two cases of nasal cancer (0.1 expected). The two furnacemen who died from nasal cancer both worked in factory 14, one for less than 5 years and one for over 20 years. The periods between first exposure and death were 16 and 33 years respectively. It is not known how important nickel-containing steel was in the production of factory 14. Studies of nickel refiners have reported excesses of both lung and nasal cancer (Doll et al, 1977); Enterline and Marsh, 1982) but at levels of exposure much higher than those reported in steel foundries. The other major occupational cause of nasal cancer is wood dust (Rang and Acheson, 1981) but there were no nasal cancer deaths in the pattern shop workers in the present study, although it is a small group with less than 0.1 cases expected.

Of the three deaths from mesothelioma, two of the individuals were maintenance workers, one a fitter, one a fitters' mate, the jobs in the cohort most likely to place them in contact with asbestos (which is used for insulation, for example of furnaces). The other individual was a centrifugal caster, regularly operating a ladle to pour molten metal and therefore having the potential for intermittent asbestos exposure from furnace insulation and asbestos gloves and aprons. The previous jobs for these individuals as for all cohort members were not known.

6.8 Smoking as a potential confounder

Cigarette smoking is the major single cause of lung cancer in most countries, including the United Kingdom. In the study of British doctors, current smokers showed a risk 10.4 times greater than non-smokers during 29 years of follow-up (Doll and Peto, 1976). For cigarette smokers the relative risk was 14.0. Such figures are broadly consistent with the magnitude of the relative risks reported in several other countries (IARC, 1986).

An attempt was made, using union records to find the addresses of past workers so that a postal questionnaire could be sent to try and estimate directly the smoking habits of a sample of the cohort in the past. Unfortunately, very few of the foundry workers could be identified in the union records. A survey of smoking habits of current foundry workers was condidered but not carried out as the extrapolation of the smoking prevalence of current workers to their predecessors is of doubtful validity.

Several studies of lung cancer risk among foundry workers have directly controlled for smoking habits in the population. Blot et al (1983) found an excess risk for steel workers in their case control study of lung cancer in Pennsylvania, USA. This was concentrated among foundry workers who had an odds ratio of 7.1. While this latter odds ratio was not adjusted for smoking, the effect of adjusting for smoking on the odds ratio for steel industry employment only reduced the value from 2.2 to 1.8.

Decoufle et al (1977) in their case control study of cancer in Buffalo, USA, reported odds ratios before and after adjustment for smoking. For metal moulders adjustment for smokers increased the OR from 1.60 to 1.91 (based on 16 exposed cases) and for furnacemen, smeltermen and pourers the OR dropped from 1.62 to 1.34 (based on 13 exposed cases). None of these odds ratios was significantly higher than 1.0.

Kunze et al (1982) for "workers in the metal industry", a broader occupational group than foundry workers, reported a smoking adjusted odds ratio of 1.5, consistent with the other estimates reported among foundry workers when smoking was not taken into account. Neuberger et al (1982) in addition to the foundry workers, for whom the relative risk was reported as 1.73, followed up a control population matched on age, domicile and smoking habits, for whom the RR was 1.12. Therefore the excess could not be attributed to smoking.

Silverstein et al (1986) in their proportional mortality study of lung cancer among foundry workers used two reference populations. One was US males and one was smokers derived from the follow-up of US veterans. Among ever smokers the lung cancer PMR was 159 relative to US males and 157 relative to US veteran smokers.

A proportional mortality analysis of cancer deaths in the West of Scotland which standardised for smoking habits reported an excess of cancer mortality under the age of 65 for foundry workers (Hole et al, 1981). This study was only published as an abstract so little can be deduced from it. Thus in none of the seven aforementioned studies of foundry workers did control for smoking remove the excess lung cancer mortality.

Tola et al (1979) reported the smoking habits of foundry workers currently employed in 1972. Overall the proportion of current smokers was 57%, not significantly different from the Finnish average (Karava et al, 1976). The prevalence of smoking in that survey by occupational category was compared with the relative frequency among the cases. The Spearman rank correlation coefficient was -0.45, not supporting smoking as an explanation of the excess lung cancer mortality reported in that study.

Outside the UK at least two authors report no substantial difference between foundryworkers and the general population as regards smoking habits. Gibson et al (1977) in their study of a Canadian foundry reported that among a random sample of 100 foundry workers in 1976, 58% smoked cigarettes. This compared with 53% among a large random sample of all male plant personnel and 55% among a small sample of foundry workers from the study cohort. An excess lung cancer was present among foundry workers (SMR=250), but not the rest of the plant. A Finnish study of foundry workers reported no difference in smoking habits relative to the national average (Karava et al, 1976).

In Gibson et al's study they characterised the smoking habits of 24 out of the 32 lung cancer deaths, and reported 22 out of 24 had been cigarette smokers. In the Finnish study, 20 out of 21 lung cancer cases had been smokers (Koskela et al, 1976).If one assumes a smoking prevalence of 60% and a lung cancer risk ten times higher for smokers relative to non-smokers, then for every 4 cases of lung cancer among the 40% non-smokers, there would be 60 cases of lung cancer among smokers, a ratio of 1:15. Thus, the proportion of smokers in those case series are consistent with an average pattern of smoking behaviour. The relative proportion would be maintained if the lung cancer risk from foundry exposures acted equally (i.e. the Relative Risks were constant) in different smoking groups, however large the size of the risk from foundry employment.

Within the UK, several studies have addressed the smoking habits of foundry workers. In Stavely, Derbyshire, Cochrane and Moore (1980a, 1980b) reported on a cross-sectional census and inverview of men that took place in 1957. Overall 60.1% of men aged 55-64 were smokers, compared to 64.6% amongst foundry workers in the same age group. For 25-34 year olds, 67.1% of foundry workers were current smokers compared to 71.8% for all males. Therefore overall there was no difference between foundry workers and other males in that town.

Lloyd Davies (1971) reported the results of a survey of respiratory disease in a representative sample of male foundry workers. 1997 foundrymen aged 35-64 were examined during 1964-1965 and a control group of 1777 men in nearby engineering factories. The percentage of current smokers was 73.9% among foundry floor men, 73.9% among fettlers and 70.4% in the control factories. In Britain as a whole the percentage of current smokers during that period fell from approximately 70% in 1946 to 50% in 1974 (Capell, 1978). Survey data from the Tobacco Research Council indicated percentages of current smokers as 68% in 1963, 65% in 1973 and 61% in 1975 (Lee, 1976). Thus both the Stavely survey in 1957 and the national survey in 1964 suggest smoking prevalences slightly but not more than 10% above national figures.

In the OPCS Decennial Supplement (OPCS, 1978) lung cancer SMRs by occupation order were compared with the smoking prevalences by the same occupation order established during the General Household Survey of 7566 males aged 15-64 in 1972. Overall there was a strong correlation (R = 0.72). However, the SMR (155) for the order containing foundry workers, i.e. furnace, forge, foundry and rolling mill workers was the highest of all the occupation orders. Among the 103 workers interviewed in that group, 62% were current smokers compared to 54% in the whole sample. The regression of SMR against percentage current smokers would predict an SMR of approximately 120-130. Thus although the estimates are based on rather small numbers and the occupational category is broader than foundry work, some half of the reported excess can be estimated as attributable to excess smoking in this population.

Axelson (1978) considered in general the degree of effect that smoking may have as a confounder in epidemiological studies. Assuming a baseline prevalence of smoking as 50% non-smokers, 40% moderate smokers and 10% heavy smokers with relative risks of 10 and 20 for light and heavy smokers respectively, the effect of different smoking prevalences was estimated. An increase in smoking to 20% heavy, 50% moderate and 30% non-smokers would give an SMR of 165, in each case due to smoking alone. Therefore to explain the risks of around 1.5 fold reported in various studies of foundry workers, there should be some 20-30% more smokers among foundry workers than among the general population. However the average smoking prevalence in the UK has been larger than 50% and this would necessitate an even larger increase of smoking in the study group than the increases in Axelson's example, to generate risks of the order of 1.5.

The limited degree that smoking plays as a confounder because of the high percentage of smokers in the general population, despite the high risk ratio for lung cancer is borne out by Blair et al (1985). Using the prospective study of 293000 US Veterans, for whom both occupational and smoking categories were known, the occupation-specific SMRs both with and without smoking adjustment were compared. Considering job categories with at least five observed or expected lung cancer deaths, there were 29 categories. For the whole population, there were 38% current smokers, 22% never smokers and 20% not determined from two surveys in 1954 and 1957, varying by job category from 12% among clergymen up to 53% in cooks and 57% in bartenders. Fourteen SMRs were reduced by adjustment, eleven increased and four unchanged. In terms of the absolute difference in the two SMRs, ten differed by more than 20 points and only two differed by 50 or more points.

6.9 Lung cancer

Overall the lung cancer SMR for the study population is 146, significantly high ($p < 0.001$) whether compared to the entire England and Wales population or adjusted for regional differences in mortality in which case the SMR is reduced to 137. By work area the risk is concentrated in the foundry itself (SMR = 159, 95% Confidence Interval 135-185) and the fettling shop (SMR = 172, Confidence Interval 138-213). In both work areas the risk is fairly evenly spread through all eighteen occupational categories, suggesting a shared aetiology. In the foundry, the risk was highest amongst furnacemen and casters (SMRs 181 and 193) and in the fettling area the risk was highest for fettlers themselves (SMR = 188) and heat treatment loaders (SMR = 245 based on 8 cases).

The magnitude of this excess is consistent with the magnitude of excesses reported in published studies of foundry workers, most of which reported SMRs, PMRs or ORs in the range 150-200. Of the studies of lung cancer among foundry workers summarised in Chapter 2, some reported the risk increasing with duration of employment (Koskela et al, 1976; Breslin, 1979; Sherson and Iverson, 1986) or a higher risk for earlier entrants with longer follow-up (Decoufle and Wood, 1979). The SMR in the Canadian steel foundry cohort was about the same for long service workers versus the entire cohort (Gibson et al, 1977), and the other studies did not present results by duration of employment. Silverstein et al (1986) reported a higher risk for the fettlers (PMR = 179 versus, 148 overall) similar to the present findings, and Koskela et al (1976) reported a higher risk for the dusty workers (fettlers and moulders together). The highest risk in the Gibson et al. (1977) study was for crane drivers (4 obs, 0.6 expected), a finding not confirmed by Lerer et al (1974) who reported 2 observed, 2.1 expected. The crane drivers' mortality from lung cancer is raised but not above other foundry workers in the present study (SMR = 144 for foundry cranedrivers, 152 for fettling shop cranedrivers).

The reference group in the present study included three categories with raised lung cancer mortality - machinists, machine shop labourers and maintenance fitters' mates. However overall, the SMR was not significantly raised (119) and the foundry and fettling shop groups showed raised relative risks compared to the reference group workers (1.32 and 1.56 respectively, the latter significantly higher than unity).

The relationships of lung cancer mortality with time since first exposure and cumulative duration of employment were investigated for several subgroups of the population and in no case was a steady increase apparent. In the foundry, the SMRs were generally raised in all duration of employment categories. For fettlers the SMR rose up to 10-14 years and then fell. The latter pattern was evident for the subgroups defined by dust, fume or silica exposure. Each of the three exposure-defined subgroups had overall lung cancer SMRs intermediate between the foundry and fettling shop SMRs reflecting the fact that they included occupational categories from both of these subgroups.

A foundry worker who has a skill specific to foundries, such as an apprentice-trained moulder, or has experience that qualifies him to continue working in foundries is likely to have worked in other foundries during his working life than the ten foundries. Lloyd Davies (1971) reported that foundry floor workers reported an average of approximately 3.9 previous jobs and the corresponding figure for fettling shop workers was about 4.5. This was fairly constant over a wide age range suggesting that labour mobility and turnover has increased for people entering the industry in more recent years. Therefore the known employment history is certainly an underestimate of the true cumulative foundry employment during the working lifetime of the cohort members. Workers living in towns with other foundries nearby will have more opportunity to extend their cumulative foundry employment than those living in towns far from concentrations of the foundry industry. Restricting the analysis to the large towns yielded a higher overall risk (SMR = 178 for the exposed, compared to 154 for all exposed). The SMRs are higher in all duration of employment categories, though the same pattern of risk rising to the maximum for the 10-14 years' group remains apparent. This does not appear to be an artefact of high general risks for these geographical areas, because regional adjustment has little effect (the SMR falls from 178 to 168) and the SMR for the unexposed is 109 in the large towns group.

The higher SMR in the larger towns could be interpreted as a dose response effect if it is accepted that in fact these workers had worked in other foundries. However the other foundries may have been quite different from the foundries in the present study. Given that the iron foundry sector is much larger than the steel sector then the opportunities for foundry work would more likely be in iron foundries. This is particularly the case for foundry 14 where the risk was the highest (SMR = 205 for the exposed cohort against 154). This is located in the Black Country area of the West Midlands where many iron foundries are to be found. It is also significant that there is a high SMR for the first 10 years since first employment in the large town subcohort, plausibly attributable to prior employment of a similar nature.

For the small towns, where a foundry related risk, if present, would have been potentially more evident as an increase with duration of employment, the overall risk is low (SMR = 109) and there is little evidence of an increase with duration of employment. The SMRs do rise from, 96 to 130 over the first three employment groups, suggesting an effect (again maximal at 10-14 years) but they still remain below the overall raised SMR of 143 for the smaller town unexposed group overall. On the other hand there is an increase of SMR with time since first exposure, apparent in most employment duration groups.

The analysis by age at entry showed a fairly constant risk in all but the two smallest groups. Those who started under 25 had an SMR of only 114 based on 11 deaths, but the SMR rose with time since first exposure for this group, reaching 172 for over 30 years. A tiny group who started over the age of 65 showed no excess (1/1.44) but these are not typical, starting after the normal retirement age, and in any case contribute very little to the overall pattern. The absence of effect with age at entry, supports the hypothesis that this cohort is like a "window" on a period of each worker's life during which he worked prior to and subsequently in the same kind of job.

In evaluating whether the excess found can be considered as causally related to foundry work, it is helpful to apply the guidelines for evaluating causality formalised by Hill (1977) which may be summarised as chronological sequence, the strength of the association, the consistency of the relation, the presence of a dose response relationship, biological plausibility and the absence of confounding. The chronological sequence is clearly no barrier to a causal interpretation here as the cancers occurred after starting employment and in most cases sufficiently after starting employment for a lengthy latent period to have passed between first exposure and the death from cancer. Where the excess cancers are apparent shortly after starting work, the excess is entirely among foundryworkers in towns where they probably had prior employment in other foundries.

The strength of the association is not enormous with mortality being a little over 1.5 times expected. However, given the large number involved, this is a stable estimate which is highly statistically significantly greater than unity.

The consistency of the excess is remarkable, set alongside the various studies of foundry workers and data on foundry workers taken from the analysis of routine mortality data. There is a consistency also in terms of the magnitude of the effect.

A dose response relationship has not been clearly demonstrated here. The risk is higher for those directly exposed to foundry and fettling shop conditions compared to those outside. A weak relationship with duration of employment is evident up to 15 years' employment but not subsequently. However, because of other foundry employment duration of employment is a poor estimate of total relevant employment and the decrease after 15 years is plausibly attributable to the selection mechanisms discussed earlier in this chapter.

The possibility of confounding with another risk factor cannot be entirely ruled out. Smoking is the cause of most lung cancers in the UK and given the high risk of lung cancer among smokers versus non-smokers it is capable of generating a 1.5 fold relative risk in a heavily smoking population. However, as was argued in some detail above, the evidence available suggests that UK foundry workers do not smoke much more than the national average and that smoking does not account for the excesses in other studies of foundry workers which have controlled for smoking. The comparison with the internal control group and the regional correction each diminishes slightly the estimated relative risk. Thus it would appear very unlikely that confounding with smoking accounts for the excess found here.

The excess is biologically plausible. Known carcinogens have been identified in the foundry atmosphere and samples of foundry fume have shown mutagenic activity in short term tests. Most known carcinogens show activity in short term tests and while the converse is not necessarily the case, mutagenic activity is considered a priori evidence that carcinogenic potential may be present (IARC, 1980). As reviewed in Chapter 2, the potential carcinogens identified include polycyclic aromatic hydrocarbons, nitrosamines, chromium and nickel.

A small excess of nasal cancer is present among furnacemen in this cohort which would suggest that nickel or chromium could have played a role in these cases. For chromium, its role is not so clear because the valency, which appears to be critical in determining its biological activity, is unknown in the typical foundry environment. However, the excess in the present study does not correlate with the foundries with known major production of stainless steel, and exposure levels of chromium and nickel in foundries are much lower than in nickel and chromium refineries.

Experimental work on polycyclic aromatic hydrocarbons (PAHs) has demonstrated the carcinogenicity of this family of compounds expecially benzo(a)pyrene (IARC, 1983). Further, studies involving the simultaneous administration of dusts such as ferric oxide or silica (both present in the foundry atmosphere) have greatly enhanced the carcinogenic potency of the PAHs (Niemeyer et al, 1986). This is thought to be due to adsorption of the PAHs on the particle surface increasing their residence time. Thus foundry dust may play a role as a carrier for PAHs whether they come from the foundry environment or some other source such as cigarettes. These data are sufficient to provide the biological plausibility of the association between foundry work and lung cancer.

Most of the criteria for a causal association have been met. The absence of a clear increase with duration of employment is not, for the reasons outlined above, equivalent to an absence of a dose response relationship. Thus it would appear reasonable to ascribe the excess found to be, at least in major part, due to foundry employment (comprising both the ten steel foundries in the study and other foundries. Some consideration is now given to the specific agents in the foundry environment which may be more important in the aetiology of lung cancer among foundry workers.

Recently, silica itself has been suggested as being a carcinogen (Goldsmith et al, 1982). The evidence for this comes from three sources; firstly, the high lung cancer risk in some silica exposed industries. The excesses in other studies of foundry workers was reviewed in Chapter 2, but of more relevance are studies of workers with more pure quartz exposure. Amongst granite workers Davis et al (1983) reported a lung cancer PMR of 118. Costello and Graham (1986) reported no excess of lung cancer in a cohort of 5414 granite workers in the USA. Steenland and Beaumont (1986) reported a PMR of 119 among 1905 deaths of US Granite Cutters Union members. On the other hand, Selikoff (1978) reported an SMR of 160 (21 deaths) for lung cancer among New York City tunnel workers exposed to high silica levels. Some studies of gold miners have also found moderate excess risk of lung cancer but exposure to dust from other minerals and radon daughters may pose a hazard (Armstrong et al, 1979; Muller et al, 1983; Costello, 1982). Secondly, there is a quite consistent excess of lung cancer mortality among silicotics, whatever their source of exposure (see Chapter 2). Thirdly some recent animal studies reported significant excess induction of lung cancers after inhalation of crystalline silica in rats (Dagle et al, 1986; Holland et al, 1986).

Analysis of lung cancer mortality by date of entry shows no trend of either increasing or decreasing risk. The risk of non-malignant respiratory disease falls sharply over time and this parallels a fall in the incidence of certified silicosis among foundry workers during the last 30 years. Further the levels of respirable silica have fallen over the same period. Given these findings it would appear unlikely that silica is the primary aetiologic agent, though it may play a role.

The moderate excess of lung cancer among the 687 welders (SMR = 139, 14/10.1) is a level of risk consistent with the results of over a dozen epidemiological studies of welders (Peto, 1986). The risk is considered to be related to welding fume but the relative importance of fumes from stainless steel welding relative to other components is uncertain (Stern et al, 1986).

If one assumes a latent period of about 20 years as being necessary for a cancer to develop after an exposure, as is the case with asbestos-induced lung cancers (Doll and Peto, 1985), then an important period of exposure for the foundry workers in the present study would be up to 1960 and possible much earlier. It is only since 1960 that chemical binders have substantially replaced greensand systems, though there was some introduction during the 1950s. Therefore, the data on exposure from greensand binder additives is possibly the most relevant to the excess lung cancers in the present study. Greensand binders, particularly those involving the used of seacoal and pitch, yield substantial PAH exposure compared to currently used non-clay-bonded systems. However, the mutagenicity assays performed in Canada suggested that the mutagenic activity is not confined to PAH containing fractions of the fume, fractions which may be more important in non-greensand systems. In fact, the highest mutagenic activity was generated from the fumes from shell-moulding, and results for furan systems were quite similar to greensand. The absence of a trend with date of first exposure of the lung cancer mortality suggests that a risk associated with traditional exposures may be being replaced by different but still hazardous exposures; up to the 1950s greensand binders, using in many cases pitch and sea coal, plus the use of oilbound cores, combined with high dust levels led to a lung cancer risk probably related to the PAH-silica-ferric oxide combination. Since that period the substitution of new materials has qualitatively changed the foundry environment which may have maintained the level of risk or at least maintained an elevated level of risk, the magnitude of which it is too early to quantify.

6.10 Stomach Cancer

Mortality from stomach cancer or all digestive cancers was reported as raised in few published studies of foundry workers and only significantly in one of the studies (Decoufle and Wood, 1979) in contrast to the significant excess found in the present study. Data presented in the UK Decennial Supplements consistently show a moderate excess of stomach cancer mortality for moulders and fettlers. The excess here is concentrated in the foundry itself, in particular for moulders, furnacemen and furnace repair, and the largest excess is for the short term employees. The largest single SMR (364) is among furnace repairmen, a job category associated with the highest dust exposure levels in a survey of Finnish foundries (Siltanen et al, 1976).

Studies of dust exposed workers in general seem to suggest increased stomach cancer risks. Neuberger et al (1982) reported a significant SMR of 163 for their dusty workers' cohort, though the figure for the foundry subcohort is not given. Kurppa et al (1982) reported excess stomach cancers in a cohort of quartz-exposed Finnish granite workers, with 15 deaths observed versus 7.4 expected from national rates. In the 1971-82 Decennial Supplement, jobs were categorised for dustiness using two methods (OPCS, 1978). Firstly they were grouped by the size of the pneumoconiosis SMR (in three categories: no deaths, SMR 0-500, above 500) and they were categorised by a factory inspector into five general levels of "dustiness". Both approaches yielded stomach cancer SMRs increasing with grade of dustiness. McDowall (1984) reported a follow-up (from 1948 to 1981) of cement workers in 1939 in Kent and while the overall SMR was 95, the SMR for stomach cancer was 175 ($p < 0.05$, based on 22 deaths), the only significant excess cause of death. While he notes a social class gradient in stomach cancer mortality (highest in Social Class V), the excess was much more than the equivalent social class SMRs.

The respiratory clearance mechanism removes much dust from the lungs on the ciliary escalator. Some mucus is expectorated but a great part is swallowed and reaches the stomach. If the dust contains carcinogenic material, then this may account for the excess stomach cancer risk shown in dusty workers in general and in foundry workers in particular. Several studies of asbestos workers have reported raised stomach cancer risks as well as raised lung cancer risks (McDonald et al, 1983; Peto et al, 1985). While a strong effect was found in the foundry workers in the present study, there was no excess apparent in the fettlers group (SMR = 64), and there is only limited support from previous studies. Thus the evidence for a causal association between foundry work and stomach cancer is plausible but weaker than for lung cancer.

6.11 Non-malignant respiratory disease

The low number of deaths from silicosis (four deaths plus two from silicotuberculosis) is surprising given the high prevalences of silicosis reported in cross-sectional surveys of UK foundryworkers, especially for fettlers, None of these six deaths occurred among fettlers, although one was a knockout gridman, a job associated with high silica exposures. In the Decennial Supplements of 1951, 1961 and 1971, the ratios of deaths from pneumoconiosis to deaths from lung cancer were respectively 12 to 186, 24 to 300 and 6 to 155 (Registrar General, 1958 and 1971; OPCS, 1978). In the present study the ratio is 4 to 316, substantially lower. Sherson and Iverson (1986) reported 17 silicosis deaths (0.5 expected) out of cohort of 5579 (with 74 lung cancer deaths). Most other published studies provided no information on numbers of silicosis deaths. Both silica dust levels and silicosis prevalence, where comparison has been possible, have been higher in steel than other foundries.

It would appear that either the study foundries are less dusty than the average in the UK, or the deaths from silicosis under-represent the true involvement of silicosis. Nickol (1977) demonstrated how medical screening and displacement of workers with pneumoconiosis can reduce the prevalence among the employed, but such close medical screening has developed relatively recently and would not keep workers out of an inception cohort as in the present study.

Some of the silicotics may have died of tuberculosis among which there ranked a sandmiller and two furnace repairmen, but again no fettlers. It would seem more probable that among the silicotics who did not die of lung cancer or other specific diseases they are well represented among the deaths from respiratory disease, in particular the category of bronchitis, emphysema and asthma. The excess mortality from respiratory disease is highest in the fettling shop workers, with substantial excesses among fettlers, welders, crane drivers and labourers. In addition sand millers, furnacemen and labourers in the foundry show an excess, although there is a slight overall deficit and only a small excess for knockout workers. Aside from moulders there is therefore excess respiratory disease and bronchitis mortality in virtually all dusty jobs with potential silica exposure.

Overall there is a tendency for both respiratory disease and bronchitis mortality to rise with duration of employment up to a maximum at 15-19 years employment. For example, in the fettling shop cohort the SMR for 15-19 years employment is 218 and for 10+ years together the SMR is 189. The same arguments apply concerning prior employment and health selection tending to flatten out these relationships with duration of employment as were duscussed in the section on lung cancer. There is little difference between the SMRs for jobs categorised as dust, fume or silica exposed. Both silica dust and various respiratory irritants such as formaldehyde, acrolein and isocyanates are potential etiological factors in this excess mortality. The most striking feature of the respiratory disease and bronchitis mortality is the sharp drop over time. The effect of regulations introduced in the 1950s should have been to reduce dust levels, especially in fettling shops. This is to some extent supported by published data on dust levels. Presumably the improvement in mortality of the cohort can be attributed to dust improvements. The largest excess is concentrated in those enrolled in 1946-1950 and many of these will have had prior employment and so accumulated substantial exposure before the first dust control regulations in 1953. The unexposed workers show no analogous drop in mortality by entry cohort and thus the change cannot be attributed to some other time-related factors. Controlling for age at entry and length of employment did not reduce the effect of the cohort of entry - the gradient of which remains significant whether fitted alone or in combination with the two other variables.

The excess respiratory disease mortality is consistent with findings in several mortality studies as well as numerous studies of reduced lung function or respiratory symptoms showing adverse effects in foundry workers. There is some evidence of an association with duration of employment, some concentration in the dustiest job categories and a fall with time which parallels presumed dust exposure improvements. Thus the excess may be largely attributed to dust exposure. There is however still excess mortality for later entrants (after 1956), from bronchitis, emphysema and asthma, but not for respiratory disease as a whole. Numbers are small, but for both the two most recent 5 year entry cohorts the SMR shows a pattern of increasing bronchitis mortality with time since first employment. This might be due to the incomplete dust control measures, but given its persistence at the same time as the excess of respiratory disease has virtually disappeared, suggests a different aetiology. The introduction of chemical binders from the 1950s, bearing in mind the data linking resin binder exposures to respiratory morbidity, may be relevant in this excess mortality from bronchitis, emphysema and asthma.

6.12 Circulatory disease

Hygiene measurements have indicated quite high levels of carbon monoxide in the foundry environment from melting and casting operations, although much higher in iron foundries than steel foundries (Virtamo and Tossavainen, 1976a).

Mortality studies of foundry workers have, except in two cases, reported circulatory disease deaths to be close to or less than expected. Silverstein et al (1986) reported a raised PMR for cardiovascular disease among non-white but not among white workers. Sherson and Iverson (1986) reported no overall excess but a moderately increasing risk with both overall duration of employment and employment in jobs estimated as being more exposed to carbon monoxide. Koskela et al (1976) reported a deficit of cardiovascular disease mortality and no difference between jobs with higher carbon monoxide exposure compared to the others. In a morbidity study of foundry workers, Hernberg et al (1976) reported an association between angina pectoris but not electrocardiographic results suggestive of heart disease, and levels of carbon monoxide exposure. The jobs with raised carbon monoxide exposure were casters and furnacemen and the labourers assisting them. In the present study the casters and furnacemen have a lower SMR (103) than the overall SMR of 110, relative to national rates. The only significant excesses are for machinists and machine shop labourers, and as the latter group also has a high mortality from respiratory disease and lung cancer, smoking may be relevant in this case.

However, after regional adjustment the overall excess is removed and the SMR becomes 98. There is a reduced mortality in the first ten years since first exposure, a result of the "healthy worker effect" seen in other studies of heart disease in working populations (Fox and Goldblatt, 1982). There is therefore in this study no evidence of an overall excess of mortality from circulatory disease relative to regional mortality rates. There does however appear to be an excess within circulatory disease other than ischaemic and cerebrovascular disease which warrants further attention.

CHAPTER 7 - CONCLUSIONS AND FUTURE RESEARCH

7.1 Conclusions

The steel foundry workers included in this study experienced a significantly elevated risk of lung cancer compared to the general population. The risk is approximately 1.5 fold overall, is slightly higher for fettling shop workers than for the foundry proper and is highest for furnacemen, casters, furnace repair workers, fettlers and heat treatment workers. Confounding by other risk factors, in particular cigarette smoking is very unlikely to explain more than a small part of the excess found. The relative importance of the various different components of foundry air contaminants is unknown but overall it is concluded that the excess of lung cancer mortality (101 excess cases) is in large part causally associated with exposure to the ferrous foundry atmosphere. There is no evidence of a change in the magnitude of the risk over time. Marked differences in risk between foundries and to a lesser extent between job categories may offer a starting point for investigating specific aetiological factors.

There is a significant two-fold excess of stomach cancer mortality restricted to the foundry subgroup. This excess has limited support from past research, and there is a strong inverse relationship with duration of employment.

There is a significant excess of non-malignant respiratory disease, concentrated in the fettling shop where it is 1.7 fold (and 1.5 fold after regional adjustment), although also apparent in most of the dusty jobs in the foundry. Much of the excess is due to bronchitis, emphysema and asthma. The respiratory disease mortality has fallen significantly over time and appears to be attributable to past exposure to dust, mainly silica. A persistent excess of bronchitis mortality apparent in more recent entrants with no overall excess of respiratory disease mortality may be related to the presence of upper respiratory irritants associated with the use of binder materials.

After allowing for regional differences in mortality, there is no evidence of an increased risk of mortality from diseases of the circulatory system.

7.2 Recommendations for further research

Given the strength of the findings in the present study and the overwhelming evidence in other studies, there is no need for further studies to evaluate whether there is a lung cancer risk associated, in general, with past employment in ferrous foundries. A study of lung cancer risk related to individual assessment of exposure histories or, more likely, histories of the use of binders, binder additives, metals and other materials would however be useful.

The present study population, especially given the large differences in risk between foundries, should be studied further to assess in detail the differences in chemical usage between each foundry in relation to the level of risk. Further analysis of the mortality at a future date should be carried out to monitor the level of risk among the younger and more recent entrants, in respect to mortality from both lung cancer and chronic bronchitis.

Evaluations of the relative biological importance for lung cancer risk of different elements in the foundry environment should be developed in exposed worker populations using methods such as urine mutagenicity and peripheral lymphocyte clastogenicity assays and the currently developing DNA-adduct methods; and in animal models using carcinogenicity and mutagenicity testing of the fumes from casting into different binder formulations. Some experimental work is already under way (Animal experiments at the National Institute of Occupational Safety and Health USA and the University of Birmingham, UK; mutagenicity assays at the Health and Safety Excecutive, UK) and decisions on appropriate future work should await the results of this work.

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APPENDIX A

Brief descriptions of the development of each factory

In this Appendix is provided a schematic description of the kind of production and materials used for most of the foundries in this study. The level of detail is uneven, reflecting the different degrees of detailed information made available. No data is available for Factory 14 which closed in between the initial data collection and the return visits which were to include the collection of the information summarised in this Appendix.

FOUNDRY 10

Foundry 10 arose from a splitting up of a primarily stainless steels company into a company specialising in Special Steels and foundry 10. Foundry 10 comprises two sites in close proximity: A (primarily moulding and casting)
and B (primarily dressing and machine shops). The machine shop moved site in 1954 or 1955, then again to site B in 1974 or 1975.

The foundry was built in the second war for Ministry of Air Production, to make sleeves for aero engines which were centrifugally die-cast then machined on site. From the start, centrifugal casting was important, accounting for about a half of the castings. About half of these were spun in horizontal metal dies and half in vertically spun (mainly) "centrisand" moulds - spinning sand moulds. By the early 1950s two separate foundry shops were existing and still remain - the vertical (centrisand and static) and the horizontal spun castings. There was in addition a small magnet shop and a small precision foundry making small precision castings, mainly by the lost wax method. This shut in the early 1950s. Melting was always done by high frequency induction furnace and these furnaces have increased in size over the years.

Most steel made has been corrosion and heat resistant alloy, much of which has in the past has been 18% Cr Steel or 18%CR/8%Ni steel. Though more recently a much wider range of alloys have been produced with Cr and Ni as major additives and to a lesser extent W, Cu, Mo, Ti, Al, Co & V.

Synthetic binders have always been used in the static castings in boxes up to 24" square. Shell moulding was introduced in the 1950s, particularly for magnets. Furan and phenol formaldehyde binders were tried in the 1970s. Up till 1952/4 oilsand was used for the moulds. The oilsand comprised a mixture of spermoline and bentonite or natural clay to bind the sand, which was then stoved. Subsequently sodium silicate, set by stoving or carbon dioxide (CO_2) was used until fairly recently when resin binders have been tried. The facing sand was mainly chromite, with some zircon used.

The foundry is a tall building, and several older workers expressed the opinion that it was subject to good natural ventilation. There was extraction over the "centrisand" spun sand-lined moulds for a period but changes in pouring practice reduced the fume and the extraction was abandoned. The fettling shop only developed comprehensive ventilation in the 1970s with booths for fettling, cutting and burning and a rotating table for blasting. Extraction was fitted on pedestal grinders. The lindeflame (powder wash) burning process produced so much fume that it was performed in a booth from shortly after its introduction in 1950/2. Unsuccessful attempts at welding fume extraction were attempted during the 1970s. Knockout was carried out on the floor.

FOUNDRY 11

The earliest records show employment at least as far back as the turn of the century. The company was taken over by a large engineering group around 1957-9, then moved over the years up to 1972, department by department, to the present site from the previous site. Production has risen fairly steadily from 1946 when it was about 100 Tonnes per annum (p.a.)to the present capacity of about 22000 Tonnes p.a.

The first sections to move were some greensand machine moulding and the shell moulding with high frequency melting furnaces. Then the fettling shop moved into the new building about 1962. A new electric arc furnace was installed around 1970 on the new site. The large scale moulding machines, the knockout and the shotblast moved across about 1970. The pattern shop moved in 1971, the offices in 1975. New sandplant equipment was installed at the time of this move. During the 1970s the size of the workforce was about 700-800 but was much smaller previously. Immigrants, especially from the Asian subcontinent now account for some 30% of the hourly paid workforce and have been employed since 1951-2.

There has been some recent major investment in shotblast equipment. Arc furnaces were introduced in about 1953, prior to that a cupola and convertor were used. A wide range of steels have been made, though stainless steel formed a high proportion previously. Now, this foundry makes castings in Carbon Steels, with low amounts of C,Si and Mn; low alloy steels, with low amounts of C, Si, Mn, Ni, Cr & Mo; high alloy steels, with high Cr and Ni, and wear resistant steels with high Mn.

Furnace extraction was fitted to the furnaces at the previous site in 1960, though it "could not cope with blowing" (the oxygen lancing that was usually carried out and generated much fume), it was uprated in the 1960s and then uprated at the current site a little after it moved (ie in the early 1970s). Unpleasant fumes were reported from cutting Mn steel. There was no extraction on the fettling benches in the previous site, only the blast units, although arc air had some ventilation fitted. At the new site, pedestal grinders were fitted with extraction, but not the fettling benches until recently. Rubber cartridge respirators have been issued since about 1970, but rarely worn until very recently according to long serving fettlers. Dust samples were taken by the company from about 1978, though the company was included in a SCRATA survey of dust and fume in 1977.

Shell moulding was introduced in the middle 1950s. Zircon sand is used for the shell mix and was previously recycled, but now it used and dumped. Extraction was reported as not very effective until after 1970. Just after the war mainly drysand was used - stove dried or skin dried in small or medium sized boxes. The cores and small intricate moulds were made with oilsand at that time. Silicate-carbon dioxide has steadily replaced oilsand for cores, starting in the 1950s, increasingly during the the 1960s and reaching about 80% in the 1970s. In greensand, straw and manure were used previously and had been phased out during or previous to the war.

The shake out was first fitted with extraction in 1953. 3-4 years later it was supplanted by a combined "vibrator beam" attached to a crane. Now for smaller castings there is a completely automated knockout facility.

<u>FOUNDRY 12</u>

War-time manufacture was primarily bombs, production of which stopped soon after. Much of the production has been jobbing work, though a fairly consistent production has been large rings and metal spheres used for grinding. They have mostly been making manganese steel. Cupolettes were used until the late 1960s for melting, then electric furnaces.

Moulds and cores used to be made with oilsand and "compo" - brickdust. Silicate-carbon dioxide was introduced in 1967 and in the late 1970s, resin systems have been introduced, particularly "air set".

FOUNDRY 13

Foundry 13 was founded in 1892, making tools. The iron foundry was started in 1905 and the steel foundry in 1906. An electric arc furnace was installed in 1910. Up to the Second World War, the company made jacks and cast iron brake drums and various steel castings. War production included components for tanks, warships, guns and military vehicles. The machine shop was built in 1950 and in 1956 a special alloy steel foundry was opened.

Since the second war, the steel foundry has been the largest department in the works, where the main production has been in carbon steel and high alloy steel: such castings as valves and axle cases. The smaller alloy steel foundry mainly produced chrome/-molybdenum castings for the oil industry and stainless steels for heat and corrosion resisting work. The furnaces have been both arc and induction. The iron foundry closed in 1969, and a small amount of bronze and malleable casting has been carried out. Capacity in 1949 was 300 tons a month each of steel and iron. In 1953, it was 350 for steel and 250 for iron.

In the main greensand has been used for moulding with a small amount of furan and some silicate-carbon dioxide used in the 1960s. For cores, sodium silicate (cold set and alphaset) was used for the large ones, oil/carbon dioxide for the medium and also some shellcore.

FOUNDRY 14

No data.

FOUNDRY 15

Foundry 15 manufactures a wide range of stainless steels, having concentrated in the past on high molybdenum steels. They used to make mainly valves and later after the war, sockets for cables in suspension bridges. More recently they have been making a wider variety of castings. The workforce has recently fallen to about 120 but has been about 360-400 during most of the post-war period.

There are two foundries, the heavy and the light, with arc furnaces in both plus two small induction furnaces in the light foundry. The furnaces in the light foundry were only recently ventilated. Greensand and sodium silicate moulds have been used, mainly silicate/carbon dioxide in the past but with self-set (acid-ester catalyst) more recently. Cores were mainly linseed oilsand in the past, though using more self-set and carbon dioxide in recent years. Only simple gauze masks have been made available. Knockout is currently carried out in ventilated booths and fettling and welding is all currently done in booths or on ventilated fettling benches. A new dressing shop was built in 1960 with extraction benches; there being almost no ventilation previous to that date.

FOUNDRY 16

The foundry was opened in 1935 as an iron foundry, which gradually went over to steel over the following years. The moulding was nearly all done with cement binder which did not require skilled moulders, the choice of which was largely due to the shortage of skilled labour in the area. A small amount of greensand was used, and only recently has furan been introduced. Cement was also used for large cores and CO_2 and oilsand (to a small extent) has been used for smaller cores.

In 1935 the foundry consisted of two cupolas, sand mixing plant, core drying stoves, roller conveyors and a pattern shop. The foundry made both steel and bronze castings, both static and centrifugal. A ten ton arc furnace was installed in the 1930s, and the casting of small intricate castings by the lost wax method was developed at that time.

Before the war and during it, aircraft castings were the dominant product range. During the war, steel armour plating was made in great quantity and some large bomb casings.

FOUNDRY 17

There were several departments in the foundry, with, in 1947 the following numbers of employees: Sand foundry 102, centrifugal foundry 32, cast iron rod 9, machine shop 46 (steel) & 11 (cast iron). It expanded in size in 1952 to supply armaments for use in the Korean war, and contracted severely from 1981 onwards, at which time Sintered Products - a separate part of the factory production moved to another town.

The company opened in its present form during the 2nd World War, making high alloy, high quality steels with high Cr, Ni, Mo & Mn content used for aero engines for military aircraft. With the advent of jet engines castings for these new engines were then manufactured. A limited amount of machining of these castings was carried out on site. These castings were made in the Centrifugal Foundry in a cast iron mould lined with a thin layer of refractory material.

There was also a sand foundry, in the 1950s about the same size as the centrifugal foundry. In the sand foundry, there was a small amount of steel moulding, but mainly box moulding of high alloy steels using a resin binder with an acid catalyst. Furan and silicate/carbon dioxide were tried but not taken up. Sea sand was used and some of the sand castings were spun.

In the cast iron rod foundry, continuous iron bar was drawn from a furnace, cut into lengths and in some cases machined. Only about 10 men were employed here rising for a time in the 1950s to 30-40, with about 20 more in the cast iron machine shop. Sintered products, with less than 20 persons employed, including some women, made bushes and small gears and pistons, deicing equipment and friction materials. The end product was porous and made by compressing metal powder mixed with stearates in a die and then subjected to heat treatment.

FOUNDRY 18

Foundry 18 is on a large site comprising a large drop forge, saw and file shop, a heavy foundry and another foundry (medium and light).

The heavy foundry makes castings for heavy plant, rolling mills, forging mills and presses & slag pots. The medium foundry makes smaller plant, castings up to 10 tons and much of the light foundry work is for railways. A small amount of stainless steel is cast.

For some 90 years an open hearth furnace was used in the heavy foundry, and was then replaced by arc furnaces in about 1975. The joint capacity of the 3 large electric furnaces was approximately 250 tons during the 1970s. Oxygen lancing was performed until about 1970 when there was a move over to ferric oxide which created less fume. Open hearth furnaces used to be lined with sand each melt and a full refit of the lining took a month. In the electric arc furnaces, the lining uses a base of Dolafrit - a mixture of dolomite and oil.

In the heavy foundry, drysand was used until 1975, with the skin dried by heat, then entirely furan. The light foundry always used greensand moulding. Some large castings with thin sections such as slag pots were cast with furan somewhat earlier: in the middle 1960s.

The main binders used were greensand and drysand until the 1960s and subsequently mainly furan. Heavy cores have been fully furan since 1965, previously claybonded zircon-faced drysand. Self set silicate was used to an extent in the 1960s, but after a death through the evolved hydrogen, it was used less. For the light cores, oilsand was largely replaced by furan in the same period.

In the fettling shop, arc air gouging was introduced in about 1962, initially done by welders and later classified as a dresser's job. They have been given air lines from 1968. Flame washing was introduced about the same time, and was reported as producing a great deal of fume. Powder burning has always been used for removing adhered sand. The pedestal grinders and swing frame grinders have always had extraction fitted, but they were not considered very good and the ventilation was upgraded about 1971. Fettling benches have been used in the light fettling since 1964, but the extraction was not considered very effective. For welding there was no ventilation until recently. Gauze masks and cartridge filter masks have been issued since the early 1950s, though most chose the gauze masks. These have been mainly worn by the fettlers and grinders. The maintenance workers were reported as spending some 85% of their time in the foundry.

FOUNDRY 19

Foundry 19 was established in 1914 and did not change ownership until the early 1980s, and has remained approximately the same size apart from an approximate doubling of the moulding shop in 1948. During the 1950s much of the production was for the railways - couplings, brake drums and axle boxes, plus coalcutters. More recently they have made valves. Most production has been mild steel, with a small amount of spheroidal graphite iron. Some stainless steel production has taken place recently.

The foundry is the only foundry in a traditional mining area, affected by 4 pits closing since the Second World War. In addition to many examiners, some foundry workers had previously worked in the electronics industry, a textile works, a golf club factory, the docks, the railways or on farms.

The workforce has had regular X-rays but in the opinion of the medical service, workers rarely followed advice to move from dusty jobs if they showed X-ray changes, for fear of losing the relatively high wages in fettling.

Until fairly recently all the moulding was carried out with greensand and drysand. Spermoline used to be sprayed onto the mould surface, then isopropanol-based zircon paint from the mid 1960s. More recently a resin lacquer spray was used. Zircon sand was used for facing and zircon flour as a parting powder. A semiautomated "pattern flow unit" was installed in 1969 using silicate bonded sand with an ester accelerator. Furan were tried during 1969-70 but not adopted because of friability of moulds and complaints about the fumes. A binder tried during the same period gave off hydrogen and was abandoned for safety reasons. For cores, oil sand is used which is heated to cure ("air set") and carbon dioxide blown silicate cores have been used since the 1960s. One knockout was only provided with side extraction in the mid 1970s. The other knockout was installed in 1969 with extraction fitted.

APPENDIX B

Brief descriptions of the record keeping system in each factory

In this Appendix are described the records used for establishing the cohort in each factory, any areas of incompleteness identified and specific job titles used uniquely in one factory and thus not in the main job list. This may have been because of a regional name for an occupation in all the foundries (for example Levermen for Ladlemen), or an occupation which differs from those common to all foundries and the category to which it is assigned is described here.

FOUNDRY 10

In 1974, the previous company split to form a special steels company and Foundry 10. The complete records for the foundry pre-1974 were kept in the special steels company offices. Since the original data collection in 1978/9, the Special Steels company has been taken over and the current whereabouts of the records has not been re-established.

The records in Foundry 10 give full name and date of birth and occupational history in the firm, but the data of change of the job within the factory is fairly frequently missing. Records still available started in 1948. The records for the period prior to that are assumed to be destroyed. For the earlier pre-1974 period, records were duplicated in part at both company offices but the data file at Foundry 10 was incomplete. Both the data files were completely searched and the data combined for the most complete description of occupational history.

In 1972, a subdivision consisting of machine shops was taken over by another company, and the records there were not available for this study. Thus people who had worked in the foundry and then moved to this machine shop had their complete employment records there and they could not be included in the cohort. It was thought that this involved relatively few people.

Those selected for inclusion had one years' employment in the following departments: Foundry, Foundry heat treatment, Foundry M/c shop, Centrispun, Precision.

The following job titles used in this factory were assigned to the 30 categories as follows:

2	Stoveman
6	Machinist (foundry or centrispun)
8	Spinner's labourer
10	Degreaser, Brineller, breneller crane driver
22	Roll turner
25	Die grinder
28	Melter (precision), investor (precision), precision foundry worker, precision casting hand
29	Special checker (precision)
30	Fettler (precision)

FOUNDRY 11

Parallel records with details of name, date of birth and full occupational history are kept in both wages and personnel departments. However, the personnel department records are quite incomplete because they only go back as far as 1958, and in addition a fire in the 1960s destroyed some of the personnel records. The wages department records appeared to be complete for everybody employed since 1947. Therefore the wages records were used as the source of data for the cohort. These go back to the introduction (in about 1947), of the cards still being used. The record cards used previously have been destroyed. The full name and date of birth is given except for immigrant workers, where only the year of birth is given for many of the earlier entrants.

The current works and staff are filed in order of clock number within the first letter of surname. The ex-works and staff are (separately) filed in order of date of leaving within the first letter of surname. However prior to 1960, the order was somewhat in disarray. The drawer of current workers contained some ex-employees who are still receiving a company pension.

Data was collected on all males except: Clerk (stores), Cleaner (welfare), ablutions attendant.

The following department numbers have been used in the records:

10	pattern shop
15, 16	arc melting
300	HF melting
310	shell moulding and casting
20, 21, 22	moulding
23, 24	coremaking
26	prefettling
28, 29, 365, C,E,F&G	bays fettling
415	fork lifts
49	spare men, labourers
50, 51	maintenance
91	pattern stores
93	driver, transport

<u>FOUNDRY 12</u>

Records of current employees and those who left since 1974, are in folders in filing cabinets. There are cards for those employed from 1962 to 1974. There is a ledger of people who started from 1939 (with a few going back as far as 1918) up to starters in the middle of 1954. There is also a ledger of starters from October 1975. The ledger for the period 1954 to 1975 was destroyed and so the employment records for those starting after mid 1954 and leaving before mid 1962 were absent. However the medical department records were quite complete and contained an occupational history as well as details for tracing, and allowed this shortfall to be made up.

Excluded laboratory workers, laboratory cleaner.

The departments could be identified by clock numbers as follows:

100-199	steel plant
200-299	pattern shop
300-599	foundry
600-1099	machine shop
1200-1299	maintenance
1300-1399	yard services
1400-1499	inspection department

Dumper driver is classified as outside or inside depending on clock number. Furnaceman is classified as heat treatment or melting depending on the clock number. Inspection of heavy castings done in the machine shop, light ones in a separate bay in the light castings department. Blacksmiths are in their own department, and bricklayers mainly worked on the furnaces, although the furnacemen knock out the old linings. "Vessel rammer" relines HF furnaces. "Headbench" sets the heads and knocks them off, not casting. Dumper drivers carried sand around to different parts of the foundry.

FOUNDRY 13

The data were extracted from wages department records, where for each employee there is an envelope with a bundle of slips of paper clipped together, with a slip for each annual wage rate, change of job, change of address, start and leave. Details of change of job are usually, but not always given. The form at commencement has full name, date of birth and (usually) previous occupation. All past employees are kept in alphabetical order. Currents are in semi-alphabetical order - by clock number within the first letter of surname. Records appear to be complete back to around 1926, although for the earlier starters, age at start but not date of birth is given. National insurance numbers are not given for past employees. Those currently employed in the jacks department in 1968 were refiled elsewhere, and thus the small number who transferred to jacks from the foundry prior to that date are not be represented in the cohort. Data were collected for all departments excluding jacks.

Departments corresponded to the following clock numbers:

1-40	Office
50-499	Male coreshop and foundry
500-739	Fettling
740-780	Manual Welding
781-829	Pattern Shop
840-850	Despatch
851-860	Laboratory
900-1155	Works engineers
1200-1299	NMS North Machine Shop
1300-1900	Jacks
1901-1950	Women coremakers
2001-2050	Inspection (Majority in fettling shop)

Specific job titles in this factory are as follows:

11	Machine operator (foundry) = moulding machine operator
13	Leverman = ladleman
20	Trimmers = grinders
27	Pickler
45	Garage fitter

FOUNDRY 14

Employment histories are kept on employee record cards with a good occupational history of all jobs in the foundry as well as the last job and full name, address and date of birth and in many cases, before the mid 1950s the national registration number, which was equivalent to the NHS number.

The codes for the different departments were as follows:

H (01)	Heath works - Light foundry
J (03, 04)	Jamesbridge foundry, Heavy foundry
NL (62)	Light fettling
N, NH, NX (61)	Heavy dressing
(07)	Heat treatment in fettling shop
M, ABC (05)	Machine shop
08, 09, 10, 11, 19, 20	Furnaces
T (12)	Pattern shop
W (13, 14)	Maintenance

(16) Transport

(15) General - security, inspection, apprentices, stores, despatch.

FOUNDRY 15

The records of past employees stretch back to a few in 1895, contained in a ledger of starters, covering the period from 1895 to 1942. The records in the personnel office consist of yellow cards giving date of start, leaving, date of birth and occupational history. The name of the previous employer was seldom provided. Before the 1960s the employment records were on paper forms, the most recent alphabetically in a ledger the earlier ones in a bundle alphabetically. Another set of records on 3" x 5" cards in a box are of starters up to the 1950s and largely overlaps with cards mentioned above. 33 were excluded from the cohort because no date of leaving (24), no date of birth (2) or occupational category (7) were provided in the records. All workers are included except laboratory assistants, typists, groundsmen, methods engineers, development engineers, and industrial engineers (staff).

FOUNDRY 16

The records are in the personnel department, and consist of the following:

Forms for past employees, 8" by 10" blue for males (and yellow for females), who have been working on or since 1970. Some had incomplete occupational histories and had to be checked against parallel records in large folders (which was successful in about 2/3 of the cases). Other record cards, blue for males, yellow for females, were used up to 1970. Current and recent leavers are in large folders with correspondence inside and occupational history and details of name, address, DOB, NI number written on the outside.

FOUNDRY 17

There are cards giving name, date of birth, address and occupational history filed as current employees and one alphabetical file of all past employees. Most records have NI numbers though very few have past employment described. The records are complete from when the factory opened in 1947. The foundry closed in July 1981.

Departments included: Sand foundry (SF), Centrifugal foundry (CF), SAC Inspection, Maintenance.

Excluded: Sintered products (SP), Canteen, Laboratory, Production control, Bronze foundry, SAC sales.

FOUNDRY 18

Records are filed in the employment office as currents by clock number, and the most recent past records are filed in alphabetical order. Records of leavers before about 1960 are stored in the basement in approximately alphabetical order.

In addition to the foundry, the site contains a number of drop forges and a saw and file shop, plus various laboratories, a power station, welfare, etc. The department numbers relevant to this study were defined in conjunction with the employment office staff and the data collection was restricted to those with at least one year's employment in the following departments:

133-136	Machine shop
233	Furnace bricklayers
304-349	Grimesthorpe: Melding, moulding, fettling
356-357	Foundry
373	Foundry heat treatment
375-376	Heavy fettling
384	Sand plant
405-406	Foundry Fitters

Specific job categories used in this factory are:

4	Pit helper, utility man,
18	Stamper (340, 341), Checker (341)
22	Stamper sawyer (134), Trepanner (133)
26	Rigger (405), MCM Maintenance Fitter's mate

FOUNDRY 19

The early records consist of paper forms with name, address, date of birth (or age at start for many of the earliest), NI number, clock number and department. In addition , many of the earliest ones have NHS number. These forms went back at least as far as 1940.

There was also a ledger of starters with name address, clock no., age, job or department. Two ledgers covered the period 1940 to the present.

There was a small black book listing by department - moulding, dressing, engineering, general - the changes of rates - in many cases this was a change of job and could be used to resolve ambiguous job histories derived from the other records. The paper forms were sometimes rewritten, particularly in late 1969, at which time the job current at that time but not previous ones was recorded. In such cases, referring to initial job in the starters' ledger and possible changes in the rate changes book helped build up the occupational history but it was not complete because, 1. the starters' ledger did not have all the jobs - often just departments and 2. the changes of occupation were often not entered into the rate changes book. The clock numbers relate to departments as follows:

1-179	Moulding and coreshop
180-200	Furnace shop
201-350	Dressing shop
351-599, 801-850	Engineering
601-800	R&M (repairs and maintenance, and patternshop)

The gas plant, where they made their own producer gas is not included in the cohort.

Unfortunately, when the firm was closed down in the early 1980s and sold to a new company the old records were all burnt and so are no longer accessible.

APPENDIX C

Detailed tables of mortality analyses

In this Appendix are presented analyses by various age, job category, exposure and duration categories, the mortality from all causes, all malignant neoplasms, lung cancer, stomach cancer, all respiratory diseases, bronchitis, emphysema and asthma and irculatory diseases. The full list of tables in this Appendix is given first, a brief commentary and then 243 tables of observed and expected deaths and SMRs, mostly with the regional correction applied in addition to the SMRs relative to national rates.

The subcohort comprising workers of immigrant origin have been analysed separately because of their poor trace rate. Table 1 presents the results by detailed cause and a major deficit of observed deaths is apparent. The only cause not showing a large deficit is diseases of the digestive system (3/2.1) and cancer of rectum (1/0.9). The most marked deficit is for malignant neoplasms as a whole.

Mortality by detailed cause and work area

Table 2 shows for the total cohort, exposed plus unexposed, the mortality by detailed cause. The overall mortality is significantly raised (SMR = 111) as is the mortality from malignant neoplasms (SMR = 119). By specific site the excess is accounted for by significant excesses of lung cancer (SMR = 146) and stomach cancer (SMR = 143), plus slight non-significant excesses of cancers of the rectum, larynx and bladder. Within the "other malignant neoplasms", there is a small excess of cancers of the nose and nasal cavities (SMR = 267, obs/exp = 4/1.5). Mortality from diseases of the circulatory system is significantly raised (SMR = 110), being partly accounted for by cerebrovascular disease (SMR = 120) but mainly from the remainder category for which reference rates for more specific disease categories were not available. Mortality from diseases of the respiratory system is significantly raised (SMR = 140) this excess largely due to the large and significant excess from bronchitis, emphysema and asthma (SMR = 164) although moderate non-significant excesses were present for deaths from influenza (SMR = 134), pneumonia (SMR = 118) and the remainder category (SMR = 122). For the other cause of death categories presented the SMRs were unexceptional, except for the "other known causes" of death, showing a substantial and significant deficit (SMR = 53).

Table 3 to 7 show the mortality by detailed cause for, respectively, those employed only in the foundry area, fettling shop, maintenance jobs, other jobs plus more than one work area and finally the "unexposed" group: only employed in the pattern shop, machine shop, inspection, etc. The significantly elevated excesses found for the whole cohort are described in more detail in subsequent sections. The deficit for other known causes of death is present in each subgroup. Other interesting excesses are: cancer of the buccal cavity and pharynx (SMR = 163, foundry), laryngeal cancer (SMR = 442, fettling), ischaemic heart disease (SMR = 125, mixed/other), influenza (SMR = 200, foundry) and pneumonia (SMR = 164, fettling). In addition analysis by detailed cause and occupational categories revealed a number of clusters of excess cancers as follows: intestine (furnacemen: 6/2.2), rectum (moulders, 6/2.5 and shotblasters, 2/0.5), bladder (labourers in the foundry, 5/3.3, feltling shop, 2/0.7, and shotblasters, 2/0.4) and nasal cavities (furnacemen, 2/0.09).

Mortality by factory

Tables 8 to 17 show the mortality by detailed cause by factory for the exposed cohort i.e. excluding those employed only in the pattern shop, machine shop etc. and Tables 18 to 27 give the equivalent results for unexposed. Mortality is significantly raised only in factories 10, 14, 18 and 19, and for lung cancer it is significantly raised in only factories 10, 11 and 14. Excesses based on small numbers exist for cancers of the buccal cavities and pharynx (factories 10, 19 exposed only), larynx (11, exposed only), rectum (10, 14 exposed only), intestine (18, 19 exposed only) and bladder (11 exposed and unexposed). The factory (13) with the lowest SMR has a curious pattern of mortality whereby most of the deficit in the exposed population is accounted for by a deficit of lung cancer (3/8.6) of borderline significance. These three cases occurred after the cohort had been defined. Up to the end of 1978, there were no cases and 5.9 expected.

In tables 28-47 is shown the mortality by foundry, exposed then unexposed, by follow-up for 7 diseases groups under primary consideration. For mortality from all causes, lung cancer and non-malignant respiratory disease the effect of subcounty correction factors are shown. For mortality from all causes the first period of up to 10 years of follow-up is the only one for which the SMR is not significantly raised, in the exposed population (Table 28), contrasting with the unexposed where the SMR for the first follow-up period is 103, close to the overall value of 105 (Table 38). Both groups show the highest SMR in the period 10-19 years since starting. This pattern of a low SMR among the early exposure period is shown in each of the foundry populations except foundries 17 and 18 (although for the latter the SMR is lower than in the second follow-up period). Furthermore it is reflected in most of the categories of disease - a distinctive increase in SMR from the first to the second follow-up group, for both exposed and unexposed. This pattern is not evident for mortality from lung and stomach cancers and non malignant respiratory disease among the unexposed (Tables 41-45). For the latter disease there is in fact a significant excess, deriving entirely from a high SMR in the early follow-up period in factory 18 (Table 44).

Considering the relationship between lung cancer and follow-up by individual factory, it is interesting to note that the factories which have significant excesses (10, 11 and 14, exposed and 17, unexposed) all have high SMRs in the short follow-up periods. None of the factories show an increasing trend with time since first exposure, except 15, exposed (Table 31) based on rather small numbers. The trend in this latter case is of borderline significance ($X^2 = 3.88$).

The correction factors calculated from the regional rates and the correction factors based on subcounty level differ by individual factory. However for all causes (compare Tables 28 and 29) the pooled SMR is similar using either correction: 104 in one case 106 in the other. For lung cancer (Tables 31 and 32) the local correction has more effect. The regional correction reduces the pooled SMR by 6%, the local correction by 11%. For non-malignant respiratory disease (Tables 34 and 35) the local factor has slightly less effect the percentage reductions being 14% and 12% for regional and local corrections, respectively. Because there is a potential problem of overcorrection in the use of correction factors based on a too limited a geographical area, the subsequent tables, present, in the main, the SMRs with and without correction for region.

<u>Mortality by age at death</u>

Tables 48 to 61 present the mortality by factory and age at death. For all causes the mortality aside from the youngest and oldest age groups is virtually constant for the exposed group (Table 48). There is a rather high SMR for the 65-74 year old group among the unexposed (Table 55). The same rather constant pattern is apparent for all malignant neoplasms. For lung cancer, stomach cancer, and non-malignant respiratory disease, smaller numbers in each cell lead to fluctuations, but overall the excesses are spread over all age groups (Tables 50-52). For mortality from circulatory disease (Table 54), the excess is concentrated in the younger age groups, most markedly in factory 10 (under 45), 13 (45-64) and factories 18 and 19 (35-54).

Mortality by work area

Tables 62 to 75 present the mortality by factory and work area, and each work area by length of follow-up. For all causes, the excess in the foundry and fettling shop workers is concentrated in factories 10, 14 and 19. For maintenance workers the only excess is in factory 11 and there is a significant excess is for factory 18, though this is not significant after correction for regional mortality. By length of follow-up (Table 63) all work areas show a low SMR less than 10 years since first employment though most dramatically in the fettling group when the SMR is 73. For all malignant neoplasms, the excess in foundry and fettling shop is shared by several foundries (10, 11, 14, 18, 19), and by follow-up the foundry workers exhibit no deficit in the first 10 years since first exposure (Tables 64, 65). There is no clear trend for any of the five work areas. The same factories (plus 16) share the excess for lung cancer and stomach cancer in the foundry group (Tables 66, 68). By length of follow up the foundry group shows uniformly high lung cancer mortality whereas the fettling shop group show no excess in the first period (Table 67). For stomach cancer there is an excess for all follow-up periods for the foundry group, but for fettling an excess is only apparent in the first 20 years since first exposure (Table 69).

For non-malignant respiratory disease, a different mixture of foundries (10, 13, 14, 17) contribute to the foundry excess and most (all but 13 and 19) contribute to the excess for fettling shop workers. For the unexposed, all the excess is contributed by foundry 18 and this excess is concentrated in the first 10 years since first employment (Table 71). By follow-up, SMRs are only low in the first 10 years since employment for fettling and maintenance workers (Table 71). For bronchitis, emphysema and asthma, numbers are smaller but the pattern is similar (Table 72). By time since first exposure (Table 73) the SMRs are slightly lower in the first follow-up period for the foundry and fettling shop workers, but highest in that period for the unexposed. For circulatory disease, the mixed and other occupations show the highest SMR and that is present mainly in factory 18 (Table 74). By follow-up (Table 75) the foundry and fettling shop have lower SMRs at first, but not the other work areas.

Mortality by occupational category

Tables 76-82 show the 7 principal cause by main occupational category. For all causes significant excesses are shown for furnace casters and repairmen (categories 4 and 5), foundry labourers (8), fettlers (11) and machine shop labourers (23) with high SMRs for shotblasters (12), heat treatment loaders (15) and precision foundry workers (28), (Table 76). For sand millers (1), there is a moderate non-significantly elevated lung cancer SMR (134) but significant excess mortality from respiratory disease, in particular chronic bronchitis (SMR = 266). For moulders (2) the overall slight deficit masks high stomach cancer (209) but also rectal cancer (6/2.48, SMR = 242 not significant). The SMR for lung cancer is similar to that of the millers (133) and there is no excess for respiratory disease. The group of shell moulders (3) is small and there are no excesses. For the furnacemen (4), the excess comes entirely from malignant neoplasms and respiratory disease (Tables 77 and 80). In addition to significantly raised lung cancer (SMR = 182), intestinal cancer is also raised (6 obs, 2.21 exp. SMR = 272) and non-significant excesses are present for buccal cavity (2/0.53), stomach (8/390) and prostate cancers (3/1.28). For chronic bronchitis the SMR is significant (187). For furnace repairers (5), most of the excess is from malignant neoplasms, in particular stomach (SMR = 364) and lung (SMR = 181), although some excess mortality is present from violent deaths (10/5.78). For centrifugal casters (6) both lung cancer (7/3.63) and respiratory disease (7/4.0) are elevated, and there is also a small excess of oesophageal cancer (2/0.25). Foundry labourers' (8) high overall mortality was due to significant excesses of cancers, respiratory disease and violent deaths (23/14.01, SMR = 164). As well as significantly high SMRs for bronchitis, emphysema and asthma (SMR = 214) and lung cancer (SMR = 157) there is a non-significant excess of buccal cavity cancer (4/1.31) and also leukaemia (5/1.98).

For fettlers (11) mortality is raised for cancers, respiratory disease and violent causes (20/13.90, not significant). In addition to the significant excess of lung cancer (188), small excesses are present for intestinal (6/3.61), rectal (6/2.65) and laryngeal (2/0.56) cancers. Welders (13) have a significant SMR for respiratory disease (187), contributed to by bronchitis (192) and pneumonia (5/2.60, SMR = 192). There is a non-significant excess of lung cancer (SMR = 130). Machine shop and maintenance welders (24) are a smaller group but also have raised mortality from lung cancer (2/1.18), pneumonia (2/0.31) and bronchitis etc (1/0.43). Pooling the two groups of welders together with the arc/air burners (14), the SMRs for these three diseases are: lung cancer - 138 (14/10.12), bronchitis, emphysema and asthma - 188 (8/4.26), pneumonia - 299 (7/3.06). The only significant excess for heat treatment loaders (15) is for lung cancer (SMR = 245). For fettling shop cranedrivers (16), raised lung cancer mortality (SMR = 152 based on only 5 cases) contributes to the overall excess, but it mostly comes from a very high respiratory disease mortality (SMR = 368) with pneumonia (SMR = 560, 6/1.07) and chronic bronchitis (SMR = 297) contributing. This contrasted with the foundry cranedrivers (7), who whilst having a similar lung cancer SMR (144), have a slight deficit of non-malignant respiratory disease mortality. Fettling shop labourers (17) have unexceptional cancer mortality but a doubled respiratory disease mortality, the biggest excess being pneumonia (SMR = 302, 12/3.98), and chronic bronchitis (SMR = 172).

Maintenance fitters (25) have a low overall mortality (SMR = 92) and no specific categories are significantly elevated, but maintenance fitters mates (26) have significantly raised lung cancer SMR (183) and chronic bronchitis SMR (226).

Pattern makers (19) show no significant excess although the lung cancer SMR is 143 based on 5 cases. Labourers in the pattern shop (20) show a significant excess mortality from only one disease category: stomach cancer (SMR = 447 based on 4 cases). There were no cases of nasal cancer in either pattern shop job category, with 0.02 cases expected in each category. Inspection workers (21) show no excesses, both machinists (22) and labourers (23) in the machine shop show raised lung cancer mortality (SMRs of 153 and 146 respectively). They also both have significantly high SMRs for circulatory diseases. The labourers but not the machinists have a high respiratory disease mortality, (SMR = 197). The group of yard labourers, lorry drivers, etc (27) has a fairly low mortality for most causes, although chronic bronchitis is high with an SMR of 154 (not significant). The small group of precision foundry workers has only one excess risk and this is 3 cases of lung cancer against 0.84 expected: two were categorised as precision foundrymen and one as an inspector in the precision foundry.

Tables 83-89 present the mortality by first occupational category. By comparing the expected deaths, it is apparent that labourers in the foundry and fettling shop are larger category when considered as the first rather than the main occupation (Table 83). Many workers are assigned a labouring job on first employment and then assigned a more specific task later. The 3 job titles with quite different all cause SMRs as first job category are sand miller, knockout gridman and arc air burner. The contribution of these jobs is underestimated by only taking first job category. This same pattern is apparent for lung cancer (Table 85) though not for other disease categories.

In tables 90-96 the mortality from the 7 principal causes is presented by detailed occupational category ever occupied for at least one year. Thus individuals can and do contribute to more than one job category (three individuals reached the maximum count of spending at least one year in five different categories). The effect of this is the total observed and expected deaths are some 14% higher than the real total for all causes (Table 90). The patterns of mortality are broadly similar as for the analysis by main category. The main evident difference is that the observed and expected deaths are higher in the ever employed analysis, for the categories containing unskilled workers, such as labourers in foundry, fettling shop, machine shop and yard, but also sand millers and moulders, furnacemen, fettlers and shotblasters. The magnitude of the SMRs is somewhat lower for sandmillers (1), shotblasters (12) and fettling shop crane drivers (16), suggesting that including people employed for shorter periods in these categories has the effect of diluting the risk. On the other hand the pattern shop labourers (20) show a higher SMR than considered as a main category (122 versus 104) suggesting that there may have been transfer of the relatively sick individuals into work into the comparatively clean pattern shop environment. For lung cancer (Table 92) the pattern is much the same as for the main occupational category. The SMR for the centrifugal casters is a little higher and for the heat treatment loaders it is a little lower. For stomach cancer and respiratory diseases, the patterns are similar and for chronic bronchitis the largest difference is that chronic bronchitis mortality is higher for fettling shop labourers when considered as job ever held (Tables 93-95). For diseases of the circulatory system, foundry labourers and heat treatment loaders both have higher SMRs for ever employed compared to main job category (Table 96).

Mortality by age at entry

Tables 97 to 116 present the mortality results by age at entry. For overall mortality, the SMRs are less than 100 for the very youngest (except in factories 10 and 14) and the oldest entrants. For the exposed subcohort, most factories contribute to the excess in the 4 age groups from 24 to 65 (Table 97). The same is true for the unexposed in the only factory contributing an excess (Factory 18, Table 107). For lung cancer the excess is also spread over these four age groups, the highest excess being among those who started quite young (25-34), with all but factory 18 contributing to the excess (Table 98). Among the unexposed the moderate excess comes from older entrants (45-54, Table 108). By time since first exposure (Table 102), the pattern of lung cancer SMRs is quite flat within each of the age at entry groups. For stomach cancer, the high SMR in the 10-19 years follow-up period (Table 103) is present in all age at entry groups, and the overall excess is also fairly evenly spread, even among whose started after 65, where there are 3 cases against 0.6 expected. For non-malignant respiratory disease, the highest excess mortality is amongst those starting at ages 35-54 the excess being showed by all factories except 12 (Table 99). This increases with time since first employment for the 35-44 year entrants but not 45-54 years. The same pattern is more or less evident for chronic bronchitis among the exposed (Tables 104, 105). Among the unexposed the entire excess for respiratory disease is concentrated among older entrants in factory 18, and the deaths mainly occurr 1-9 years since first exposure in this group (Tables 109 and 114). This concentration in older entrants is even more marked for chronic bronchitis (Table 115). For circulatory diseases, the highest excess is amongst the younger entrants and short follow-up for both exposed and unexposed (Tables 106, 116).

Mortality by date of entry

Tables 117 to 136 break the mortality down by date of starting employment. Overall the highest SMR is among the earliest entrants, though there are excesses among the later entrants in factories 14 and 15 (Table 117). The mortality is highest in 10-19 years follow-up group for each entry cohort (Table 120). For the unexposed the excess comes from later entrants in factory 18 (Table 127). Mortality from lung cancer is quite constant by entry cohort, both overall and within each factory, except 18 which has a low SMR in the earliest entry cohort (Table 118). Within each entry cohort the mortality is higher more than 10 years since first exposure (Table 122). Among the unexposed there is a significant excess in the 1956-60 cohort in factory 18, but this entry cohort has a negative relationship between lung cancer SMR and time since first exposure (Tables 128, 132). For stomach cancer, the excess is present in each entry cohort, though the earliest shows a pattern of falling SMR with follow-up (Table 123). Among the unexposed there is a small, significant cluster of stomach cancers in the early entry cohort 30+ years since first exposure (Table 133). For non-malignant respiratory disease, the SMR falls with entry cohort among the unexposed, although only in factory 14 for the unexposed (Tables 119 and 129). The overall trend is significant (X^2 = 8.54) and is reflected in virtually all factories, the notable exception being factory 14, where it remains rather high. For the earliest entrants where the SMR is highest the excess is concentrated 10-29 years since first exposure. For chronic bronchitis the decreasing trend is even steeper and though based on smaller numbers is significant (X^2 = 8.98; Table 125). Among the unexposed, the excess of chronic bronchitis is rather lower among the earlier entrants (Table 135).

Mortality by date of exit

Table 137 to 156 present the mortality broken down by 5 year period of leaving each factory. As the data were collected in 1977-78, the period 1976+ is equivalent to following up currently employed people for a short period hence the significantly low SMR for both exposed and unexposed. The same effect is also evident, though to a lesser extent among those who left 1971-75. In factory 14 which contributes most of the excess, SMRs are high for all exit cohorts up to 1970, though in five of the factories (11, 12, 13, 17, 19) the excess is mainly present among those leaving before 1956. For mortality from lung cancer, all factories but 13, 14 and 16 show an excess among those leaving before 1956 (Table 138). Factory 14 shows an excess in most exit cohorts. As this factory contributes most of the excess, the overall pattern is fairly flat by date of exit. Among the long follow-up periods, the excess lung cancer mortality is spread over several exit cohorts (Table 142). The cohort 1951-55 with the highest overall SMR, shows no relationship with time since first exposure. For stomach cancer, the excess mortality appears quite independent of date of leaving (Table 143). For mortality for diseases of the respiratory system, the excess is only present among leavers before 1971, but is fairly evenly spread among the exit cohorts and factories where there is an excess, even within the longer follow-up periods (Table 139, 144). The same is the case for chronic bronchitis, both for the exposed and unexposed (Tables 135, 145). For circulatory diseases, the excess in the 51-55 exit cohort is in the shorter follow-up, the 61-70 exit cohorts in the longer follow-up (Table 146). Among the unexposed there is a cluster of deaths from circulatory diseases in the short term workers who started in 1946-50 and left before 1951 (Table 156).

<u>Mortality by length of employment</u>

Tables 157 to 166 present the mortality among the exposed by duration of employment. Overall there is no association with duration, though for factory 10 the SMR rises steadily with duration (X_1^2 for trend = 3.95). There are significant excesses for short term workers in factories 11 and 14. Overall the largest excess is for those with 10-14 years' employment. Neither is there any clear pattern when length and time since first exposure are considered simultaneously (Table 160). For lung cancer, the SMR increases over the first 3 length groups, but not subsequently (Table 158). Half the overall excess derives from factory 14 which has an SMR between 202 and 249 in all but the longest employment category. For 20 or more years since first exposure the association even for the first 3 periods is completely absent with SMRs of 160, 180, 153, 124 and 135 respectively (Table 162). The same lack of association is evident for stomach cancer, where the highest excess is among those employed less than 5 years (Table 163). For non-malignant respiratory disease, the highest excess is in the 15-19 years employment group, though the SMR is only 120 in the 20+ group (Table 159). In none of the factories is any pattern evident. By length of follow-up, there is a suggestion of an excess mortality shortly after leaving (Table 164). For 5-9 years employment the excess is in 10-19 years since first employment and for 10-19 years employment the excess is in 20-29 years since first employment and the same pattern is evident for chronic bronchitis mortality (Table 165). No pattern is evident for circulatory disease (Table 166).

Tables 167 to 176 present the results by length of employment for the unexposed cohort. For factory 18, the only factory with a significant excess mortality among the unexposed, there is a slight rise with the first three employment periods for overall mortality and lung cancer, but for respiratory disease the only significant excess is the shortest employment category (Tables 167-169). Overall and for other factories no patterns are evident. Neither is any pattern evident for the other causes of death.

The next series of tables break the analysis by length of employment into more homogeneous subgroups of the exposed workers. Table 177 to 186 present the results for the foundry subcohort. For all causes, an increasing pattern is evident for factory 10 as for the total exposed cohort and also for factory 15). The X^2 values for trend are 2.76 and 5.36, respectively. For lung cancer mortality there are high SMRs for both the 2 shortest periods and also the longest, the latter excess coming from several factories, however in none is there any pattern, and neither in the longer follow-up periods is there any relationship with duration of employment (Tables 178, 182). For stomach cancer the excess is concentrated in the shortest employment group with relatively short follow-up (10-19 years since first exposure, Table 183). As for the total exposed cohort, for non-malignant respiratory disease, there is an excess in the 15-19 years' employment group, but no patterns within any of the factories (Table 179). No patterns are evident for the excess of chronic bronchitis or for circulatory disease where there is no overall excess (Tables 185, 186).

Tables 187 to 196 present the results by length of employment for those employed in the fettling shop. For all causes no pattern is evident within any of the factories with a few significantly raised SMRs scattered in the Table (Table 187). For mortality from lung cancer, there is an excess in the 10-14 years' employment group (and 10-19 years' follow-up) to which 5 of the factories contribute (Table 188). There is no trend in any of the factories; factory 14 which contributes most to the excess has high SMRs in the first 3 employment duration groups. For stomach cancer, there is no excess overall and neither is there any suggestion of an association with duration of employment (Table 193). For non-malignant respiratory disease, the excess is present in all duration groups, with no trend (Table 189). In factory 14, the SMR is above 200 for all 5 duration groups. By length of follow-up the tendency for the highest mortality soon after leaving is apparent (Table 194).

Tables 197 to 206 present the mortality by duration of employment for the maintenance subcohort. For all causes the overall SMR is 100 and there are no trends apparent by factory. The only significant excess is for the shortest employment period in factory 11 (Table 197). For lung cancer, no SMR by duration or factory is significantly raised, and the only moderate excess is in the 5-9 years' employment group, an excess shared by 5 factories (Table 198). For this group, however the SMR does rise with time since first exposure (Table 202). For other causes of death, there is no overall excess, nor patterns with duration and/or follow-up. However numbers in each cell are quite small.

Mortality by location of foundry

The next series of tables (207-222) present the mortality by length of employment for the factories in smaller and larger towns aggregated separately. Workers in the larger towns are more likely to have worked in other foundries, as they are in areas with a concentration of foundries (Factories 10, 11, 12, 14 and 18). Mortality from all causes, lung and stomach cancer and non-malignant respiratory disease is presented. Tables 207 to 218 present the data for the exposed. For mortality from all causes, there is no overall excess in the small town group, nor any relationship with duration of employment or time since first exposure, although a low SMR is evident in the first follow-up period (Table 207). The excess is entirely concentrated in the large town group where some moderate increase of SMR with duration of exposure is evident for the first three employment periods (Table 211). For lung cancer, the excess is again only present for the large town group, although in the small town group there is a suggestion of an increase with the first 3 duration groups overall but not in the long follow-up groups (Table 208). In the large town group, the SMRs are uniformly high in all follow-up periods and employment duration groups (Table 212). Similarly for stomach cancer no excess or pattern is evident for the small town group, but for the large town group, there is a significant excess, largest for this cause of death, in the short term employees as already noted for the whole cohort (Tables 209, 213). This excess is most apparent in the shorter follow-up periods. For respiratory disease mortality, the difference is less marked between the small and large town groups (Tables 210, 214). In the small town group, the overall SMR is 125 and increases with time since first exposure up to 29 years, but with no relationship with duration. For the large towns, the SMR remains high in all duration categories buth the longest and is pronounced in the second and third follow-up periods (Table 214).

Tables 215 to 222 present the same analyses by large and small towns and duration for the unexposed. The SMRs for all causes are a little higher in the large town group but otherwise there are no patterns (Tables 215, 219). For lung cancer the SMR is higher for the small town group (Table 216) and shows the highest SMRs for the two longest employment periods, though the numbers are small (8/3.72). In the large town group no excess or pattern is evident (Table 220). For stomach cancer numbers are very small and no pattern can be discerned (Tables 217, 221). For non-malignant respiratory disease the overall SMR is twice as large in the large town group, where however the excess in concentrated in both short employment and follow-up groups (Table 222).

Mortality by exposure category

Tables 223 to 243 present, for mortality from each of the seven causes of death the results for subcohorts defined by exposure categories - "dust", "fume" and "silica". In each case, the cummulative length of employment is that spent in the occupational categories as defined in Chapter 3. Therefore, although a minimum of one year's employment is a requirement of inclusion in the cohort, some individuals spent less than one year in these defined exposure subgroups.

For all causes (Tables 223-225), the patterns are virtually identical in all three groups with an overall significant excess that drops to non-significance after regional adjustment and highest SMRs in the 1-14 years employment category. For all malignant neoplasms (Tables 226-228) the risk is higher for fume exposed, although the risk is again highest for the 10-14 years duration of employment. For lung cancer (Tables 229-231) the risk is highest for fume exposed, with an SMR of 163 compared to 150 for dust exposed. For the fume exposed, the risk is clearly higher after 10 years cumulative employment. The pattern is similar but less striking for the dust exposed. For the silica group, the pattern is similar except the SMRs are lower for those exposed less than 5 years. The results for stomach cancer (Tables 232-234) show the largest discrimination between dust and fume exposed, with fume exposed being lower and non-significant, although there are raised SMRs spread over longer employment categories. Although there is a high stomach cancer SMR (148) for the dust exposed it is not related to duration of employment with the highest SMRs for 1-4 and 5-9 years' employment. The silica exposed group exhibits the highest SMR overall (165) although the excess is almost entirely in the 1-4 years' employment group and spread over all follow-up groups.

For mortality from non-malignant respiratory disease (Tables 235-237), the risk rises with years since first exposure for both dust and fume exposed, though more rapidly for the latter. For dust exposed the SMR rises up to the 15-19 years employment category, though there is no significant trend. For the silica exposed there is even less pattern, with the highest SMR in the less than one years' employment group. The SMRs from chronic bronchitis are a little higher than for non-malignant respiratory disease (Tables 238-240). For dust exposed these SMRs are higher for less than one year and then 10-19 years of employment, whereas for the fume exposed they remain high for all employment periods except the shortest and the longest. For the silica group, they are high in all groups except the longest. For mortality from circulatory disease (tables 241-243), overall significant excesses in all three groups are removed by regional correction and the only substantial excess is a cluster in the 1-4 years' employment and 10-19 years' follow-up in both the dust group and silica group.

Appendix C

List of detailed tables of mortality analysis

The first 27 Tables present the results of analysis of various subgroups by detailed cause. In each subsequent analysis, similar tables are presented in sequence for several causes, as follows:

7 causes: All causes, all malignant neoplasms, lung cancer, stomach cancer, respiratory disease, bronchitis emphysema & asthma, circulatory disease

4 causes: All causes, lung cancer, stomach cancer, respiratory disease

3 causes: All causes, lung cancer, respiratory disease

Appendix C: Table 1

Mortality by detailed cause

Immigrant workers subcohort - exposed and unexposed

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	31	77.26	40	(27-57)
ALL MALIGNANT NEOPLASMS (140-209)	2	19.86	10	(1-36)
Buccal cavity & pharynx (140-149)	0	0.32	0	(0-1160)
Oesophagus (150)	0	0.60	0	(0-617)
Stomach (151)	0	1.93	0	(0-191)
Intestine, except rectum (152-153)	0	1.26	0	(0-293)
Rectum (154)	1	0.90	111	(3-618)
Larynx (161)	0	0.19	0	(0-1962)
Trachea, bronchus and lung (162)	0	7.83	0	(0-47)
Bone (170)	0	0.10	0	(0-3803)
Prostate (185)	0	0.63	0	(0-588)
Bladder (188)	0	0.62	0	(0-592)
Leukaemia (204-207)	0	0.58	0	(0-640)
Other Lymph. & haemato. (200-203,208-209)	0	0.95	0	(0-387)
Other malignant neoplasms	1	3.94	25	(1-142)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.27	0	(0-1356)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	13	36.51	36	(19-61)
Ischaemic heart disease (410-414)	5	26.03	19	(6-45)
Cerebrovascular disease (430-438)	4	5.48	73	(20-187)
Other diseases of the circulatory system	4	5.01	80	(22-205)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	2	7.60	26	(3-95)
Acute infections (460-466)	0	0.13	0	(0-2816)
Influenza (470-474)	0	0.21	0	(0-1748)
Pneumonia (480-486)	1	2.97	34	(1-187)
Bronchitis, emphysema & asthma (490-493)	1	3.44	29	(1-162)
Other diseases of the respiratory system	0	0.84	0	(0-438)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	3	2.13	141	(29-412)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	1	5.73	17	(0-97)
Industrial type (E916-E921,E923-E928)	0	0.42	0	(0-870)
Suicide (E950-E959)	0	1.67	0	(0-221)
Other violent causes	1	3.63	28	(1-153)
OTHER KNOWN CAUSES	2	5.16	39	(4-139)
CAUSE UNKNOWN	8			

Appendix C: Table 2

Mortality by detailed cause

Total cohort excluding immigrant workers

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	2789	2507.03	111	(107-115)
ALL MALIGNANT NEOPLASMS (140-209)	767	646.35	119	(110-127)
Buccal cavity & pharynx (140-149)	8	9.64	83	(36-164)
Oesophagus (150)	15	18.16	83	(46-136)
Stomach (151)	101	70.45	143	(117-174)
Intestine, except rectum (152-153)	34	40.01	85	(59-119)
Rectum (154)	32	29.58	108	(74-153)
Larynx (161)	7	6.21	113	(45-232)
Trachea, bronchus and lung (162)	393	269.80	146	(132-161)
Bone (170)	1	3.12	32	(1-179)
Prostate (185)	20	26.53	75	(46-116)
Bladder (188)	25	22.50	111	(72-164)
Leukaemia (204-207)	13	15.88	82	(44-140)
Other Lymph. & haemato. (200-203,208-209)	23	25.10	92	(58-137)
Other malignant neoplasms	95	109.58	87	(70-106)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	10	7.74	129	(62-238)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	1281	1160.28	110	(104-117)
Ischaemic heart disease (410-414)	819	808.86	101	(94-108)
Cerebrovascular disease (430-438)	248	206.16	120	(106-136)
Other diseases of the circulatory system	214	145.26	147	(128-168)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	416	297.97	140	(127-154)
Acute infections (460-466)	0	5.03	0	(0-73)
Influenza (470-474)	12	8.98	134	(69-233)
Pneumonia (480-486)	125	105.86	118	(98-141)
Bronchitis, emphysema & asthma (490-493)	241	147.03	164	(144-186)
Other diseases of the respiratory system	38	31.06	122	(87-168)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	59	66.30	89	(68-115)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	127	133.09	95	(80-114)
Industrial type (E916-E921,E923-E928)	6	10.10	59	(22-129)
Suicide (E950-E959)	23	37.58	61	(39-92)
Other violent causes	98	85.41	115	(93-140)
OTHER KNOWN CAUSES	103	195.31	53	(43-64)
CAUSE UNKNOWN	26			

Appendix C: Table 3

Mortality by detailed cause

Work area:- Foundry

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	1087	961.22	113	(106-120)
ALL MALIGNANT NEOPLASMS (140-209)	327	247.10	132	(118-147)
Buccal cavity & pharynx (140-149)	6	3.69	163	(60-354)
Oesophagus (150)	8	6.93	116	(50-228)
Stomach (151)	52	27.14	192	(143-251)
Intestine, except rectum (152-153)	13	15.33	85	(45-145)
Rectum (154)	14	11.35	123	(67-207)
Larynx (161)	1	2.38	42	(1-234)
Trachea, bronchus and lung (162)	164	103.26	159	(135-185)
Bone (170)	1	1.18	85	(2-471)
Prostate (185)	6	10.36	58	(21-126)
Bladder (188)	10	8.66	116	(55-212)
Leukaemia (204-207)	6	5.99	100	(37-218)
Other Lymph. & haemato. (200-203,208-209)	7	9.44	74	(30-153)
Other malignant neoplasms	39	41.50	94	(67-128)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	5	2.93	170	(55-398)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	473	444.88	106	(97-116)
Ischaemic heart disease (410-414)	298	309.57	96	(86-108)
Cerebrovascular disease (430-438)	99	80.15	124	(100-150)
Other diseases of the circulatory system	76	55.16	138	(109-172)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	156	115.73	135	(114-158)
Acute infections (460-466)	0	1.97	0	(0-188)
Influenza (470-474)	7	3.51	200	(80-411)
Pneumonia (480-486)	44	41.11	107	(78-144)
Bronchitis, emphysema & asthma (490-493)	91	57.17	159	(128-195)
Other diseases of the respiratory system	14	11.97	117	(64-196)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	22	25.40	87	(54-131)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	56	49.20	114	(86-148)
Industrial type (E916-E921,E923-E928)	2	3.73	54	(6-193)
Suicide (E950-E959)	9	13.96	64	(29-122)
Other violent causes	45	31.50	143	(104-191)
OTHER KNOWN CAUSES	40	75.97	53	(38-72)
CAUSE UNKNOWN	8			

Appendix C: Table 4

Mortality by detailed cause

Work area:- Fettling shop

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	539	451.57	119	(109-130)
ALL MALIGNANT NEOPLASMS (140-209)	146	118.98	123	(104-144)
Buccal cavity & pharynx (140-149)	0	1.77	0	(0-208)
Oesophagus (150)	3	3.38	89	(18-260)
Stomach (151)	13	12.74	102	(54-174)
Intestine, except rectum (152-153)	7	7.28	96	(39-198)
Rectum (154)	7	5.36	131	(52-269)
Larynx (161)	5	1.13	442	(144-1032)
Trachea, bronchus and lung (162)	86	49.91	172	(138-213)
Bone (170)	0	0.57	0	(0-645)
Prostate (185)	3	4.35	69	(14-202)
Bladder (188)	5	3.99	125	(41-292)
Leukaemia (204-207)	3	2.96	101	(21-296)
Other Lymph. & haemato. (200-203,208-209)	1	4.80	21	(1-116)
Other malignant neoplasms	13	20.73	63	(33-107)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	1.47	0	(0-250)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	235	209.66	112	(98-127)
Ischaemic heart disease (410-414)	154	148.55	104	(88-121)
Cerebrovascular disease (430-438)	42	34.98	120	(87-162)
Other diseases of the circulatory system	39	26.13	149	(106-204)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	86	49.90	172	(138-213)
Acute infections (460-466)	0	0.85	0	(0-434)
Influenza (470-474)	2	1.52	131	(16-475)
Pneumonia (480-486)	28	17.11	164	(109-237)
Bronchitis, emphysema & asthma (490-493)	48	24.91	193	(142-255)
Other diseases of the respiratory system	8	5.52	145	(63-286)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	17	12.05	141	(82-226)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	29	25.34	114	(77-164)
Industrial type (E916-E921,E923-E928)	1	1.98	51	(1-282)
Suicide (E950-E959)	6	7.33	82	(30-178)
Other violent causes	22	16.03	137	(86-208)
OTHER KNOWN CAUSES	21	34.16	62	(38-94)
CAUSE UNKNOWN	5			

Appendix C: Table 5

Mortality by detailed cause

Work area:- Maintenance

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	243	242.53	100	(88-114)
ALL MALIGNANT NEOPLASMS (140-209)	70	62.71	112	(87-141)
Buccal cavity & pharynx (140-149)	1	0.93	108	(3-602)
Oesophagus (150)	3	1.76	170	(35-497)
Stomach (151)	9	6.78	133	(61-252)
Intestine, except rectum (152-153)	3	3.87	77	(16-226)
Rectum (154)	1	2.86	35	(1-195)
Larynx (161)	0	0.60	0	(0-617)
Trachea, bronchus and lung (162)	32	26.19	122	(84-173)
Bone (170)	0	0.30	0	(0-1217)
Prostate (185)	2	2.56	78	(9-282)
Bladder (188)	2	2.19	91	(11-330)
Leukaemia (204-207)	2	1.55	129	(16-465)
Other Lymph. & haemato. (200-203,208-209)	5	2.46	203	(66-474)
Other malignant neoplasms	10	10.68	94	(45-172)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	2	0.75	267	(32-963)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	116	112.58	103	(85-124)
Ischaemic heart disease (410-414)	76	78.33	97	(76-121)
Cerebrovascular disease (430-438)	20	19.79	101	(62-156)
Other diseases of the circulatory system	20	14.46	138	(85-214)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	31	28.59	108	(74-154)
Acute infections (460-466)	0	0.47	0	(0-778)
Influenza (470-474)	0	0.85	0	(0-436)
Pneumonia (480-486)	9	10.20	88	(40-167)
Bronchitis, emphysema & asthma (490-493)	19	14.10	135	(81-210)
Other diseases of the respiratory system	3	2.97	101	(21-295)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	4	6.38	63	(17-161)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	12	13.20	91	(47-159)
Industrial type (E916-E921,E923-E928)	1	0.99	101	(3-562)
Suicide (E950-E959)	2	3.68	54	(7-196)
Other violent causes	9	8.53	106	(48-200)
OTHER KNOWN CAUSES	7	18.32	32	(15-79)
CAUSE UNKNOWN	1			

Appendix C: Table 6

Mortality by detailed cause

Work area:- Mixed and other occupations

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	272	231.89	117	(104-132)
ALL MALIGNANT NEOPLASMS (140-209)	60	61.37	98	(75-126)
Buccal cavity & pharynx (140-149)	1	0.91	110	(3-612)
Oesophagus (150)	1	1.74	58	(1-321)
Stomach (151)	7	6.59	106	(43-219)
Intestine, except rectum (152-153)	3	3.73	80	(17-235)
Rectum (154)	2	2.76	73	(9-262)
Larynx (161)	0	0.58	0	(0-635)
Trachea, bronchus and lung (162)	34	25.89	131	(91-184)
Bone (170)	0	0.29	0	(0-1250)
Prostate (185)	2	2.23	90	(11-325)
Bladder (188)	1	2.06	49	(1-271)
Leukaemia (204-207)	0	1.51	0	(0-244)
Other Lymph. & haemato. (200-203,208-209)	2	2.45	81	(10-294)
Other malignant neoplasms	7	10.63	66	(26-136)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.76	0	(0-487)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	142	107.51	132	(111-156)
Ischaemic heart disease (410-414)	96	76.18	126	(102-154)
Cerebrovascular disease (430-438)	19	17.91	106	(64-166)
Other diseases of the circulatory system	27	13.43	201	(132-293)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	44	25.70	171	(124-230)
Acute infections (460-466)	0	0.44	0	(0-848)
Influenza (470-474)	3	0.79	382	(79-1115)
Pneumonia (480-486)	12	8.75	137	(71-240)
Bronchitis, emphysema & asthma (490-493)	22	12.88	171	(107-259)
Other diseases of the respiratory system	7	2.85	246	(99-507)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	4	6.18	65	(18-166)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	10	12.87	78	(37-143)
Industrial type (E916-E921,E923-E928)	1	1.00	100	(3-557)
Suicide (E950-E959)	2	3.70	54	(7-195)
Other violent causes	7	8.17	86	(34-176)
OTHER KNOWN CAUSES	6	17.50	34	(13-75)
CAUSE UNKNOWN	6			

Appendix C: Table 7

Mortality by detailed cause

Work area:- Pattern shop, machine shop etc.

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	648	619.83	105	(97-113)
ALL MALIGNANT NEOPLASMS (140-209)	164	156.19	105	(90-122)
Buccal cavity & pharynx (140-149)	0	2.34	0	(0-157)
Oesophagus (150)	0	4.36	0	(0-85)
Stomach (151)	20	17.21	116	(71-180)
Intestine, except rectum (152-153)	8	9.79	82	(35-161)
Rectum (154)	8	7.26	110	(48-217)
Larynx (161)	1	1.51	66	(2-368)
Trachea, bronchus and lung (162)	77	64.55	119	(94-149)
Bone (170)	0	0.76	0	(0-483)
Prostate (185)	7	7.04	99	(40-205)
Bladder (188)	7	5.60	125	(50-257)
Leukaemia (204-207)	2	3.85	52	(6-188)
Other Lymph. & haemato. (200-203,208-209)	8	5.95	135	(58-265)
Other malignant neoplasms	26	26.05	100	(65-146)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	3	1.83	164	(34-480)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	315	285.66	110	(98-123)
Ischaemic heart disease (410-414)	195	196.24	99	(86-114)
Cerebrovascular disease (430-438)	68	53.33	128	(99-162)
Other diseases of the circulatory system	52	36.09	144	(108-189)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	99	78.04	127	(103-154)
Acute infections (460-466)	0	1.31	0	(0-282)
Influenza (470-474)	0	2.32	0	(0-159)
Pneumonia (480-486)	32	28.69	112	(76-157)
Bronchitis, emphysema & asthma (490-493)	61	37.96	161	(123-206)
Other diseases of the respiratory system	6	7.76	77	(28-168)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	12	16.29	74	(38-129)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	20	32.47	62	(38-95)
Industrial type (E916-E921,E923-E928)	1	2.39	42	(1-233)
Suicide (E950-E959)	4	8.90	45	(12-115)
Other violent causes	15	21.18	71	(40-117)
OTHER KNOWN CAUSES	29	49.35	59	(39-84)
CAUSE UNKNOWN	6			

Appendix C: Table 8

Mortality by detailed cause

Exposed cohort by factory: 10

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	218	177.97	122	(107-140)
ALL MALIGNANT NEOPLASMS (140-209)	72	44.13	163	(128-205)
Buccal cavity & pharynx (140-149)	3	0.68	440	(91-1286)
Oesophagus (150)	2	1.23	162	(20-587)
Stomach (151)	10	5.09	196	(94-361)
Intestine, except rectum (152-153)	1	2.81	36	(1-199)
Rectum (154)	4	2.11	189	(52-485)
Larynx (161)	0	0.44	0	(0-838)
Trachea, bronchus and lung (162)	37	18.28	202	(143-279)
Bone (170)	0	0.21	0	(0-1791)
Prostate (185)	3	2.17	138	(28-404)
Bladder (188)	3	1.61	186	(38-543)
Leukaemia (204-207)	0	1.00	0	(0-368)
Other Lymph. & haemato. (200-203,208-209)	1	1.52	66	(2-366)
Other malignant neoplasms	8	7.03	114	(49-224)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.49	0	(0-751)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	84	82.12	102	(82-127)
Ischaemic heart disease (410-414)	49	56.23	87	(64-115)
Cerebrovascular disease (430-438)	17	16.41	104	(60-166)
Other diseases of the circulatory system	18	9.48	190	(113-300)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	39	23.58	165	(118-226)
Acute infections (460-466)	0	0.42	0	(0-874)
Influenza (470-474)	3	0.75	402	(83-1175)
Pneumonia (480-486)	11	8.59	128	(64-229)
Bronchitis, emphysema & asthma (490-493)	22	11.57	190	(119-288)
Other diseases of the respiratory system	3	2.25	133	(27-389)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	5	4.68	107	(35-249)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	8	7.35	109	(47-215)
Industrial type (E916-E921,E923-E928)	0	0.54	0	(0-678)
Suicide (E950-E959)	0	2.10	0	(0-175)
Other violent causes	8	4.70	170	(74-336)
OTHER KNOWN CAUSES	8	15.62	51	(22-101)
CAUSE UNKNOWN	2			

Appendix C: Table 9

Mortality by detailed cause

Exposed cohort by factory: 11

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	278	243.06	114	(101-129)
ALL MALIGNANT NEOPLASMS (140-209)	97	63.22	153	(124-187)
Buccal cavity & pharynx (140-149)	1	0.94	106	(3-593)
Oesophagus (150)	2	1.78	112	(14-406)
Stomach (151)	11	6.91	159	(79-285)
Intestine, except rectum (152-153)	5	3.90	128	(42-299)
Rectum (154)	3	2.89	104	(21-304)
Larynx (161)	3	0.61	493	(102-1442)
Trachea, bronchus and lung (162)	50	26.55	188	(140-248)
Bone (170)	0	0.30	0	(0-1246)
Prostate (185)	1	2.53	39	(1-220)
Bladder (188)	5	2.18	229	(74-534)
Leukaemia (204-207)	2	1.52	131	(16-475)
Other Lymph. & haemato. (200-203,208-209)	3	2.42	124	(26-362)
Other malignant neoplasms	11	10.70	103	(51-184)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	2	0.75	265	(32-957)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	116	112.86	103	(85-123)
Ischaemic heart disease (410-414)	85	79.17	107	(86-133)
Cerebrovascular disease (430-438)	14	19.84	71	(39-118)
Other diseases of the circulatory system	17	13.85	123	(71-196)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	33	28.54	116	(80-162)
Acute infections (460-466)	0	0.48	0	(0-764)
Influenza (470-474)	0	0.86	0	(0-430)
Pneumonia (480-486)	11	9.98	110	(55-197)
Bronchitis, emphysema & asthma (490-493)	19	14.18	134	(81-209)
Other diseases of the respiratory system	3	3.03	99	(20-289)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	7	6.45	109	(44-224)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	14	12.32	114	(62-191)
Industrial type (E916-E921,E923-E928)	0	0.95	0	(0-388)
Suicide (E950-E959)	1	3.58	28	(1-156)
Other violent causes	13	7.79	167	(89-285)
OTHER KNOWN CAUSES	7	18.91	37	(14-76)
CAUSE UNKNOWN	2			

Appendix C: Table 10

Mortality by detailed cause

Exposed cohort by factory: 12

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	73	69.21	105	(83-133)
ALL MALIGNANT NEOPLASMS (140-209)	16	17.47	92	(52-149)
Buccal cavity & pharynx (140-149)	0	0.26	0	(0-1408)
Oesophagus (150)	1	0.48	207	(5-1154)
Stomach (151)	1	1.96	51	(1-284)
Intestine, except rectum (152-153)	0	1.10	0	(0-335)
Rectum (154)	0	0.82	0	(0-452)
Larynx (161)	0	0.17	0	(0-2170)
Trachea, bronchus and lung (162)	11	7.24	152	(76-272)
Bone (170)	0	0.09	0	(0-4340)
Prostate (185)	0	0.81	0	(0-454)
Bladder (188)	0	0.63	0	(0-586)
Leukaemia (204-207)	2	0.42	475	(58-1716)
Other Lymph. & haemato. (200-203,208-209)	1	0.65	155	(4-862)
Other malignant neoplasms	0	2.86	0	(0-129)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	0.20	500	(13-2786)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	37	31.77	116	(82-161)
Ischaemic heart disease (410-414)	25	21.89	114	(74-169)
Cerebrovascular disease (430-438)	5	6.09	82	(27-192)
Other diseases of the circulatory system	7	3.79	185	(74-381)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	9	8.74	103	(47-196)
Acute infections (460-466)	0	0.15	0	(0-2427)
Influenza (470-474)	0	0.27	0	(0-1376)
Pneumonia (480-486)	4	3.07	130	(36-334)
Bronchitis, emphysema & asthma (490-493)	4	4.37	92	(25-234)
Other diseases of the respiratory system	1	0.88	113	(3-632)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	1.81	0	(0-203)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	6	3.45	174	(64-379)
Industrial type (E916-E921,E923-E928)	0	0.25	0	(0-1470)
Suicide (E950-E959)	0	0.95	0	(0-390)
Other violent causes	6	2.25	267	(98-581)
OTHER KNOWN CAUSES	3	5.77	52	(10-152)
CAUSE UNKNOWN	1			

Appendix C: Table 11

Mortality by detailed cause

Exposed cohort by factory: 13

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	76	82.06	93	(73-116)
ALL MALIGNANT NEOPLASMS (140-209)	15	20.86	72	(40-119)
Buccal cavity & pharynx (140-149)	0	0.32	0	(0-1160)
Oesophagus (150)	0	0.60	0	(0-618)
Stomach (151)	2	2.20	91	(11-328)
Intestine, except rectum (152-153)	1	1.30	77	(2-428)
Rectum (154)	0	0.96	0	(0-385)
Larynx (161)	1	0.20	503	(13-2800)
Trachea, bronchus and lung (162)	3	8.55	35	(7-103)
Bone (170)	0	0.10	0	(0-3617)
Prostate (185)	1	0.85	118	(3-656)
Bladder (188)	1	0.72	139	(4-773)
Leukaemia (204-207)	1	0.54	186	(5-1034)
Other Lymph. & haemato. (200-203,208-209)	2	0.86	233	(28-843)
Other malignant neoplasms	3	3.66	82	(17-239)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.26	0	(0-1430)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	39	38.24	102	(73-139)
Ischaemic heart disease (410-414)	26	26.47	98	(64-144)
Cerebrovascular disease (430-438)	7	6.64	105	(42-217)
Other diseases of the circulatory system	6	5.13	117	(43-254)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	10	9.60	104	(50-192)
Acute infections (460-466)	0	0.16	0	(0-2320)
Influenza (470-474)	1	0.28	355	(9-1976)
Pneumonia (480-486)	6	3.63	165	(61-360)
Bronchitis, emphysema & asthma (490-493)	3	4.55	66	(14-193)
Other diseases of the respiratory system	0	0.98	0	(0-376)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	1	2.17	46	(1-256)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	8	4.82	166	(72-327)
Industrial type (E916-E921,E923-E928)	0	0.36	0	(0-1013)
Suicide (E950-E959)	2	1.34	149	(18-539)
Other violent causes	6	3.12	192	(71-419)
OTHER KNOWN CAUSES	0	6.09	0	(0-62)
CAUSE UNKNOWN	3			

Appendix C: Table 12

Mortality by detailed cause

Exposed cohort by factory: 14

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	515	413.04	125	(114-136)
ALL MALIGNANT NEOPLASMS (140-209)	157	109.64	143	(122-167)
Buccal cavity & pharynx (140-149)	2	1.61	125	(15-450)
Oesophagus (150)	2	3.10	65	(8-233)
Stomach (151)	15	11.77	127	(71-210)
Intestine, except rectum (152-153)	5	6.67	75	(24-175)
Rectum (154)	9	4.91	183	(84-348)
Larynx (161)	2	1.04	192	(23-695)
Trachea, bronchus and lung (162)	95	46.44	205	(166-250)
Bone (170)	1	0.51	195	(5-1086)
Prostate (185)	0	4.02	0	(0-92)
Bladder (188)	2	3.71	54	(7-195)
Leukaemia (204-207)	2	2.67	75	(9-270)
Other Lymph. & haemato. (200-203,208-209)	4	4.33	92	(25-237)
Other malignant neoplasms	18	18.86	95	(57-151)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	2	1.33	150	(18-542)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	208	192.64	108	(94-124)
Ischaemic heart disease (410-414)	123	136.31	90	(75-108)
Cerebrovascular disease (430-438)	44	32.03	137	(100-184)
Other diseases of the circulatory system	41	24.29	169	(121-229)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	95	46.12	206	(167-252)
Acute infections (460-466)	0	0.76	0	(0-484)
Influenza (470-474)	5	1.37	364	(118-850)
Pneumonia (480-486)	26	15.75	165	(108-242)
Bronchitis, emphysema & asthma (490-493)	56	23.17	242	(183-314)
Other diseases of the respiratory system	8	5.07	158	(68-311)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	12	10.94	110	(57-192)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	21	22.03	95	(59-146)
Industrial type (E916-E921,E923-E928)	0	1.72	0	(0-214)
Suicide (E950-E959)	6	6.42	94	(34-204)
Other violent causes	15	13.89	108	(60-178)
OTHER KNOWN CAUSES	17	30.34	56	(33-90)
CAUSE UNKNOWN	3			

Appendix C: Table 13

Mortality by detailed cause

Exposed cohort by factory: 15

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	133	124.89	106	(89-126)
ALL MALIGNANT NEOPLASMS (140-209)	26	32.49	80	(52-117)
Buccal cavity & pharynx (140-149)	0	0.47	0	(0-777)
Oesophagus (150)	1	0.90	111	(3-618)
Stomach (151)	3	3.57	84	(17-246)
Intestine, except rectum (152-153)	0	2.00	0	(0-185)
Rectum (154)	2	1.48	136	(16-489)
Larynx (161)	0	0.31	0	(0-1190)
Trachea, bronchus and lung (162)	16	13.68	117	(67-190)
Bone (170)	0	0.16	0	(0-2365)
Prostate (185)	0	1.34	0	(0-276)
Bladder (188)	1	1.14	88	(2-489)
Leukaemia (204-207)	0	0.79	0	(0-468)
Other Lymph. & haemato. (200-203,208-209)	0	1.24	0	(0-297)
Other malignant neoplasms	3	5.43	55	(11-161)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.38	0	(0-958)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	69	57.58	120	(93-152)
Ischaemic heart disease (410-414)	41	40.15	102	(73-139)
Cerebrovascular disease (430-438)	17	10.26	166	(97-265)
Other diseases of the circulatory system	11	7.16	154	(77-275)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	21	14.94	141	(87-215)
Acute infections (460-466)	0	0.25	0	(0-1487)
Influenza (470-474)	1	0.45	222	(6-1238)
Pneumonia (480-486)	6	5.18	116	(42-252)
Bronchitis, emphysema & asthma (490-493)	10	7.49	133	(64-245)
Other diseases of the respiratory system	4	1.57	254	(69-652)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	2	3.30	61	(7-219)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	8	6.50	123	(53-242)
Industrial type (E916-E921,E923-E928)	0	0.49	0	(0-750)
Suicide (E950-E959)	0	1.83	0	(0-201)
Other violent causes	8	4.18	191	(83-377)
OTHER KNOWN CAUSES	3	9.70	31	(6-90)
CAUSE UNKNOWN	4			

Appendix C: Table 14

Mortality by detailed cause

Exposed cohort by factory: 16

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	208	218.13	95	(83-109)
ALL MALIGNANT NEOPLASMS (140-209)	56	57.16	98	(74-127)
Buccal cavity & pharynx (140-149)	0	0.84	0	(0-439)
Oesophagus (150)	0	1.63	0	(0-227)
Stomach (151)	8	5.97	134	(58-264)
Intestine, except rectum (152-153)	0	3.50	0	(0-105)
Rectum (154)	3	2.56	117	(24-343)
Larynx (161)	0	0.54	0	(0-690)
Trachea, bronchus and lung (162)	29	23.83	122	(82-175)
Bone (170)	0	0.28	0	(0-1322)
Prostate (185)	4	2.14	187	(51-478)
Bladder (188)	1	1.94	52	(1-287)
Leukaemia (204-207)	1	1.48	68	(2-377)
Other Lymph. & haemato. (200-203,208-209)	1	2.38	42	(1-234)
Other malignant neoplasms	9	10.07	89	(41-170)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	0.72	139	(4-776)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	98	101.50	97	(78-118)
Ischaemic heart disease (410-414)	72	71.08	101	(79-128)
Cerebrovascular disease (430-438)	14	16.70	84	(46-141)
Other diseases of the circulatory system	12	13.72	87	(45-153)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	30	24.10	124	(84-178)
Acute infections (460-466)	0	0.39	0	(0-953)
Influenza (470-474)	1	0.69	146	(4-811)
Pneumonia (480-486)	10	8.65	116	(55-213)
Bronchitis, emphysema & asthma (490-493)	13	11.72	111	(59-190)
Other diseases of the respiratory system	6	2.65	226	(83-492)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	7	5.78	121	(49-249)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	10	13.22	76	(36-139)
Industrial type (E916-E921,E923-E928)	1	1.00	101	(3-560)
Suicide (E950-E959)	4	3.68	109	(30-278)
Other violent causes	5	8.55	58	(19-136)
OTHER KNOWN CAUSES	5	15.65	32	(10-75)
CAUSE UNKNOWN	1			

Appendix C: Table 15

Mortality by detailed cause

Exposed cohort by factory: 17

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	143	134.81	106	(89-125)
ALL MALIGNANT NEOPLASMS (140-209)	31	35.10	88	(60-125)
Buccal cavity & pharynx (140-149)	0	0.52	0	(0-712)
Oesophagus (150)	2	0.98	204	(25-737)
Stomach (151)	1	3.87	26	(1-144)
Intestine, except rectum (152-153)	2	2.16	93	(11-334)
Rectum (154)	2	1.60	125	(15-451)
Larynx (161)	0	0.34	0	(0-1091)
Trachea, bronchus and lung (162)	14	14.80	95	(52-159)
Bone (170)	0	0.17	0	(0-2222)
Prostate (185)	0	1.43	0	(0-259)
Bladder (188)	1	1.22	82	(2-457)
Leukaemia (204-207)	2	0.84	238	(29-859)
Other Lymph. & haemato. (200-203,208-209)	1	1.33	75	(2-419)
Other malignant neoplasms	6	5.87	102	(38-222)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.42	0	(0-883)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	71	62.27	114	(89-144)
Ischaemic heart disease (410-414)	41	43.53	94	(68-128)
Cerebrovascular disease (430-438)	10	11.06	90	(43-166)
Other diseases of the circulatory system	20	7.68	260	(159-402)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	25	16.07	156	(101-230)
Acute infections (460-466)	0	0.27	0	(0-1371)
Influenza (470-474)	0	0.49	0	(0-750)
Pneumonia (480-486)	5	5.53	90	(29-211)
Bronchitis, emphysema & asthma (490-493)	17	8.05	211	(123-338)
Other diseases of the respiratory system	3	1.72	175	(36-510)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	3.58	0	(0-103)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	7	6.76	104	(42-213)
Industrial type (E916-E921,E923-E928)	2	0.51	388	(47-1403)
Suicide (E950-E959)	0	1.95	0	(0-189)
Other violent causes	5	4.29	116	(38-272)
OTHER KNOWN CAUSES	9	10.61	85	(39-161)
CAUSE UNKNOWN	0			

Appendix C: Table 16

Mortality by detailed cause

Exposed cohort by factory: 18

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	369	319.62	115	(104-128)
ALL MALIGNANT NEOPLASMS (140-209)	99	83.42	119	(96-144)
Buccal cavity & pharynx (140-149)	0	1.25	0	(0-295)
Oesophagus (150)	2	2.36	85	(10-307)
Stomach (151)	26	9.01	289	(189-423)
Intestine, except rectum (152-153)	9	5.12	176	(80-334)
Rectum (154)	0	3.78	0	(0-98)
Larynx (161)	0	0.79	0	(0-465)
Trachea, bronchus and lung (162)	45	34.90	129	(94-173)
Bone (170)	0	0.41	0	(0-898)
Prostate (185)	3	3.13	96	(20-280)
Bladder (188)	4	2.81	142	(39-364)
Leukaemia (204-207)	1	2.08	48	(1-268)
Other Lymph. & haemato. (200-203,208-209)	2	3.35	60	(7-216)
Other malignant neoplasms	7	14.45	48	(19-100)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	1.03	97	(2-540)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	180	147.85	122	(105-141)
Ischaemic heart disease (410-414)	117	104.32	112	(93-134)
Cerebrovascular disease (430-438)	38	25.22	151	(107-207)
Other diseases of the circulatory system	25	18.31	137	(88-202)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	45	36.01	125	(91-167)
Acute infections (460-466)	0	0.62	0	(0-591)
Influenza (470-474)	1	1.11	90	(2-501)
Pneumonia (480-486)	14	12.55	112	(61-187)
Bronchitis, emphysema & asthma (490-493)	27	17.83	151	(100-220)
Other diseases of the respiratory system	3	3.90	77	(16-225)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	9	8.51	106	(48-201)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	19	17.98	106	(64-165)
Industrial type (E916-E921,E923-E928)	1	1.41	71	(2-396)
Suicide (E950-E959)	5	5.11	98	(32-228)
Other violent causes	13	11.46	113	(60-194)
OTHER KNOWN CAUSES	15	24.82	60	(34-100)
CAUSE UNKNOWN	1			

Appendix C: Table 17

Mortality by detailed cause

Exposed cohort by factory: 19

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	128	104.41	123	(102-146)
ALL MALIGNANT NEOPLASMS (140-209)	34	26.65	128	(88-178)
Buccal cavity & pharynx (140-149)	2	0.41	491	(60-1775)
Oesophagus (150)	3	0.75	401	(83-1171)
Stomach (151)	4	2.90	138	(38-353)
Intestine, except rectum (152-153)	3	1.66	181	(37-528)
Rectum (154)	1	1.22	82	(2-455)
Larynx (161)	0	0.26	0	(0-1430)
Trachea, bronchus and lung (162)	16	10.98	146	(83-237)
Bone (170)	0	0.14	0	(0-2693)
Prostate (185)	1	1.07	93	(2-520)
Bladder (188)	0	0.92	0	(0-402)
Leukaemia (204-207)	0	0.68	0	(0-541)
Other Lymph. & haemato. (200-203,208-209)	0	1.08	0	(0-343)
Other malignant neoplasms	4	4.59	87	(24-223)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.33	0	(0-1128)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	64	47.79	134	(103-171)
Ischaemic heart disease (410-414)	45	33.46	135	(98-180)
Cerebrovascular disease (430-438)	14	8.57	163	(89-274)
Other diseases of the circulatory system	5	5.76	87	(28-203)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	10	12.23	82	(39-150)
Acute infections (460-466)	0	0.22	0	(0-1700)
Influenza (470-474)	0	0.39	0	(0-943)
Pneumonia (480-486)	0	4.24	0	(0-87)
Bronchitis, emphysema & asthma (490-493)	9	6.13	147	(67-279)
Other diseases of the respiratory system	1	1.25	80	(2-446)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	4	2.79	144	(39-368)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	6	6.18	97	(36-211)
Industrial type (E916-E921,E923-E928)	1	0.47	215	(5-1196)
Suicide (E950-E959)	1	1.71	58	(1-325)
Other violent causes	4	4.00	100	(27-256)
OTHER KNOWN CAUSES	7	8.45	83	(33-171)
CAUSE UNKNOWN	3			

Appendix C: Table 18

Mortality by detailed cause

Unexposed cohort by factory: 10

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	46	55.80	82	(60-110)
ALL MALIGNANT NEOPLASMS (140-209)	15	14.60	103	(58-169)
Buccal cavity & pharynx (140-149)	0	0.21	0	(0-1732)
Oesophagus (150)	0	0.41	0	(0-891)
Stomach (151)	2	1.55	129	(16-465)
Intestine, except rectum (152-153)	0	0.90	0	(0-411)
Rectum (154)	0	0.66	0	(0-559)
Larynx (161)	0	0.14	0	(0-2673)
Trachea, bronchus and lung (162)	10	6.13	163	(78-300)
Bone (170)	0	0.07	0	(0-5506)
Prostate (185)	1	0.58	172	(4-956)
Bladder (188)	0	0.51	0	(0-729)
Leukaemia (204-207)	0	0.36	0	(0-1030)
Other Lymph. & haemato. (200-203,208-209)	1	0.57	175	(4-972)
Other malignant neoplasms	1	2.50	40	(1-223)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.18	0	(0-2084)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	24	26.15	92	(59-137)
Ischaemic heart disease (410-414)	19	18.23	104	(63-163)
Cerebrovascular disease (430-438)	2	4.43	45	(5-163)
Other diseases of the circulatory system	3	3.49	86	(18-251)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	2	6.47	31	(4-112)
Acute infections (460-466)	0	0.10	0	(0-3652)
Influenza (470-474)	0	0.18	0	(0-2038)
Pneumonia (480-486)	1	2.34	43	(1-238)
Bronchitis, emphysema & asthma (490-493)	1	3.13	32	(1-178)
Other diseases of the respiratory system	0	0.70	0	(0-523)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	2	1.47	136	(16-491)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	0	2.93	0	(0-126)
Industrial type (E916-E921,E923-E928)	0	0.23	0	(0-1618)
Suicide (E950-E959)	0	0.83	0	(0-442)
Other violent causes	0	1.86	0	(0-198)
OTHER KNOWN CAUSES	3	4.01	75	(15-219)
CAUSE UNKNOWN	0			

Appendix C: Table 19

Mortality by detailed cause

Unexposed cohort by factory: 11

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	47	48.37	97	(71-129)
ALL MALIGNANT NEOPLASMS (140-209)	12	12.52	96	(50-167)
Buccal cavity & pharynx (140-149)	0	0.18	0	(0-2049)
Oesophagus (150)	0	0.35	0	(0-1042)
Stomach (151)	0	1.35	0	(0-274)
Intestine, except rectum (152-153)	0	0.78	0	(0-475)
Rectum (154)	1	0.57	175	(4-972)
Larynx (161)	1	0.12	840	(21-4682)
Trachea, bronchus and lung (162)	4	5.28	76	(21-194)
Bone (170)	0	0.05	0	(0-7094)
Prostate (185)	0	0.57	0	(0-652)
Bladder (188)	3	0.46	649	(134-1898)
Leukaemia (204-207)	0	0.29	0	(0-1268)
Other Lymph. & haemato. (200-203,208-209)	0	0.46	0	(0-809)
Other malignant neoplasms	3	2.06	146	(30-425)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	0.14	735	(19-4097)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	24	23.02	104	(67-155)
Ischaemic heart disease (410-414)	16	15.75	102	(58-165)
Cerebrovascular disease (430-438)	2	4.12	49	(6-176)
Other diseases of the circulatory system	6	3.15	190	(70-414)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	6	6.09	99	(36-215)
Acute infections (460-466)	0	0.09	0	(0-4054)
Influenza (470-474)	0	0.16	0	(0-2365)
Pneumonia (480-486)	0	2.29	0	(0-161)
Bronchitis, emphysema & asthma (490-493)	6	2.95	203	(75-442)
Other diseases of the respiratory system	0	0.59	0	(0-622)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	1.23	0	(0-300)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	2	2.11	95	(11-342)
Industrial type (E916-E921,E923-E928)	0	0.15	0	(0-2427)
Suicide (E950-E959)	0	0.60	0	(0-612)
Other violent causes	2	1.36	147	(18-532)
OTHER KNOWN CAUSES	0	3.27	0	(0-113)
CAUSE UNKNOWN	2			

Appendix C: Table 20

Mortality by detailed cause

Unexposed cohort by factory: 12

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	19	16.85	113	(68-176)
ALL MALIGNANT NEOPLASMS (140-209)	6	4.26	141	(52-307)
Buccal cavity & pharynx (140-149)	0	0.06	0	(0-5764)
Oesophagus (150)	0	0.12	0	(0-3180)
Stomach (151)	2	0.49	411	(50-1484)
Intestine, except rectum (152-153)	0	0.27	0	(0-1382)
Rectum (154)	0	0.20	0	(0-1844)
Larynx (161)	0	0.04	0	(0-8783)
Trachea, bronchus and lung (162)	1	1.77	57	(1-315)
Bone (170)	0	0.02	0	(0-****)
Prostate (185)	1	0.20	495	(13-2758)
Bladder (188)	0	0.15	0	(0-2395)
Leukaemia (204-207)	0	0.10	0	(0-3652)
Other Lymph. & haemato. (200-203,208-209)	0	0.15	0	(0-2411)
Other malignant neoplasms	2	0.69	292	(35-1055)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.05	0	(0-7685)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	7	7.63	92	(37-189)
Ischaemic heart disease (410-414)	1	5.28	19	(0-106)
Cerebrovascular disease (430-438)	4	1.50	268	(73-685)
Other diseases of the circulatory system	2	0.86	234	(28-845)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	3	2.19	137	(28-400)
Acute infections (460-466)	0	0.04	0	(0-9708)
Influenza (470-474)	0	0.07	0	(0-5589)
Pneumonia (480-486)	0	0.76	0	(0-485)
Bronchitis, emphysema & asthma (490-493)	1	1.10	91	(2-508)
Other diseases of the respiratory system	2	0.23	862	(104-3114)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	0.45	0	(0-825)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	0	0.81	0	(0-454)
Industrial type (E916-E921,E923-E928)	0	0.06	0	(0-6360)
Suicide (E950-E959)	0	0.22	0	(0-1662)
Other violent causes	0	0.53	0	(0-692)
OTHER KNOWN CAUSES	3	1.47	205	(42-598)
CAUSE UNKNOWN	0			

Appendix C: Table 21

Mortality by detailed cause

Unexposed cohort by factory: 13

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	18	30.40	59	(35-94)
ALL MALIGNANT NEOPLASMS (140-209)	3	7.91	38	(8-111)
Buccal cavity & pharynx (140-149)	0	0.12	0	(0-3208)
Oesophagus (150)	0	0.22	0	(0-1654)
Stomach (151)	0	0.82	0	(0-450)
Intestine, except rectum (152-153)	0	0.48	0	(0-762)
Rectum (154)	0	0.35	0	(0-1048)
Larynx (161)	0	0.07	0	(0-5053)
Trachea, bronchus and lung (162)	2	3.27	61	(7-221)
Bone (170)	0	0.04	0	(0-8997)
Prostate (185)	0	0.30	0	(0-1213)
Bladder (188)	0	0.27	0	(0-1366)
Leukaemia (204-207)	0	0.21	0	(0-1740)
Other Lymph. & haemato. (200-203,208-209)	0	0.34	0	(0-1091)
Other malignant neoplasms	1	1.40	71	(2-397)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.10	0	(0-3726)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	11	14.03	78	(39-140)
Ischaemic heart disease (410-414)	7	9.79	72	(29-147)
Cerebrovascular disease (430-438)	4	2.34	171	(47-438)
Other diseases of the circulatory system	0	1.90	0	(0-194)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	1	3.39	29	(1-164)
Acute infections (460-466)	0	0.05	0	(0-6831)
Influenza (470-474)	0	0.09	0	(0-4010)
Pneumonia (480-486)	0	1.24	0	(0-299)
Bronchitis, emphysema & asthma (490-493)	1	1.64	61	(2-340)
Other diseases of the respiratory system	0	0.37	0	(0-994)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	1	0.80	125	(3-696)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	0	2.04	0	(0-181)
Industrial type (E916-E921,E923-E928)	0	0.15	0	(0-2443)
Suicide (E950-E959)	0	0.54	0	(0-681)
Other violent causes	0	1.35	0	(0-274)
OTHER KNOWN CAUSES	2	2.13	94	(11-339)
CAUSE UNKNOWN	0			

Appendix C: Table 22

Mortality by detailed cause

Unexposed cohort by factory: 14

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	82	88.46	93	(74-115)
ALL MALIGNANT NEOPLASMS (140-209)	16	22.83	70	(40-114)
Buccal cavity & pharynx (140-149)	0	0.33	0	(0-1104)
Oesophagus (150)	0	0.64	0	(0-575)
Stomach (151)	2	2.44	82	(10-296)
Intestine, except rectum (152-153)	2	1.41	141	(17-511)
Rectum (154)	0	1.04	0	(0-356)
Larynx (161)	0	0.22	0	(0-1708)
Trachea, bronchus and lung (162)	4	9.50	42	(11-108)
Bone (170)	0	0.11	0	(0-3354)
Prostate (185)	2	0.95	210	(25-760)
Bladder (188)	0	0.80	0	(0-459)
Leukaemia (204-207)	0	0.58	0	(0-640)
Other Lymph. & haemato. (200-203,208-209)	3	0.91	331	(68-968)
Other malignant neoplasms	3	3.91	77	(16-224)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.27	0	(0-1366)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	48	41.13	117	(86-155)
Ischaemic heart disease (410-414)	34	28.50	119	(83-167)
Cerebrovascular disease (430-438)	5	7.23	69	(22-161)
Other diseases of the circulatory system	9	5.41	167	(76-316)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	12	10.50	114	(59-200)
Acute infections (460-466)	0	0.17	0	(0-2183)
Influenza (470-474)	0	0.30	0	(0-1246)
Pneumonia (480-486)	5	3.78	132	(43-309)
Bronchitis, emphysema & asthma (490-493)	6	5.18	116	(43-252)
Other diseases of the respiratory system	1	1.08	93	(2-515)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	2.31	0	(0-160)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	2	5.01	40	(5-144)
Industrial type (E916-E921,E923-E928)	0	0.37	0	(0-1011)
Suicide (E950-E959)	1	1.38	73	(2-405)
Other violent causes	1	3.27	31	(1-170)
OTHER KNOWN CAUSES	2	6.40	31	(4-113)
CAUSE UNKNOWN	0			

Appendix C: Table 23

Mortality by detailed cause

Unexposed cohort by factory: 15

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	10	9.30	108	(52-198)
ALL MALIGNANT NEOPLASMS (140-209)	1	2.48	40	(1-225)
Buccal cavity & pharynx (140-149)	0	0.04	0	(0-****)
Oesophagus (150)	0	0.07	0	(0-5425)
Stomach (151)	1	0.27	368	(9-2048)
Intestine, except rectum (152-153)	0	0.15	0	(0-2476)
Rectum (154)	0	0.11	0	(0-3354)
Larynx (161)	0	0.02	0	(0-****)
Trachea, bronchus and lung (162)	0	1.07	0	(0-346)
Bone (170)	0	0.01	0	(0-****)
Prostate (185)	0	0.10	0	(0-3803)
Bladder (188)	0	0.09	0	(0-4289)
Leukaemia (204-207)	0	0.06	0	(0-6252)
Other Lymph. & haemato. (200-203,208-209)	0	0.09	0	(0-3924)
Other malignant neoplasms	0	0.41	0	(0-898)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.03	0	(0-****)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	6	4.29	140	(51-304)
Ischaemic heart disease (410-414)	5	3.01	166	(54-388)
Cerebrovascular disease (430-438)	0	0.74	0	(0-497)
Other diseases of the circulatory system	1	0.54	186	(5-1038)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	1	1.08	92	(2-514)
Acute infections (460-466)	0	0.02	0	(0-****)
Influenza (470-474)	0	0.03	0	(0-****)
Pneumonia (480-486)	0	0.35	0	(0-1042)
Bronchitis, emphysema & asthma (490-493)	1	0.56	179	(5-995)
Other diseases of the respiratory system	0	0.12	0	(0-3049)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	1	0.24	410	(10-2283)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	0	0.49	0	(0-761)
Industrial type (E916-E921,E923-E928)	0	0.04	0	(0-****)
Suicide (E950-E959)	0	0.14	0	(0-2733)
Other violent causes	0	0.31	0	(0-1171)
OTHER KNOWN CAUSES	1	0.69	145	(4-810)
CAUSE UNKNOWN	0			

Appendix C: Table 24

Mortality by detailed cause

Unexposed cohort by factory: 16

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	39	35.38	110	(78-151)
ALL MALIGNANT NEOPLASMS (140-209)	11	8.94	123	(61-220)
Buccal cavity & pharynx (140-149)	0	0.13	0	(0-2795)
Oesophagus (150)	0	0.25	0	(0-1458)
Stomach (151)	0	0.95	0	(0-389)
Intestine, except rectum (152-153)	1	0.56	179	(5-999)
Rectum (154)	0	0.41	0	(0-902)
Larynx (161)	0	0.08	0	(0-4392)
Trachea, bronchus and lung (162)	6	3.67	163	(60-356)
Bone (170)	0	0.04	0	(0-8384)
Prostate (185)	1	0.39	256	(6-1425)
Bladder (188)	1	0.32	313	(8-1741)
Leukaemia (204-207)	0	0.23	0	(0-1604)
Other Lymph. & haemato. (200-203,208-209)	0	0.36	0	(0-1025)
Other malignant neoplasms	2	1.54	130	(16-469)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.11	0	(0-3448)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	18	16.48	109	(65-173)
Ischaemic heart disease (410-414)	12	11.28	106	(55-186)
Cerebrovascular disease (430-438)	2	2.94	68	(8-246)
Other diseases of the circulatory system	4	2.27	176	(48-452)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	5	4.31	116	(38-271)
Acute infections (460-466)	0	0.07	0	(0-5346)
Influenza (470-474)	0	0.12	0	(0-3100)
Pneumonia (480-486)	1	1.67	60	(2-334)
Bronchitis, emphysema & asthma (490-493)	4	2.03	197	(54-505)
Other diseases of the respiratory system	0	0.42	0	(0-870)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	0	0.92	0	(0-401)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	2	2.05	98	(12-353)
Industrial type (E916-E921,E923-E928)	1	0.15	676	(17-3765)
Suicide (E950-E959)	0	0.54	0	(0-679)
Other violent causes	1	1.35	74	(2-411)
OTHER KNOWN CAUSES	3	2.58	116	(24-340)
CAUSE UNKNOWN	0			

Appendix C: Table 25

Mortality by detailed cause

Unexposed cohort by factory: 17

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	45	46.51	97	(71-129)
ALL MALIGNANT NEOPLASMS (140-209)	14	11.71	120	(65-201)
Buccal cavity & pharynx (140-149)	0	0.18	0	(0-2049)
Oesophagus (150)	0	0.33	0	(0-1111)
Stomach (151)	0	1.29	0	(0-286)
Intestine, except rectum (152-153)	2	0.74	271	(33-980)
Rectum (154)	1	0.55	182	(5-1017)
Larynx (161)	0	0.12	0	(0-3208)
Trachea, bronchus and lung (162)	10	4.81	208	(100-382)
Bone (170)	0	0.06	0	(0-6360)
Prostate (185)	0	0.50	0	(0-730)
Bladder (188)	0	0.41	0	(0-904)
Leukaemia (204-207)	0	0.29	0	(0-1272)
Other Lymph. & haemato. (200-203,208-209)	0	0.45	0	(0-814)
Other malignant neoplasms	1	1.99	50	(1-280)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	0	0.14	0	(0-2598)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	21	21.44	98	(61-150)
Ischaemic heart disease (410-414)	11	14.82	74	(37-133)
Cerebrovascular disease (430-438)	5	3.93	127	(41-297)
Other diseases of the circulatory system	5	2.69	186	(60-434)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	7	5.71	123	(49-253)
Acute infections (460-466)	0	0.10	0	(0-3726)
Influenza (470-474)	0	0.18	0	(0-2061)
Pneumonia (480-486)	5	2.11	238	(77-554)
Bronchitis, emphysema & asthma (490-493)	2	2.74	73	(9-264)
Other diseases of the respiratory system	0	0.59	0	(0-630)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	1	1.25	80	(2-447)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	1	2.44	41	(1-229)
Industrial type (E916-E921,E923-E928)	0	0.19	0	(0-1994)
Suicide (E950-E959)	0	0.69	0	(0-533)
Other violent causes	1	1.56	64	(2-357)
OTHER KNOWN CAUSES	1	3.82	26	(1-146)
CAUSE UNKNOWN	0			

Appendix C: Table 26

Mortality by detailed cause

Unexposed cohort by factory: 18

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	267	218.99	122	(108-137)
ALL MALIGNANT NEOPLASMS (140-209)	62	52.99	117	(90-150)
Buccal cavity & pharynx (140-149)	0	0.82	0	(0-451)
Oesophagus (150)	0	1.45	0	(0-254)
Stomach (151)	9	6.14	146	(67-278)
Intestine, except rectum (152-153)	2	3.40	59	(7-212)
Rectum (154)	5	2.56	196	(63-456)
Larynx (161)	0	0.53	0	(0-691)
Trachea, bronchus and lung (162)	29	21.66	134	(90-192)
Bone (170)	0	0.26	0	(0-1403)
Prostate (185)	2	2.76	72	(9-262)
Bladder (188)	2	1.99	101	(12-363)
Leukaemia (204-207)	1	1.25	80	(2-444)
Other Lymph. & haemato. (200-203,208-209)	4	1.85	216	(59-553)
Other malignant neoplasms	8	8.38	96	(41-188)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	0.59	170	(4-949)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	119	99.73	119	(99-143)
Ischaemic heart disease (410-414)	70	67.28	104	(81-131)
Cerebrovascular disease (430-438)	30	20.67	145	(98-207)
Other diseases of the circulatory system	19	11.77	161	(97-252)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	60	30.41	197	(151-254)
Acute infections (460-466)	0	0.54	0	(0-690)
Influenza (470-474)	0	0.95	0	(0-387)
Pneumonia (480-486)	20	11.36	176	(108-272)
Bronchitis, emphysema & asthma (490-493)	37	14.76	251	(177-346)
Other diseases of the respiratory system	3	2.80	107	(22-313)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	4	5.76	70	(19-178)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	10	9.97	100	(48-184)
Industrial type (E916-E921,E923-E928)	0	0.72	0	(0-513)
Suicide (E950-E959)	2	2.71	74	(9-267)
Other violent causes	8	6.55	122	(53-241)
OTHER KNOWN CAUSES	10	19.55	51	(25-94)
CAUSE UNKNOWN	1			

Appendix C: Table 27

Mortality by detailed cause

Unexposed cohort by factory: 19

Cause of death (ICD 8th. Rev.)	Obs.	Exp.	SMR	95% Conf.Int.
ALL CAUSES (000-999)	75	69.78	107	(85-135)
ALL MALIGNANT NEOPLASMS (140-209)	24	17.96	134	(86-199)
Buccal cavity & pharynx (140-149)	0	0.27	0	(0-1361)
Oesophagus (150)	0	0.50	0	(0-730)
Stomach (151)	4	1.90	210	(57-538)
Intestine, except rectum (152-153)	1	1.11	90	(2-504)
Rectum (154)	1	0.81	123	(3-687)
Larynx (161)	0	0.17	0	(0-2157)
Trachea, bronchus and lung (162)	11	7.39	149	(74-266)
Bone (170)	0	0.10	0	(0-3843)
Prostate (185)	0	0.68	0	(0-545)
Bladder (188)	1	0.60	166	(4-924)
Leukaemia (204-207)	1	0.48	208	(5-1161)
Other Lymph. & haemato. (200-203,208-209)	0	0.76	0	(0-484)
Other malignant neoplasms	5	3.18	157	(51-367)
BENIGN & UNSPECIFIED NEOPLASMS (210-239)	1	0.23	439	(11-2444)
DISEASES OF THE CIRCULATORY SYSTEM(390-458)	37	31.76	116	(82-161)
Ischaemic heart disease (410-414)	20	22.31	90	(55-138)
Cerebrovascular disease (430-438)	14	5.45	257	(141-431)
Other diseases of the circulatory system	3	4.01	75	(15-219)
DISEASES OF THE RESPIRATORY SYSTEM(460-519)	2	7.90	25	(3-91)
Acute infections (460-466)	0	0.14	0	(0-2693)
Influenza (470-474)	0	0.25	0	(0-1506)
Pneumonia (480-486)	0	2.80	0	(0-132)
Bronchitis, emphysema & asthma (490-493)	2	3.87	52	(6-186)
Other diseases of the respiratory system	0	0.85	0	(0-437)
DISEASES OF THE DIGESTIVE SYSTEM (520-577)	3	1.87	161	(33-469)
ACCIDENTS, POISONING & VIOLENCE (E800-E999)	3	4.63	65	(13-189)
Industrial type (E916-E921,E923-E928)	0	0.35	0	(0-1060)
Suicide (E950-E959)	1	1.25	80	(2-446)
Other violent causes	2	3.03	66	(8-238)
OTHER KNOWN CAUSES	4	5.43	74	(20-189)
CAUSE UNKNOWN	1			

Appendix C: Table 28

Mortality from all causes (000-999)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	30/34.61	90/65.72	79/57.35	19/20.29	218/178.0
	87	137**	138**	94	122**
	(80)	(127*)	(128*)	(87)	(113)
11	38/39.70	108/85.28	107/92.61	25/25.48	278/243.1
	96	127*	116	98	114*
	(87)	(115)	(105)	(89)	(104)
12	11/12.49	28/23.88	23/23.92	11/8.91	73/69.21
	88	117	96	124	105
	(80)	(107)	(87)	(112)	(96)
13	11/13.47	34/28.47	25/31.97	6/8.15	76/82.06
	82	119	78	74	93
	(84)	(123)	(81)	(76)	(95)
14	67/64.61	186/139.7	201/163.3	61/45.47	515/413.0
	104	133***	123**	134*	125***
	(95)	(122**)	(113)	(123)	(114**)
15	13/17.74	44/39.42	53/50.75	23/16.98	133/124.9
	73	112	104	135	106
	(63)	(96)	(90)	(117)	(92)
16	18/31.61	62/63.35	77/80.99	51/42.19	208/218.1
	57*	98	95	121	95
	(51**)	(88)	(86)	(109)	(86*)
17	24/18.93	47/41.98	53/54.22	19/19.68	143/134.8
	127	112	98	97	106
	(126)	(111)	(97)	(96)	(105)
18	65/53.46	140/105.5	124/123.6	40/37.09	369/319.6
	122	133**	100	108	115**
	(112)	(122*)	(92)	(99)	(106)
19	18/19.67	45/40.89	54/36.76	11/7.09	128/104.4
	91	110	147**	155	123*
	(74)	(89)	(119)	(126)	(100)
Total	295/306.3	784/634.2	796/715.4	266/231.3	2141/1887.2
	96	124***	111**	115*	113***
	(88*)	(113***)	(102)	(105)	(104)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 29

Mortality from all causes (000-999)
By factory (exposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	30/36.34 83	90/69.00 130*	79/60.22 131*	19/21.31 89	218/186.9 117*
11	38/42.87 89	108/92.10 117	107/100.0 107	25/27.52 91	278/262.5 106
12	11/12.99 85	28/24.84 113	23/24.88 92	11/9.26 119	73/71.97 101
13	11/12.53 88	34/26.47 128	25/29.74 84	6/7.58 79	76/76.31 100
14	67/73.66 91	186/159.3 117*	201/186.1 108	61/51.83 118	515/470.9 109*
15	13/18.27 71	44/40.60 108	53/52.27 101	23/17.49 131	133/128.6 103
16	18/33.19 54**	62/66.52 93	77/85.04 91	51/44.30 115	208/229.0 91
17	24/18.55 129	47/41.14 114	53/53.13 100	19/19.29 99	143/132.1 108
18	65/56.13 116	140/110.8 126**	124/129.8 96	40/38.94 103	369/335.6 110
19	18/24.20 74	45/50.29 89	54/45.21 119	11/8.72 126	128/128.4 100
Total	295/328.7 90	784/681.0 115***	796/766.4 104	266/246.2 108	2141/2022.3 106**

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 30

Mortality from all malignant neoplasms (140-209)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	9/8.44 107 (104)	30/15.99 188** (182**)	23/14.67 157 (152)	10/5.04 198 (193)	72/44.13 163*** (158***)
11	15/9.69 155 (149)	43/22.12 194*** (187***)	33/24.49 135 (130)	6/6.93 87 (83)	97/63.22 153*** (148***)
12	1/2.99 33 (32)	6/5.96 101 (98)	5/6.14 81 (79)	4/2.39 168 (163)	16/17.47 92 (89)
13	1/3.25 31 (31)	7/7.34 95 (95)	6/8.06 74 (74)	1/2.21 45 (45)	15/20.86 72 (72)
14	20/15.95 125 (116)	57/37.19 153** (142*)	63/44.25 142** (132*)	17/12.25 139 (129)	157/109.6 143*** (133***)
15	1/4.29 23 (20)	9/10.23 88 (77)	10/13.45 74 (65)	6/4.52 133 (116)	26/32.49 80 (70)
16	6/7.34 82 (78)	16/16.29 98 (94)	18/21.85 82 (78)	16/11.68 137 (130)	56/57.16 98 (93)
17	8/4.56 175 (183)	10/10.79 93 (96)	8/14.44 55 (58)	5/5.31 94 (98)	31/35.10 88 (92)
18	16/12.92 124 (119)	43/27.40 157** (151*)	31/32.82 94 (91)	9/10.27 88 (84)	99/83.42 119 (114)
19	4/4.76 84 (73)	12/10.41 115 (100)	16/9.47 169 (147)	2/2.00 100 (87)	34/26.65 128 (111)
Total	81/74.20 109 (104)	233/163.7 142*** (135***)	213/189.6 112 (107)	76/62.60 121 (116)	603/490.1 123*** (117***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 31

Mortality from cancers of the trachea, bronchus and lung (162)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	6/3.41 176 (169)	13/6.66 195* (188)	11/6.17 178 (172)	7/2.05 342* (329*)	37/18.28 202*** (195***)
11	8/3.87 207 (197)	21/9.42 223** (212**)	18/10.35 174* (166)	3/2.92 103 (98)	50/26.55 188*** (179***)
12	0/1.19 0 (0)	3/2.49 121 (117)	5/2.57 195 (189)	3/0.99 302 (293)	11/7.24 152 (148)
13	0/1.30 0 (0)	1/3.05 33 (32)	1/3.29 30 (30)	1/0.92 109 (108)	3/8.55 35 (35)
14	14/6.44 218* (200*)	31/15.98 194** (178**)	39/18.89 206*** (189***)	11/5.13 214* (197)	95/46.44 205*** (188***)
15	0/1.71 0 (0)	4/4.37 92 (78)	8/5.72 140 (119)	4/1.88 213 (180)	16/13.68 117 (99)
16	2/2.83 71 (67)	10/6.73 149 (140)	9/9.33 96 (91)	8/4.95 162 (153)	29/23.83 122 (115)
17	1/1.80 56 (60)	7/4.61 152 (163)	4/6.17 65 (70)	2/2.22 90 (97)	14/14.79 95 (102)
18	6/5.15 117 (111)	19/11.60 164 (156)	16/13.82 116 (110)	4/4.33 92 (88)	45/34.90 129 (123)
19	1/1.91 52 (44)	5/4.33 115 (97)	9/3.90 231* (194)	1/0.85 118 (99)	16/10.98 146 (122)
Total	38/29.60 128 (121)	114/69.23 165*** (155***)	120/80.20 150*** (141***)	44/26.23 168** (158**)	316/205.2 154*** (145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 32

Mortality from cancers of the trachea, bronchus and lung (162)
By factory (exposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	6/4.33	13/8.45	11/7.83	7/2.60	37/23.21
	139	154	140	269*	159*
11	8/4.87	21/11.87	18/13.04	3/3.68	50/33.45
	164	177*	138	82	149**
12	0/1.06	3/2.21	5/2.28	3/0.88	11/6.44
	0	136	219	339	171
13	0/1.31	1/3.08	1/3.32	1/0.93	3/8.64
	0	32	30	108	35
14	14/7.66	31/19.02	39/22.48	11/6.11	95/55.26
	183	163*	173**	180	172***
15	0/1.59	4/4.07	8/5.32	4/1.75	16/12.72
	0	98	150	229	126
16	2/2.49	10/5.92	9/8.21	8/4.35	29/20.97
	80	169	110	184	138
17	1/1.60	7/4.10	4/5.49	2/1.97	14/13.17
	62	171	73	101	106
18	6/6.54	19/14.73	16/17.55	4/5.50	45/44.32
	92	129	91	73	102
19	1/2.27	5/5.15	9/4.64	1/1.01	16/13.07
	44	97	194	99	122
Total	38/33.72	114/78.60	120/90.16	44/28.77	316/231.3
	113	145***	133**	153**	137***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 33

Mortality from cancer of the stomach (151)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	2/1.19	4/1.91	4/1.51	0/0.48	10/5.09
	168	210	264	0	196
	(160)	(200)	(251)	(0)	(187)
11	2/1.29	7/2.51	2/2.46	0/0.66	11/6.92
	156	279*	81	0	159
	(147)	(263*)	(77)	(0)	(150)
12	0/0.40	1/0.69	0/0.64	0/0.23	1/1.96
	0	144	0	0	51
	(0)	(137)	(0)	(0)	(49)
13	0/0.41	1/0.80	1/0.80	0/0.20	2/2.20
	0	125	126	0	91
	(0)	(137)	(138)	(0)	(100)
14	1/2.03	7/4.14	6/4.43	1/1.16	15/11.77
	49	169	135	86	127
	(44)	(151)	(121)	(77)	(114)
15	0/0.57	3/1.19	0/1.38	0/0.43	3/3.57
	0	253	0	0	84
	(0)	(199)	(0)	(0)	(66)
16	1/0.88	3/1.78	3/2.21	1/1.10	8/5.97
	113	168	136	91	134
	(106)	(157)	(127)	(85)	(125)
17	1/0.62	0/1.27	0/1.48	0/0.50	1/3.87
	162	0	0	0	26
	(163)	(0)	(0)	(0)	(26)
18	6/1.69	12/3.08	6/3.27	2/0.97	26/9.01
	355*	390***	183	207	289***
	(335*)	(368***)	(173)	(196)	(272***)
19	1/0.61	2/1.16	1/0.94	0/0.18	4/2.90
	163	172	106	0	138
	(149)	(156)	(97)	(0)	(125)
Total	14/9.69	40/18.54	23/19.11	4/5.91	81/53.25
	144	216***	120	68	152***
	(134)	(200***)	(112)	(63)	(141**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 34

Mortality from diseases of the respiratory system (460-519)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	5/4.31 116 (104)	16/8.85 181* (161)	14/7.44 188* (168)	4/2.98 134 (120)	39/23.58 165** (148*)
11	3/4.31 70 (60)	11/9.86 112 (96)	15/11.22 134 (115)	4/3.15 127 (109)	33/28.54 116 (100)
12	0/1.48 0 (0)	3/3.05 98 (84)	4/3.10 129 (110)	2/1.10 181 (155)	9/8.74 103 (88)
13	0/1.41 0 (0)	2/3.19 63 (67)	8/4.05 197 (212)	0/0.95 0 (0)	10/9.60 104 (112)
14	12/6.61 182 (144)	35/15.18 231*** (183**)	41/18.65 220*** (174**)	7/5.69 123 (98)	95/46.12 206*** (163***)
15	3/1.90 158 (123)	5/4.65 108 (84)	10/6.22 161 (126)	3/2.17 138 (108)	21/14.94 141 (110)
16	1/3.32 30 (25)	9/6.96 129 (108)	13/8.96 145 (121)	7/4.86 144 (120)	30/24.10 124 (104)
17	3/2.05 146 (139)	8/5.03 159 (151)	12/6.54 183 (175)	2/2.44 82 (78)	25/16.07 156* (148)
18	8/5.75 139 (123)	17/11.76 145 (128)	15/14.24 105 (93)	5/4.25 118 (104)	45/36.01 125 (111)
19	2/2.16 93 (92)	1/4.85 21 (20)	5/4.47 112 (111)	2/0.75 268 (266)	10/12.23 82 (81)
Total	37/33.30 111 (96)	107/73.38 146*** (126*)	137/84.90 161*** (139***)	36/28.34 127 (109)	317/219.9 144*** (124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 35

Mortality from diseases of the respiratory system (460-519)
By factory (exposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	5/4.61 108	16/9.47 169	14/7.96 176	4/3.19 125	39/25.23 155*
11	3/4.57 66	11/10.45 105	15/11.89 126	4/3.34 120	33/30.25 109
12	0/1.34 0	3/2.75 109	4/2.79 143	2/0.99 201	9/7.86 114
13	0/1.26 0	2/2.87 70	8/3.65 219	0/0.86 0	10/8.64 116
14	12/10.70 112	35/24.58 142	41/30.22 136	7/9.21 76	95/74.72 127*
15	3/1.40 214	5/3.44 145	10/4.60 217*	3/1.61 186	21/11.06 190**
16	1/3.62 28	9/7.58 119	13/9.77 133	7/5.30 132	30/26.27 114
17	3/2.18 138	8/5.34 150	12/6.93 173	2/2.58 77	25/17.03 147
18	8/6.16 130	17/12.59 135	15/15.24 98	5/4.55 110	45/38.53 117
19	2/2.18 92	1/4.90 20	5/4.52 111	2/0.75 266	10/12.35 81
Total	37/38.02 97	107/83.97 127*	137/97.57 140***	36/32.39 111	317/251.9 126***

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 36

Mortality from bronchitis, emphysema & asthma (490-493)
By factory (exposed only) and years since first exposure

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	3/2.36 127	11/4.63 238*	6/3.48 172	2/1.10 182	22/11.57 190**
11	1/2.24 45	8/5.40 148	8/5.22 153	2/1.32 151	19/14.18 134
12	0/0.81 0	1/1.63 61	3/1.48 203	0/0.45 0	4/4.37 92
13	0/0.73 0	0/1.71 0	3/1.73 173	0/0.39 0	3/4.55 66
14	6/3.38 178	22/8.40 262***	23/9.08 253***	5/2.32 216	56/23.17 242***
15	2/0.97 206	2/2.60 77	5/3.04 164	1/0.88 113	10/7.49 133
16	0/1.65 0	6/3.56 169	5/4.45 112	2/2.06 97	13/11.72 111
17	3/1.04 289	6/2.81 213	7/3.20 219	1/1.00 100	17/8.05 211**
18	3/2.99 100	13/6.37 204*	9/6.67 135	2/1.80 111	27/17.83 151
19	2/1.14 175	1/2.63 38	5/2.04 245	1/0.32 313	9/6.13 147
Total	20/17.31 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 37

Mortality from diseases of the circulatory system(390-458)
By factory (exposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	11/12.52 88 (78)	36/29.95 120 (106)	33/29.24 113 (100)	4/10.42 38* (34*)	84/82.12 102 (91)
11	10/13.62 73 (64)	46/38.86 118 (103)	46/47.27 97 (85)	14/13.12 107 (93)	116/112.9 103 (89)
12	6/4.38 137 (118)	15/10.72 140 (121)	11/12.07 91 (79)	5/4.59 109 (94)	37/31.77 116 (100)
13	3/4.64 65 (69)	21/13.05 161 (171*)	11/16.36 67 (72)	4/4.20 95 (101)	39/38.24 102 (108)
14	20/22.12 90 (84)	71/63.77 111 (103)	82/83.34 98 (91)	35/23.41 150* (138)	208/192.6 108 (100)
15	5/5.83 86 (71)	22/17.30 127 (105)	29/25.71 113 (93)	13/8.74 149 (123)	69/57.58 120 (99)
16	6/10.65 56 (49)	29/28.14 103 (89)	38/40.95 93 (80)	25/21.75 115 (99)	98/101.5 97 (83)
17	3/6.08 49 (47)	25/18.41 136 (131)	32/27.65 116 (111)	11/10.13 109 (104)	71/62.27 114 (110)
18	30/17.97 167* (146)	61/47.81 128 (112)	67/62.94 106 (93)	22/19.12 115 (101)	180/147.8 122* (107)
19	8/6.70 119 (92)	28/18.66 150 (115)	22/18.77 117 (90)	6/3.66 164 (126)	64/47.79 134* (103)
Total	102/104.5 98 (86)	354/286.7 123*** (109)	371/364.3 102 (90)	139/119.1 117 (103)	966/874.6 110** (98)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 38

Mortality from all causes (000-999)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	10/6.89	12/15.12	15/24.66	9/9.12	46/55.80
	145	79	61	99	82
	(134)	(73)	(56*)	(91)	(76)
11	8/10.74	23/19.71	14/15.44	2/2.49	47/48.37
	75	117	91	80	97
	(68)	(106)	(82)	(73)	(88)
12	3/4.12	9/6.15	6/5.30	1/1.29	19/16.85
	73	146	113	78	113
	(66)	(133)	(103)	(71)	(102)
13	3/4.63	7/10.36	7/12.22	1/3.20	18/30.41
	65	68	57	31	59*
	(67)	(70)	(59)	(32)	(61*)
14	12/16.88	33/36.38	31/28.74	6/6.46	82/88.46
	71	91	108	93	93
	(65)	(83)	(99)	(85)	(85)
15	4/1.53	2/2.89	2/2.90	2/1.98	10/9.30
	261	69	69	101	108
	(225)	(60)	(59)	(87)	(93)
16	3/6.90	13/13.45	17/11.16	6/3.88	39/35.38
	43	97	152	155	110
	(39)	(87)	(137)	(139)	(99)
17	8/6.72	12/14.32	14/19.10	11/6.36	45/46.51
	119	84	73	173	97
	(118)	(83)	(73)	(171)	(96)
18	60/47.22	108/75.26	73/74.49	26/22.02	267/219.0
	127	143***	98	118	122**
	(117)	(132**)	(90)	(108)	(112)
19	11/12.41	29/24.18	27/26.53	8/6.65	75/69.78
	89	120	102	120	107
	(72)	(97)	(83)	(98)	(87)
Total	122/118.0	248/217.8	206/220.5	72/63.44	648/619.8
	103	114*	93	114	105
	(94)	(104)	(85*)	(104)	(95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 39

Mortality from all causes (000-999)
By factory (unexposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	10/7.24 138	12/15.88 76	15/25.89 58*	9/9.58 94	46/58.59 79
11	8/11.60 69	23/21.28 108	14/16.67 84	2/2.68 75	47/52.24 90
12	3/4.28 70	9/6.39 141	6/5.51 109	1/1.34 75	19/17.53 108
13	3/4.31 70	7/9.63 73	7/11.36 62	1/2.97 34	18/28.28 64
14	12/19.24 62	33/41.47 80	31/32.76 95	6/7.37 81	82/100.8 81
15	4/1.58 253	2/2.98 67	2/2.99 67	2/2.04 98	10/9.58 104
16	3/7.24 41	13/14.12 92	17/11.71 145	6/4.07 147	39/37.15 105
17	8/6.59 121	12/14.03 86	14/18.72 75	11/6.24 176	45/45.57 99
18	60/49.58 121	108/79.03 137**	73/78.21 93	26/23.12 112	267/229.9 116*
19	11/15.26 72	29/29.75 97	27/32.64 83	8/8.18 98	75/85.82 87
Total	122/126.9 96	248/234.6 106	206/236.5 87*	72/67.58 107	648/665.5 97

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 40

Mortality from all malignant neoplasms (140-209)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	2/1.64 122 (118)	4/3.93 102 (99)	7/6.57 107 (104)	2/2.46 81 (79)	15/14.60 103 (100)
11	2/2.78 72 (69)	5/5.09 98 (94)	5/4.01 125 (120)	0/0.64 0 (0)	12/12.52 96 (92)
12	1/1.01 99 (96)	4/1.58 253 (246)	0/1.30 0 (0)	1/0.36 275 (267)	6/4.26 141 (137)
13	0/1.10 0 (0)	1/2.74 37 (37)	2/3.23 62 (62)	0/0.84 0 (0)	3/7.91 38 (38)
14	4/4.23 95 (88)	6/9.45 63 (59)	3/7.39 41 (38)	3/1.76 170 (158)	16/22.83 70 (65)
15	0/0.39 0 (0)	0/0.77 0 (0)	0/0.79 0 (0)	1/0.53 189 (166)	1/2.48 40 (35)
16	0/1.69 0 (0)	4/3.46 116 (110)	5/2.79 179 (171)	2/1.01 199 (189)	11/8.94 123 (117)
17	3/1.57 191 (199)	3/3.60 83 (87)	5/4.83 104 (108)	3/1.71 176 (183)	14/11.71 120 (125)
18	11/11.63 95 (91)	31/18.42 168** (162*)	15/17.42 86 (83)	5/5.51 91 (87)	62/52.99 117 (112)
19	5/2.96 169 (147)	5/6.28 80 (69)	7/6.93 101 (88)	7/1.79 390** (339*)	24/17.96 134 (116)
Total	28/28.99 97 (92)	63/55.33 114 (108)	49/55.26 89 (84)	24/16.61 145 (138)	164/156.2 105 (100)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 41

Mortality from cancers of the trachea, bronchus and lung (162)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	2/0.64 312 (300)	2/1.67 120 (115)	5/2.79 179 (172)	1/1.03 97 (93)	10/6.13 163 (157)
11	2/1.20 166 (158)	2/2.16 93 (88)	0/1.66 0 (0)	0/0.26 0 (0)	4/5.29 76 (72)
12	0/0.42 0 (0)	0/0.67 0 (0)	0/0.53 0 (0)	1/0.15 654 (635)	1/1.77 57 (55)
13	0/0.44 0 (0)	1/1.16 87 (86)	1/1.34 75 (74)	0/0.34 0 (0)	2/3.27 61 (60)
14	1/1.76 57 (52)	0/3.96 0* (0*)	2/3.04 66 (60)	1/0.74 135 (124)	4/9.50 42 (39*)
15	0/0.16 0 (0)	0/0.34 0 (0)	0/0.35 0 (0)	0/0.22 0 (0)	0/1.07 0 (0)
16	0/0.70 0 (0)	3/1.43 209 (197)	2/1.13 177 (167)	1/0.41 244 (230)	6/3.67 163 (154)
17	2/0.60 334 (360)	1/1.50 67 (72)	4/2.01 200 (215)	3/0.71 423 (454)	10/4.81 208 (224*)
18	6/4.84 124 (118)	14/7.65 183* (174)	7/6.94 101 (96)	2/2.24 89 (85)	29/21.66 134 (128)
19	1/1.17 86 (72)	4/2.62 153 (128)	4/2.86 140 (118)	2/0.75 268 (226)	11/7.39 149 (125)
Total	14/11.93 117 (110)	27/23.15 117 (110)	25/22.63 110 (104)	11/6.85 161 (152)	77/64.55 119 (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 42

Mortality from cancers of the trachea, bronchus and lung (162)
By factory (unexposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	2/0.81 246	2/2.12 94	5/3.55 141	1/1.31 77	10/7.79 128
11	2/1.52 132	2/2.72 74	0/2.09 0	0/0.33 0	4/6.66 60
12	0/0.37 0	0/0.59 0	0/0.47 0	1/0.14 734	1/1.57 64
13	0/0.44 0	1/1.17 86	1/1.35 74	0/0.35 0	2/3.31 60
14	1/2.09 48	0/4.71 0*	2/3.61 55	1/0.88 114	4/11.30 35*
15	0/0.15 0	0/0.31 0	0/0.32 0	0/0.20 0	0/0.99 0
16	0/0.61 0	3/1.26 238	2/1.00 201	1/0.36 277	6/3.23 186
17	2/0.53 376	1/1.33 75	4/1.78 224	3/0.63 475	10/4.28 234*
18	6/6.14 98	14/9.72 144	7/8.81 79	2/2.84 70	29/27.50 105
19	1/1.39 72	4/3.12 128	4/3.40 118	2/0.89 226	11/8.80 125
Total	14/14.07 99	27/27.06 100	25/26.38 95	11/7.92 139	77/75.43 102

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 43

Mortality from cancer of the stomach (151)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	0/0.21 0 (0)	1/0.45 223 (213)	1/0.66 152 (144)	0/0.24 0 (0)	2/1.55 129 (123)
11	0/0.35 0 (0)	0/0.55 0 (0)	0/0.39 0 (0)	0/0.06 0 (0)	0/1.35 0 (0)
12	1/0.14 714 (680)	1/0.18 552 (526)	0/0.13 0 (0)	0/0.03 0 (0)	2/0.49 412 (392)
13	0/0.13 0 (0)	0/0.29 0 (0)	0/0.32 0 (0)	0/0.08 0 (0)	0/0.82 0 (0)
14	0/0.52 0 (0)	0/1.02 0 (0)	1/0.73 136 (122)	1/0.17 595 (531)	2/2.44 82 (73)
15	0/0.05 0 (0)	0/0.09 0 (0)	0/0.08 0 (0)	1/0.05 1961 (1544)	1/0.27 369 (291)
16	0/0.21 0 (0)	0/0.37 0 (0)	0/0.28 0 (0)	0/0.09 0 (0)	0/0.95 0 (0)
17	0/0.22 0 (0)	0/0.42 0 (0)	0/0.49 0 (0)	0/0.16 0 (0)	0/1.29 0 (0)
18	2/1.63 123 (116)	4/2.20 182 (171)	2/1.80 111 (105)	1/0.52 193 (182)	9/6.14 146 (138)
19	2/0.37 539 (490)	0/0.68 0 (0)	0/0.68 0 (0)	2/0.17 1205* (1095*)	4/1.90 210 (191)
Total	5/3.83 131 (123)	6/6.26 96 (90)	4/5.56 72 (68)	5/1.56 320* (302)	20/17.20 116 (109)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 44

Mortality from diseases of the respiratory system (460-519)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	0/0.70 0 (0)	1/1.69 59 (53)	0/2.94 0 (0)	1/1.13 88 (79)	2/6.47 31 (28*)
11	2/1.28 156 (134)	3/2.47 121 (105)	1/1.99 50 (43)	0/0.34 0 (0)	6/6.08 99 (85)
12	0/0.53 0 (0)	2/0.78 256 (219)	1/0.75 134 (115)	0/0.14 0 (0)	3/2.19 137 (117)
13	0/0.45 0 (0)	1/1.12 89 (96)	0/1.42 0 (0)	0/0.40 0 (0)	1/3.39 29 (32)
14	2/1.83 109 (87)	2/4.32 46 (37)	7/3.58 196 (155)	1/0.78 129 (102)	12/10.50 114 (91)
15	0/0.16 0 (0)	0/0.34 0 (0)	1/0.34 299 (233)	0/0.25 0 (0)	1/1.08 92 (72)
16	0/0.77 0 (0)	2/1.60 125 (104)	3/1.44 208 (173)	0/0.50 0 (0)	5/4.31 116 (97)
17	2/0.75 266 (253)	0/1.72 0 (0)	1/2.46 41 (39)	4/0.78 512* (488*)	7/5.71 123 (117)
18	21/6.06 347*** (307***)	20/10.21 196** (173*)	14/11.04 127 (112)	5/3.10 161 (143)	60/30.40 197*** (175***)
19	0/1.30 0 (0)	0/2.66 0 (0)	2/3.16 63 (63)	0/0.78 0 (0)	2/7.90 25* (25*)
Total	27/13.83 195** (172*)	31/26.91 115 (101)	30/29.11 103 (92)	11/8.19 134 (120)	99/78.04 127* (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 45

Mortality from diseases of the respiratory system (460-519)
By factory (unexposed only) and years since first exposure
Expected deaths corrected for subcounty mortality

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	0/0.75 0	1/1.81 55	0/3.15 0	1/1.21 82	2/6.92 29
11	2/1.36 147	3/2.62 114	1/2.11 47	0/0.36 0	6/6.45 93
12	0/0.48 0	2/0.70 285	1/0.67 149	0/0.12 0	3/1.97 152
13	0/0.41 0	1/1.01 99	0/1.28 0	0/0.36 0	1/3.05 33
14	2/2.96 68	2/7.00 29	7/5.79 121	1/1.26 79	12/17.01 71
15	0/0.12 0	0/0.25 0	1/0.25 403	0/0.18 0	1/0.80 125
16	0/0.83 0	2/1.75 115	3/1.57 191	0/0.54 0	5/4.70 106
17	2/0.80 251	0/1.82 0	1/2.60 38	4/0.83 483*	7/6.05 116
18	21/6.48 324***	20/10.92 183*	14/11.82 118	5/3.32 151	60/32.53 184***
19	0/1.31 0	0/2.68 0	2/3.19 63	0/0.79 0	2/7.98 25*
Total	27/15.49 174*	31/30.57 101	30/32.43 93	11/8.97 123	99/87.46 113

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 46

Mortality from bronchitis, emphysema & asthma (490-493)
By factory (unexposed only) and years since first exposure

KEY: Obs./Exp.
SMR

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	0/0.35 0	1/0.91 109	0/1.40 0	0/0.47 0	1/3.13 32
11	2/0.73 274	3/1.23 244	1/0.86 116	0/0.13 0	6/2.95 203
12	0/0.30 0	1/0.42 238	0/0.31 0	0/0.06 0	1/1.10 91
13	0/0.23 0	1/0.61 164	0/0.65 0	0/0.16 0	1/1.64 61
14	0/1.00 0	2/2.26 89	3/1.60 187	1/0.32 310	6/5.18 116
15	0/0.09 0	0/0.19 0	1/0.18 556	0/0.10 0	1/0.56 178
16	0/0.42 0	1/0.80 124	3/0.62 486*	0/0.19 0	4/2.03 197
17	2/0.38 522	0/0.95 0	0/1.10 0	0/0.31 0	2/2.74 73
18	14/3.43 408***	12/5.59 214*	9/4.60 196	2/1.13 177	37/14.76 251***
19	0/0.67 0	0/1.45 0	2/1.44 139	0/0.31 0	2/3.87 52
Total	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.96 161***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 47

Mortality from diseases of the circulatory system(390-458)
By factory (unexposed only) and years since first exposure
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Factory	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
10	7/2.22	6/6.70	6/12.54	5/4.70	24/26.15
	316*	90	48	106	92
	(280*)	(79)	(42*)	(94)	(81)
11	3/4.27	13/9.57	7/7.90	1/1.28	24/23.02
	70	136	89	78	104
	(61)	(118)	(77)	(68)	(91)
12	1/1.50	3/2.79	3/2.68	0/0.67	7/7.63
	67	108	112	0	92
	(58)	(93)	(97)	(0)	(79)
13	3/1.50	3/4.70	4/6.19	1/1.64	11/14.03
	200	64	65	61	78
	(213)	(68)	(69)	(65)	(83)
14	5/6.13	21/17.10	20/14.58	2/3.33	48/41.13
	82	123	137	60	117
	(76)	(114)	(127)	(56)	(108)
15	3/0.55	2/1.27	1/1.45	0/1.02	6/4.29
	547*	157	69	0	140
	(452)	(130)	(57)	(0)	(116)
16	2/2.54	5/6.32	7/5.63	4/1.99	18/16.48
	79	79	124	201	109
	(68)	(68)	(107)	(173)	(94)
17	1/2.14	9/6.26	7/9.76	4/3.28	21/21.44
	47	144	72	122	98
	(45)	(138)	(69)	(117)	(94)
18	21/16.75	47/33.77	36/37.90	15/11.30	119/99.73
	125	139*	95	133	119
	(110)	(122)	(83)	(116)	(105)
19	3/4.06	20/10.85	14/13.43	0/3.42	37/31.76
	74	184*	104	0	116
	(57)	(142)	(80)	(0*)	(90)
Total	49/41.66	129/99.32	105/112.1	32/32.62	315/285.7
	118	130**	94	98	110
	(103)	(114)	(83)	(87)	(97)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 48

Factory (exposed only) age at death

Mortality from all causes (000-999)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	4/2.20 182 (50-467)	10/7.28 137 (66-253)	29/25.46 114 (76-164)	74/54.93 135 (106-169)	73/55.25 132 (104-166)	28/32.86 85 (57-123)	218/178.0 122 (107-140)
11	2/4.63 43 (5-156)	18/15.17 119 (70-188)	49/46.76 105 (78-139)	108/81.20 133 (109-161)	78/69.00 113 (89-141)	23/26.30 87 (55-131)	278/243.1 114 (101-129)
12	3/1.84 163 (34-478)	3/3.69 81 (17-238)	9/9.99 90 (41-171)	22/19.67 112 (70-169)	20/23.95 84 (51-129)	16/10.08 159 (91-258)	73/69.21 105 (83-133)
13	2/2.56 78 (9-282)	4/6.10 66 (18-168)	19/16.35 116 (70-181)	32/25.84 124 (85-175)	12/19.36 62 (32-108)	7/11.84 59 (24-122)	76/82.06 93 (73-116)
14	8/8.71 92 (40-181)	32/27.91 115 (78-162)	107/85.78 125 (102-151)	193/145.3 133 (115-153)	142/115.9 123 (103-144)	33/29.44 112 (77-157)	515/413.0 125 (114-136)
15	1/3.15 32 (1-177)	7/7.39 95 (38-195)	23/21.76 106 (67-159)	46/40.13 115 (84-153)	38/39.91 95 (67-131)	18/12.54 144 (85-227)	133/124.9 106 (89-126)
16	5/7.76 64 (21-150)	18/16.88 107 (63-169)	40/43.99 91 (65-124)	65/72.18 90 (70-115)	61/57.38 106 (81-137)	19/19.95 95 (57-149)	208/218.1 95 (83-109)
17	6/2.87 209 (77-455)	9/8.02 112 (51-213)	23/24.43 94 (60-141)	44/44.59 99 (72-132)	43/40.22 107 (77-144)	18/14.68 123 (73-194)	143/134.8 106 (89-125)
18	1/8.47 12 (0-66)	24/22.47 107 (68-159)	84/64.31 131 (104-162)	116/111.0 105 (86-125)	125/85.75 146 (121-174)	19/27.62 69 (41-107)	369/319.6 115 (104-128)
19	0/3.51 0 (0-105)	13/7.37 176 (94-302)	30/19.59 153 (103-219)	33/32.98 100 (69-141)	34/28.97 117 (81-164)	18/11.99 150 (89-237)	128/104.4 123 (102-146)
Total	32/45.69 70 (48-99)	138/122.3 113 (95-133)	413/358.4 115 (104-127)	733/627.9 117 (108-126)	626/535.6 117 (108-126)	199/197.3 101 (87-116)	2141/1887.2 113 (109-118)

Appendix C: Table 49

Factory (exposed only) age at death

Mortality from all malignant neoplasms (140-209)

KEY: Obs:/Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.33	1/1.58	12/6.81	24/15.90	28/14.07	7/5.45	72/44.13
	0	63	176	151	199	128	163
	(0-1121)	(2-352)	(91-308)	(97-225)	(132-288)	(52-265)	(128-205)
11	0/0.71	7/3.28	22/12.48	37/23.71	25/18.17	6/4.87	97/63.22
	0	213	176	156	138	123	153
	(0-520)	(86-439)	(111-267)	(110-215)	(89-203)	(45-268)	(124-187)
12	0/0.27	1/0.80	4/2.66	4/5.70	3/6.18	4/1.87	16/17.47
	0	126	150	70	49	214	92
	(0-1382)	(3-700)	(41-384)	(19-180)	(10-142)	(58-549)	(52-149)
13	0/0.39	1/1.32	4/4.35	8/7.59	1/5.10	1/2.12	15/20.86
	0	76	92	105	20	47	72
	(0-953)	(2-423)	(25-236)	(45-208)	(0-109)	(1-262)	(40-119)
14	1/1.33	10/6.04	31/22.86	62/42.60	43/31.06	10/5.75	157/109.6
	75	165	136	146	138	174	143
	(2-418)	(79-304)	(92-192)	(112-187)	(100-187)	(83-320)	(122-167)
15	0/0.47	0/1.60	4/5.81	13/11.70	5/10.50	4/2.41	26/32.49
	0	0	69	111	48	166	80
	(0-788)	(0-231)	(19-176)	(59-190)	(15-111)	(45-425)	(52-117)
16	0/1.15	7/3.64	10/11.71	18/21.30	19/15.38	2/3.98	56/57.16
	0	192	85	84	124	50	98
	(0-321)	(77-396)	(41-157)	(50-134)	(74-193)	(6-182)	(74-127)
17	1/0.43	2/1.73	3/6.53	13/12.99	10/10.58	2/2.85	31/35.11
	233	115	46	100	95	70	88
	(6-1299)	(14-417)	(9-134)	(53-171)	(45-174)	(9-254)	(60-125)
18	0/1.27	5/4.86	20/17.15	33/32.53	39/22.86	2/4.76	99/83.42
	0	103	117	101	171	42	119
	(0-291)	(33-240)	(71-180)	(70-142)	(121-233)	(5-152)	(96-144)
19	0/0.53	1/1.59	4/5.21	16/9.63	8/7.49	5/2.21	34/26.65
	0	63	77	166	107	226	128
	(0-699)	(2-350)	(21-197)	(95-270)	(46-210)	(73-528)	(88-178)
Total	2/6.87	35/26.45	114/95.56	228/183.6	181/141.4	43/36.26	603/490.2
	29	132	119	124	128	119	123
	(4-105)	(92-184)	(98-143)	(109-141)	(110-148)	(86-160)	(113-133)

Appendix C: Table 50

Factory (exposed only) age at death

Mortality from cancers of the trachea, bronchus and lung (162)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.04 0 (0-9459)	1/0.45 222 (6-1238)	8/2.88 278 (120-547)	11/7.31 150 (75-269)	16/5.90 271 (155-440)	1/1.69 59 (1-330)	37/18.28 202 (143-279)
11	0/0.08 0 (0-4444)	2/0.91 219 (27-791)	12/5.19 231 (119-404)	22/10.91 202 (126-305)	11/7.79 141 (70-253)	3/1.66 181 (37-529)	50/26.55 188 (140-248)
12	0/0.03 0 (0-****)	1/0.21 469 (12-2616)	3/1.11 271 (56-792)	1/2.63 38 (1-212)	3/2.63 114 (24-334)	3/0.63 475 (98-1389)	11/7.24 152 (76-272)
13	0/0.04 0 (0-8997)	1/0.35 283 (7-1578)	0/1.79 0 (0-207)	2/3.46 58 (7-209)	0/2.20 0 (0-168)	0/0.71 0 (0-517)	3/8.55 35 (7-103)
14	1/0.16 645 (16-3595)	5/1.69 297 (96-692)	19/9.50 200 (120-312)	38/19.62 194 (137-266)	27/13.45 201 (132-292)	5/2.04 245 (80-572)	95/46.44 205 (166-250)
15	0/0.05 0 (0-7685)	0/0.44 0 (0-842)	3/2.42 124 (26-362)	8/5.40 148 (64-292)	3/4.52 66 (14-194)	2/0.85 236 (29-854)	16/13.68 117 (67-190)
16	0/0.13 0 (0-2928)	2/0.99 201 (24-727)	7/4.84 144 (58-298)	10/9.76 102 (49-188)	9/6.67 135 (62-256)	1/1.44 70 (2-388)	29/23.83 122 (82-175)
17	0/0.05 0 (0-7528)	0/0.49 0 (0-757)	1/2.73 37 (1-204)	8/5.96 134 (58-264)	3/4.56 66 (14-192)	2/1.01 199 (24-717)	14/14.80 95 (52-159)
18	0/0.14 0 (0-2616)	3/1.34 225 (46-657)	10/7.12 140 (67-258)	17/14.96 114 (66-182)	15/9.81 153 (86-252)	0/1.54 0 (0-240)	45/34.90 129 (94-173)
19	0/0.05 0 (0-7094)	0/0.42 0 (0-874)	2/2.14 93 (11-338)	7/4.42 159 (64-327)	4/3.21 125 (34-319)	3/0.75 401 (83-1172)	16/10.99 146 (83-237)
Total	1/0.76 131 (3-731)	15/7.29 206 (115-339)	65/39.72 164 (126-209)	124/84.44 147 (122-175)	91/60.73 150 (121-184)	20/12.30 163 (99-251)	316/205.2 154 (137-172)

Appendix C: Table 51

Factory (exposed only) age at death

Mortality from cancer of the stomach (151)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.02 0 (0-****)	0/0.17 0 (0-2170)	2/0.78 258 (31-932)	4/1.79 223 (61-572)	2/1.70 118 (14-425)	2/0.63 315 (38-1140)	10/5.09 196 (94-361)
11	0/0.04 0 (0-9459)	1/0.34 295 (7-1644)	4/1.36 294 (80-754)	3/2.58 116 (24-339)	3/2.07 145 (30-424)	0/0.53 0 (0-701)	11/6.92 159 (79-285)
12	0/0.01 0 (0-****)	0/0.08 0 (0-4611)	0/0.29 0 (0-1255)	1/0.64 156 (4-867)	0/0.72 0 (0-512)	0/0.21 0 (0-1748)	1/1.96 51 (1-284)
13	0/0.02 0 (0-****)	0/0.13 0 (0-2860)	0/0.45 0 (0-818)	2/0.80 251 (30-905)	0/0.58 0 (0-639)	0/0.23 0 (0-1618)	2/2.20 91 (11-328)
14	0/0.07 0 (0-4985)	0/0.62 0 (0-591)	5/2.47 203 (66-473)	5/4.57 109 (35-255)	3/3.43 87 (18-256)	2/0.60 334 (41-1208)	15/11.77 127 (71-210)
15	0/0.02 0 (0-****)	0/0.17 0 (0-2236)	1/0.65 155 (4-862)	2/1.29 155 (19-561)	0/1.19 0 (0-310)	0/0.26 0 (0-1441)	3/3.57 84 (17-246)
16	0/0.06 0 (0-6252)	2/0.37 539 (65-1947)	2/1.24 161 (20-582)	1/2.21 45 (1-252)	2/1.68 119 (14-429)	1/0.40 248 (6-1383)	8/5.96 134 (58-264)
17	0/0.03 0 (0-****)	0/0.18 0 (0-2016)	0/0.72 0 (0-511)	0/1.43 0 (0-258)	1/1.20 83 (2-463)	0/0.30 0 (0-1213)	1/3.87 26 (1-144)
18	0/0.07 0 (0-5589)	1/0.49 202 (5-1128)	4/1.85 216 (59-553)	9/3.50 257 (118-488)	12/2.57 467 (241-816)	0/0.53 0 (0-700)	26/9.01 289 (189-423)
19	0/0.02 0 (0-****)	1/0.15 649 (16-3618)	1/0.55 181 (5-1008)	2/1.05 191 (23-691)	0/0.88 0 (0-421)	0/0.25 0 (0-1476)	4/2.90 138 (38-353)
Total	0/0.36 0 (0-1028)	5/2.71 185 (60-431)	19/10.36 183 (110-286)	29/19.86 146 (98-210)	23/16.02 144 (91-215)	5/3.94 127 (41-296)	81/53.25 152 (121-189)

Appendix C: Table 52

Factory (exposed only) age at death

Mortality from diseases of the respiratory system (460-519)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.12 0 (0-3100)	2/0.48 417 (50-1505)	4/2.12 188 (51-482)	14/6.11 229 (125-385)	14/8.02 175 (95-293)	5/6.73 74 (24-173)	39/23.58 165 (118-226)
11	0/0.25 0 (0-1470)	0/0.97 0 (0-381)	1/3.69 27 (1-151)	12/8.66 139 (72-242)	15/9.73 154 (86-254)	5/5.23 96 (31-223)	33/28.54 116 (80-162)
12	0/0.10 0 (0-3803)	0/0.23 0 (0-1597)	0/0.80 0 (0-463)	2/2.19 91 (11-329)	3/3.48 86 (18-252)	4/1.95 206 (56-526)	9/8.74 103 (47-196)
13	0/0.14 0 (0-2693)	0/0.38 0 (0-984)	2/1.23 163 (20-588)	1/2.64 38 (1-211)	3/2.76 109 (22-318)	4/2.47 162 (44-414)	10/9.60 104 (50-192)
14	2/0.47 422 (51-1524)	3/1.79 168 (35-490)	14/6.71 208 (114-350)	38/15.27 249 (176-342)	31/16.04 193 (131-274)	7/5.83 120 (48-247)	95/46.12 206 (167-252)
15	0/0.17 0 (0-2183)	1/0.47 211 (5-1178)	4/1.75 228 (62-584)	7/4.35 161 (65-332)	5/5.68 88 (29-205)	4/2.52 159 (43-407)	21/14.94 141 (87-215)
16	0/0.41 0 (0-891)	1/1.07 94 (2-522)	5/3.37 148 (48-346)	9/7.26 124 (57-235)	8/7.99 100 (43-197)	7/3.99 175 (70-361)	30/24.10 124 (84-178)
17	0/0.16 0 (0-2380)	0/0.52 0 (0-709)	4/1.96 204 (56-522)	8/4.81 166 (72-328)	9/5.73 157 (72-298)	4/2.89 138 (38-354)	25/16.07 156 (101-230)
18	1/0.46 220 (6-1225)	2/1.42 141 (17-508)	5/5.02 100 (32-232)	14/11.66 120 (66-201)	17/11.81 144 (84-230)	6/5.64 106 (39-232)	45/36.01 125 (91-167)
19	0/0.19 0 (0-1994)	0/0.45 0 (0-820)	1/1.50 67 (2-372)	3/3.51 85 (18-250)	6/4.22 142 (52-310)	0/2.37 0 (0-156)	10/12.23 82 (39-150)
Total	3/2.45 122 (25-357)	9/7.78 116 (53-220)	40/28.16 142 (101-193)	108/66.46 162 (133-196)	111/75.45 147 (121-177)	46/39.62 116 (85-155)	317/219.9 144 (129-161)

Appendix C: Table 53

Factory (exposed only) age at death

Mortality from bronchitis, emphysema & asthma (490-493)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.02 0 (0-****)	1/0.15 654 (17-3642)	3/1.08 279 (57-814)	7/3.56 197 (79-405)	9/4.33 208 (95-395)	2/2.44 82 (10-296)	22/11.57 190 (119-288)
11	0/0.04 0 (0-9222)	0/0.31 0 (0-1186)	0/1.84 0 (0-200)	7/5.02 140 (56-288)	10/5.09 196 (94-361)	2/1.88 106 (13-384)	19/14.18 134 (81-209)
12	0/0.02 0 (0-****)	0/0.07 0 (0-4985)	0/0.40 0 (0-929)	1/1.29 78 (2-433)	1/1.84 54 (1-302)	2/0.75 266 (32-962)	4/4.37 92 (25-234)
13	0/0.02 0 (0-****)	0/0.12 0 (0-3049)	1/0.61 164 (4-915)	0/1.49 0 (0-248)	1/1.45 69 (2-384)	1/0.86 116 (3-648)	3/4.55 66 (14-193)
14	2/0.08 2597 (315-9383)	0/0.57 0 (0-643)	6/3.35 179 (66-390)	22/8.81 250 (156-378)	22/8.27 266 (167-403)	4/2.09 192 (52-491)	56/23.17 242 (183-314)
15	0/0.03 0 (0-****)	0/0.15 0 (0-2443)	1/0.88 114 (3-636)	3/2.53 119 (24-347)	3/3.00 100 (21-293)	3/0.91 329 (68-961)	10/7.49 133 (64-245)
16	0/0.07 0 (0-5346)	1/0.34 294 (7-1639)	1/1.68 60 (2-332)	4/4.12 97 (26-249)	5/4.11 122 (40-284)	2/1.41 142 (17-513)	13/11.72 111 (59-190)
17	0/0.02 0 (0-****)	0/0.17 0 (0-2222)	2/0.98 204 (25-737)	7/2.78 252 (101-520)	5/3.03 165 (54-385)	3/1.08 278 (57-813)	17/8.05 211 (123-338)
18	0/0.07 0 (0-5196)	0/0.45 0 (0-813)	3/2.50 120 (25-351)	10/6.73 149 (71-273)	10/6.10 164 (79-301)	4/1.97 203 (55-521)	27/17.83 151 (100-220)
19	0/0.03 0 (0-****)	0/0.15 0 (0-2544)	1/0.74 135 (3-752)	3/2.02 149 (31-434)	5/2.28 220 (71-513)	0/0.92 0 (0-401)	9/6.13 147 (67-279)
Total	2/0.40 500 (61-1806)	2/2.49 80 (10-290)	18/14.05 128 (76-202)	64/38.33 167 (129-213)	71/39.50 180 (140-227)	23/14.30 161 (102-241)	180/109.1 165 (142-191)

Appendix C: Table 54

Factory (exposed only) age at death

Mortality from diseases of the circulatory system(390-458)

KEY: Obs:/Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	2/0.29 694 (84-2509)	5/2.41 207 (67-484)	10/11.32 88 (42-162)	29/25.38 114 (77-164)	24/26.18 92 (59-136)	14/16.54 85 (46-142)	84/82.12 102 (82-127)
11	1/0.62 162 (4-902)	5/5.21 96 (31-224)	23/21.44 107 (68-161)	46/38.32 120 (88-160)	33/34.01 97 (67-136)	8/13.27 60 (26-119)	116/112.9 103 (85-123)
12	0/0.22 0 (0-1662)	0/1.27 0 (0-291)	5/4.52 111 (36-258)	14/9.09 154 (84-258)	11/11.65 94 (47-169)	7/5.02 139 (56-287)	37/31.77 116 (82-161)
13	0/0.33 0 (0-1135)	1/2.15 47 (1-259)	11/7.74 142 (71-254)	18/12.41 145 (86-229)	7/9.52 74 (30-152)	2/6.11 33 (4-118)	39/38.24 102 (73-139)
14	1/1.16 86 (2-479)	9/9.59 94 (43-178)	50/39.55 126 (94-167)	74/69.24 107 (84-134)	60/58.09 103 (79-133)	14/15.01 93 (51-157)	208/192.6 108 (94-124)
15	0/0.39 0 (0-948)	4/2.51 159 (43-408)	11/9.82 112 (56-201)	19/18.85 101 (61-157)	25/19.68 127 (82-188)	10/6.34 158 (76-290)	69/57.58 120 (93-152)
16	2/0.98 204 (25-739)	6/5.73 105 (38-228)	17/20.55 83 (48-132)	33/35.10 94 (65-132)	31/28.97 107 (73-152)	9/10.18 88 (40-168)	98/101.5 97 (78-118)
17	0/0.37 0 (0-986)	3/2.69 112 (23-326)	12/11.10 108 (56-189)	20/20.87 96 (59-148)	24/19.76 121 (78-181)	12/7.48 160 (83-280)	71/62.27 114 (89-144)
18	0/1.08 0 (0-342)	11/7.75 142 (71-254)	47/29.65 158 (116-211)	57/52.89 108 (82-140)	56/42.44 132 (100-171)	9/14.03 64 (29-122)	180/147.9 122 (105-141)
19	0/0.44 0 (0-844)	8/2.62 306 (132-603)	18/9.13 197 (117-312)	11/15.54 71 (35-127)	14/13.95 100 (55-168)	13/6.11 213 (113-364)	64/47.79 134 (103-171)
Total	6/5.87 102 (38-222)	52/41.93 124 (93-163)	204/164.8 124 (107-142)	321/297.7 108 (96-120)	285/264.2 108 (96-121)	98/100.1 98 (79-119)	966/874.6 110 (104-118)

Appendix C: Table 55

Factory (unexposed only) age at death

Mortality from all causes (000-999)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/1.31 0 (0-283)	6/3.69 163 (60-354)	13/10.73 121 (65-207)	11/18.42 60 (30-107)	6/15.71 38 (14-83)	10/5.94 168 (81-309)	46/55.80 82 (60-110)
11	1/0.71 141 (4-787)	2/2.32 86 (10-311)	4/7.29 55 (15-140)	15/15.44 97 (54-160)	19/15.56 122 (74-191)	6/7.05 85 (31-185)	47/48.37 97 (71-129)
12	0/0.47 0 (0-790)	1/0.75 133 (3-742)	5/2.08 241 (78-562)	3/5.08 59 (12-173)	9/6.13 147 (67-279)	1/2.35 43 (1-237)	19/16.85 113 (68-176)
13	2/1.44 139 (17-501)	0/2.31 0 (0-160)	1/5.70 18 (0-98)	7/9.84 71 (29-147)	8/7.87 102 (44-200)	0/3.23 0 (0-114)	18/30.40 59 (35-94)
14	2/2.82 71 (9-256)	2/5.83 34 (4-124)	16/15.21 105 (60-171)	24/26.80 90 (57-133)	26/27.72 94 (61-137)	12/10.07 119 (62-208)	82/88.46 93 (74-115)
15	0/0.28 0 (0-1341)	1/0.47 214 (5-1193)	0/1.55 0 (0-238)	4/3.25 123 (34-316)	4/3.32 121 (33-309)	1/0.45 224 (6-1249)	10/9.30 108 (52-198)
16	1/1.28 78 (2-436)	3/2.29 131 (27-382)	4/5.96 67 (18-172)	13/10.55 123 (66-211)	13/10.05 129 (69-221)	5/5.25 95 (31-222)	39/35.38 110 (78-151)
17	1/1.15 87 (2-483)	1/2.99 33 (1-186)	9/8.65 104 (48-197)	14/14.14 99 (54-166)	12/12.58 95 (49-167)	8/6.98 115 (49-226)	45/46.50 97 (71-129)
18	2/4.98 40 (5-145)	14/9.55 147 (80-246)	26/25.75 101 (66-148)	86/62.21 138 (111-171)	103/70.04 147 (120-178)	36/46.46 77 (54-107)	267/219.0 122 (108-137)
19	0/3.12 0 (0-118)	7/5.47 128 (51-264)	16/13.16 122 (69-197)	17/23.34 73 (42-117)	28/17.62 159 (106-230)	7/7.07 99 (40-204)	75/69.78 107 (85-135)
Total	9/17.55 51 (23-97)	37/35.68 104 (73-143)	94/96.08 98 (79-120)	194/189.1 103 (89-118)	228/186.6 122 (107-139)	86/94.85 91 (73-112)	648/619.8 105 (97-113)

Appendix C: Table 56

Factory (unexposed only) age at death

Mortality from all malignant neoplasms (140-209)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.19 0 (0-1901)	1/0.80 125 (3-699)	4/2.85 140 (38-359)	4/5.41 74 (20-189)	3/4.17 72 (15-210)	3/1.18 255 (53-745)	15/14.60 103 (58-169)
11	0/0.11 0 (0-3354)	1/0.50 199 (5-1108)	2/1.95 103 (12-371)	3/4.50 67 (14-195)	3/4.14 72 (15-212)	3/1.32 228 (47-667)	12/12.52 96 (50-167)
12	0/0.07 0 (0-5589)	0/0.16 0 (0-2277)	3/0.55 543 (112-1588)	0/1.45 0 (0-254)	3/1.56 192 (40-562)	0/0.46 0 (0-795)	6/4.26 141 (52-307)
13	0/0.21 0 (0-1748)	0/0.50 0 (0-738)	1/1.52 66 (2-367)	0/2.89 0 (0-128)	2/2.11 95 (11-342)	0/0.68 0 (0-547)	3/7.91 38 (8-111)
14	0/0.42 0 (0-870)	0/1.26 0 (0-293)	4/4.05 99 (27-253)	5/7.81 64 (21-149)	4/7.32 55 (15-140)	3/1.97 152 (31-444)	16/22.83 70 (40-114)
15	0/0.04 0 (0-9459)	0/0.10 0 (0-3652)	0/0.41 0 (0-893)	0/0.95 0 (0-390)	0/0.88 0 (0-418)	1/0.10 1000 (25-5572)	1/2.48 40 (1-225)
16	0/0.19 0 (0-1983)	1/0.50 202 (5-1123)	1/1.59 63 (2-351)	4/3.09 129 (35-331)	3/2.66 113 (23-330)	2/0.92 217 (26-784)	11/8.94 123 (61-220)
17	1/0.17 581 (15-3239)	0/0.65 0 (0-569)	4/2.31 173 (47-444)	3/4.12 73 (15-213)	5/3.25 154 (50-359)	1/1.21 82 (2-459)	14/11.71 120 (65-201)
18	1/0.72 138 (3-770)	2/2.07 97 (12-350)	8/6.87 116 (50-229)	23/17.80 129 (82-194)	20/17.61 114 (69-175)	8/7.92 101 (44-199)	62/52.99 117 (90-150)
19	0/0.46 0 (0-802)	1/1.18 85 (2-471)	6/3.49 172 (63-374)	7/6.82 103 (41-211)	8/4.67 171 (74-338)	2/1.33 150 (18-543)	24/17.96 134 (86-199)
Total	2/2.59 77 (9-279)	6/7.71 78 (29-169)	33/25.58 129 (89-181)	49/54.85 89 (66-118)	51/48.36 105 (79-139)	23/17.09 135 (85-202)	164/156.2 105 (90-122)

Appendix C: Table 57

Factory (unexposed only) age at death

Mortality from cancers of the trachea, bronchus and lung (162)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.02 0 (0-****)	0/0.23 0 (0-1640)	3/1.19 253 (52-739)	4/2.48 161 (44-413)	1/1.80 56 (1-310)	2/0.42 472 (57-1704)	10/6.13 163 (78-300)
11	0/0.01 0 (0-****)	0/0.14 0 (0-2712)	1/0.80 125 (3-696)	2/2.09 96 (12-346)	0/1.80 0 (0-206)	1/0.46 219 (6-1222)	4/5.29 76 (21-194)
12	0/0.01 0 (0-****)	0/0.04 0 (0-8579)	1/0.23 439 (11-2444)	0/0.67 0 (0-555)	0/0.66 0 (0-560)	0/0.16 0 (0-2249)	1/1.77 57 (1-315)
13	0/0.02 0 (0-****)	0/0.13 0 (0-2860)	1/0.62 161 (4-897)	0/1.33 0 (0-277)	1/0.92 109 (3-606)	0/0.25 0 (0-1470)	2/3.27 61 (7-221)
14	0/0.04 0 (0-8997)	0/0.33 0 (0-1118)	1/1.65 60 (2-337)	1/3.60 28 (1-155)	2/3.17 63 (8-228)	0/0.71 0 (0-523)	4/9.50 42 (11-108)
15	0/0.00 0 (0-****)	0/0.03 0 (0-****)	0/0.17 0 (0-2145)	0/0.44 0 (0-836)	0/0.38 0 (0-963)	0/0.04 0 (0-9708)	0/1.07 0 (0-346)
16	0/0.02 0 (0-****)	1/0.13 769 (19-4286)	0/0.65 0 (0-568)	3/1.43 210 (43-614)	2/1.14 175 (21-633)	0/0.31 0 (0-1209)	6/3.67 163 (60-356)
17	0/0.02 0 (0-****)	0/0.18 0 (0-2038)	3/0.96 314 (65-918)	2/1.88 107 (13-385)	4/1.38 290 (79-742)	1/0.40 253 (6-1411)	10/4.81 208 (100-382)
18	0/0.07 0 (0-5123)	1/0.55 182 (5-1017)	3/2.87 105 (22-305)	12/8.20 146 (76-256)	8/7.43 108 (46-212)	5/2.53 198 (64-461)	29/21.66 134 (90-192)
19	0/0.05 0 (0-8198)	0/0.31 0 (0-1194)	3/1.43 210 (43-614)	3/3.13 96 (20-280)	5/2.02 247 (80-577)	0/0.46 0 (0-802)	11/7.39 149 (74-266)
Total	0/0.26 0 (0-1419)	2/2.06 97 (12-351)	16/10.57 151 (87-246)	27/25.24 107 (71-156)	23/20.70 111 (70-167)	9/5.73 157 (72-298)	77/64.55 119 (94-149)

Appendix C: Table 58

Factory (unexposed only) age at death

Mortality from cancer of the stomach (151)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.01 0 (0-****)	0/0.08 0 (0-4392)	1/0.31 326 (8-1815)	0/0.57 0 (0-646)	0/0.46 0 (0-797)	1/0.12 855 (22-4762)	2/1.55 129 (16-465)
11	0/0.01 0 (0-****)	0/0.05 0 (0-7378)	0/0.20 0 (0-1826)	0/0.50 0 (0-744)	0/0.46 0 (0-798)	0/0.13 0 (0-2753)	0/1.35 0 (0-274)
12	0/0.00 0 (0-****)	0/0.02 0 (0-****)	0/0.06 0 (0-6047)	0/0.17 0 (0-2170)	2/0.19 1058 (128-3823)	0/0.05 0 (0-7685)	2/0.49 411 (50-1484)
13	0/0.01 0 (0-****)	0/0.05 0 (0-8019)	0/0.16 0 (0-2320)	0/0.31 0 (0-1194)	0/0.23 0 (0-1597)	0/0.07 0 (0-5589)	0/0.82 0 (0-450)
14	0/0.02 0 (0-****)	0/0.12 0 (0-3100)	0/0.42 0 (0-880)	0/0.86 0 (0-429)	0/0.82 0 (0-448)	2/0.20 985 (119-3559)	2/2.44 82 (10-296)
15	0/0.00 0 (0-****)	0/0.01 0 (0-****)	0/0.05 0 (0-7849)	0/0.11 0 (0-3513)	0/0.10 0 (0-3803)	1/0.01 10000 (253-****)	1/0.27 368 (9-2048)
16	0/0.01 0 (0-****)	0/0.05 0 (0-7849)	0/0.17 0 (0-2222)	0/0.33 0 (0-1111)	0/0.30 0 (0-1234)	0/0.10 0 (0-3843)	0/0.95 0 (0-389)
17	0/0.01 0 (0-****)	0/0.07 0 (0-5506)	0/0.25 0 (0-1500)	0/0.45 0 (0-820)	0/0.38 0 (0-966)	0/0.13 0 (0-2753)	0/1.29 0 (0-286)
18	0/0.03 0 (0-****)	0/0.20 0 (0-1817)	1/0.77 131 (3-728)	3/2.09 143 (30-419)	5/2.17 231 (75-538)	0/0.88 0 (0-417)	9/6.14 146 (67-278)
19	0/0.02 0 (0-****)	0/0.11 0 (0-3294)	1/0.37 273 (7-1522)	3/0.74 407 (84-1190)	0/0.53 0 (0-697)	0/0.14 0 (0-2635)	4/1.90 210 (57-538)
Total	0/0.12 0 (0-3074)	0/0.75 0 (0-489)	3/2.74 110 (23-320)	6/6.12 98 (36-213)	7/5.64 124 (50-256)	4/1.83 218 (59-559)	20/17.21 116 (71-180)

Appendix C: Table 59

Factory (unexposed only) age at death

Mortality from diseases of the respiratory system (460-519)

KEY: Obs:/Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.07 0 (0-5196)	1/0.24 420 (11-2341)	0/0.84 0 (0-440)	0/1.90 0 (0-195)	0/2.22 0 (0-166)	1/1.20 83 (2-463)	2/6.46 31 (4-112)
11	0/0.04 0 (0-9708)	0/0.14 0 (0-2580)	0/0.55 0 (0-676)	3/1.68 178 (37-521)	3/2.19 137 (28-401)	0/1.49 0 (0-248)	6/6.09 99 (36-215)
12	0/0.02 0 (0-****)	0/0.05 0 (0-8019)	1/0.17 606 (15-3377)	0/0.59 0 (0-626)	1/0.90 111 (3-617)	1/0.47 215 (5-1196)	3/2.19 137 (28-400)
13	0/0.08 0 (0-4854)	0/0.14 0 (0-2712)	0/0.43 0 (0-858)	1/1.03 97 (2-539)	0/1.09 0 (0-338)	0/0.63 0 (0-589)	1/3.39 29 (1-164)
14	0/0.15 0 (0-2459)	0/0.35 0 (0-1051)	3/1.14 264 (55-772)	1/2.90 34 (1-192)	6/3.95 152 (56-330)	2/2.01 100 (12-360)	12/10.50 114 (59-200)
15	0/0.02 0 (0-****)	0/0.03 0 (0-****)	0/0.13 0 (0-2860)	0/0.36 0 (0-1022)	1/0.47 213 (5-1185)	0/0.08 0 (0-4611)	1/1.08 92 (2-514)
16	0/0.07 0 (0-5506)	1/0.14 719 (18-4008)	0/0.45 0 (0-822)	1/1.11 90 (2-502)	2/1.41 142 (17-512)	1/1.13 88 (2-491)	5/4.31 116 (38-271)
17	0/0.06 0 (0-5950)	0/0.19 0 (0-1921)	0/0.67 0 (0-553)	3/1.50 200 (41-586)	1/1.81 55 (1-307)	3/1.48 203 (42-594)	7/5.71 123 (49-253)
18	0/0.26 0 (0-1397)	3/0.59 510 (105-1491)	4/2.09 192 (52-491)	16/7.26 220 (126-358)	27/10.48 258 (170-375)	10/9.72 103 (49-189)	60/30.40 197 (151-254)
19	0/0.16 0 (0-2263)	0/0.33 0 (0-1118)	0/0.99 0 (0-371)	1/2.48 40 (1-225)	1/2.49 40 (1-224)	0/1.44 0 (0-255)	2/7.90 25 (3-91)
Total	0/0.93 0 (0-396)	5/2.19 228 (74-532)	8/7.44 108 (46-212)	26/20.81 125 (82-183)	42/27.02 155 (112-210)	18/19.65 92 (54-145)	99/78.04 127 (103-154)

Appendix C: Table 60

Factory (unexposed only) age at death

Mortality from bronchitis, emphysema & asthma (490-493)

KEY: Obs./Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.01 0 (0-****)	1/0.08 1333 (34-7429)	0/0.42 0 (0-880)	0/1.08 0 (0-342)	0/1.14 0 (0-323)	0/0.41 0 (0-902)	1/3.13 32 (1-178)
11	0/0.01 0 (0-****)	0/0.05 0 (0-7849)	0/0.27 0 (0-1361)	3/0.99 304 (63-887)	3/1.14 263 (54-769)	0/0.50 0 (0-739)	6/2.95 203 (75-442)
12	0/0.00 0 (0-****)	0/0.02 0 (0-****)	0/0.08 0 (0-4499)	0/0.35 0 (0-1069)	0/0.49 0 (0-759)	1/0.16 610 (15-3397)	1/1.10 91 (2-508)
13	0/0.01 0 (0-****)	0/0.04 0 (0-8384)	0/0.21 0 (0-1740)	1/0.60 168 (4-935)	0/0.56 0 (0-658)	0/0.22 0 (0-1716)	1/1.64 61 (2-340)
14	0/0.03 0 (0-****)	0/0.11 0 (0-3236)	2/0.56 358 (43-1295)	0/1.69 0 (0-218)	3/2.08 144 (30-422)	1/0.71 141 (4-785)	6/5.18 116 (43-252)
15	0/0.00 0 (0-****)	0/0.01 0 (0-****)	0/0.06 0 (0-5764)	0/0.21 0 (0-1724)	1/0.24 415 (11-2312)	0/0.03 0 (0-****)	1/0.56 179 (5-995)
16	0/0.01 0 (0-****)	0/0.05 0 (0-8198)	0/0.22 0 (0-1662)	1/0.64 155 (4-865)	2/0.74 272 (33-983)	1/0.37 268 (7-1494)	4/2.03 197 (54-505)
17	0/0.01 0 (0-****)	0/0.06 0 (0-6047)	0/0.33 0 (0-1118)	2/0.86 233 (28-843)	0/0.97 0 (0-380)	0/0.51 0 (0-720)	2/2.74 73 (9-264)
18	0/0.04 0 (0-8783)	2/0.19 1064 (129-3843)	3/1.05 287 (59-837)	10/4.28 234 (112-429)	17/5.80 293 (171-470)	5/3.40 147 (48-343)	37/14.75 251 (177-346)
19	0/0.03 0 (0-****)	0/0.11 0 (0-3448)	0/0.49 0 (0-753)	1/1.42 71 (2-393)	1/1.33 75 (2-420)	0/0.51 0 (0-730)	2/3.87 52 (6-186)
Total	0/0.15 0 (0-2411)	3/0.71 425 (88-1242)	5/3.69 135 (44-316)	18/12.11 149 (88-235)	27/14.48 187 (123-271)	8/6.82 117 (51-231)	61/37.96 161 (123-206)

Appendix C: Table 61

Factory (unexposed only) age at death

Mortality from diseases of the circulatory system(390-458)

KEY: Obs:/Exp.
SMR
(95% Conf. Int.)

Factory	Age group -34	35 - 44	45 - 54	55 - 64	65 - 74	75+	Total
10	0/0.17 0 (0-2183)	4/1.24 322 (88-823)	5/4.98 100 (33-234)	7/8.83 79 (32-163)	3/7.91 38 (8-111)	5/3.03 165 (54-386)	24/26.15 92 (59-137)
11	0/0.09 0 (0-3924)	1/0.84 120 (3-667)	2/3.44 58 (7-210)	9/7.29 124 (56-235)	11/7.76 142 (71-254)	1/3.61 28 (1-154)	24/23.02 104 (67-155)
12	0/0.05 0 (0-6831)	0/0.26 0 (0-1397)	1/0.95 105 (3-586)	2/2.28 88 (11-317)	4/2.91 137 (37-351)	0/1.17 0 (0-315)	7/7.63 92 (37-189)
13	2/0.17 1198 (145-4326)	0/0.84 0 (0-442)	0/2.68 0 (0-138)	4/4.69 85 (23-218)	5/4.01 125 (40-291)	0/1.64 0 (0-225)	11/14.03 78 (39-140)
14	2/0.35 580 (70-2094)	2/2.09 96 (12-345)	9/7.19 125 (57-238)	14/12.55 112 (61-187)	14/13.81 101 (55-170)	7/5.15 136 (55-280)	48/41.13 117 (86-155)
15	0/0.03 0 (0-****)	1/0.16 621 (16-3461)	0/0.68 0 (0-541)	3/1.51 198 (41-580)	2/1.67 119 (14-432)	0/0.23 0 (0-1625)	6/4.29 140 (51-304)
16	0/0.15 0 (0-2443)	0/0.82 0 (0-449)	3/2.80 107 (22-313)	6/5.05 119 (44-259)	8/4.96 161 (70-318)	1/2.69 37 (1-207)	18/16.48 109 (65-173)
17	0/0.15 0 (0-2443)	0/1.02 0 (0-362)	5/4.03 124 (40-290)	7/6.65 105 (42-217)	5/6.03 83 (27-193)	4/3.56 112 (31-287)	21/21.44 98 (61-150)
18	1/0.59 169 (4-940)	7/3.31 212 (85-436)	10/11.65 86 (41-158)	38/27.82 137 (97-188)	47/32.79 143 (105-191)	16/23.57 68 (39-110)	119/99.73 119 (99-143)
19	0/0.37 0 (0-997)	2/1.95 103 (12-370)	7/6.17 113 (46-234)	9/11.02 82 (37-155)	16/8.68 184 (105-299)	3/3.57 84 (17-246)	37/31.76 116 (82-161)
Total	5/2.13 235 (76-549)	17/12.53 136 (79-217)	42/44.56 94 (68-127)	99/87.68 113 (92-137)	115/90.55 127 (105-152)	37/48.21 77 (54-106)	315/285.7 110 (98-123)

Appendix C: Table 62

Factory by work area

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	149/117.6 127** (117)	21/16.31 129 (119)	24/26.58 90 (84)	24/17.52 137 (127)	46/55.80 82 (76)	264/233.8 113 (105)
11	127/110.1 115 (105)	90/84.95 106 (96)	54/39.20 138* (125)	7/8.77 80 (73)	47/48.37 97 (88)	325/291.4 112 (101)
12	48/47.95 100 (91)	11/9.54 115 (105)	5/5.20 96 (87)	9/6.52 138 (126)	19/16.85 113 (102)	92/86.06 107 (97)
13	41/42.83 96 (99)	12/10.80 111 (115)	9/11.65 77 (80)	14/16.78 83 (86)	18/30.40 59* (61*)	94/112.5 84 (86)
14	266/213.5 125*** (114*)	137/105.8 130** (119)	50/43.68 114 (105)	62/50.09 124 (114)	82/88.46 93 (85)	597/501.5 119*** (109*)
15	42/44.16 95 (82)	75/67.54 111 (96)	4/6.81 59 (51)	12/6.39 188 (162)	10/9.30 108 (93)	143/134.2 107 (92)
16	99/105.4 94 (85)	40/34.77 115 (104)	24/33.58 71 (64*)	45/44.39 101 (91)	39/35.38 110 (99)	247/253.5 97 (88*)
17	60/55.79 108 (106)	14/14.65 96 (95)	28/27.20 103 (102)	41/37.16 110 (109)	45/46.50 97 (96)	188/181.3 104 (103)
18	197/177.3 111 (102)	96/79.09 121 (111)	35/34.86 100 (92)	41/28.39 144* (132)	267/219.0 122** (112)	636/538.6 118*** (108*)
19	58/46.61 124 (101)	43/28.14 153* (124)	10/13.76 73 (59)	17/15.89 107 (87)	75/69.78 107 (87)	203/174.2 117* (95)
Total	1087/961.2 113*** (103)	539/451.6 119*** (108)	243/242.5 100 (92)	272/231.9 117* (108)	648/619.8 105 (95)	2789/2507.0 111*** (102)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 63

Mortality from all causes (000-999)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	175/161.5	392/323.1	384/359.7	136/116.9	1087/961.2
	108	121***	107	116	113***
	(99)	(111*)	(98)	(107)	(103)
Fettling	52/70.78	215/152.9	210/176.3	62/51.64	539/451.6
	73*	141***	119*	120	119***
	(66**)	(127***)	(108)	(109)	(108)
Mainten.	34/39.78	95/84.43	90/88.12	24/30.20	243/242.5
	85	113	102	79	100
	(79)	(103)	(94)	(73)	(92)
Mix/oth.	34/34.19	82/73.70	112/91.37	44/32.63	272/231.9
	99	111	123*	135	117*
	(92)	(103)	(113)	(125)	(108)
Unexp.	122/118.0	248/217.8	206/220.5	72/63.44	648/619.8
	103	114*	93	114	105
	(94)	(104)	(85*)	(104)	(95)
Total	417/424.3	1032/852.0	1002/936.0	338/294.8	2789/2507.0
	98	121***	107*	115*	111***
	(90*)	(111**)	(98)	(105)	(102)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 64

Factory by work area

Mortality from all malignant neoplasms (140-209)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	50/28.73 174*** (169***)	7/4.39 159 (155)	5/6.31 79 (77)	10/4.70 213* (206)	15/14.60 103 (100)	87/58.73 148*** (144**)
11	49/28.45 172*** (166**)	27/21.88 123 (119)	18/10.49 172* (165)	3/2.40 125 (120)	12/12.52 96 (92)	109/75.74 144*** (138**)
12	13/12.04 108 (105)	1/2.34 43 (41)	0/1.32 0 (0)	2/1.76 113 (110)	6/4.26 141 (137)	22/21.73 101 (98)
13	10/10.73 93 (93)	2/2.83 71 (71)	2/3.10 65 (65)	1/4.21 24 (24)	3/7.91 38 (38)	18/28.77 63* (63*)
14	78/56.52 138** (128*)	44/28.15 156** (145*)	17/11.68 146 (135)	18/13.29 135 (125)	16/22.83 70 (65)	173/132.5 131*** (121*)
15	4/11.24 36* (31**)	22/17.82 123 (108)	0/1.70 0 (0)	0/1.73 0 (0)	1/2.48 40 (35)	27/34.97 77 (68*)
16	31/27.55 113 (107)	8/9.18 87 (83)	6/8.61 70 (66)	11/11.82 93 (89)	11/8.94 123 (117)	67/66.10 101 (97)
17	14/14.51 96 (101)	2/3.91 51 (53)	8/6.84 117 (122)	7/9.84 71 (74)	14/11.71 120 (125)	45/46.81 96 (100)
18	62/45.28 137* (132*)	23/21.19 109 (104)	7/9.26 76 (73)	7/7.69 91 (88)	62/52.99 117 (112)	161/136.4 118* (113)
19	16/12.05 133 (115)	10/7.27 137 (120)	7/3.40 206 (179)	1/3.93 25 (22)	24/17.96 134 (116)	58/44.61 130 (113)
Total	327/247.1 132*** (126***)	146/119.0 123* (115)	70/62.71 112 (107)	60/61.37 98 (94)	164/156.2 105 (100)	767/646.3 119*** (113**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 65

Mortality from all malignant neoplasms (140-209)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	55/39.16	117/82.42	110/94.11	45/31.41	327/247.1
	140*	142***	117	143*	132***
	(133*)	(135**)	(111)	(136)	(126***)
Fettling	11/17.02	61/39.95	55/47.59	19/14.42	146/119.0
	65	153**	116	132	123*
	(60)	(143**)	(108)	(124)	(115)
Mainten.	9/9.73	29/22.01	25/23.24	7/7.73	70/62.71
	92	132	108	91	112
	(89)	(126)	(103)	(87)	(107)
Mix/oth.	6/8.29	26/19.35	23/24.68	5/9.04	60/61.37
	72	134	93	55	98
	(69)	(129)	(89)	(53)	(94)
Unexp.	28/29.00	63/55.33	49/55.26	24/16.61	164/156.2
	97	114	89	144	105
	(92)	(108)	(84)	(138)	(100)
Total	109/103.2	296/219.1	262/244.9	100/79.21	767/646.3
	106	135***	107	126*	119***
	(100)	(128***)	(102)	(120)	(113**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 66

Factory by work area

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	24/11.82	5/1.89	3/2.54	5/2.03	10/6.13	47/24.41
	203**	264	118	247	163	193***
	(195**)	(254)	(114)	(237)	(157)	(185***)
11	27/11.94	14/9.17	7/4.43	2/1.01	4/5.29	54/31.83
	226***	153	158	198	76	170***
	(215***)	(145)	(151)	(189)	(72)	(162**)
12	8/5.00	1/0.94	0/0.55	2/0.75	1/1.77	12/9.00
	160	106	0	267	57	133
	(155)	(103)	(0)	(259)	(55)	(129)
13	2/4.40	1/1.14	0/1.32	0/1.70	2/3.27	5/11.83
	46	87	0	0	61	42*
	(45)	(87)	(0)	(0)	(60)	(42*)
14	44/24.03	31/11.84	8/4.97	12/5.60	4/9.50	99/55.94
	183***	262***	161	214*	42	177***
	(168**)	(240***)	(148)	(197*)	(39*)	(162***)
15	2/4.65	14/7.59	0/0.71	0/0.73	0/1.07	16/14.75
	43	184*	0	0	0	109
	(36)	(156)	(0)	(0)	(0)	(92)
16	18/11.51	4/3.76	3/3.58	4/4.98	6/3.67	35/27.50
	156	106	84	80	163	127
	(148)	(100)	(79)	(76)	(154)	(120)
17	6/6.10	0/1.68	4/2.83	4/4.19	10/4.81	24/19.60
	98	0	141	95	208	122
	(106)	(0)	(152)	(103)	(224*)	(132)
18	26/18.77	11/8.90	4/3.89	4/3.34	29/21.66	74/56.56
	139	124	103	120	134	131*
	(132)	(118)	(98)	(114)	(128)	(125)
19	7/5.05	5/2.99	3/1.37	1/1.57	11/7.39	27/18.38
	139	167	218	64	149	147
	(116)	(141)	(184)	(54)	(125)	(123)
Total	164/103.3	86/49.91	32/26.19	34/25.89	77/64.55	393/269.8
	159***	172***	122	131	119	146***
	(150***)	(159***)	(116)	(125)	(112)	(137***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 67

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	26/15.72 165* (156*)	54/34.79 155** (146*)	59/39.64 149** (140*)	25/13.12 191** (180**)	164/103.3 159*** (150***)
Fettling	5/6.65 75 (69)	34/16.88 201*** (186**)	34/20.26 168** (155*)	13/6.12 212* (197*)	86/49.91 172*** (159***)
Mainten.	4/3.94 102 (97)	11/9.32 118 (112)	13/9.77 133 (126)	4/3.16 127 (120)	32/26.19 122 (116)
Mix/oth.	3/3.29 91 (87)	15/8.23 182* (173)	14/10.53 133 (126)	2/3.83 52 (50)	34/25.89 131 (125)
Unexp.	14/11.93 117 (110)	27/23.15 117 (110)	25/22.63 110 (104)	11/6.84 161 (152)	77/64.55 119 (112)
Total	52/41.52 125 (118)	141/92.38 153*** (143***)	145/102.8 141*** (133**)	55/33.07 166*** (157**)	393/269.8 146*** (137***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 68

Factory by work area

Mortality from cancer of the stomach (151)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	9/3.36 268* (255*)	1/0.50 202 (192)	0/0.73 0 (0)	0/0.51 0 (0)	2/1.55 129 (123)	12/6.65 181 (172)
11	4/3.15 127 (120)	2/2.41 83 (78)	4/1.11 362 (341)	1/0.24 410 (387)	0/1.35 0 (0)	11/8.26 133 (126)
12	1/1.37 73 (70)	0/0.26 0 (0)	0/0.14 0 (0)	0/0.19 0 (0)	2/0.49 411 (391)	3/2.45 123 (117)
13	2/1.15 174 (191)	0/0.28 0 (0)	0/0.33 0 (0)	0/0.44 0 (0)	0/0.82 0 (0)	2/3.02 66 (73)
14	10/6.12 163 (146)	2/2.98 67 (60)	2/1.25 160 (143)	1/1.41 71 (63)	2/2.44 82 (73)	17/14.21 120 (107)
15	1/1.24 81 (63)	2/1.96 102 (80)	0/0.19 0 (0)	0/0.18 0 (0)	1/0.27 368 (289)	4/3.84 104 (82)
16	3/2.88 104 (97)	0/0.92 0 (0)	1/0.92 109 (102)	4/1.25 321 (300)	0/0.95 0 (0)	8/6.91 116 (108)
17	1/1.58 63 (64)	0/0.43 0 (0)	0/0.77 0 (0)	0/1.08 0 (0)	0/1.29 0 (0)	1/5.15 19 (20)
18	18/4.96 363*** (343***)	5/2.22 225 (213)	2/0.98 205 (194)	1/0.86 117 (110)	9/6.14 146 (138)	35/15.15 231*** (218***)
19	3/1.33 226 (205)	1/0.77 129 (118)	0/0.37 0 (0)	0/0.43 0 (0)	4/1.90 210 (191)	8/4.80 166 (151)
Total	52/27.14 192*** (178***)	13/12.74 102 (92)	9/6.78 133 (125)	7/6.59 106 (100)	20/17.21 116 (109)	101/70.45 143*** (133**)

Group: Foundry, Fettling, Mainten., Mix/oth., Unexp.

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 69

Mortality from cancer of the stomach (151)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	8/5.20	24/9.44	16/9.53	4/2.97	52/27.14
	154	254***	168	135	192***
	(144)	(237***)	(156)	(125)	(178***)
Fettling	4/2.18	7/4.46	2/4.75	0/1.36	13/12.74
	184	157	42	0	102
	(167)	(142)	(38)	(0)	(92)
Mainten.	1/1.24	6/2.46	2/2.35	0/0.73	9/6.78
	81	244	85	0	133
	(76)	(230)	(80)	(0)	(125)
Mix/oth.	1/1.07	3/2.18	3/2.48	0/0.85	7/6.59
	93	137	121	0	106
	(88)	(130)	(114)	(0)	(100)
Unexp.	5/3.83	6/6.26	4/5.56	5/1.56	20/17.21
	131	96	72	320*	116
	(123)	(90)	(68)	(301)	(109)
Total	19/13.52	46/24.79	27/24.67	9/7.47	101/70.45
	141	186***	109	120	143***
	(131)	(173***)	(102)	(112)	(133**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 70

Factory by work area

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	27/15.87 170* (152*)	4/1.88 213 (190)	5/3.80 132 (118)	3/2.04 147 (131)	2/6.46 31 (28*)	41/30.05 136 (122)
11	12/13.18 91 (79)	15/10.42 144 (124)	6/4.12 145 (125)	0/0.82 0 (0)	6/6.09 99 (85)	39/34.62 113 (97)
12	6/6.21 97 (83)	2/1.18 169 (144)	0/0.66 0 (0)	1/0.68 146 (125)	3/2.19 137 (117)	12/10.93 110 (94)
13	7/5.31 132 (142)	1/1.03 97 (105)	0/1.34 0 (0)	2/1.92 104 (112)	1/3.39 29 (32)	11/12.99 85 (91)
14	45/24.54 183*** (146*)	30/11.28 266*** (211***)	7/4.82 145 (115)	13/5.48 237** (188*)	12/10.50 114 (91)	107/56.62 189*** (150***)
15	6/5.42 111 (87)	12/7.98 150 (117)	1/0.93 108 (84)	2/0.61 326 (254)	1/1.08 92 (72)	22/16.03 137 (107)
16	12/11.94 100 (84)	6/3.29 182 (152)	6/4.11 146 (122)	6/4.75 126 (105)	5/4.31 116 (97)	35/28.41 123 (103)
17	14/6.64 211* (201*)	1/1.72 58 (55)	2/3.41 59 (56)	8/4.29 186 (177)	7/5.71 123 (117)	32/21.78 147* (140)
18	22/21.00 105 (93)	13/8.05 161 (143)	4/3.71 108 (95)	6/3.25 185 (163)	60/30.40 197*** (175***)	105/66.42 158*** (140**)
19	5/5.62 89 (88)	2/3.08 65 (64)	0/1.68 0 (0)	3/1.85 162 (160)	2/7.90 25* (25*)	12/20.12 60 (59)
Total	156/115.7 135*** (117)	86/49.91 172*** (146**)	31/28.59 108 (95)	44/25.70 171** (150*)	99/78.04 127* (112)	416/298.0 140*** (121***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 71

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	23/18.27	49/38.86	72/44.07	12/14.52	156/115.7
	126	126	163***	83	135***
	(109)	(109)	(141**)	(71)	(117)
Fettling	7/7.27	32/16.72	36/20.03	11/5.90	86/49.91
	96	191**	180**	187	172***
	(82)	(162*)	(152*)	(157)	(146**)
Mainten.	2/4.25	13/9.73	12/10.50	4/4.12	31/28.59
	47	134	114	97	108
	(41)	(117)	(100)	(84)	(95)
Mix/oth.	5/3.52	13/8.07	17/10.31	9/3.81	44/25.70
	142	161	165	236*	171**
	(125)	(142)	(145)	(205)	(150*)
Unexp.	27/13.83	31/26.91	30/29.10	11/8.19	99/78.04
	195**	115	103	134	127*
	(172*)	(101)	(92)	(120)	(112)
Total	64/47.13	138/100.3	167/114.0	47/36.54	416/298.0
	136*	138***	146***	129	140***
	(118)	(120*)	(127**)	(111)	(121***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 72

Foundry by work area

Mortality from bronchitis, emphysema & asthma (490-493)

KEY: Obs./Exp.
SMR

Foundry	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	16/7.77 206*	3/1.00 301	3/1.75 171	0/1.05 0	1/3.13 32	23/14.71 156
11	6/6.55 92	11/5.13 214*	2/2.10 95	0/0.40 0	6/2.95 203	25/17.13 146
12	4/3.12 128	0/0.58 0	0/0.32 0	0/0.34 0	1/1.10 91	5/5.46 91
13	2/2.51 80	1/0.49 204	0/0.66 0	0/0.90 0	1/1.64 61	4/6.19 65
14	28/12.32 227***	16/5.68 282***	4/2.46 163	8/2.72 294*	6/5.18 116	62/28.35 219***
15	4/2.69 149	4/4.06 99	1/0.43 234	1/0.31 318	1/0.56 179	11/8.05 137
16	4/5.82 69	2/1.56 128	4/1.99 201	3/2.36 127	4/2.03 197	17/13.75 124
17	12/3.29 364***	0/0.88 0	2/1.70 118	3/2.18 137	2/2.74 73	19/10.79 176*
18	10/10.22 98	9/4.03 223*	3/1.87 160	5/1.71 292	37/14.75 251***	64/32.58 196***
19	5/2.89 173	2/1.52 131	0/0.82 0	2/0.90 221	2/3.87 52	11/10.01 110
Total	91/57.17 159***	48/24.91 193***	19/14.10 135	22/12.88 171*	61/37.96 161***	241/147.0 164***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 73

Mortality from bronchitis, emphysema & asthma (490–493)
by years since first exposure and work area

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	12/9.65 124	36/20.91 172**	37/20.70 179**	6/5.92 101	91/57.17 159***
Fettling	5/3.66 137	18/9.10 198*	20/9.62 208**	5/2.53 197	48/24.91 193***
Mainten.	0/2.22 0	8/5.28 151	10/5.04 199	1/1.56 64	19/14.10 135
Mix/oth.	3/1.78 169	8/4.45 180	7/5.04 139	4/1.62 247	22/12.88 171*
Unexp.	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.96 161***
Total	38/24.90 153*	91/54.16 168***	93/53.16 175***	19/14.82 128	241/147.0 164***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 74

Factory by work area

Mortality from diseases of the circulatory system(390-458)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Foundry	Fettling	Mainten.	Mix/oth.	Unexp.	Total
10	57/54.12 105 (93)	7/7.47 94 (83)	11/12.32 89 (79)	9/8.22 110 (97)	24/26.15 92 (81)	108/108.3 100 (88)
11	52/50.92 102 (89)	35/39.47 89 (77)	25/18.33 136 (119)	4/4.13 97 (84)	24/23.02 104 (91)	140/135.9 103 (90)
12	21/22.02 95 (82)	6/4.31 139 (120)	5/2.41 207 (179)	5/3.03 165 (142)	7/7.63 92 (79)	44/39.40 112 (96)
13	17/19.99 85 (90)	8/4.97 161 (171)	5/5.47 91 (97)	9/7.81 115 (123)	11/14.03 78 (83)	50/52.27 96 (102)
14	110/99.58 110 (102)	48/49.32 97 (90)	25/20.39 123 (114)	25/23.35 107 (99)	48/41.13 117 (108)	256/233.8 110 (101)
15	29/20.04 145 (120)	32/31.43 102 (84)	2/3.17 63 (52)	6/2.94 204 (169)	6/4.29 140 (116)	75/61.87 121 (100)
16	43/49.28 87 (75)	21/16.02 131 (113)	9/15.57 58 (50*)	25/20.63 121 (104)	18/16.48 109 (94)	116/118.0 98 (85)
17	24/25.83 93 (89)	10/6.89 145 (140)	13/12.49 104 (100)	24/17.07 141 (135)	21/21.44 98 (94)	92/83.72 110 (106)
18	91/81.77 111 (98)	46/36.90 125 (109)	19/16.12 118 (103)	24/13.06 184** (161*)	119/99.73 119 (105)	299/247.6 121** (106)
19	29/21.34 136 (105)	22/12.87 171* (131)	2/6.30 32 (24*)	11/7.28 151 (116)	37/31.76 116 (90)	101/79.55 127* (98)
Total	473/444.9 106 (94)	235/209.7 112 (98)	116/112.6 103 (92)	142/107.5 132** (119)	315/285.7 110 (97)	1281/1160.3 110*** (98)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 75

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and work area
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Foundry	53/55.84	183/145.9	165/183.0	72/60.17	473/444.9
	95	125**	90	120	106
	(84)	(111)	(80**)	(106)	(94)
Fettling	21/23.68	94/69.39	93/89.96	27/26.64	235/209.7
	89	135**	103	101	112
	(78)	(119)	(91)	(89)	(98)
Mainten.	15/13.71	41/38.50	47/44.83	13/15.53	116/112.6
	109	106	105	84	103
	(97)	(95)	(93)	(74)	(92)
Mix/oth.	13/11.27	36/32.95	66/46.49	27/16.81	142/107.5
	115	109	142**	161*	132**
	(104)	(98)	(128)	(145)	(119)
Unexp.	49/41.66	129/99.31	105/112.1	32/32.62	315/285.7
	118	130**	94	98	110
	(103)	(115)	(83)	(87)	(97)
Total	151/146.2	483/386.0	476/476.4	171/151.8	1281/1160.3
	103	125***	100	113	110***
	(91)	(111*)	(89**)	(100)	(98)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 76

Main occupational category

Mortality from all causes (000-999)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	56	44.73	125	(95-163)
2 Moulder	204	214.12	95	(83-109)
3 Shell moulder	5	8.38	60	(19-139)
4 Furnaceman/caster	167	136.45	122	(105-142)
5 Furnace repair	146	113.97	128	(108-151)
6 Centrifugal caster	39	33.86	115	(82-157)
7 Cranedriver, foundry	66	75.80	87	(67-111)
8 Labourer, foundry	420	351.31	120	(108-132)
9 Knockout gridman	41	37.33	110	(79-149)
10 Other foundry jobs	31	29.52	105	(71-149)
11 Fettler	275	223.01	123	(109-139)
12 Shotblaster	55	44.83	123	(92-160)
13 Welder/burner	85	77.25	110	(88-136)
14 Arc air burner	6	4.74	126	(46-275)
15 Heat treatment loader	35	28.06	125	(87-173)
16 Cranedriver, fettling	35	28.63	122	(85-170)
17 Labourer, fettling shop	93	78.42	119	(96-145)
18 Other fettling shop jobs	31	30.50	102	(69-144)
19 Pattern maker	35	37.27	94	(65-131)
20 Labourer, pattern shop	32	30.87	104	(71-146)
21 Inspection	66	71.97	92	(71-117)
22 Machinist	214	206.86	103	(90-118)
23 Labourer, machine shop	266	211.45	126	(111-142)
24 Welder: m/c shop, maint.	10	11.04	91	(43-167)
25 Maintenance fitter	139	150.55	92	(78-109)
26 Maintenance fitters mate	117	98.61	119	(98-142)
27 Yard lab., lorry driver	112	120.46	93	(77-112)
28 Precision foundry worker	6	3.83	157	(57-341)
29 Precision inspection	1	1.69	59	(2-330)
30 Precision fettler	1	1.54	65	(2-362)
Total	2789	2507.03	111	(107-115)

Appendix C: Table 77

Main occupational category

Mortality from all malignant neoplasms (140-209)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	10	12.08	83	(40-152)
2 Moulder	58	55.33	105	(80-136)
3 Shell moulder	1	2.24	45	(1-249)
4 Furnaceman/caster	62	36.39	170	(131-218)
5 Furnace repair	48	29.98	160	(118-212)
6 Centrifugal caster	14	8.69	161	(88-270)
7 Cranedriver, foundry	22	19.97	110	(69-167)
8 Labourer, foundry	111	88.26	126	(103-151)
9 Knockout gridman	11	9.52	115	(58-207)
10 Other foundry jobs	15	7.01	214	(120-353)
11 Fettler	78	59.58	131	(103-163)
12 Shotblaster	16	12.08	132	(76-215)
13 Welder/burner	17	20.50	83	(48-133)
14 Arc air burner	1	1.27	79	(2-440)
15 Heat treatment loader	12	7.58	158	(82-277)
16 Cranedriver, fettling	7	7.67	91	(37-188)
17 Labourer, fettling shop	21	19.30	109	(67-166)
18 Other fettling shop jobs	8	7.99	100	(43-197)
19 Pattern maker	7	9.21	76	(31-157)
20 Labourer, pattern shop	12	7.89	152	(79-266)
21 Inspection	16	18.26	88	(50-142)
22 Machinist	62	54.28	114	(88-146)
23 Labourer, machine shop	59	51.08	116	(88-149)
24 Welder: m/c shop, maint.	4	2.93	137	(37-350)
25 Maintenance fitter	34	38.74	88	(61-123)
26 Maintenance fitters mate	36	25.67	140	(98-194)
27 Yard lab., lorry driver	22	30.97	71	(45-108)
28 Precision foundry worker	2	1.08	186	(23-671)
29 Precision inspection	0	0.42	0	(0-887)
30 Precision fettler	1	0.43	233	(6-1296)
Total	767	646.35	119	(110-127)

Appendix C: Table 78

Main occupational category

Mortality from cancers of the trachea, bronchus and lung (162)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	7	5.22	134	(54-276)
2 Moulder	30	22.62	133	(89-189)
3 Shell moulder	0	0.94	0	(0-390)
4 Furnaceman/caster	28	15.41	182	(121-263)
5 Furnace repair	23	12.71	181	(115-272)
6 Centrifugal caster	7	3.63	193	(78-398)
7 Cranedriver, foundry	12	8.35	144	(74-251)
8 Labourer, foundry	58	37.01	157	(119-203)
9 Knockout gridman	6	3.98	151	(55-328)
10 Other foundry jobs	5	2.83	177	(57-412)
11 Fettler	47	24.97	188	(138-250)
12 Shotblaster	8	5.15	155	(67-306)
13 Welder/burner	11	8.43	130	(65-233)
14 Arc air burner	1	0.51	198	(5-1101)
15 Heat treatment loader	8	3.27	245	(106-482)
16 Cranedriver, fettling	5	3.28	152	(50-356)
17 Labourer, fettling shop	9	7.99	113	(52-214)
18 Other fettling shop jobs	6	3.42	176	(64-382)
19 Pattern maker	5	3.49	143	(47-334)
20 Labourer, pattern shop	2	3.35	60	(7-216)
21 Inspection	6	7.63	79	(29-171)
22 Machinist	34	22.27	153	(106-213)
23 Labourer, machine shop	31	21.25	146	(99-207)
24 Welder: m/c shop, maint.	2	1.18	170	(21-614)
25 Maintenance fitter	13	16.02	81	(43-139)
26 Maintenance fitters mate	20	10.92	183	(112-283)
27 Yard lab., lorry driver	6	13.16	46	(17-99)
28 Precision foundry worker	2	0.48	418	(51-1508)
29 Precision inspection	0	0.17	0	(0-2132)
30 Precision fettler	1	0.19	541	(14-3012)
Total	393	269.80	146	(132-161)

Appendix C: Table 79

Main occupational category

Mortality from cancer of the stomach (151)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	2	1.33	151	(18-545)
2 Moulder	12	5.74	209	(108-365)
3 Shell moulder	0	0.24	0	(0-1556)
4 Furnaceman/caster	8	3.90	205	(89-404)
5 Furnace repair	12	3.29	364	(188-637)
6 Centrifugal caster	1	0.96	104	(3-577)
7 Cranedriver, foundry	3	2.09	143	(30-419)
8 Labourer, foundry	12	10.12	119	(61-207)
9 Knockout gridman	2	1.06	189	(23-683)
10 Other foundry jobs	3	0.83	363	(75-1060)
11 Fettler	4	6.24	64	(17-164)
12 Shotblaster	2	1.29	155	(19-560)
13 Welder/burner	3	2.07	145	(30-424)
14 Arc air burner	0	0.12	0	(0-3024)
15 Heat treatment loader	0	0.82	0	(0-447)
16 Cranedriver, fettling	1	0.84	120	(3-666)
17 Labourer, fettling shop	3	2.24	134	(28-391)
18 Other fettling shop jobs	1	0.88	114	(3-632)
19 Pattern maker	1	0.90	111	(3-621)
20 Labourer, pattern shop	4	0.89	447	(122-1146)
21 Inspection	4	2.00	200	(54-511)
22 Machinist	6	5.55	108	(40-235)
23 Labourer, machine shop	7	6.12	114	(46-236)
24 Welder: m/c shop, maint.	0	0.28	0	(0-1313)
25 Maintenance fitter	5	4.14	121	(39-282)
26 Maintenance fitters mate	4	2.85	140	(38-359)
27 Yard lab., lorry driver	1	3.45	29	(1-162)
28 Precision foundry worker	0	0.12	0	(0-3074)
29 Precision inspection	0	0.05	0	(0-7685)
30 Precision fettler	0	0.04	0	(0-8384)
Total	101	70.45	143	(117-174)

Appendix C: Table 80

Main occupational category

Mortality from diseases of the respiratory system (460-519)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	11	5.10	216	(108-386)
2 Moulder	19	22.89	83	(50-130)
3 Shell moulder	0	0.94	0	(0-394)
4 Furnaceman/caster	23	14.91	154	(98-232)
5 Furnace repair	18	13.19	136	(81-216)
6 Centrifugal caster	7	4.00	175	(70-361)
7 Cranedriver, foundry	7	8.25	85	(34-175)
8 Labourer, foundry	77	47.09	164	(129-204)
9 Knockout gridman	6	4.51	133	(49-290)
10 Other foundry jobs	4	4.25	94	(26-241)
11 Fettler	37	22.84	162	(114-223)
12 Shotblaster	6	4.81	125	(46-272)
13 Welder/burner	14	7.48	187	(102-314)
14 Arc air burner	0	0.42	0	(0-878)
15 Heat treatment loader	3	3.21	94	(19-273)
16 Cranedriver, fettling	12	3.26	368	(190-642)
17 Labourer, fettling shop	21	10.72	196	(121-299)
18 Other fettling shop jobs	4	3.77	106	(29-272)
19 Pattern maker	4	3.58	112	(30-286)
20 Labourer, pattern shop	2	4.14	48	(6-175)
21 Inspection	11	9.30	118	(59-212)
22 Machinist	17	20.68	82	(48-132)
23 Labourer, machine shop	62	31.44	197	(151-253)
24 Welder: m/c shop, maint.	3	0.92	327	(67-956)
25 Maintenance fitter	14	17.37	81	(44-135)
26 Maintenance fitters mate	19	12.27	155	(93-242)
27 Yard lab., lorry driver	15	15.84	95	(53-156)
28 Precision foundry worker	0	0.43	0	(0-868)
29 Precision inspection	0	0.24	0	(0-1543)
30 Precision fettler	0	0.15	0	(0-2476)
Total	416	297.97	140	(127-154)

Appendix C: Table 81

Main occupational category

Mortality from bronchitis, emphysema & asthma (490-493)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	7	2.63	266	(107-549)
2 Moulder	12	11.08	108	(56-189)
3 Shell moulder	0	0.46	0	(0-797)
4 Furnaceman/caster	14	7.51	187	(102-313)
5 Furnace repair	8	6.65	120	(52-237)
6 Centrifugal caster	3	1.98	151	(31-442)
7 Cranedriver, foundry	4	4.02	99	(27-255)
8 Labourer, foundry	50	23.35	214	(159-282)
9 Knockout gridman	1	2.20	45	(1-253)
10 Other foundry jobs	3	2.03	147	(30-431)
11 Fettler	20	11.45	175	(107-270)
12 Shotblaster	6	2.44	246	(90-536)
13 Welder/burner	7	3.63	193	(78-398)
14 Arc air burner	0	0.20	0	(0-1835)
15 Heat treatment loader	2	1.64	122	(15-439)
16 Cranedriver, fettling	5	1.68	297	(97-694)
17 Labourer, fettling shop	9	5.22	172	(79-327)
18 Other fettling shop jobs	3	1.90	158	(33-462)
19 Pattern maker	2	1.62	124	(15-447)
20 Labourer, pattern shop	2	2.06	97	(12-351)
21 Inspection	5	4.49	111	(36-260)
22 Machinist	10	10.14	99	(47-181)
23 Labourer, machine shop	35	15.34	228	(159-317)
24 Welder: m/c shop, maint.	1	0.43	231	(6-1287)
25 Maintenance fitter	6	8.46	71	(26-154)
26 Maintenance fitters mate	14	6.19	226	(124-380)
27 Yard lab., lorry driver	12	7.80	154	(80-269)
28 Precision foundry worker	0	0.23	0	(0-1611)
29 Precision inspection	0	0.13	0	(0-2860)
30 Precision fettler	0	0.08	0	(0-4854)
Total	241	147.03	164	(144-186)

Appendix C: Table 82

Main occupational category

Mortality from diseases of the circulatory system(390-458)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	29	20.82	139	(93-200)
2 Moulder	105	98.03	107	(88-130)
3 Shell moulder	4	3.95	101	(28-259)
4 Furnaceman/caster	65	63.35	103	(79-131)
5 Furnace repair	61	52.72	116	(88-149)
6 Centrifugal caster	11	15.60	71	(35-126)
7 Cranedriver, foundry	28	35.63	79	(52-114)
8 Labourer, foundry	180	162.77	111	(95-128)
9 Knockout gridman	21	17.36	121	(75-185)
10 Other foundry jobs	10	13.61	73	(35-135)
11 Fettler	122	103.28	118	(98-141)
12 Shotblaster	24	20.97	114	(73-170)
13 Welder/burner	46	35.92	128	(94-171)
14 Arc air burner	4	2.26	177	(48-454)
15 Heat treatment loader	13	13.18	99	(53-169)
16 Cranedriver, fettling	14	13.35	105	(57-176)
17 Labourer, fettling shop	41	36.25	113	(81-153)
18 Other fettling shop jobs	13	14.29	91	(48-156)
19 Pattern maker	18	16.33	110	(65-174)
20 Labourer, pattern shop	14	14.51	96	(53-162)
21 Inspection	33	33.86	97	(67-137)
22 Machinist	114	93.99	121	(100-146)
23 Labourer, machine shop	119	97.56	122	(101-146)
24 Welder: m/c shop, maint.	3	5.01	60	(12-175)
25 Maintenance fitter	75	69.62	108	(85-135)
26 Maintenance fitters mate	49	46.06	106	(79-141)
27 Yard lab., lorry driver	61	56.67	108	(82-138)
28 Precision foundry worker	3	1.78	168	(35-492)
29 Precision inspection	1	0.78	128	(3-711)
30 Precision fettler	0	0.74	0	(0-497)
Total	1281	1160.28	110	(104-117)

Appendix C: Table 83

First occupational category

Mortality from all causes (000-999)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	42	38.50	109	(79-147)
2 Moulder	193	202.89	95	(82-110)
3 Shell moulder	7	6.39	109	(44-226)
4 Furnaceman/caster	161	131.06	123	(105-143)
5 Furnace repair	150	114.14	131	(111-154)
6 Centrifugal caster	39	32.10	121	(86-166)
7 Cranedriver, foundry	62	68.34	91	(70-116)
8 Labourer, foundry	496	410.86	121	(110-132)
9 Knockout gridman	30	36.12	83	(56-119)
10 Other foundry jobs	32	28.10	114	(78-161)
11 Fettler	258	210.00	123	(108-139)
12 Shotblaster	38	30.08	126	(89-173)
13 Welder/burner	67	63.76	105	(81-133)
14 Arc air burner	1	2.36	42	(1-236)
15 Heat treatment loader	26	19.93	130	(85-191)
16 Cranedriver, fettling	33	29.23	113	(78-159)
17 Labourer, fettling shop	150	124.65	120	(102-141)
18 Other fettling shop jobs	25	24.36	103	(66-151)
19 Pattern maker	35	37.98	92	(64-128)
20 Labourer, pattern shop	26	27.39	95	(62-139)
21 Inspection	64	70.57	91	(70-116)
22 Machinist	217	210.08	103	(90-118)
23 Labourer, machine shop	253	206.61	122	(108-139)
24 Welder: m/c shop, maint.	12	12.07	99	(51-174)
25 Maintenance fitter	135	146.88	92	(77-109)
26 Maintenance fitters mate	125	101.69	123	(102-146)
27 Yard lab., lorry driver	105	114.56	92	(75-111)
28 Precision foundry worker	6	3.92	153	(56-333)
29 Precision inspection	0	0.57	0	(0-647)
30 Precision fettler	1	1.86	54	(1-300)
Total	2789	2507.03	111	(107-115)

Appendix C: Table 84

First occupational category

Mortality from all malignant neoplasms (140-209)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	5	10.42	48	(16-112)
2 Moulder	55	52.36	105	(79-137)
3 Shell moulder	1	1.72	58	(1-325)
4 Furnaceman/caster	61	34.89	175	(134-225)
5 Furnace repair	48	30.01	160	(118-212)
6 Centrifugal caster	14	8.13	172	(94-289)
7 Cranedriver, foundry	20	17.92	112	(68-172)
8 Labourer, foundry	133	104.31	128	(107-151)
9 Knockout gridman	7	9.17	76	(31-157)
10 Other foundry jobs	14	6.63	211	(115-354)
11 Fettler	72	56.08	128	(100-162)
12 Shotblaster	9	8.09	111	(51-211)
13 Welder/burner	15	16.91	89	(50-146)
14 Arc air burner	0	0.62	0	(0-593)
15 Heat treatment loader	7	5.40	130	(52-267)
16 Cranedriver, fettling	6	7.86	76	(28-166)
17 Labourer, fettling shop	43	31.88	135	(98-182)
18 Other fettling shop jobs	7	6.38	110	(44-226)
19 Pattern maker	7	9.41	74	(30-153)
20 Labourer, pattern shop	9	6.93	130	(59-246)
21 Inspection	15	17.89	84	(47-138)
22 Machinist	65	55.01	118	(91-151)
23 Labourer, machine shop	53	49.64	107	(80-140)
24 Welder: m/c shop, maint.	3	3.21	94	(19-273)
25 Maintenance fitter	34	37.76	90	(62-126)
26 Maintenance fitters mate	39	26.58	147	(104-201)
27 Yard lab., lorry driver	22	29.35	75	(47-113)
28 Precision foundry worker	2	1.11	181	(22-653)
29 Precision inspection	0	0.16	0	(0-2306)
30 Precision fettler	1	0.52	192	(5-1067)
Total	767	646.35	119	(110-127)

Appendix C: Table 85

First occupational category

Mortality from cancers of the trachea, bronchus and lung (162)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	2	4.52	44	(5-160)
2 Moulder	30	21.38	140	(95-200)
3 Shell moulder	0	0.72	0	(0-514)
4 Furnaceman/caster	26	14.83	175	(114-257)
5 Furnace repair	22	12.72	173	(108-262)
6 Centrifugal caster	7	3.38	207	(83-426)
7 Cranedriver, foundry	12	7.46	161	(83-281)
8 Labourer, foundry	73	43.79	167	(131-210)
9 Knockout gridman	4	3.81	105	(29-269)
10 Other foundry jobs	5	2.68	186	(61-435)
11 Fettler	43	23.53	183	(132-246)
12 Shotblaster	4	3.47	115	(31-295)
13 Welder/burner	10	6.95	144	(69-265)
14 Arc air burner	0	0.24	0	(0-1563)
15 Heat treatment loader	4	2.34	171	(47-438)
16 Cranedriver, fettling	4	3.37	119	(32-304)
17 Labourer, fettling shop	23	13.32	173	(109-259)
18 Other fettling shop jobs	5	2.72	184	(60-429)
19 Pattern maker	5	3.58	140	(45-326)
20 Labourer, pattern shop	2	2.93	68	(8-246)
21 Inspection	6	7.49	80	(29-174)
22 Machinist	34	22.55	151	(104-211)
23 Labourer, machine shop	26	20.57	126	(83-185)
24 Welder: m/c shop, maint.	2	1.30	154	(19-557)
25 Maintenance fitter	13	15.63	83	(44-142)
26 Maintenance fitters mate	22	11.32	194	(122-294)
27 Yard lab., lorry driver	6	12.43	48	(18-105)
28 Precision foundry worker	2	0.49	408	(49-1474)
29 Precision inspection	0	0.07	0	(0-5506)
30 Precision fettler	1	0.23	442	(11-2465)
Total	393	269.80	146	(132-161)

Appendix C: Table 86

First occupational category

Mortality from cancer of the stomach (151)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	2	1.14	176	(21-634)
2 Moulder	10	5.43	184	(88-339)
3 Shell moulder	0	0.18	0	(0-2072)
4 Furnaceman/caster	11	3.78	291	(145-521)
5 Furnace repair	13	3.30	394	(210-673)
6 Centrifugal caster	1	0.91	110	(3-610)
7 Cranedriver, foundry	2	1.88	107	(13-385)
8 Labourer, foundry	12	11.82	102	(52-177)
9 Knockout gridman	2	0.99	202	(24-728)
10 Other foundry jobs	3	0.79	380	(78-1110)
11 Fettler	5	5.88	85	(28-198)
12 Shotblaster	1	0.88	113	(3-632)
13 Welder/burner	1	1.71	59	(1-327)
14 Arc air burner	0	0.06	0	(0-6587)
15 Heat treatment loader	0	0.59	0	(0-622)
16 Cranedriver, fettling	1	0.86	117	(3-651)
17 Labourer, fettling shop	5	3.54	141	(46-329)
18 Other fettling shop jobs	1	0.71	142	(4-789)
19 Pattern maker	1	0.92	109	(3-608)
20 Labourer, pattern shop	3	0.79	381	(79-1114)
21 Inspection	3	1.97	153	(31-446)
22 Machinist	7	5.64	124	(50-256)
23 Labourer, machine shop	7	5.94	118	(47-243)
24 Welder: m/c shop, maint.	0	0.31	0	(0-1179)
25 Maintenance fitter	5	4.05	123	(40-288)
26 Maintenance fitters mate	4	2.94	136	(37-348)
27 Yard lab., lorry driver	1	3.27	31	(1-170)
28 Precision foundry worker	0	0.12	0	(0-3074)
29 Precision inspection	0	0.01	0	(0-****)
30 Precision fettler	0	0.05	0	(0-6960)
Total	101	70.45	143	(117-174)

Appendix C: Table 87

First occupational category

Mortality from diseases of the respiratory system (460-519)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	8	4.43	180	(78-355)
2 Moulder	19	21.71	88	(53-137)
3 Shell moulder	0	0.65	0	(0-570)
4 Furnaceman/caster	17	14.71	116	(67-185)
5 Furnace repair	19	13.21	144	(87-225)
6 Centrifugal caster	6	3.96	152	(56-330)
7 Cranedriver, foundry	7	7.45	94	(38-194)
8 Labourer, foundry	92	53.06	173	(140-213)
9 Knockout gridman	6	4.35	138	(51-300)
10 Other foundry jobs	5	4.14	121	(39-282)
11 Fettler	33	21.70	152	(105-214)
12 Shotblaster	4	3.35	119	(32-305)
13 Welder/burner	10	6.16	162	(78-299)
14 Arc air burner	0	0.17	0	(0-2157)
15 Heat treatment loader	1	2.28	44	(1-245)
16 Cranedriver, fettling	12	3.32	361	(187-631)
17 Labourer, fettling shop	31	15.40	201	(137-286)
18 Other fettling shop jobs	4	2.98	134	(37-343)
19 Pattern maker	4	3.65	109	(30-280)
20 Labourer, pattern shop	3	3.77	80	(16-233)
21 Inspection	11	9.20	120	(60-214)
22 Machinist	20	21.10	95	(58-146)
23 Labourer, machine shop	55	30.88	178	(134-232)
24 Welder: m/c shop, maint.	3	1.04	289	(60-845)
25 Maintenance fitter	12	17.09	70	(36-123)
26 Maintenance fitters mate	18	12.41	145	(86-229)
27 Yard lab., lorry driver	16	15.17	105	(60-171)
28 Precision foundry worker	0	0.42	0	(0-887)
29 Precision inspection	0	0.05	0	(0-8019)
30 Precision fettler	0	0.18	0	(0-2072)
Total	416	297.97	140	(127-154)

Appendix C: Table 88

First occupational category

Mortality from bronchitis, emphysema & asthma (490-493)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	5	2.28	220	(71-512)
2 Moulder	12	10.51	114	(59-199)
3 Shell moulder	0	0.32	0	(0-1153)
4 Furnaceman/caster	10	7.44	134	(64-247)
5 Furnace repair	7	6.66	105	(42-217)
6 Centrifugal caster	3	1.96	153	(32-446)
7 Cranedriver, foundry	4	3.61	111	(30-284)
8 Labourer, foundry	59	26.40	223	(170-288)
9 Knockout gridman	1	2.05	49	(1-272)
10 Other foundry jobs	3	1.98	152	(31-443)
11 Fettler	16	10.87	147	(84-239)
12 Shotblaster	4	1.71	234	(64-598)
13 Welder/burner	4	2.99	134	(36-343)
14 Arc air burner	0	0.08	0	(0-4729)
15 Heat treatment loader	1	1.18	85	(2-471)
16 Cranedriver, fettling	5	1.72	291	(94-678)
17 Labourer, fettling shop	19	7.58	251	(151-391)
18 Other fettling shop jobs	3	1.51	199	(41-581)
19 Pattern maker	2	1.66	121	(15-436)
20 Labourer, pattern shop	2	1.87	107	(13-387)
21 Inspection	4	4.43	90	(25-231)
22 Machinist	13	10.35	126	(67-215)
23 Labourer, machine shop	32	14.98	214	(146-301)
24 Welder: m/c shop, maint.	1	0.50	200	(5-1114)
25 Maintenance fitter	5	8.33	60	(19-140)
26 Maintenance fitters mate	14	6.29	223	(122-373)
27 Yard lab., lorry driver	12	7.43	161	(83-282)
28 Precision foundry worker	0	0.22	0	(0-1692)
29 Precision inspection	0	0.02	0	(0-****)
30 Precision fettler	0	0.09	0	(0-4054)
Total	241	147.03	164	(144-186)

Appendix C: Table 89

First occupational category

Mortality from diseases of the circulatory system(390-458)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	24	18.11	133	(85-197)
2 Moulder	101	92.73	109	(89-132)
3 Shell moulder	5	2.97	168	(55-393)
4 Furnaceman/caster	66	60.73	109	(84-138)
5 Furnace repair	62	52.73	118	(90-151)
6 Centrifugal caster	13	14.79	88	(47-150)
7 Cranedriver, foundry	26	32.11	81	(53-119)
8 Labourer, foundry	212	190.30	111	(97-127)
9 Knockout gridman	14	16.99	82	(45-138)
10 Other foundry jobs	11	12.98	85	(42-152)
11 Fettler	120	97.24	123	(102-148)
12 Shotblaster	16	13.99	114	(65-186)
13 Welder/burner	35	29.67	118	(82-164)
14 Arc air burner	1	1.11	90	(2-504)
15 Heat treatment loader	13	9.31	140	(74-239)
16 Cranedriver, fettling	13	13.60	96	(51-163)
17 Labourer, fettling shop	59	58.03	102	(77-131)
18 Other fettling shop jobs	9	11.35	79	(36-150)
19 Pattern maker	18	16.68	108	(64-171)
20 Labourer, pattern shop	11	12.90	85	(43-153)
21 Inspection	31	33.26	93	(63-132)
22 Machinist	111	95.40	116	(96-140)
23 Labourer, machine shop	120	95.50	126	(104-150)
24 Welder: m/c shop, maint.	6	5.48	110	(40-238)
25 Maintenance fitter	74	67.93	109	(86-137)
26 Maintenance fitters mate	53	47.48	112	(84-146)
27 Yard lab., lorry driver	54	53.84	100	(75-131)
28 Precision foundry worker	3	1.86	161	(33-471)
29 Precision inspection	0	0.27	0	(0-1346)
30 Precision fettler	0	0.90	0	(0-410)
Total	1281	1160.28	110	(104-117)

Appendix C: Table 90

Ever employed in each occupational category

Mortality from all causes (000-999)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	68	59.74	114	(88-144)
2 Moulder	241	244.61	99	(86-112)
3 Shell moulder	9	10.16	89	(40-168)
4 Furnaceman/caster	190	161.03	118	(102-136)
5 Furnace repair	155	119.27	130	(110-152)
6 Centrifugal caster	43	37.76	114	(82-153)
7 Cranedriver, foundry	74	86.14	86	(67-108)
8 Labourer, foundry	504	414.59	122	(111-133)
9 Knockout gridman	60	50.98	118	(90-151)
10 Other foundry jobs	37	33.31	111	(78-153)
11 Fettler	299	250.60	119	(106-134)
12 Shotblaster	62	54.33	114	(87-146)
13 Welder/burner	90	83.65	108	(87-132)
14 Arc air burner	7	5.66	124	(50-255)
15 Heat treatment loader	41	31.86	129	(92-175)
16 Cranedriver, fettling	37	34.79	106	(75-147)
17 Labourer, fettling shop	129	109.04	118	(99-141)
18 Other fettling shop jobs	35	36.19	97	(67-135)
19 Pattern maker	36	38.31	94	(66-130)
20 Labourer, pattern shop	43	35.31	122	(88-164)
21 Inspection	78	84.40	92	(73-115)
22 Machinist	228	220.47	103	(90-118)
23 Labourer, machine shop	288	227.91	126	(112-142)
24 Welder: m/c shop, maint.	13	11.99	108	(58-185)
25 Maintenance fitter	150	158.18	95	(80-111)
26 Maintenance fitters mate	131	109.24	120	(100-142)
27 Yard lab., lorry driver	131	148.26	88	(74-105)
28 Precision foundry worker	5	3.66	137	(44-319)
29 Precision inspection	1	1.69	59	(2-330)
30 Precision fettler	2	1.87	107	(13-387)
Total	3187	2865.00	111	(107-115)

Appendix C: Table 91

Ever employed in each occupational category

Mortality from all malignant neoplasms (140-209)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	12	15.97	75	(39-131)
2 Moulder	65	63.36	103	(79-131)
3 Shell moulder	2	2.70	74	(9-267)
4 Furnaceman/caster	68	43.00	158	(123-200)
5 Furnace repair	50	31.38	159	(118-210)
6 Centrifugal caster	18	9.75	185	(109-292)
7 Cranedriver, foundry	25	22.76	110	(71-162)
8 Labourer, foundry	129	105.01	123	(103-146)
9 Knockout gridman	17	13.18	129	(75-207)
10 Other foundry jobs	18	7.96	226	(134-357)
11 Fettler	82	66.76	123	(98-152)
12 Shotblaster	18	14.62	123	(73-195)
13 Welder/burner	20	22.19	90	(55-139)
14 Arc air burner	1	1.50	67	(2-372)
15 Heat treatment loader	11	8.58	128	(64-229)
16 Cranedriver, fettling	7	9.37	75	(30-154)
17 Labourer, fettling shop	32	27.55	116	(79-164)
18 Other fettling shop jobs	9	9.53	94	(43-179)
19 Pattern maker	7	9.48	74	(30-152)
20 Labourer, pattern shop	15	9.12	164	(92-271)
21 Inspection	17	21.62	79	(46-126)
22 Machinist	68	57.82	118	(91-149)
23 Labourer, machine shop	62	55.32	112	(86-144)
24 Welder: m/c shop, maint.	4	3.17	126	(34-323)
25 Maintenance fitter	36	40.81	88	(62-122)
26 Maintenance fitters mate	39	28.51	137	(97-187)
27 Yard lab., lorry driver	28	38.39	73	(48-105)
28 Precision foundry worker	1	1.03	97	(2-540)
29 Precision inspection	0	0.42	0	(0-887)
30 Precision fettler	1	0.52	191	(5-1065)
Total	862	741.37	116	(109-124)

Appendix C: Table 92

Ever employed in each occupational category

Mortality from cancers of the trachea, bronchus and lung (162)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	7	6.89	102	(41-209)
2 Moulder	33	26.01	127	(87-178)
3 Shell moulder	0	1.14	0	(0-324)
4 Furnaceman/caster	31	18.24	170	(115-241)
5 Furnace repair	23	13.32	173	(109-259)
6 Centrifugal caster	9	4.06	222	(101-420)
7 Cranedriver, foundry	15	9.53	157	(88-260)
8 Labourer, foundry	72	44.11	163	(128-206)
9 Knockout gridman	10	5.55	180	(86-331)
10 Other foundry jobs	7	3.22	217	(87-448)
11 Fettler	51	27.94	183	(136-240)
12 Shotblaster	8	6.23	128	(55-253)
13 Welder/burner	13	9.14	142	(76-243)
14 Arc air burner	1	0.59	169	(4-943)
15 Heat treatment loader	7	3.70	189	(76-390)
16 Cranedriver, fettling	5	4.01	125	(40-291)
17 Labourer, fettling shop	15	11.52	130	(73-215)
18 Other fettling shop jobs	7	4.07	172	(69-354)
19 Pattern maker	5	3.60	139	(45-324)
20 Labourer, pattern shop	4	3.89	103	(28-263)
21 Inspection	7	9.03	78	(31-160)
22 Machinist	36	23.73	152	(106-210)
23 Labourer, machine shop	32	23.03	139	(95-196)
24 Welder: m/c shop, maint.	2	1.27	158	(19-570)
25 Maintenance fitter	14	16.92	83	(45-139)
26 Maintenance fitters mate	23	12.12	190	(120-285)
27 Yard lab., lorry driver	9	16.32	55	(25-105)
28 Precision foundry worker	1	0.45	220	(6-1227)
29 Precision inspection	0	0.17	0	(0-2132)
30 Precision fettler	1	0.23	442	(11-2465)
Total	448	310.04	144	(131-159)

Appendix C: Table 93

Ever employed in each occupational category

Mortality from cancer of the stomach (151)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	3	1.76	171	(35-498)
2 Moulder	12	6.60	182	(94-318)
3 Shell moulder	0	0.29	0	(0-1285)
4 Furnaceman/caster	11	4.61	239	(119-427)
5 Furnace repair	13	3.45	376	(200-644)
6 Centrifugal caster	2	1.07	188	(23-678)
7 Cranedriver, foundry	3	2.38	126	(26-368)
8 Labourer, foundry	13	11.93	109	(58-186)
9 Knockout gridman	2	1.47	136	(16-492)
10 Other foundry jobs	3	0.94	318	(66-930)
11 Fettler	5	6.99	72	(23-167)
12 Shotblaster	3	1.56	192	(40-562)
13 Welder/burner	3	2.24	134	(28-391)
14 Arc air burner	0	0.14	0	(0-2544)
15 Heat treatment loader	0	0.94	0	(0-393)
16 Cranedriver, fettling	1	1.01	99	(2-549)
17 Labourer, fettling shop	5	3.12	160	(52-374)
18 Other fettling shop jobs	1	1.04	96	(2-533)
19 Pattern maker	1	0.92	108	(3-604)
20 Labourer, pattern shop	4	1.03	388	(106-992)
21 Inspection	4	2.34	171	(47-438)
22 Machinist	7	5.93	118	(47-243)
23 Labourer, machine shop	7	6.59	106	(43-219)
24 Welder: m/c shop, maint.	0	0.30	0	(0-1221)
25 Maintenance fitter	5	4.37	114	(37-267)
26 Maintenance fitters mate	4	3.15	127	(35-325)
27 Yard lab., lorry driver	1	4.26	23	(1-131)
28 Precision foundry worker	0	0.11	0	(0-3323)
29 Precision inspection	0	0.05	0	(0-7685)
30 Precision fettler	0	0.05	0	(0-6960)
Total	113	80.67	140	(115-168)

Appendix C: Table 94

Ever employed in each occupational category

Mortality from diseases of the respiratory system (460-519)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	13	7.07	184	(98-314)
2 Moulder	23	26.32	87	(55-131)
3 Shell moulder	1	1.13	89	(2-495)
4 Furnaceman/caster	25	17.55	142	(92-210)
5 Furnace repair	20	13.83	145	(88-223)
6 Centrifugal caster	6	4.32	139	(51-302)
7 Cranedriver, foundry	7	9.30	75	(30-155)
8 Labourer, foundry	88	54.07	163	(131-201)
9 Knockout gridman	11	6.11	180	(90-322)
10 Other foundry jobs	5	4.70	106	(35-248)
11 Fettler	37	25.91	143	(101-197)
12 Shotblaster	7	5.88	119	(48-245)
13 Welder/burner	14	8.16	172	(94-288)
14 Arc air burner	1	0.49	204	(5-1139)
15 Heat treatment loader	5	3.66	137	(44-319)
16 Cranedriver, fettling	13	3.94	330	(176-565)
17 Labourer, fettling shop	28	14.08	199	(132-287)
18 Other fettling shop jobs	6	4.40	136	(50-297)
19 Pattern maker	4	3.67	109	(30-279)
20 Labourer, pattern shop	7	4.61	152	(61-313)
21 Inspection	13	10.43	125	(66-213)
22 Machinist	20	22.17	90	(55-139)
23 Labourer, machine shop	65	33.50	194	(150-247)
24 Welder: m/c shop, maint.	3	0.98	305	(63-893)
25 Maintenance fitter	16	18.23	88	(50-143)
26 Maintenance fitters mate	22	13.36	165	(103-249)
27 Yard lab., lorry driver	18	18.98	95	(56-150)
28 Precision foundry worker	0	0.38	0	(0-958)
29 Precision inspection	0	0.24	0	(0-1543)
30 Precision fettler	0	0.18	0	(0-2072)
Total	478	337.67	142	(129-155)

Appendix C: Table 95

Ever employed in each occupational category

Mortality from bronchitis, emphysema & asthma (490–493)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	8	3.60	222	(96–438)
2 Moulder	14	12.81	109	(60–183)
3 Shell moulder	0	0.56	0	(0–654)
4 Furnaceman/caster	15	8.87	169	(95–279)
5 Furnace repair	9	6.99	129	(59–244)
6 Centrifugal caster	3	2.13	141	(29–411)
7 Cranedriver, foundry	4	4.54	88	(24–225)
8 Labourer, foundry	57	26.90	212	(161–275)
9 Knockout gridman	2	3.03	66	(8–239)
10 Other foundry jobs	3	2.27	132	(27–386)
11 Fettler	20	12.92	155	(95–239)
12 Shotblaster	7	2.97	236	(95–485)
13 Welder/burner	7	3.95	177	(71–365)
14 Arc air burner	1	0.23	429	(11–2391)
15 Heat treatment loader	3	1.89	159	(33–464)
16 Cranedriver, fettling	5	2.02	248	(81–579)
17 Labourer, fettling shop	15	6.92	217	(121–358)
18 Other fettling shop jobs	4	2.21	181	(49–463)
19 Pattern maker	2	1.66	120	(15–435)
20 Labourer, pattern shop	3	2.32	130	(27–379)
21 Inspection	5	5.05	99	(32–231)
22 Machinist	12	10.89	110	(57–193)
23 Labourer, machine shop	37	16.36	226	(159–312)
24 Welder: m/c shop, maint.	1	0.46	217	(5–1209)
25 Maintenance fitter	7	8.92	79	(32–162)
26 Maintenance fitters mate	16	6.75	237	(135–385)
27 Yard lab., lorry driver	15	9.40	160	(89–263)
28 Precision foundry worker	0	0.20	0	(0–1835)
29 Precision inspection	0	0.13	0	(0–2860)
30 Precision fettler	0	0.09	0	(0–4054)
Total	275	167.02	165	(146–185)

Appendix C: Table 96

Ever employed in each occupational category

Mortality from diseases of the circulatory system(390-458)

Group	Obs.	Exp.	SMR	95% Conf.Int.
1 Sand miller	36	27.87	129	(90-179)
2 Moulder	126	112.14	112	(94-134)
3 Shell moulder	5	4.75	105	(34-246)
4 Furnaceman/caster	80	74.65	107	(85-133)
5 Furnace repair	64	55.12	116	(89-148)
6 Centrifugal caster	12	17.45	69	(36-120)
7 Cranedriver, foundry	33	40.46	82	(56-115)
8 Labourer, foundry	227	192.01	118	(103-135)
9 Knockout gridman	28	23.65	118	(79-171)
10 Other foundry jobs	12	15.31	78	(41-137)
11 Fettler	137	116.18	118	(99-139)
12 Shotblaster	27	25.45	106	(70-154)
13 Welder/burner	48	38.93	123	(91-163)
14 Arc air burner	4	2.64	151	(41-388)
15 Heat treatment loader	18	14.88	121	(72-191)
16 Cranedriver, fettling	15	16.30	92	(52-152)
17 Labourer, fettling shop	57	50.65	113	(85-146)
18 Other fettling shop jobs	14	16.99	82	(45-138)
19 Pattern maker	19	16.80	113	(68-177)
20 Labourer, pattern shop	17	16.51	103	(60-165)
21 Inspection	39	39.64	98	(70-135)
22 Machinist	118	100.22	118	(97-141)
23 Labourer, machine shop	134	105.14	127	(107-151)
24 Welder: m/c shop, maint.	5	5.43	92	(30-215)
25 Maintenance fitter	81	73.11	111	(88-138)
26 Maintenance fitters mate	56	50.94	110	(83-143)
27 Yard lab., lorry driver	71	69.63	102	(80-129)
28 Precision foundry worker	3	1.73	174	(36-507)
29 Precision inspection	1	0.78	128	(3-711)
30 Precision fettler	0	0.90	0	(0-409)
Total	1487	1326.26	112	(106-118)

Appendix C: Table 97

Factory by age at entry (exposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Under 25	25-34	35-44	45-54	55-64	65+	Total
10	10/6.44	32/27.59	67/52.59	63/48.16	41/33.01	5/10.19	218/178.0
	155	116	127	131*	124	49	122**
	(144)	(107)	(118)	(121)	(115)	(45)	(113)
11	10/12.41	64/56.06	99/78.58	81/68.61	23/23.74	1/3.66	278/243.1
	81	114	126*	118	97	27	114*
	(73)	(104)	(115)	(107)	(88)	(25)	(104)
12	4/5.88	18/11.60	15/18.45	21/22.51	14/9.04	1/1.71	73/69.21
	68	155	81	93	155	59	105
	(62)	(141)	(74)	(85)	(141)	(53)	(96)
13	4/7.40	17/18.92	27/23.93	20/17.42	8/14.39	0/0.00	76/82.06
	54	90	113	115	56	-	93
	(56)	(93)	(116)	(118)	(57)	-	(95)
14	30/23.95	125/103.9	191/142.7	137/114.8	32/27.63	0/0.00	515/413.0
	125	120*	134***	119*	116	-	125***
	(115)	(110)	(123**)	(109)	(106)	-	(114**)
15	8/8.38	32/26.91	45/42.67	34/35.38	14/11.55	0/0.00	133/124.9
	95	119	105	96	121	-	106
	(82)	(103)	(91)	(83)	(104)	-	(92)
16	27/25.27	63/65.81	62/60.83	41/46.94	8/12.30	7/6.98	208/218.1
	107	96	102	87	65	100	95
	(96)	(86)	(92)	(79)	(59)	(90)	(86*)
17	8/10.25	36/28.95	45/47.44	41/39.26	12/8.87	1/0.04	143/134.8
	78	124	95	104	135	2857	106
	(77)	(123)	(94)	(103)	(134)	(2829)	(105)
18	19/26.62	78/81.83	124/95.31	107/81.58	38/30.31	3/3.98	369/319.6
	71	95	130**	131**	125	75	115**
	(65)	(87)	(119)	(120)	(115)	(69)	(106)
19	9/9.41	30/20.56	33/25.53	40/31.12	16/17.79	0/0.00	128/104.4
	96	146	129	129	90	-	123*
	(78)	(119)	(105)	(104)	(73)	-	(100)
Total	129/136.0	495/442.1	708/588.0	585/505.8	206/188.6	18/26.55	2141/1887.2
	95	112*	120***	116***	109	68	113***
	(87)	(102)	(110*)	(106)	(100)	(62*)	(104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 98

Factory by age at entry (exposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Under 25	25-34	35-44	45-54	55-64	65+	Total
10	0/0.47 0 (0)	9/3.08 292** (281*)	14/6.48 216* (208*)	9/5.19 173 (167)	4/2.60 154 (148)	1/0.45 222 (213)	37/18.28 202*** (195***)
11	1/0.86 116 (110)	9/6.07 148 (141)	23/9.67 238*** (226***)	14/7.93 177 (168)	3/1.89 159 (151)	0/0.13 0 (0)	50/26.55 188*** (179***)
12	2/0.42 481 (467)	2/1.28 156 (152)	3/2.21 136 (132)	3/2.47 121 (118)	1/0.82 122 (119)	0/0.05 0 (0)	11/7.24 152 (148)
13	0/0.48 0 (0)	3/2.04 147 (145)	0/2.90 0 (0)	0/2.05 0 (0)	0/1.08 0 (0)	0/0.00 - -	3/8.55 35 (35)
14	1/1.70 59 (54)	24/11.23 214** (196**)	40/17.67 226*** (208***)	25/13.27 188** (173*)	5/2.57 195 (178)	0/0.00 - -	95/46.44 205*** (188***)
15	0/0.52 0 (0)	6/3.00 200 (170)	6/5.26 114 (97)	4/3.89 103 (87)	0/1.01 0 (0)	0/0.00 - -	16/13.68 117 (99)
16	4/1.88 213 (201)	9/7.42 121 (115)	8/7.44 107 (101)	8/5.19 154 (145)	0/1.29 0 (0)	0/0.61 0 (0)	29/23.83 122 (115)
17	0/0.80 0 (0)	4/3.23 124 (133)	3/5.81 52 (56)	5/4.23 118 (127)	2/0.73 275 (295)	0/0.00 0 (0)	14/14.79 95 (102)
18	3/1.88 160 (152)	9/9.04 100 (95)	13/11.84 110 (105)	17/9.63 177* (168)	3/2.31 130 (124)	0/0.20 0 (0)	45/34.90 129 (123)
19	0/0.59 0 (0)	5/2.16 231 (194)	4/3.18 126 (106)	2/3.62 55 (46)	5/1.43 351* (295)	0/0.00 - -	16/10.98 146 (122)
Total	11/9.61 114 (108)	80/48.54 165*** (155***)	114/72.46 157*** (148***)	87/57.46 151*** (142**)	23/15.73 146 (137)	1/1.44 70 (66)	316/205.2 154*** (145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 99

Factory by age at entry (exposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Under 25	25-34	35-44	45-54	55-64	65+	Total
10	2/0.38 531 (474)	2/2.19 91 (82)	15/5.89 255** (228**)	13/7.45 174 (156)	7/5.64 124 (111)	0/2.03 0 (0)	39/23.58 165** (148*)
11	0/0.72 0 (0)	3/4.24 71 (61)	10/8.68 115 (99)	15/10.01 150 (129)	4/4.15 96 (83)	1/0.74 134 (116)	33/28.54 116 (100)
12	0/0.34 0 (0)	2/0.93 216 (184)	1/2.31 43 (37)	3/3.37 89 (76)	3/1.51 198 (170)	0/0.28 0 (0)	9/8.74 103 (88)
13	0/0.42 0 (0)	1/1.43 70 (75)	3/2.56 117 (126)	3/2.44 123 (132)	3/2.75 109 (117)	0/0.00 - -	10/9.60 104 (112)
14	3/1.38 218 (173)	15/7.88 190* (151)	36/15.59 231*** (183**)	34/16.63 204*** (162*)	7/4.64 151 (120)	0/0.00 - -	95/46.12 206*** (163***)
15	1/0.46 215 (168)	4/2.13 188 (147)	7/4.95 141 (110)	8/5.40 148 (116)	1/2.00 50 (39)	0/0.00 - -	21/14.94 141 (110)
16	1/1.49 67 (56)	7/5.37 130 (109)	12/6.88 174 (145)	7/7.08 99 (82)	1/1.97 51 (42)	2/1.30 154 (128)	30/24.10 124 (104)
17	0/0.61 0 (0)	5/2.28 219 (209)	5/5.50 91 (87)	11/6.16 179 (170)	4/1.52 264 (251)	0/0.01 0 (0)	25/16.07 156* (148)
18	4/1.53 261 (231)	6/6.43 93 (83)	12/10.35 116 (103)	17/11.53 147 (130)	6/5.43 111 (98)	0/0.74 0 (0)	45/36.01 125 (111)
19	0/0.53 0 (0)	1/1.54 65 (65)	2/2.57 78 (77)	7/4.46 157 (155)	0/3.14 0 (0)	0/0.00 - -	10/12.23 82 (81)
Total	11/7.85 140 (121)	46/34.41 134 (115)	103/65.26 158*** (135**)	118/74.55 158*** (136**)	36/32.76 110 (97)	3/5.10 59 (51)	317/219.9 144*** (124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 100

Mortality from all causes (000-999)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	10/20.67	39/32.81	52/52.98	28/29.54	129/136.0
	48*	119	98	95	95
	(44**)	(108)	(90)	(87)	(87)
25-34	45/41.88	131/108.4	215/195.6	104/96.22	495/442.1
	107	121*	110	108	112*
	(98)	(110)	(100)	(99)	(102)
35-44	79/70.11	227/187.2	301/253.3	101/77.37	708/588.0
	113	121**	119**	131*	120***
	(103)	(111)	(109)	(120)	(110*)
45-54	107/101.6	264/206.6	183/172.3	31/25.31	585/505.8
	105	128***	106	123	116***
	(96)	(117*)	(97)	(112)	(106)
55-64	47/61.94	114/85.71	43/38.09	2/2.90	206/188.6
	76	133**	113	69	109
	(69**)	(121)	(104)	(64)	(100)
65+	7/10.08	9/13.37	2/3.09	0/0.00	18/26.55
	69	67	65	-	68
	(63)	(62)	(59)	-	(62*)
Total	295/306.3	784/634.2	796/715.4	266/231.3	2141/1887.2
	96	124***	111**	115*	113***
	(88*)	(113***)	(102)	(105)	(104)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 101

Mortality from all malignant neoplasms (140-209)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/2.76	7/6.62	10/13.18	11/8.57	28/31.12
	0	106	76	128	90
	(0)	(100)	(72)	(122)	(85)
25-34	7/7.89	33/26.56	58/56.09	33/28.96	131/119.5
	89	124	103	114	110
	(84)	(118)	(98)	(108)	(104)
35-44	23/17.64	79/53.36	93/72.87	25/20.06	220/163.9
	130	148**	128*	125	134***
	(124)	(140**)	(121)	(119)	(127***)
45-54	34/28.23	80/56.59	45/41.13	7/4.59	166/130.5
	120	141**	109	153	127**
	(114)	(134*)	(104)	(145)	(121*)
55-64	14/15.54	30/18.63	7/5.93	0/0.43	51/40.53
	90	161*	118	0	126
	(86)	(153*)	(112)	(0)	(119)
65+	3/2.15	4/1.97	0/0.43	0/0.00	7/4.54
	140	203	0	-	154
	(134)	(196)	(0)	-	(148)
Total	81/74.20	233/163.7	213/189.6	76/62.60	603/490.1
	109	142***	112	121	123***
	(104)	(135***)	(107)	(116)	(117***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 102

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.23	0/1.34	5/4.54	6/3.49	11/9.61
	0	0	110	172	114
	(0)	(0)	(104)	(163)	(108)
25–34	3/1.82	17/9.76	38/24.22	22/12.74	80/48.54
	165	174*	157*	173*	165***
	(154)	(163)	(147*)	(163*)	(155***)
35–44	13/7.02	41/24.41	46/32.73	14/8.31	114/72.46
	185	168**	141*	168	157***
	(174)	(158**)	(132)	(159)	(148***)
45–54	19/13.11	39/25.97	27/16.82	2/1.56	87/57.46
	145	150*	161*	128	151***
	(136)	(141*)	(151)	(121)	(142**)
55–64	3/6.63	16/7.21	4/1.77	0/0.13	23/15.73
	45	222**	226	0	146
	(42)	(208*)	(211)	(0)	(137)
65+	0/0.78	1/0.54	0/0.12	0/0.00	1/1.44
	0	186	0	-	70
	(0)	(177)	(0)	-	(66)
Total	38/29.60	114/69.23	120/80.20	44/26.23	316/205.2
	128	165***	150***	168**	154***
	(121)	(155***)	(141***)	(158**)	(145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 103

Mortality from cancer of the stomach (151)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.11 0 (0)	2/0.50 400 (373)	2/1.14 175 (163)	1/0.73 137 (128)	5/2.48 202 (188)
25-34	0/0.77 0 (0)	8/2.71 295* (274*)	4/5.25 76 (71)	2/2.65 75 (70)	14/11.37 123 (114)
35-44	4/2.32 173 (160)	12/6.00 200* (185)	12/7.57 159 (147)	1/2.04 49 (45)	29/17.92 162* (150*)
45-54	3/3.91 77 (71)	12/6.70 179 (166)	4/4.44 90 (83)	0/0.44 0 (0)	19/15.50 123 (114)
55-64	5/2.29 219 (204)	5/2.39 209 (195)	1/0.67 150 (142)	0/0.04 0 (0)	11/5.38 205* (191)
65+	2/0.31 649 (613)	1/0.24 410 (388)	0/0.05 0 (0)	0/0.00 - -	3/0.60 503* (475)
Total	14/9.69 144 (134)	40/18.54 216*** (200***)	23/19.11 120 (112)	4/5.91 68 (63)	81/53.25 152*** (141**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 104

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	2/1.05	5/1.85	2/3.04	2/1.91	11/7.85
	190	271	66	105	140
	(165)	(234)	(57)	(91)	(121)
25-34	2/2.65	7/7.53	24/15.25	13/8.99	46/34.41
	75	93	157*	145	134
	(65)	(80)	(135)	(124)	(115)
35-44	6/6.14	31/18.56	54/29.34	12/11.22	103/65.26
	98	167*	184***	107	158***
	(84)	(144)	(158**)	(92)	(135**)
45-54	20/12.46	44/28.22	45/28.34	9/5.51	118/74.55
	160	156**	159**	163	158***
	(139)	(135)	(137)	(139)	(136**)
55-64	6/9.35	19/14.49	11/8.20	0/0.71	36/32.76
	64	131	134	0	110
	(56)	(115)	(120)	(0)	(97)
65+	1/1.64	1/2.73	1/0.73	0/0.00	3/5.10
	61	37	137	-	59
	(52)	(32)	(121)	-	(51)
Total	37/33.30	107/73.38	137/84.90	36/28.34	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 105

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and age at entry (exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	1/0.15 676	2/0.53 376	2/1.28 157	0/0.88 0	5/2.83 176
25-34	0/0.64 0	3/3.29 91	11/7.91 139	5/4.26 117	19/16.10 118
35-44	2/2.73 73	22/10.72 205**	32/15.60 205***	5/4.68 107	61/33.73 181***
45-54	12/7.24 166	29/16.73 173**	26/12.68 205**	6/1.63 367*	73/38.28 191***
55-64	5/5.63 89	14/7.48 187*	3/2.74 110	0/0.18 0	22/16.02 137
65+	0/0.91 0	0/0.99 0	0/0.20 0	0/0.00 -	0/2.10 0
Total	20/17.31 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 106

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and age at entry (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	1/2.01	18/9.82	30/25.69	13/15.41	62/52.93
	50	183*	117	84	117
	(44)	(162)	(103)	(75)	(104)
25-34	11/9.88	63/47.56	114/100.2	52/49.61	240/207.3
	111	132*	114	105	116*
	(99)	(118)	(101)	(93)	(103)
35-44	32/25.02	95/86.59	125/128.7	58/39.82	310/280.1
	128	110	97	146**	111
	(114)	(98)	(86)	(129)	(98)
45-54	37/38.92	123/96.07	78/88.13	15/12.83	253/235.9
	95	128**	89	117	107
	(84)	(113)	(78*)	(103)	(95)
55-64	19/24.25	51/40.00	23/19.95	1/1.47	94/85.66
	78	128	115	68	110
	(69)	(112)	(103)	(62)	(97)
65+	2/4.43	4/6.66	1/1.63	0/0.00	7/12.71
	45	60	62	-	55
	(39)	(53)	(54)	-	(48*)
Total	102/104.5	354/286.7	371/364.3	139/119.1	966/874.6
	98	123***	102	117	110**
	(86)	(109)	(90)	(103)	(98)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 107

Factory by age at entry (unexposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Under 25	25-34	35-44	45-54	55-64	65+	Total
10	2/4.33	14/15.45	13/18.54	14/13.68	3/3.81	0/0.00	46/55.80
	46	91	70	102	79	-	82
	(43)	(84)	(65)	(95)	(73)	-	(76)
11	1/1.61	3/7.33	14/12.75	15/15.57	14/8.99	0/2.11	47/48.37
	62	41	110	96	156	0	97
	(56)	(37)	(100)	(88)	(142)	(0)	(88)
12	4/1.24	2/2.26	2/2.72	6/6.08	5/4.56	0/0.00	19/16.85
	323	89	73	99	110	-	113
	(294)	(81)	(67)	(90)	(100)	-	(102)
13	1/3.73	3/5.67	5/7.45	7/12.00	2/1.56	0/0.00	18/30.41
	27	53	67	58	128	-	59*
	(28)	(55)	(69)	(60)	(132)	-	(61*)
14	2/6.10	18/18.32	17/18.36	39/30.91	6/14.76	0/0.00	82/88.46
	33	98	93	126	41*	-	93
	(30)	(90)	(85)	(116)	(37**)	-	(85)
15	0/0.80	0/1.25	5/4.05	3/2.33	2/0.87	0/0.00	10/9.30
	0	0	123	129	231	-	108
	(0)	(0)	(106)	(111)	(199)	-	(93)
16	5/3.10	8/7.13	6/7.49	14/10.12	6/7.54	0/0.00	39/35.38
	161	112	80	138	80	-	110
	(145)	(101)	(72)	(125)	(72)	-	(99)
17	2/4.59	9/9.54	16/13.30	11/13.63	7/5.45	0/0.00	45/46.51
	44	94	120	81	128	-	97
	(43)	(93)	(119)	(80)	(127)	-	(96)
18	13/13.99	34/29.96	46/37.91	94/71.23	80/65.90	0/0.00	267/219.0
	93	113	121	132*	121	-	122**
	(85)	(104)	(111)	(121)	(111)	-	(112)
19	8/7.81	12/14.14	19/18.87	28/24.44	7/3.28	1/1.23	75/69.78
	102	85	101	115	213	81	107
	(83)	(69)	(82)	(93)	(173)	(66)	(87)
Total	38/47.30	103/111.0	143/141.4	231/200.0	132/116.7	1/3.34	648/619.8
	80	93	101	116*	113	30	105
	(73)	(85)	(92)	(105)	(104)	(26)	(95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 108

Factory by age at entry (unexposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Under 25	25-34	35-44	45-54	55-64	65+	Total
10	0/0.33 0 (0)	2/1.73 115 (111)	3/2.26 133 (128)	4/1.44 279 (268)	1/0.37 267 (257)	0/0.00 - -	10/6.13 163 (157)
11	0/0.10 0 (0)	0/0.75 0 (0)	0/1.60 0 (0)	2/1.77 113 (108)	2/0.94 213 (203)	0/0.13 0 (0)	4/5.29 76 (72)
12	1/0.08 1333 (1294)	0/0.25 0 (0)	0/0.33 0 (0)	0/0.67 0 (0)	0/0.45 0 (0)	0/0.00 - -	1/1.77 57 (55)
13	0/0.21 0 (0)	1/0.61 164 (163)	0/0.93 0 (0)	1/1.35 74 (73)	0/0.18 0 (0)	0/0.00 - -	2/3.27 61 (60)
14	1/0.34 292 (268)	1/1.90 53 (48)	0/2.26 0 (0)	2/3.55 56 (52)	0/1.44 0 (0)	0/0.00 - -	4/9.50 42 (39*)
15	0/0.05 0 (0)	0/0.14 0 (0)	0/0.50 0 (0)	0/0.27 0 (0)	0/0.10 0 (0)	0/0.00 - -	0/1.07 0 (0)
16	1/0.17 575 (542)	1/0.77 129 (122)	0/0.93 0 (0)	4/1.18 339 (320)	0/0.62 0 (0)	0/0.00 - -	6/3.67 163 (154)
17	1/0.36 277 (298)	1/1.05 95 (102)	4/1.64 244 (262)	4/1.38 291 (313)	0/0.38 0 (0)	0/0.00 - -	10/4.81 208 (224*)
18	1/0.89 112 (107)	2/3.33 60 (57)	7/4.67 150 (143)	10/7.91 127 (120)	9/4.86 185 (176)	0/0.00 - -	29/21.66 134 (128)
19	1/0.45 224 (188)	2/1.50 134 (112)	5/2.33 214 (180)	2/2.72 74 (62)	1/0.34 297 (249)	0/0.06 0 (0)	11/7.39 149 (125)
Total	6/2.98 201 (190)	10/12.03 83 (78)	19/17.46 109 (102)	29/22.22 131 (123)	13/9.67 134 (127)	0/0.19 0 (0)	77/64.55 119 (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 109

Factory by age at entry (unexposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: Under 25	25-34	35-44	45-54	55-64	65+	Total
10	0/0.26	1/1.23	0/2.15	1/2.20	0/0.62	0/0.00	2/6.47
	0	81	0	45	0	-	31
	(0)	(72)	(0)	(41)	(0)	-	(28*)
11	0/0.09	0/0.52	2/1.28	2/2.27	2/1.47	0/0.46	6/6.08
	0	0	156	88	137	0	99
	(0)	(0)	(135)	(76)	(118)	(0)	(85)
12	1/0.07	0/0.17	0/0.33	1/0.91	1/0.71	0/0.00	3/2.19
	1449	0	0	110	141	-	137
	(1239)	(0)	(0)	(94)	(120)	-	(117)
13	0/0.20	0/0.41	0/0.75	1/1.79	0/0.24	0/0.00	1/3.39
	0	0	0	56	0	-	29
	(0)	(0)	(0)	(60)	(0)	-	(32)
14	0/0.34	2/1.36	3/1.88	6/4.47	1/2.46	0/0.00	12/10.50
	0	147	160	134	41	-	114
	(0)	(117)	(127)	(107)	(32)	-	(91)
15	0/0.04	0/0.10	0/0.47	1/0.34	0/0.13	0/0.00	1/1.08
	0	0	0	296	0	-	92
	(0)	(0)	(0)	(231)	(0)	-	(72)
16	1/0.17	0/0.56	1/0.77	2/1.40	1/1.41	0/0.00	5/4.31
	592	0	130	143	71	-	116
	(493)	(0)	(108)	(119)	(59)	-	(97)
17	0/0.27	1/0.74	2/1.46	3/2.26	1/0.98	0/0.00	7/5.71
	0	136	137	133	102	-	123
	(0)	(130)	(130)	(126)	(97)	-	(117)
18	1/0.80	3/2.36	8/4.22	22/10.94	26/12.08	0/0.00	60/30.40
	125	127	190	201**	215***	-	197***
	(111)	(112)	(168)	(178*)	(190**)	-	(175***)
19	0/0.43	1/1.05	0/1.97	1/3.68	0/0.55	0/0.21	2/7.90
	0	95	0	27	0	0	25*
	(0)	(94)	(0)	(27)	(0)	(0)	(25*)
Total	3/2.67	8/8.49	16/15.28	40/30.28	32/20.65	0/0.67	99/78.04
	112	94	105	132	155*	0	127*
	(101)	(84)	(93)	(117)	(135)	(0)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 110

Mortality from all causes (000-999)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	4/8.16 49 (44)	9/11.74 77 (70)	14/18.28 77 (70)	11/9.12 121 (110)	38/47.30 80 (73)
25-34	8/10.86 74 (67)	32/27.69 116 (105)	38/48.54 78 (71*)	25/23.96 104 (95)	103/111.0 93 (85)
35-44	15/17.43 86 (78)	46/47.17 98 (89)	61/59.90 102 (93)	21/16.93 124 (113)	143/141.4 101 (92)
45-54	46/41.13 112 (102)	101/79.49 127* (116)	70/69.56 101 (92)	14/9.80 143 (132)	231/200.0 116* (105)
55-64	49/39.31 125 (114)	59/49.53 119 (109)	23/24.25 95 (87)	1/3.62 28 (25)	132/116.7 113 (104)
65+	0/1.15 0 (0)	1/2.19 46 (40)	0/0.00 - -	0/0.00 - -	1/3.34 30 (26)
Total	122/118.0 103 (94)	248/217.8 114* (104)	206/220.5 93 (85*)	72/63.44 114 (104)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 111

Mortality from all malignant neoplasms (140-209)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	1/1.02 98 (92)	1/2.30 44 (41)	5/4.45 112 (107)	6/2.61 230 (220)	13/10.38 125 (119)
25-34	1/2.03 49 (47)	8/6.75 119 (112)	6/13.87 43* (41*)	8/7.22 111 (106)	23/29.87 77 (73)
35-44	4/4.37 92 (87)	15/13.48 111 (106)	17/17.28 98 (94)	6/4.45 135 (128)	42/39.58 106 (101)
45-54	13/11.45 114 (108)	27/21.66 125 (118)	15/15.91 94 (90)	4/1.79 223 (214)	59/50.82 116 (110)
55-64	9/9.87 91 (87)	12/10.79 111 (106)	6/3.74 160 (153)	0/0.54 0 (0)	27/24.94 108 (104)
65+	0/0.25 0 (0)	0/0.35 0 (0)	0/0.00 - -	0/0.00 - -	0/0.59 0 (0)
Total	28/28.99 97 (92)	63/55.33 114 (108)	49/55.26 89 (84)	24/16.61 145 (138)	164/156.2 105 (100)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 112

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.08	0/0.42	3/1.44	3/1.05	6/2.98
	0	0	208	287	201
	(0)	(0)	(197)	(272)	(190)
25-34	0/0.46	2/2.44	2/5.96	6/3.18	10/12.03
	0	82	34	189	83
	(0)	(77)	(32)	(179)	(78)
35-44	4/1.73	6/6.12	7/7.76	2/1.85	19/17.46
	231	98	90	108	109
	(217)	(92)	(85)	(102)	(102)
45-54	6/5.35	13/9.89	10/6.37	0/0.61	29/22.22
	112	131	157	0	131
	(105)	(123)	(148)	(0)	(123)
55-64	4/4.22	6/4.18	3/1.11	0/0.16	13/9.67
	95	144	271	0	134
	(90)	(136)	(256)	(0)	(127)
65+	0/0.09	0/0.10	0/0.00	0/0.00	0/0.19
	0	0	-	-	0
	(0)	(0)	-	-	(0)
Total	14/11.93	27/23.15	25/22.63	11/6.85	77/64.55
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 113

Mortality from cancer of the stomach (151)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.03 0 (0)	0/0.16 0 (0)	0/0.38 0 (0)	2/0.22 901* (851*)	2/0.79 253 (240)
25–34	0/0.19 0 (0)	1/0.68 147 (138)	1/1.29 77 (73)	0/0.66 0 (0)	2/2.82 71 (67)
35–44	0/0.56 0 (0)	1/1.47 68 (64)	1/1.78 56 (53)	3/0.46 659* (618*)	5/4.27 117 (110)
45–54	2/1.57 128 (120)	2/2.55 78 (74)	1/1.71 58 (55)	0/0.17 0 (0)	5/6.00 83 (78)
55–64	3/1.44 208 (196)	2/1.35 148 (139)	1/0.41 247 (232)	0/0.05 0 (0)	6/3.25 185 (173)
65+	0/0.04 0 (0)	0/0.04 0 (0)	0/0.00 – –	0/0.00 – –	0/0.08 0 (0)
Total	5/3.83 131 (123)	6/6.26 96 (90)	4/5.56 72 (68)	5/1.56 320* (302)	20/17.20 116 (109)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 114

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	0/0.41	1/0.66	1/1.02	1/0.58	3/2.67
	0	153	98	172	112
	(0)	(137)	(88)	(154)	(101)
25-34	1/0.68	1/1.88	5/3.73	1/2.20	8/8.49
	147	53	134	45	94
	(130)	(47)	(119)	(40)	(84)
35-44	2/1.49	6/4.53	4/6.86	4/2.40	16/15.28
	134	132	58	167	105
	(119)	(118)	(52)	(148)	(93)
45-54	8/5.12	13/10.95	14/12.09	5/2.12	40/30.28
	156	119	116	235	132
	(138)	(105)	(104)	(211)	(117)
55-64	16/5.94	10/8.42	6/5.40	0/0.89	32/20.65
	270***	119	111	0	155*
	(236**)	(103)	(97)	(0)	(135)
65+	0/0.19	0/0.48	0/0.00	0/0.00	0/0.67
	0	0	-	-	0
	(0)	(0)	-	-	(0)
Total	27/13.83	31/26.91	30/29.11	11/8.19	99/78.04
	195**	115	103	134	127*
	(172*)	(101)	(92)	(120)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 115

Mortality from bronchitis, emphysema & asthma (490–493)
by years since first exposure and age at entry (unexposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 – 9	10 – 19	20 – 29	30 +	Total
Under 25	0/0.05 0	0/0.18 0	0/0.42 0	1/0.26 380	1/0.91 110
25–34	1/0.16 617	1/0.81 123	4/1.92 208	1/1.04 96	7/3.94 178
35–44	1/0.67 150	3/2.58 116	2/3.63 55	0/1.02 0	6/7.90 76
45–54	5/3.02 166	10/6.44 155	11/5.12 215*	1/0.63 158	27/15.21 178**
55–64	11/3.59 307**	7/4.24 165	2/1.68 119	0/0.22 0	20/9.73 205**
65+	0/0.11 0	0/0.16 0	0/0.00 –	0/0.00 –	0/0.27 0
Total	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.96 161***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 116

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and age at entry (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
Under 25	2/0.68	4/3.17	4/8.56	3/4.74	13/17.15
	292	126	47	63	76
	(257)	(111)	(41)	(56)	(67)
25-34	5/2.55	20/12.15	20/24.87	15/12.36	60/51.92
	196	165*	80	121	116
	(173)	(145)	(71)	(107)	(102)
35-44	7/6.45	24/22.23	35/30.47	9/8.73	75/67.87
	109	108	115	103	111
	(96)	(95)	(101)	(90)	(97)
45-54	14/16.00	49/37.22	37/35.54	4/4.96	104/93.72
	88	132	104	81	111
	(77)	(116)	(92)	(72)	(98)
55-64	21/15.48	31/23.49	9/12.63	1/1.83	62/53.42
	136	132	71	55	116
	(119)	(117)	(63)	(48)	(103)
65+	0/0.51	1/1.07	0/0.00	0/0.00	1/1.58
	0	93	-	-	63
	(0)	(78)	-	-	(53)
Total	49/41.66	129/99.32	105/112.1	32/32.62	315/285.7
	118	130**	94	98	110
	(103)	(114)	(83)	(87)	(97)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 117

Factory by entry cohort (exposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	94/78.06 120 (111)	75/54.38 138** (128*)	29/28.43 102 (94)	20/17.10 117 (108)	218/178.0 122** (113)
11	102/75.67 135** (123)	100/90.17 111 (101)	56/60.46 93 (84)	20/16.77 119 (108)	278/243.1 114* (104)
12	38/33.61 113 (103)	13/13.65 95 (87)	13/14.60 89 (81)	9/7.34 123 (111)	73/69.21 105 (96)
13	23/21.39 108 (111)	23/30.72 75 (77)	18/18.74 96 (99)	12/11.21 107 (110)	76/82.06 93 (95)
14	172/128.6 134*** (123*)	177/161.1 110 (101)	110/80.07 137** (126*)	56/43.26 129 (119)	515/413.0 125*** (114**)
15	58/50.79 114 (98)	51/53.34 96 (82)	8/10.58 76 (65)	16/10.18 157 (136)	133/124.9 106 (92)
16	103/101.5 102 (91)	50/58.27 86 (77)	29/29.33 99 (89)	26/29.07 89 (81)	208/218.1 95 (86*)
17	70/55.43 126 (125)	56/65.27 86 (85)	7/5.71 122 (121)	10/8.40 119 (118)	143/134.8 106 (105)
18	124/112.9 110 (101)	135/103.1 131** (120*)	89/77.27 115 (106)	21/26.40 80 (73)	369/319.6 115** (106)
19	37/27.65 134 (109)	43/34.26 125 (102)	34/31.26 109 (88)	14/11.23 125 (101)	128/104.4 123* (100)
Total	821/685.6 120*** (109*)	723/664.2 109* (100)	393/356.5 110 (100)	204/181.0 113 (103)	2141/1887.2 113*** (104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 118

Factory by entry cohort (exposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	14/7.42 189* (181)	13/5.98 218* (209*)	8/2.93 273* (263*)	2/1.96 102 (98)	37/18.28 202*** (195***)
11	17/8.39 203* (193*)	16/9.73 164 (157)	12/6.63 181 (172)	5/1.80 278 (265)	50/26.55 188*** (179***)
12	5/3.58 140 (136)	3/1.31 229 (223)	2/1.55 129 (126)	1/0.80 125 (121)	11/7.24 152 (148)
13	1/2.34 43 (42)	1/3.00 33 (33)	0/2.02 0 (0)	1/1.19 84 (83)	3/8.55 35 (35)
14	24/14.17 169* (155)	45/18.65 241*** (221***)	15/8.96 167 (154)	11/4.66 236* (217*)	95/46.44 205*** (188***)
15	5/5.57 90 (76)	9/5.88 153 (130)	1/1.14 88 (74)	1/1.09 91 (78)	16/13.68 117 (99)
16	14/11.35 123 (116)	5/6.60 76 (71)	5/3.08 162 (153)	5/2.79 179 (169)	29/23.83 122 (115)
17	8/6.04 133 (143)	5/7.29 69 (74)	1/0.63 159 (171)	0/0.85 0 (0)	14/14.80 95 (102)
18	12/12.10 99 (94)	18/11.39 158 (150)	13/8.44 154 (147)	2/2.97 67 (64)	45/34.90 129 (123)
19	4/2.80 143 (120)	5/3.64 137 (115)	6/3.37 178 (150)	1/1.17 85 (72)	16/10.99 146 (122)
Total	104/73.75 141** (133**)	120/73.46 163*** (154***)	63/38.75 163*** (152**)	29/19.28 150* (141)	316/205.2 154*** (145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 119

Factory by entry cohort (exposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	22/11.21 196** (175*)	9/6.78 133 (118)	6/3.70 162 (145)	2/1.89 106 (95)	39/23.58 165** (148*)
11	14/9.33 150 (129)	16/11.17 143 (123)	2/6.56 30 (26*)	1/1.48 68 (58)	33/28.54 116 (100)
12	7/4.34 161 (138)	0/1.74 0 (0)	2/1.88 106 (91)	0/0.77 0 (0)	9/8.74 103 (88)
13	5/2.36 212 (228)	4/4.20 95 (102)	0/1.94 0 (0)	1/1.10 91 (98)	10/9.60 104 (112)
14	31/15.79 196*** (156*)	34/17.94 190*** (150*)	23/8.47 271*** (215**)	7/3.92 179 (142)	95/46.12 206*** (163***)
15	12/6.38 188 (147)	4/6.65 60 (47)	3/0.95 314 (246)	2/0.96 209 (163)	21/14.94 141 (110)
16	16/10.89 147 (122)	8/6.76 118 (99)	4/3.03 132 (110)	2/3.42 58 (49)	30/24.10 124 (104)
17	13/7.00 186 (177)	9/7.86 114 (109)	2/0.52 386 (368)	1/0.69 146 (139)	25/16.07 156* (148)
18	21/13.35 157 (139)	17/12.02 141 (125)	5/8.04 62 (55)	2/2.59 77 (68)	45/36.01 125 (111)
19	5/3.43 146 (144)	5/4.27 117 (116)	0/3.56 0 (0)	0/0.97 0 (0)	10/12.23 82 (81)
Total	146/84.09 174*** (149***)	106/79.39 134** (115)	47/38.65 122 (106)	18/17.79 101 (87)	317/219.9 144*** (124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 120

Mortality from all causes (000-999)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	87/75.24	208/159.2	303/263.3	223/187.9	821/685.6
	116	131***	115*	119*	120***
	(106)	(119*)	(105)	(109)	(109*)
1951-55	86/97.90	243/208.2	351/314.7	43/43.44	723/664.2
	88	117*	112*	99	109*
	(80*)	(107)	(102)	(91)	(100)
1956-60	67/73.38	192/157.4	134/125.6	0/0.00	393/356.5
	91	122**	107	-	110
	(83)	(111)	(97)	-	(100)
1961-65	55/59.77	141/109.4	8/11.83	0/0.00	204/181.0
	92	129**	68	-	113
	(84)	(118)	(62)	-	(103)
Total	295/306.3	784/634.2	796/715.4	266/231.3	2141/1887.2
	96	124***	111**	115*	113***
	(88*)	(113***)	(102)	(105)	(104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 121

Mortality from all malignant neoplasms (140-209)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	23/17.09	50/39.38	72/68.08	58/50.95	203/175.5
	135	127	106	114	116*
	(128)	(121)	(101)	(108)	(110)
1951-55	20/23.91	72/53.51	98/84.35	18/11.65	208/173.4
	84	135*	116	155	120*
	(79)	(128)	(110)	(147)	(114)
1956-60	17/18.23	68/41.38	39/33.94	0/0.00	124/93.54
	93	164***	115	-	133**
	(88)	(155***)	(109)	-	(125*)
1961-65	21/14.97	43/29.47	4/3.27	0/0.00	68/47.71
	140	146*	122	-	143**
	(133)	(138)	(116)	-	(135*)
Total	81/74.20	233/163.7	213/189.6	76/62.60	603/490.2
	109	142***	112	121	123***
	(104)	(135***)	(107)	(116)	(117***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 122

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	8/6.33	23/16.64	38/29.38	35/21.39	104/73.75
	126	138	129	164**	141**
	(119)	(130)	(122)	(154*)	(133**)
1951-55	12/9.70	39/23.25	60/35.67	9/4.83	120/73.46
	124	168**	168***	186	163***
	(116)	(158**)	(158**)	(176)	(154***)
1956-60	10/7.49	33/17.43	20/13.82	0/0.00	63/38.75
	133	189**	145	-	163***
	(125)	(177**)	(135)	-	(152**)
1961-65	8/6.07	19/11.89	2/1.32	0/0.00	29/19.28
	132	160	152	-	150*
	(124)	(150)	(142)	-	(141)
Total	38/29.60	114/69.23	120/80.20	44/26.23	316/205.2
	128	165***	150***	168**	154***
	(121)	(155***)	(141***)	(158**)	(145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 123

Mortality from cancer of the stomach (151)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	6/2.58	9/5.15	11/7.31	2/4.81	28/19.84
	233	175	150	42	141
	(216)	(162)	(139)	(39)	(131)
1951-55	3/3.33	16/6.31	9/8.34	2/1.10	30/19.09
	90	254**	108	181	157*
	(84)	(235**)	(100)	(168)	(146)
1956-60	3/2.20	10/4.32	3/3.16	0/0.00	16/9.67
	137	232*	95	-	165
	(127)	(216*)	(88)	-	(154)
1961-65	2/1.59	5/2.76	0/0.30	0/0.00	7/4.65
	126	181	0	-	151
	(117)	(168)	(0)	-	(140)
Total	14/9.69	40/18.54	23/19.11	4/5.91	81/53.24
	144	216***	120	68	152***
	(134)	(200***)	(112)	(63)	(141**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 124

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	11/8.54	42/20.00	62/32.67	31/22.89	146/84.09
	129	210***	190***	135	174***
	(112)	(182***)	(163***)	(116)	(149***)
1951-55	14/11.19	30/25.45	57/37.30	5/5.46	106/79.39
	125	118	153**	92	134**
	(109)	(102)	(132)	(79)	(115)
1956-60	9/7.65	21/17.21	17/13.79	0/0.00	47/38.65
	118	122	123	-	122
	(102)	(106)	(107)	-	(106)
1961-65	3/5.93	14/10.72	1/1.14	0/0.00	18/17.79
	51	131	88	-	101
	(43)	(112)	(77)	-	(87)
Total	37/33.30	107/73.38	137/84.90	36/28.35	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 125

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and entry cohort (exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	7/4.15 169	29/11.13 261***	37/16.83 220***	14/9.43 148	87/41.54 209***
1951-55	9/5.80 155	23/14.53 158*	26/17.26 151	2/2.20 91	60/39.80 151**
1956-60	4/4.13 97	10/9.10 110	11/5.81 189	0/0.00 -	25/19.04 131
1961-65	0/3.23 0	8/4.97 161	0/0.49 0	0/0.00 -	8/8.69 92
Total	20/17.31 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 126

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and entry cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	27/21.37	83/62.63	140/132.2	124/96.76	374/313.0
	126	133*	106	128**	119***
	(112)	(117)	(94)	(114)	(106)
1951-55	32/31.67	114/93.06	167/161.7	15/22.38	328/308.8
	101	123*	103	67	106
	(90)	(109)	(92)	(60*)	(95)
1956-60	23/26.45	89/76.76	62/64.34	0/0.00	174/167.6
	87	116	96	-	104
	(77)	(102)	(85)	-	(92)
1961-65	20/25.00	68/54.23	2/6.02	0/0.00	90/85.25
	80	125	33	-	106
	(71)	(111)	(30)	-	(94)
Total	102/104.5	354/286.7	371/364.3	139/119.1	966/874.6
	98	123***	102	117	110**
	(86)	(109)	(90)	(103)	(98)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 127

Factory by entry cohort (unexposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	20/23.39 85 (79)	12/19.42 62 (57*)	8/8.66 92 (86)	6/4.33 139 (128)	46/55.80 82 (76)
11	4/5.28 76 (69)	13/15.08 86 (78)	18/14.67 123 (112)	12/13.33 90 (82)	47/48.37 97 (88)
12	9/5.48 164 (149)	4/5.76 69 (63)	2/1.49 134 (122)	4/4.13 97 (88)	19/16.85 113 (102)
13	4/4.85 83 (85)	6/16.26 37** (38**)	6/4.93 122 (125)	2/4.37 46 (47)	18/30.40 59* (61*)
14	22/21.19 104 (95)	29/24.76 117 (107)	13/19.69 66 (61)	18/22.81 79 (72)	82/88.46 93 (85)
15	5/5.79 86 (74)	1/0.96 104 (90)	1/1.21 83 (71)	3/1.34 224 (193)	10/9.30 108 (93)
16	11/9.59 115 (103)	11/9.97 110 (99)	10/7.51 133 (120)	7/8.31 84 (76)	39/35.38 110 (99)
17	20/18.37 109 (108)	24/21.29 113 (112)	0/3.60 0 (0)	1/3.25 31 (30)	45/46.50 97 (96)
18	92/85.18 108 (99)	86/75.49 114 (105)	57/36.93 154** (142*)	32/21.39 150* (137)	267/219.0 122** (112)
19	27/21.73 124 (101)	24/24.82 97 (79)	14/14.57 96 (78)	10/8.66 115 (94)	75/69.78 107 (87)
Total	214/200.8 107 (97)	210/213.8 98 (90)	129/113.3 114 (103)	95/91.92 103 (94)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 128

Factory by entry cohort (unexposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	5/2.66	1/2.05	2/0.98	2/0.44	10/6.13
	188	49	204	455	163
	(180)	(47)	(196)	(437)	(157)
11	0/0.58	0/1.66	3/1.61	1/1.44	4/5.29
	0	0	186	70	76
	(0)	(0)	(177)	(66)	(72)
12	1/0.60	0/0.53	0/0.16	0/0.47	1/1.77
	167	0	0	0	57
	(162)	(0)	(0)	(0)	(55)
13	0/0.55	1/1.74	0/0.54	1/0.45	2/3.27
	0	58	0	221	61
	(0)	(57)	(0)	(219)	(60)
14	1/2.41	2/2.50	1/2.08	0/2.51	4/9.50
	41	80	48	0	42
	(38)	(74)	(44)	(0)	(39*)
15	0/0.66	0/0.11	0/0.14	0/0.16	0/1.07
	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
16	1/1.03	3/0.92	1/0.81	1/0.92	6/3.67
	97	328	124	109	163
	(91)	(309)	(117)	(103)	(154)
17	2/1.84	7/2.24	0/0.39	1/0.34	10/4.81
	109	312*	0	291	208
	(117)	(336*)	(0)	(313)	(224*)
18	6/7.91	6/7.47	13/3.93	4/2.35	29/21.66
	76	80	331***	170	134
	(72)	(77)	(315***)	(162)	(128)
19	3/2.33	4/2.56	1/1.57	3/0.92	11/7.39
	129	156	64	325	149
	(108)	(131)	(53)	(273)	(125)
Total	19/20.57	24/21.78	21/12.20	13/10.01	77/64.55
	92	110	172*	130	119
	(87)	(104)	(161)	(122)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 129

Factory by entry cohort (unexposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	Total
10	1/2.80 36 (32)	1/2.31 43 (39)	0/0.75 0 (0)	0/0.60 0 (0)	2/6.46 31 (28*)
11	0/0.61 0 (0)	2/2.02 99 (85)	2/1.71 117 (101)	2/1.75 115 (99)	6/6.09 99 (85)
12	0/0.64 0 (0)	2/0.89 225 (192)	1/0.16 633 (541)	0/0.51 0 (0)	3/2.19 137 (117)
13	1/0.52 193 (207)	0/1.97 0 (0)	0/0.49 0 (0)	0/0.42 0 (0)	1/3.39 29 (32)
14	5/2.58 194 (154)	4/3.19 125 (99)	2/2.06 97 (77)	1/2.67 37 (30)	12/10.50 114 (91)
15	1/0.70 144 (112)	0/0.11 0 (0)	0/0.15 0 (0)	0/0.13 0 (0)	1/1.08 92 (72)
16	1/1.12 89 (74)	0/1.32 0 (0)	2/0.95 211 (176)	2/0.91 219 (183)	5/4.31 116 (97)
17	2/2.47 81 (77)	5/2.56 195 (186)	0/0.40 0 (0)	0/0.28 0 (0)	7/5.71 123 (117)
18	24/12.23 196** (174*)	20/11.13 180* (159)	8/4.69 171 (151)	8/2.35 340** (301*)	60/30.41 197*** (175***)
19	0/2.68 0 (0)	2/3.04 66 (65)	0/1.44 0 (0)	0/0.74 0 (0)	2/7.90 25* (25*)
Total	35/26.34 133 (118)	36/28.54 126 (113)	15/12.80 117 (103)	13/10.35 126 (108)	99/78.04 127* (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 130

Mortality from all causes (000-999)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	35/25.43	49/46.37	71/77.42	59/51.62	214/200.8
	138	106	92	114	107
	(125)	(96)	(84)	(104)	(97)
1951-55	29/35.65	73/69.83	95/96.50	13/11.82	210/213.8
	81	105	98	110	98
	(74)	(96)	(90)	(103)	(90)
1956-60	35/27.22	65/47.53	29/38.52	0/0.00	129/113.3
	129	137*	75	-	114
	(117)	(124)	(68*)	-	(103)
1961-65	23/29.74	61/54.09	11/8.09	0/0.00	95/91.92
	77	113	136	-	103
	(70)	(103)	(124)	-	(94)
Total	122/118.0	248/217.8	206/220.5	72/63.43	648/619.8
	103	114*	93	114	105
	(94)	(104)	(85*)	(104)	(95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 131

Mortality from all malignant neoplasms (140-209)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	5/5.84 86 (82)	12/11.32 106 (101)	11/19.00 58 (55*)	20/13.62 147 (140)	48/49.78 96 (92)
1951-55	7/8.65 81 (77)	12/17.18 70 (67)	25/24.05 104 (99)	4/2.99 134 (130)	48/52.87 91 (87)
1956-60	12/6.78 177 (168)	23/12.46 185** (174*)	10/10.19 98 (93)	0/0.00 - -	45/29.43 153** (145*)
1961-65	4/7.72 52 (49)	16/14.37 111 (105)	3/2.01 149 (142)	0/0.00 - -	23/24.10 95 (90)
Total	28/28.99 97 (92)	63/55.33 114 (108)	49/55.26 89 (84)	24/16.61 144 (138)	164/156.2 105 (100)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 132

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	1/2.20	3/4.74	7/7.98	8/5.64	19/20.57
	45	63	88	142	92
	(43)	(60)	(83)	(134)	(87)
1951-55	3/3.55	6/7.26	12/9.77	3/1.20	24/21.78
	85	83	123	250	110
	(80)	(78)	(116)	(240)	(104)
1956-60	7/2.86	10/5.25	4/4.10	0/0.00	21/12.20
	245	191	98	-	172*
	(229)	(178)	(91)	-	(161)
1961-65	3/3.32	8/5.91	2/0.79	0/0.00	13/10.01
	90	135	254	-	130
	(85)	(127)	(239)	-	(122)
Total	14/11.93	27/23.16	25/22.63	11/6.85	77/64.55
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 133

Mortality from cancer of the stomach (151)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	2/0.90 221 (208)	1/1.50 67 (63)	0/2.06 0 (0)	5/1.28 390* (365*)	8/5.74 139 (131)
1951-55	1/1.23 81 (77)	2/2.06 97 (92)	3/2.38 126 (120)	0/0.28 0 (0)	6/5.94 101 (96)
1956-60	2/0.84 239 (224)	2/1.31 153 (143)	0/0.94 0 (0)	0/0.00 - -	4/3.09 129 (121)
1961-65	0/0.86 0 (0)	1/1.40 71 (67)	1/0.19 535 (501)	0/0.00 - -	2/2.44 82 (76)
Total	5/3.83 131 (123)	6/6.26 96 (90)	4/5.57 72 (68)	5/1.56 320* (302)	20/17.21 116 (109)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 134

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	11/3.13	6/6.10	9/10.54	9/6.58	35/26.34
	352***	98	85	137	133
	(313**)	(87)	(76)	(121)	(118)
1951-55	7/4.43	12/9.41	15/13.09	2/1.62	36/28.54
	158	128	115	124	126
	(141)	(114)	(103)	(113)	(113)
1956-60	6/3.09	5/5.32	4/4.39	0/0.00	15/12.80
	194	94	91	-	117
	(170)	(83)	(80)	-	(103)
1961-65	3/3.17	8/6.09	2/1.10	0/0.00	13/10.35
	95	131	183	-	126
	(82)	(113)	(158)	-	(108)
Total	27/13.83	31/26.92	30/29.10	11/8.19	99/78.04
	195**	115	103	134	127*
	(172*)	(101)	(92)	(120)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 135

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and entry cohort (unexposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	5/1.61 311*	3/3.45 87	5/5.10 98	3/2.59 116	16/12.75 126
1951-55	5/2.42 207	11/5.28 208*	9/5.48 164	0/0.60 0	25/13.77 182**
1956-60	6/1.74 345*	2/2.86 70	4/1.78 225	0/0.00 -	12/6.38 188
1961-65	2/1.82 110	5/2.83 177	1/0.41 246	0/0.00 -	8/5.07 158
Total	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.97 161***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 136

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and entry cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	13/7.59	25/18.20	40/39.00	27/26.55	105/91.34
	171	137	103	102	115
	(150)	(121)	(90)	(89)	(101)
1951-55	11/11.69	43/31.25	47/49.37	5/6.07	106/98.38
	94	138	95	82	108
	(83)	(122)	(85)	(75)	(96)
1956-60	12/9.78	30/22.85	13/19.60	0/0.00	55/52.23
	123	131	66	-	105
	(107)	(115)	(58*)	-	(92)
1961-65	13/12.60	31/27.01	5/4.10	0/0.00	49/43.70
	103	115	122	-	112
	(91)	(102)	(108)	-	(99)
Total	49/41.66	129/99.32	105/112.1	32/32.62	315/285.7
	118	130**	94	98	110
	(103)	(114)	(83)	(87)	(97)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 137

Factory by exit cohort (exposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	19/18.30	55/44.79	44/37.36	39/30.71	34/24.45	18/12.64	9/9.72	218/178.0
	104	123	118	127	139	142	93	122**
	(96)	(114)	(109)	(118)	(129)	(132)	(86)	(113)
11	43/25.35	69/54.58	45/44.75	50/44.38	30/23.61	29/22.32	12/28.08	278/243.1
	170**	126	101	113	127	130	43**	114*
	(154**)	(115)	(91)	(102)	(116)	(118)	(39***)	(104)
12	10/8.12	16/10.72	10/13.38	15/16.25	10/8.44	9/6.59	3/5.71	73/69.21
	123	149	75	92	119	137	53	105
	(112)	(136)	(68)	(84)	(108)	(124)	(48)	(96)
13	1/2.23	14/10.02	22/21.07	16/17.24	15/11.29	4/6.86	4/13.35	76/82.06
	45	140	104	93	133	58	30**	93
	(46)	(144)	(108)	(96)	(137)	(60)	(31**)	(95)
14	12/9.29	94/72.05	131/95.73	98/63.46	68/44.12	62/51.52	50/76.87	515/413.0
	129	130*	137***	154***	154**	120	65**	125***
	(119)	(120)	(126*)	(142**)	(141**)	(110)	(60***)	(114**)
15	6/8.40	21/20.17	31/31.17	20/13.60	28/20.98	18/16.66	9/13.92	133/124.9
	71	104	99	147	133	108	65	106
	(62)	(90)	(86)	(127)	(115)	(93)	(56)	(92)
16	21/24.24	39/36.21	33/29.55	34/24.19	34/32.27	24/29.71	23/41.97	208/218.1
	87	108	112	141	105	81	55**	95
	(78)	(97)	(101)	(127)	(95)	(73)	(49***)	(86*)
17	5/4.12	58/37.91	21/28.73	14/14.75	29/19.55	10/10.34	6/19.42	143/134.8
	121	153**	73	95	148	97	31***	106
	(120)	(151**)	(72)	(94)	(147)	(96)	(31***)	(105)
18	22/27.98	90/65.23	71/60.90	87/58.35	62/45.80	30/32.43	7/28.93	369/319.6
	79	138**	117	149***	135*	93	24***	115**
	(72)	(127*)	(107)	(137**)	(124)	(85)	(22***)	(106)
19	1/1.12	32/20.74	38/27.91	23/17.04	17/13.21	10/11.28	7/13.10	128/104.4
	89	154*	136	135	129	89	53	123*
	(73)	(125)	(111)	(110)	(105)	(72)	(43*)	(100)
Total	140/129.1	488/372.4	446/390.5	396/300.0	327/243.7	214/200.3	130/251.1	2141/1887.2
	108	131***	114**	132***	134***	107	52***	113***
	(99)	(120***)	(104)	(121***)	(123***)	(97)	(47***)	(104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 138

Factory by exit cohort (exposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	2/1.75	10/4.50	8/3.63	7/2.89	5/2.79	2/1.57	3/1.14	37/18.28
	114	222*	221	242	179	128	263	202***
	(110)	(214*)	(212)	(233)	(172)	(123)	(253)	(195***)
11	5/2.58	16/5.97	7/4.66	5/4.96	6/2.53	7/2.59	4/3.25	50/26.55
	193	268***	150	101	237	270*	123	188***
	(184)	(255**)	(143)	(96)	(226)	(257*)	(117)	(179***)
12	2/0.88	1/1.22	2/1.25	3/1.55	1/0.94	1/0.78	1/0.63	11/7.24
	229	82	161	194	106	129	158	152
	(222)	(80)	(156)	(188)	(103)	(125)	(154)	(148)
13	0/0.22	1/1.08	1/2.02	0/1.79	0/1.15	0/0.76	1/1.55	3/8.55
	0	93	50	0	0	0	65	35
	(0)	(92)	(49)	(0)	(0)	(0)	(64)	(35)
14	1/1.11	19/8.04	28/10.63	14/7.11	7/4.86	20/6.13	6/8.56	95/46.44
	90	236**	264***	197*	144	326***	70	205***
	(82)	(217**)	(242***)	(181)	(132)	(299***)	(64)	(188***)
15	0/0.94	4/2.22	5/3.33	1/1.39	4/2.32	2/1.88	0/1.60	16/13.68
	0	181	150	72	172	107	0	117
	(0)	(153)	(127)	(61)	(146)	(90)	(0)	(99)
16	2/2.82	4/3.99	6/3.24	3/2.40	5/3.30	3/3.47	6/4.61	29/23.83
	71	100	185	125	152	87	130	122
	(67)	(95)	(175)	(118)	(143)	(82)	(123)	(115)
17	0/0.47	7/4.19	2/3.06	1/1.48	3/2.21	0/1.20	1/2.20	14/14.80
	0	167	65	67	136	0	45	95
	(0)	(180)	(70)	(73)	(146)	(0)	(49)	(102)
18	2/2.76	11/7.06	2/6.37	15/6.51	8/5.07	7/3.91	0/3.21	45/34.90
	72	156	31	230**	158	179	0	129
	(69)	(148)	(30)	(219**)	(150)	(171)	(0)	(123)
19	0/0.12	5/2.18	5/2.71	1/1.78	2/1.41	1/1.30	2/1.48	16/10.98
	0	229	185	56	142	77	135	146
	(0)	(193)	(155)	(47)	(119)	(65)	(114)	(122)
Total	14/13.66	78/40.44	66/40.89	50/31.88	41/26.58	43/23.57	24/28.23	316/205.2
	103	193***	161***	157**	154*	182***	85	154***
	(97)	(182***)	(151**)	(147*)	(145*)	(170**)	(80)	(145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 139

Factory by exit cohort (exposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	6/2.64	7/5.96	10/5.15	7/4.41	8/3.12	1/1.46	0/0.85	39/23.58
	227	117	194	159	256*	69	0	165**
	(203)	(105)	(174)	(142)	(229)	(61)	(0)	(148*)
11	5/3.14	8/7.01	8/5.66	6/4.74	5/2.82	1/2.63	0/2.53	33/28.54
	159	114	141	127	177	38	0	116
	(137)	(98)	(122)	(109)	(153)	(33)	(0)	(100)
12	1/1.07	1/1.19	3/1.83	2/2.36	1/1.00	0/0.79	1/0.51	9/8.74
	94	84	164	85	100	0	198	103
	(80)	(72)	(140)	(73)	(85)	(0)	(169)	(88)
13	0/0.31	4/1.12	3/2.96	1/2.05	2/1.22	0/0.77	0/1.17	10/9.60
	0	358	101	49	164	0	0	104
	(0)	(385*)	(109)	(52)	(176)	(0)	(0)	(112)
14	1/1.05	18/8.55	27/11.08	19/6.90	13/5.77	10/6.44	7/6.33	95/46.12
	95	211**	244***	275***	225*	155	110	206***
	(75)	(167)	(193**)	(219**)	(179)	(123)	(88)	(163***)
15	2/1.23	2/2.53	4/3.90	6/1.65	5/2.45	1/1.97	1/1.22	21/14.94
	163	79	103	365*	204	51	82	141
	(127)	(62)	(80)	(285*)	(159)	(40)	(64)	(110)
16	4/2.47	4/4.02	3/3.35	6/2.77	7/4.58	4/3.52	2/3.40	30/24.10
	162	99	90	217	153	114	59	124
	(135)	(83)	(75)	(181)	(127)	(95)	(49)	(104)
17	0/0.41	9/4.79	6/3.69	3/1.99	4/2.29	1/1.27	2/1.63	25/16.07
	0	188	163	151	175	79	123	156*
	(0)	(179)	(155)	(143)	(166)	(75)	(117)	(148)
18	6/3.55	8/7.50	10/7.16	10/5.90	10/5.72	1/3.72	0/2.46	45/36.01
	169	107	140	169	175	27	0	125
	(150)	(94)	(124)	(150)	(155)	(24)	(0)	(111)
19	0/0.09	3/2.57	4/3.82	2/1.91	1/1.55	0/1.21	0/1.09	10/12.23
	0	117	105	105	65	0	0	82
	(0)	(116)	(104)	(104)	(64)	(0)	(0)	(81)
Total	25/15.95	64/45.23	78/48.60	62/34.67	56/30.53	19/23.77	13/21.19	317/219.9
	157*	142**	161***	179***	183***	80	61	144***
	(135)	(123)	(139**)	(155**)	(158**)	(68)	(52*)	(124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 140

Mortality from all causes (000-999)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	17/13.73 124 (113)	33/29.23 113 (103)	49/46.67 105 (96)	41/39.51 104 (95)	140/129.1 108 (99)
1951-55	98/48.97 200*** (183***)	137/98.37 139*** (127**)	168/159.7 105 (96)	85/65.37 130* (119)	488/372.4 131*** (120***)
1956-60	68/64.22 106 (96)	162/127.9 127** (116)	187/164.3 114 (104)	29/34.09 85 (78)	446/390.5 114** (104)
1961-65	58/59.65 97 (89)	185/121.4 152*** (139***)	128/100.0 128** (117)	25/18.91 132 (121)	396/300.0 132*** (121***)
1966-70	42/54.18 78 (71*)	162/100.5 161*** (147***)	95/71.15 134** (122)	28/17.92 156* (144)	327/243.7 134*** (123***)
1971-75	12/32.00 38*** (34***)	74/73.26 101 (92)	105/74.63 141** (128*)	23/20.47 112 (103)	214/200.3 107 (97)
1976+	0/33.55 0*** (0***)	31/83.54 37*** (34***)	64/98.93 65*** (59***)	35/35.06 100 (92)	130/251.1 52*** (47***)
Total	295/306.3 96 (88*)	784/634.2 124*** (113***)	796/715.4 111** (102)	266/231.3 115* (105)	2141/1887.2 113*** (104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 141

Mortality from all malignant neoplasms (140-209)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	6/3.06 196 (188)	11/6.96 158 (151)	12/11.90 101 (96)	8/10.79 74 (71)	37/32.72 113 (108)
1951-55	23/11.50 200** (191**)	37/24.74 150* (143*)	56/42.12 133* (127)	35/17.64 198*** (189***)	151/96.01 157*** (150***)
1956-60	21/15.43 136 (129)	43/31.76 135 (128)	44/42.48 104 (98)	10/9.06 110 (105)	118/98.73 120 (113)
1961-65	15/14.67 102 (97)	52/31.29 166*** (158**)	35/26.41 133 (126)	2/4.78 42 (40)	104/77.15 135** (128*)
1966-70	11/13.77 80 (76)	49/26.50 185*** (175***)	20/18.20 110 (104)	5/4.44 113 (108)	85/62.90 135** (128*)
1971-75	5/8.31 60 (57)	29/20.10 144 (136)	25/20.25 123 (117)	9/5.53 163 (154)	68/54.19 125 (118)
1976+	0/7.45 0** (0***)	12/22.37 54* (51*)	21/28.27 74 (70)	7/10.38 67 (64)	40/68.47 58*** (55***)
Total	81/74.19 109 (104)	233/163.7 142*** (135***)	213/189.6 112 (107)	76/62.60 121 (116)	603/490.2 123*** (117***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 142

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	0/1.10 0 (0)	4/2.85 141 (133)	3/5.15 58 (55)	7/4.55 154 (146)	14/13.66 103 (97)
1951-55	15/4.43 338*** (320***)	17/10.64 160 (151)	30/18.02 167* (157*)	16/7.35 218** (205*)	78/40.44 193*** (182***)
1956-60	9/6.13 147 (137)	20/13.35 150 (140)	30/17.64 170** (159*)	7/3.77 186 (175)	66/40.89 161*** (151**)
1961-65	7/5.96 117 (111)	23/13.06 176* (166*)	18/10.91 165 (155)	2/1.95 103 (97)	50/31.88 157** (147*)
1966-70	3/5.85 51 (48)	27/11.34 238*** (223***)	10/7.59 132 (124)	1/1.79 56 (53)	41/26.58 154* (145*)
1971-75	4/3.57 112 (104)	17/8.90 191* (178*)	17/8.78 194* (181*)	5/2.33 215 (201)	43/23.57 182*** (170**)
1976+	0/2.55 0 (0)	6/9.09 66 (62)	12/12.11 99 (93)	6/4.49 134 (126)	24/28.23 85 (80)
Total	38/29.60 128 (121)	114/69.22 165*** (155***)	120/80.19 150*** (141***)	44/26.23 168** (158**)	316/205.2 154*** (145***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 143

Mortality from cancer of the stomach (151)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	2/0.47	4/0.94	3/1.31	0/1.02	9/3.74
	425	425*	230	0	241*
	(396)	(395*)	(213)	(0)	(224*)
1951-55	4/1.70	9/3.08	7/4.34	3/1.66	23/10.77
	236	292**	161	181	214**
	(220)	(273*)	(150)	(168)	(199**)
1956-60	3/2.17	5/3.77	3/4.23	1/0.86	12/11.04
	138	132	71	116	109
	(128)	(123)	(66)	(107)	(101)
1961-65	3/1.85	8/3.40	4/2.58	0/0.45	15/8.28
	162	235*	155	0	181*
	(152)	(219)	(144)	(0)	(169)
1966-70	1/1.70	9/2.90	3/1.86	0/0.42	13/6.88
	59	311**	161	0	189*
	(55)	(288**)	(149)	(0)	(175)
1971-75	1/1.03	5/2.24	1/2.12	0/0.55	7/5.93
	97	224	47	0	118
	(89)	(206)	(44)	(0)	(109)
1976+	0/0.77	0/2.20	2/2.68	0/0.95	2/6.60
	0	0	75	0	30
	(0)	(0)	(69)	(0)	(28)
Total	14/9.69	40/18.54	23/19.11	4/5.91	81/53.25
	144	216***	120	68	152***
	(134)	(200***)	(112)	(63)	(141**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 144

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	1/1.58	2/3.75	14/5.84	8/4.77	25/15.95
	63	53	240**	168	157*
	(55)	(46)	(206*)	(145)	(135)
1951-55	13/5.63	16/12.26	27/19.34	8/7.99	64/45.23
	231*	130	140	100	142**
	(202*)	(114)	(121)	(86)	(123)
1956-60	12/7.60	31/16.15	28/20.46	7/4.38	78/48.60
	158	192**	137	160	161***
	(138)	(167*)	(119)	(136)	(139**)
1961-65	7/6.51	28/13.93	22/11.61	5/2.64	62/34.67
	108	201**	190**	190	179***
	(93)	(174**)	(165*)	(165)	(155**)
1966-70	4/6.18	23/12.09	23/9.62	6/2.64	56/30.53
	65	190**	239***	227	183***
	(56)	(165*)	(205**)	(194)	(158**)
1971-75	0/3.32	5/8.40	14/9.40	0/2.66	19/23.77
	0	60	149	0	80
	(0*)	(51)	(127)	(0)	(68)
1976+	0/2.49	2/6.80	9/8.64	2/3.26	13/21.19
	0	29	104	61	61
	(0)	(25*)	(89)	(53)	(52*)
Total	37/33.30	107/73.38	137/84.90	36/28.35	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 145

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and exit cohort (exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	1/0.78 129	1/2.03 49	7/3.04 230	5/2.00 250	14/7.85 178
1951-55	9/2.81 320**	13/6.89 189*	19/9.48 200**	3/3.25 92	44/22.42 196***
1956-60	6/4.02 149	22/8.92 247***	15/9.16 164	2/1.74 115	45/23.84 189***
1961-65	4/3.48 115	18/7.42 243**	11/5.34 206*	2/0.97 207	35/17.20 204***
1966-70	0/3.42 0	13/6.50 200*	15/4.48 335***	3/1.01 298	31/15.40 201***
1971-75	0/1.79 0	2/4.61 43	4/4.60 87	0/1.14 0	6/12.14 49
1976+	0/1.01 0	1/3.37 30	3/4.31 70	1/1.52 66	5/10.21 49
Total	20/17.30 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 146

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and exit cohort (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	2/3.88 52 (45)	17/11.30 150 (132)	18/23.28 77 (68)	20/20.36 98 (86)	57/58.82 97 (85)
1951-55	37/14.86 249*** (220***)	67/41.21 163*** (144**)	69/81.42 85 (75*)	37/33.68 110 (97)	210/171.2 123** (109)
1956-60	21/21.24 99 (87)	65/57.44 113 (100)	96/84.17 114 (101)	11/17.54 63 (56)	193/180.4 107 (95)
1961-65	19/20.84 91 (81)	84/56.58 148*** (132*)	63/51.01 124 (110)	18/9.70 185* (165)	184/138.1 133*** (118*)
1966-70	17/20.69 82 (73)	71/46.89 151** (134*)	48/36.07 133 (118)	17/9.18 185* (166)	153/112.8 136*** (120*)
1971-75	6/12.08 50 (44*)	36/34.46 104 (92)	51/37.96 134* (119)	14/10.56 133 (118)	107/95.06 113 (100)
1976+	0/10.91 0*** (0***)	14/38.79 36*** (32***)	26/50.40 52*** (46***)	22/18.11 121 (108)	62/118.2 52*** (47***)
Total	102/104.5 98 (86)	354/286.7 123*** (109)	371/364.3 102 (90)	139/119.1 117 (103)	966/874.6 110** (98)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 147

Factory by exit cohort (unexposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	7/9.98 70 (65)	10/15.06 66 (61)	10/9.98 100 (93)	6/6.17 97 (90)	8/8.75 91 (85)	5/3.03 165 (153)	0/2.82 0 (0)	46/55.80 82 (76)
11	4/3.02 132 (120)	3/3.78 79 (72)	3/6.14 49 (44)	19/14.30 133 (121)	5/4.85 103 (94)	10/9.04 111 (101)	3/7.23 41 (38)	47/48.37 97 (88)
12	3/1.47 204 (185)	2/2.50 80 (73)	2/3.85 52 (47)	4/3.63 110 (100)	4/1.10 364 (331)	3/3.12 96 (87)	1/1.18 85 (77)	19/16.85 113 (102)
13	0/0.00 - -	2/2.30 87 (90)	5/8.43 59 (61)	4/3.50 114 (118)	3/6.26 48 (49)	3/4.71 64 (66)	1/5.21 19 (20)	18/30.40 59* (61*)
14	2/1.52 131 (120)	10/5.83 172 (157)	17/13.50 126 (116)	20/14.99 133 (122)	14/17.45 80 (74)	15/17.18 87 (80)	4/17.98 22*** (20***)	82/88.46 93 (85)
15	1/0.01 14286* (12315*)	2/2.00 100 (86)	0/0.91 0 (0)	1/1.12 89 (77)	2/0.62 321 (277)	4/2.35 171 (147)	0/2.29 0 (0)	10/9.30 108 (93)
16	1/1.44 69 (62)	4/4.55 88 (79)	8/4.53 177 (159)	8/7.68 104 (94)	7/7.22 97 (87)	8/6.06 132 (119)	3/3.90 77 (69)	39/35.38 110 (99)
17	6/3.75 160 (159)	18/15.35 117 (116)	11/9.07 121 (120)	3/1.29 233 (230)	2/5.60 36 (35)	2/4.25 47 (47)	3/7.19 42 (41)	45/46.50 97 (96)
18	17/19.23 88 (81)	42/29.87 141* (129)	67/54.20 124 (113)	65/52.54 124 (114)	45/30.19 149* (137)	19/14.91 127 (117)	12/18.05 66 (61)	267/219.0 122** (112)
19	6/3.16 190 (154)	19/14.88 128 (104)	19/19.20 99 (80)	14/11.38 123 (100)	5/8.63 58 (47)	6/4.09 147 (119)	6/8.43 71 (58)	75/69.78 107 (87)
Total	47/43.59 108 (99)	112/96.12 117 (106)	142/129.8 109 (100)	144/116.6 124* (112)	95/90.69 105 (96)	75/68.75 109 (100)	33/74.29 44*** (41***)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 148

Factory by exit cohort (unexposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	2/1.11 180 (173)	2/1.72 117 (112)	1/1.06 95 (91)	1/0.61 165 (159)	1/0.98 103 (99)	3/0.35 857* (824*)	0/0.32 0 (0)	10/6.13 163 (157)
11	0/0.32 0 (0)	0/0.35 0 (0)	0/0.63 0 (0)	3/1.51 198 (189)	1/0.56 180 (172)	0/1.06 0 (0)	0/0.86 0 (0)	4/5.29 76 (72)
12	0/0.16 0 (0)	0/0.21 0 (0)	0/0.36 0 (0)	0/0.42 0 (0)	0/0.12 0 (0)	0/0.37 0 (0)	1/0.13 752 (730)	1/1.77 57 (55)
13	0/0.00 - -	0/0.25 0 (0)	0/0.92 0 (0)	1/0.35 290 (287)	1/0.65 154 (153)	0/0.53 0 (0)	0/0.58 0 (0)	2/3.27 61 (61)
14	0/0.18 0 (0)	0/0.65 0 (0)	1/1.36 74 (68)	1/1.60 62 (57)	1/1.75 57 (52)	0/2.01 0 (0)	1/1.95 51 (47)	4/9.50 42 (39*)
15	0/0.00 0 (0)	0/0.22 0 (0)	0/0.10 0 (0)	0/0.13 0 (0)	0/0.07 0 (0)	0/0.29 0 (0)	0/0.26 0 (0)	0/1.07 0 (0)
16	0/0.16 0 (0)	0/0.54 0 (0)	1/0.47 212 (200)	2/0.74 271 (256)	0/0.62 0 (0)	1/0.73 136 (129)	2/0.42 478 (451)	6/3.67 163 (154)
17	1/0.44 228 (245)	3/1.49 201 (216)	3/0.87 345 (371)	1/0.14 694 (747)	1/0.59 170 (183)	0/0.50 0 (0)	1/0.78 129 (138)	10/4.81 208 (224*)
18	1/1.51 66 (63)	2/3.11 64 (61)	7/4.90 143 (136)	10/5.20 192 (183)	6/3.31 181 (172)	2/1.76 114 (108)	1/1.87 54 (51)	29/21.66 134 (128)
19	0/0.35 0 (0)	0/1.64 0 (0)	4/2.02 198 (167)	3/1.14 263 (221)	0/0.83 0 (0)	1/0.46 218 (183)	3/0.96 313 (263)	11/7.39 149 (125)
Total	4/4.24 94 (90)	7/10.18 69 (65)	17/12.69 134 (126)	22/11.83 186* (174*)	11/9.47 116 (110)	7/8.04 87 (82)	9/8.11 111 (104)	77/64.55 119 (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 149

Factory by exit cohort (unexposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1946-50	1951-55	1956-60	1961-65	1966-70	1971-75	1976+	Total
10	1/1.29	0/1.65	1/1.13	0/0.73	0/1.08	0/0.35	0/0.25	2/6.47
	78	0	89	0	0	0	0	31
	(69)	(0)	(79)	(0)	(0)	(0)	(0)	(28*)
11	0/0.42	1/0.62	0/0.85	4/1.80	1/0.57	0/1.17	0/0.67	6/6.09
	0	161	0	222	176	0	0	99
	(0)	(139)	(0)	(192)	(152)	(0)	(0)	(85)
12	0/0.15	1/0.31	0/0.65	0/0.49	0/0.10	2/0.40	0/0.09	3/2.19
	0	324	0	0	0	500	0	137
	(0)	(277)	(0)	(0)	(0)	(427)	(0)	(117)
13	0/0.00	0/0.22	1/0.99	0/0.30	0/0.80	0/0.66	0/0.44	1/3.39
	–	0	102	0	0	0	0	29
	–	(0)	(109)	(0)	(0)	(0)	(0)	(32)
14	0/0.21	3/0.66	1/1.58	2/1.82	3/2.61	2/2.19	1/1.43	12/10.50
	0	457	63	110	115	91	70	114
	(0)	(363)	(50)	(87)	(91)	(73)	(55)	(91)
15	0/0.00	1/0.29	0/0.10	0/0.14	0/0.05	0/0.29	0/0.22	1/1.08
	0	350	0	0	0	0	0	92
	(0)	(273)	(0)	(0)	(0)	(0)	(0)	(72)
16	0/0.12	1/0.44	0/0.47	1/1.20	2/1.09	1/0.70	0/0.30	5/4.31
	0	229	0	84	184	142	0	116
	(0)	(191)	(0)	(70)	(153)	(119)	(0)	(97)
17	1/0.46	3/2.15	2/1.28	0/0.11	1/0.61	0/0.55	0/0.56	7/5.71
	220	140	156	0	164	0	0	123
	(209)	(133)	(149)	(0)	(157)	(0)	(0)	(117)
18	4/2.93	12/3.81	17/8.70	14/7.80	10/3.94	2/1.81	1/1.41	60/30.41
	137	315**	195*	179	254*	111	71	197***
	(121)	(278**)	(173*)	(159)	(224*)	(98)	(63)	(175***)
19	0/0.32	1/1.78	0/2.28	1/1.19	0/1.14	0/0.45	0/0.74	2/7.90
	0	56	0	84	0	0	0	25*
	(0)	(56)	(0)	(83)	(0)	(0)	(0)	(25*)
Total	6/5.88	23/11.91	22/18.02	22/15.58	17/11.99	7/8.55	2/6.10	99/78.04
	102	193**	122	141	142	82	33	127*
	(91)	(174*)	(110)	(124)	(125)	(71)	(29)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 150

Mortality from all causes (000-999)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	12/5.67 212* (194*)	7/8.99 78 (71)	11/16.08 68 (63)	17/12.85 132 (121)	47/43.59 108 (99)
1951-55	24/15.45 155 (141)	32/28.33 113 (103)	45/37.70 119 (109)	11/14.64 75 (68)	112/96.12 117 (106)
1956-60	33/25.01 132 (120)	53/41.13 129 (118)	40/52.08 77 (70*)	16/11.59 138 (125)	142/129.8 109 (100)
1961-65	31/25.67 121 (110)	67/46.32 145** (131*)	38/38.08 100 (90)	8/6.54 122 (112)	144/116.6 124* (112)
1966-70	20/20.79 96 (88)	43/37.90 113 (104)	29/28.38 102 (94)	3/3.61 83 (79)	95/90.69 105 (96)
1971-75	2/13.84 14*** (13***)	35/27.81 126 (115)	32/22.13 145 (133)	6/4.97 121 (112)	75/68.75 109 (100)
1976+	0/11.63 0*** (0***)	11/27.33 40*** (37***)	11/26.09 42** (39***)	11/9.24 119 (110)	33/74.29 44*** (41***)
Total	122/118.0 103 (94)	248/217.8 114* (104)	206/220.5 93 (85*)	72/63.43 114 (104)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 151

Mortality from all malignant neoplasms (140-209)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	0/1.24 0 (0)	1/2.07 48 (46)	1/3.81 26 (25)	6/3.37 178 (171)	8/10.48 76 (73)
1951-55	7/3.64 192 (184)	8/6.85 117 (112)	8/9.89 81 (77)	4/4.05 99 (94)	27/24.43 111 (105)
1956-60	6/6.09 98 (94)	10/9.99 100 (95)	11/12.43 88 (84)	4/2.76 145 (137)	31/31.28 99 (94)
1961-65	12/6.43 187 (177)	15/11.77 127 (121)	14/9.09 154 (146)	2/1.51 133 (127)	43/28.80 149* (142*)
1966-70	3/5.30 57 (54)	14/9.76 144 (136)	3/6.78 44 (42)	1/0.92 108 (106)	21/22.75 92 (88)
1971-75	0/3.71 0* (0*)	11/7.57 145 (138)	7/5.88 119 (113)	1/1.28 78 (75)	19/18.44 103 (98)
1976+	0/2.58 0 (0)	4/7.33 55 (52)	5/7.37 68 (65)	6/2.73 220 (210)	15/20.01 75 (71)
Total	28/29.00 97 (92)	63/55.33 114 (108)	49/55.26 89 (84)	24/16.61 144 (138)	164/156.2 105 (100)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 152

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	0/0.43	0/0.82	1/1.59	3/1.40	4/4.24
	0	0	63	214	94
	(0)	(0)	(60)	(204)	(90)
1951-55	1/1.42	2/2.86	3/4.20	1/1.70	7/10.18
	71	70	71	59	69
	(67)	(66)	(68)	(55)	(65)
1956-60	2/2.50	5/4.15	7/4.95	3/1.09	17/12.69
	80	120	141	276	134
	(76)	(113)	(132)	(257)	(126)
1961-65	8/2.73	7/4.94	7/3.58	0/0.58	22/11.83
	293*	142	196	0	186*
	(275*)	(133)	(183)	(0)	(174*)
1966-70	3/2.29	6/4.10	2/2.70	0/0.37	11/9.47
	131	146	74	0	116
	(123)	(138)	(70)	(0)	(110)
1971-75	0/1.66	4/3.34	3/2.52	0/0.53	7/8.04
	0	120	119	0	87
	(0)	(113)	(113)	(0)	(82)
1976+	0/0.90	3/2.95	2/3.09	4/1.18	9/8.11
	0	102	65	340	111
	(0)	(95)	(61)	(321)	(104)
Total	14/11.93	27/23.16	25/22.63	11/6.85	77/64.55
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 153

Mortality from cancer of the stomach (151)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	0/0.20	0/0.28	0/0.42	2/0.32	2/1.22
	0	0	0	629	164
	(0)	(0)	(0)	(595)	(155)
1951-55	2/0.55	2/0.87	0/1.02	1/0.38	5/2.81
	365	230	0	265	178
	(345)	(217)	(0)	(249)	(168)
1956-60	2/0.87	1/1.20	0/1.24	0/0.26	3/3.57
	229	84	0	0	84
	(216)	(79)	(0)	(0)	(79)
1961-65	1/0.84	2/1.31	2/0.91	0/0.14	5/3.20
	120	152	220	0	156
	(112)	(142)	(206)	(0)	(146)
1966-70	0/0.65	0/1.05	1/0.68	0/0.09	1/2.47
	0	0	147	0	41
	(0)	(0)	(140)	(0)	(38)
1971-75	0/0.46	1/0.84	1/0.62	1/0.13	3/2.04
	0	119	163	781	147
	(0)	(111)	(152)	(733)	(137)
1976+	0/0.26	0/0.70	0/0.69	1/0.25	1/1.89
	0	0	0	402	53
	(0)	(0)	(0)	(376)	(49)
Total	5/3.82	6/6.26	4/5.57	5/1.56	20/17.20
	131	96	72	320*	116
	(123)	(90)	(68)	(302)	(109)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 154

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	2/0.73 274 (244)	0/1.20 0 (0)	0/2.26 0 (0)	4/1.69 237 (211)	6/5.88 102 (91)
1951-55	11/1.92 573*** (517***)	2/3.79 53 (48)	9/4.54 198 (179)	1/1.66 60 (54)	23/11.91 193** (174*)
1956-60	6/3.24 185 (165)	10/5.55 180 (162)	5/7.46 67 (60)	1/1.77 57 (50)	22/18.02 122 (110)
1961-65	5/3.12 160 (140)	11/5.93 186 (162)	4/5.48 73 (64)	2/1.05 190 (165)	22/15.58 141 (124)
1966-70	3/2.41 124 (109)	5/4.83 104 (90)	8/4.27 188 (166)	1/0.48 207 (196)	17/11.99 142 (125)
1971-75	0/1.54 0 (0)	3/3.39 89 (76)	4/2.93 137 (119)	0/0.71 0 (0)	7/8.55 82 (71)
1976+	0/0.87 0 (0)	0/2.22 0 (0)	0/2.18 0 (0)	2/0.84 240 (211)	2/6.10 33 (29)
Total	27/13.82 195** (172*)	31/26.91 115 (101)	30/29.11 103 (92)	11/8.19 134 (120)	99/78.04 127* (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 155

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and exit cohort (unexposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	1/0.38 262	0/0.65 0	0/1.07 0	0/0.66 0	1/2.75 36
1951-55	7/1.01 692***	2/2.13 94	5/2.22 225	0/0.69 0	14/6.05 231**
1956-60	3/1.81 166	8/3.06 262*	3/3.01 100	0/0.61 0	14/8.49 165
1961-65	5/1.76 285	6/3.15 190	2/2.27 88	1/0.36 279	14/7.53 186*
1966-70	2/1.38 145	3/2.54 118	7/1.73 404**	0/0.19 0	12/5.84 206*
1971-75	0/0.88 0	2/1.82 110	2/1.40 143	0/0.29 0	4/4.39 91
1976+	0/0.37 0	0/1.08 0	0/1.07 0	2/0.39 513	2/2.90 69
Total	18/7.59 237**	21/14.42 146	19/12.76 149	3/3.19 94	61/37.96 161***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 156

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and exit cohort (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1946-50	8/1.76	4/3.50	7/8.11	4/6.61	23/19.98
	455***	114	86	61	115
	(399**)	(100)	(76)	(53)	(101)
1951-55	3/4.85	19/11.84	21/19.17	6/7.55	49/43.40
	62	160	110	80	113
	(54)	(141)	(96)	(69)	(99)
1956-60	15/8.51	28/18.57	23/26.67	10/5.94	76/59.69
	176	151*	86	168	127*
	(155)	(133)	(76)	(147)	(112)
1961-65	9/9.28	32/21.45	16/19.32	4/3.34	61/53.39
	97	149*	83	120	114
	(85)	(130)	(72)	(106)	(100)
1966-70	12/7.87	23/17.93	15/14.36	1/1.86	51/42.02
	152	128	104	54	121
	(134)	(114)	(93)	(50)	(108)
1971-75	2/5.55	18/13.35	18/11.26	4/2.56	42/32.72
	36	135	160	157	128
	(32)	(121)	(143)	(140)	(115)
1976+	0/3.84	5/12.68	5/13.18	3/4.77	13/34.47
	0*	39*	38*	63	38***
	(0*)	(35**)	(34**)	(56)	(34***)
Total	49/41.66	129/99.32	105/112.1	32/32.62	315/285.7
	118	130**	94	98	110
	(103)	(114)	(83)	(87)	(97)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 157

Factory by length of employment (exposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	111/99.85 111 (103)	46/36.53 126 (117)	31/22.67 137 (127)	18/12.88 140 (129)	12/6.04 199* (184)	218/178.0 122** (113)
11	169/140.8 120* (109)	41/40.37 102 (92)	32/26.27 122 (111)	17/17.66 96 (87)	19/17.98 106 (96)	278/243.1 114* (104)
12	32/32.68 98 (89)	19/14.53 131 (119)	9/13.12 69 (62)	9/4.83 186 (169)	4/4.04 99 (90)	73/69.21 105 (96)
13	41/38.82 106 (109)	15/20.26 74 (76)	11/9.05 122 (125)	4/5.70 70 (72)	5/8.24 61 (63)	76/82.06 93 (95)
14	208/165.4 126** (115*)	116/90.14 129* (118)	85/59.17 144** (132*)	47/47.52 99 (91)	59/50.80 116 (107)	515/413.0 125*** (114**)
15	53/49.43 107 (92)	28/32.73 86 (74)	23/18.40 125 (108)	9/10.32 87 (75)	20/14.00 143 (123)	133/124.9 106 (92)
16	90/88.27 102 (92)	34/47.81 71* (64**)	29/25.52 114 (102)	18/20.39 88 (80)	37/36.14 102 (92)	208/218.1 95 (86*)
17	70/59.62 117 (116)	27/25.16 107 (106)	18/17.77 101 (100)	14/12.73 110 (109)	14/19.54 72 (71)	143/134.8 106 (105)
18	184/171.5 107 (98)	83/57.58 144** (132*)	54/41.23 131 (120)	30/26.84 112 (103)	18/22.44 80 (74)	369/319.6 115** (106)
19	62/48.25 129 (104)	32/24.95 128 (104)	21/15.41 136 (111)	7/8.16 86 (70)	6/7.64 79 (64)	128/104.4 123* (100)
Total	1020/894.6 114*** (104)	441/390.1 113* (103)	313/248.6 126*** (115*)	173/167.0 104 (95)	194/186.9 104 (95)	2141/1887.2 113*** (104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 158

Factory by length of employment (exposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	23/10.03 229*** (220**)	9/3.80 237* (228*)	1/2.33 43 (41)	0/1.35 0 (0)	4/0.76 524* (503*)	37/18.28 202*** (195***)
11	27/15.00 180** (171*)	7/4.30 163 (155)	8/3.00 267* (254*)	3/2.02 148 (141)	5/2.22 225 (215)	50/26.55 188*** (179***)
12	4/3.43 116 (113)	3/1.42 211 (205)	2/1.40 143 (139)	1/0.50 200 (194)	1/0.48 207 (201)	11/7.24 152 (148)
13	2/4.13 48 (48)	0/1.84 0 (0)	0/0.88 0 (0)	1/0.68 148 (147)	0/1.02 0 (0)	3/8.55 35 (35)
14	37/18.34 202*** (185***)	22/10.01 220** (202**)	16/6.44 249** (228**)	13/5.52 236** (216*)	7/6.13 114 (105)	95/46.44 205*** (188***)
15	4/5.32 75 (64)	5/3.51 142 (121)	4/1.99 201 (170)	1/1.11 90 (76)	2/1.74 115 (97)	16/13.68 117 (99)
16	10/9.37 107 (101)	4/4.94 81 (76)	4/2.74 146 (138)	5/2.30 217 (205)	6/4.48 134 (126)	29/23.83 122 (115)
17	4/6.34 63 (68)	7/2.76 254* (273*)	2/1.85 108 (116)	0/1.49 0 (0)	1/2.36 42 (45)	14/14.80 95 (102)
18	19/18.09 105 (100)	11/6.42 171 (163)	10/4.51 222* (211*)	2/3.11 64 (61)	3/2.77 108 (103)	45/34.90 129 (123)
19	9/5.07 177 (149)	3/2.32 129 (109)	2/1.73 116 (97)	0/0.91 0 (0)	2/0.95 210 (177)	16/10.98 146 (122)
Total	139/95.14 146*** (138***)	71/41.31 172*** (161***)	49/26.87 182*** (171***)	26/19.00 137 (129)	31/22.92 135 (127)	316/205.2 154*** (145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 159

Factory by length of employment (exposed)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	19/12.98	8/4.91	6/3.25	6/1.86	0/0.58	39/23.58
	146	163	184	322*	0	165**
	(131)	(145)	(165)	(288*)	(0)	(148*)
11	18/16.56	6/4.81	6/3.11	2/2.18	1/1.87	33/28.54
	109	125	193	92	53	116
	(94)	(107)	(166)	(79)	(46)	(100)
12	2/4.06	4/1.86	1/1.79	1/0.64	1/0.40	9/8.74
	49	216	56	157	251	103
	(42)	(184)	(48)	(135)	(214)	(88)
13	7/4.21	2/2.85	0/1.16	1/0.57	0/0.81	10/9.60
	166	70	0	177	0	104
	(179)	(75)	(0)	(190)	(0)	(112)
14	41/17.73	19/10.45	16/7.10	9/5.43	10/5.41	95/46.12
	231***	182*	225**	166	185	206***
	(184***)	(144)	(179*)	(132)	(147)	(163***)
15	11/5.69	3/3.96	2/2.46	3/1.37	2/1.47	21/14.94
	193	76	81	219	136	141
	(151)	(59)	(64)	(171)	(106)	(110)
16	12/9.56	4/5.77	5/2.94	4/2.24	5/3.59	30/24.10
	125	69	170	179	139	124
	(105)	(58)	(142)	(149)	(116)	(104)
17	11/7.05	5/2.97	4/2.45	2/1.44	3/2.16	25/16.07
	156	168	163	139	139	156*
	(149)	(160)	(155)	(132)	(132)	(148)
18	21/19.04	11/6.29	5/5.22	8/3.27	0/2.18	45/36.01
	110	175	96	244*	0	125
	(98)	(155)	(85)	(216)	(0)	(111)
19	2/5.34	5/3.28	1/1.88	1/1.01	1/0.72	10/12.23
	37	152	53	99	138	82
	(37)	(151)	(53)	(98)	(137)	(81)
Total	144/102.2	67/47.17	46/31.37	37/19.99	23/19.19	317/219.9
	141***	142**	147*	185***	120	144***
	(122*)	(123)	(126)	(158*)	(102)	(124***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 160

Mortality from all causes (000-999)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	199/201.5	360/284.9	345/314.5	116/93.71	1020/894.6
	99	126***	110	124*	114***
	(90)	(115**)	(100)	(113)	(104)
5-9 yrs	96/104.8	163/126.0	142/121.2	40/38.03	441/390.1
	92	129**	117	105	113*
	(84)	(118*)	(107)	(96)	(103)
10-14 yr	0/0.00	185/145.3	105/80.80	23/22.52	313/248.6
	-	127**	130*	102	126***
	-	(116)	(118)	(94)	(115*)
15-19 yr	0/0.00	76/77.95	76/70.81	21/18.28	173/167.0
	-	98	107	115	104
	-	(89)	(98)	(105)	(95)
20+ yrs	0/0.00	0/0.00	128/128.1	66/58.80	194/186.9
	-	-	100	112	104
	-	-	(91)	(103)	(95)
Total	295/306.3	784/634.2	796/715.4	266/231.3	2141/1887.2
	96	124***	111**	115*	113***
	(88*)	(113***)	(102)	(105)	(104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 161

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	59/47.92 123 (117)	100/72.57 138** (131*)	96/83.80 115 (109)	35/25.59 137 (131)	290/229.9 126*** (120**)
5-9 yrs	22/26.28 84 (79)	47/31.68 148* (140*)	42/31.07 135 (128)	15/10.24 147 (138)	126/99.28 127* (120*)
10-14 yr	0/0.00 - -	64/38.14 168*** (159***)	26/19.91 131 (124)	6/5.68 106 (100)	96/63.73 151*** (143**)
15-19 yr	0/0.00 - -	22/21.34 103 (98)	17/18.59 91 (87)	3/4.45 67 (64)	42/44.38 95 (90)
20+ yrs	0/0.00 - -	0/0.00 - -	32/36.26 88 (84)	17/16.64 102 (97)	49/52.90 93 (88)
Total	81/74.20 109 (104)	233/163.7 142*** (135***)	213/189.6 112 (107)	76/62.60 121 (116)	603/490.2 123*** (117***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 162

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	26/18.70	39/30.29	52/35.41	22/10.75	139/95.14
	139	129	147*	205**	146***
	(131)	(121)	(138*)	(194**)	(138***)
5-9 yrs	12/10.90	28/13.22	24/12.92	7/4.27	71/41.31
	110	212***	186**	164	172***
	(103)	(198**)	(174*)	(153)	(161***)
10-14 yr	0/0.00	33/16.40	13/8.15	3/2.31	49/26.87
	-	201***	159	130	182***
	-	(188**)	(149)	(122)	(171***)
15-19 yr	0/0.00	14/9.31	11/7.90	1/1.79	26/19.00
	-	150	139	56	137
	-	(141)	(131)	(53)	(129)
20+ yrs	0/0.00	0/0.00	20/15.82	11/7.11	31/22.92
	-	-	126	155	135
	-	-	(119)	(146)	(127)
Total	38/29.60	114/69.23	120/80.19	44/26.22	316/205.2
	128	165***	150***	168**	154***
	(121)	(155***)	(141***)	(158**)	(145***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 163

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	12/6.30	21/8.15	9/8.38	2/2.41	44/25.25
	190	258***	107	83	174***
	(177)	(240***)	(100)	(77)	(162**)
5-9 yrs	2/3.39	6/3.67	8/3.14	1/0.97	17/11.17
	59	163	255*	104	152
	(55)	(151)	(235*)	(95)	(141)
10-14 yr	0/0.00	10/4.41	1/2.04	1/0.54	12/6.99
	-	227*	49	186	172
	-	(210*)	(45)	(171)	(159)
15-19 yr	0/0.00	3/2.31	3/1.94	0/0.42	6/4.67
	-	130	154	0	128
	-	(120)	(143)	(0)	(119)
20+ yrs	0/0.00	0/0.00	2/3.60	0/1.57	2/5.18
	-	-	55	0	39
	-	-	(51)	(0)	(36)
Total	14/9.69	40/18.54	23/19.11	4/5.91	81/53.25
	144	216***	120	68	152***
	(134)	(200***)	(112)	(63)	(141**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 164

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	22/21.58	44/32.92	62/36.50	16/11.20	144/102.2
	102	134	170***	143	141***
	(89)	(116)	(147**)	(124)	(122*)
5-9 yrs	15/11.72	28/15.62	17/15.16	7/4.68	67/47.17
	128	179**	112	150	142**
	(110)	(155*)	(97)	(127)	(123)
10-14 yr	0/0.00	24/16.91	19/11.29	3/3.18	46/31.37
	-	142	168*	94	147*
	-	(122)	(145)	(81)	(126)
15-19 yr	0/0.00	11/7.94	20/9.28	6/2.78	37/19.99
	-	139	216**	216	185***
	-	(118)	(185*)	(185)	(158*)
20+ yrs	0/0.00	0/0.00	19/12.67	4/6.52	23/19.19
	-	-	150	61	120
	-	-	(128)	(52)	(102)
Total	37/33.30	107/73.38	137/84.90	36/28.34	317/219.9
	111	146***	161***	127	144***
	(96)	(126*)	(139***)	(109)	(124***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 165

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	12/10.94 110	28/17.39 161*	37/17.31 214***	8/4.66 172	85/50.30 169***
5-9 yrs	8/6.36 126	20/8.42 238***	8/6.94 115	2/1.90 105	38/23.62 161**
10-14 yr	0/0.00 -	15/9.42 159	12/5.00 240*	1/1.17 86	28/15.59 180**
15-19 yr	0/0.00 -	7/4.50 156	11/4.51 244*	4/1.03 390*	22/10.04 219**
20+ yrs	0/0.00 -	0/0.00 -	6/6.63 90	1/2.89 35	7/9.52 74
Total	20/17.31 116	70/39.73 176***	74/40.40 183***	16/11.63 138	180/109.1 165***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 166

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	65/66.27	175/129.6	150/160.4	56/48.30	446/404.6
	98	135***	94	116	110*
	(87)	(120*)	(83*)	(103)	(98)
5-9 yrs	37/38.24	66/56.34	74/61.77	16/19.57	193/175.9
	97	117	120	82	110
	(86)	(104)	(106)	(72)	(97)
10-14 yr	0/0.00	82/64.42	53/41.12	14/11.56	149/117.1
	-	127*	129	121	127**
	-	(113)	(114)	(108)	(113)
15-19 yr	0/0.00	31/36.35	32/36.03	12/9.37	75/81.74
	-	85	89	128	92
	-	(76)	(79)	(113)	(82)
20+ yrs	0/0.00	0/0.00	62/64.96	41/30.33	103/95.29
	-	-	95	135	108
	-	-	(85)	(121)	(96)
Total	102/104.5	354/286.7	371/364.3	139/119.1	966/874.6
	98	123***	102	117	110**
	(86)	(109)	(90)	(103)	(98)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 167

Factory by length of employment (unexposed)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Group:

Factory	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	30/36.06 83 (77)	6/8.20 73 (68)	4/5.39 74 (69)	2/3.40 59 (54)	4/2.75 146 (135)	46/55.80 82 (76)
11	25/25.19 99 (90)	10/9.75 103 (93)	7/6.17 114 (103)	3/4.38 69 (62)	2/2.89 69 (63)	47/48.37 97 (88)
12	10/11.03 91 (82)	1/1.54 65 (59)	2/1.67 120 (109)	3/0.95 316 (287)	3/1.66 181 (164)	19/16.85 113 (102)
13	7/12.58 56 (57)	4/4.57 87 (90)	3/4.19 72 (74)	2/5.97 33 (35)	2/3.09 65 (67)	18/30.40 59* (61*)
14	27/23.17 117 (107)	18/25.17 72 (66)	20/17.76 113 (103)	10/12.66 79 (72)	7/9.70 72 (66)	82/88.46 93 (85)
15	3/1.87 161 (138)	4/3.42 117 (101)	0/0.76 0 (0)	0/0.51 0 (0)	3/2.74 109 (94)	10/9.30 108 (93)
16	17/14.33 119 (107)	6/7.58 79 (71)	7/7.47 94 (84)	4/3.89 103 (93)	5/2.11 237 (213)	39/35.38 110 (99)
17	26/21.55 121 (119)	10/10.29 97 (96)	2/6.59 30 (30)	2/2.76 72 (72)	5/5.31 94 (93)	45/46.50 97 (96)
18	112/96.57 116 (106)	73/56.77 129* (118)	46/33.10 139* (127)	21/19.08 110 (101)	15/13.48 111 (102)	267/219.0 122** (112)
19	42/36.22 116 (94)	16/12.43 129 (105)	6/14.81 41* (33**)	9/2.81 320** (260*)	2/3.50 57 (46)	75/69.78 107 (87)
Total	299/278.6 107 (98)	148/139.7 106 (97)	97/97.90 99 (90)	56/56.41 99 (92)	48/47.23 102 (93)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 168

Factory by length of employment (unexposed)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	6/3.94 152 (147)	2/0.91 220 (212)	0/0.54 0 (0)	0/0.40 0 (0)	2/0.35 576 (554)	10/6.13 163 (157)
11	4/2.58 155 (147)	0/1.11 0 (0)	0/0.73 0 (0)	0/0.50 0 (0)	0/0.36 0 (0)	4/5.29 76 (72)
12	0/1.08 0 (0)	0/0.18 0 (0)	0/0.19 0 (0)	0/0.12 0 (0)	1/0.20 513 (498)	1/1.77 57 (55)
13	1/1.32 76 (75)	0/0.46 0 (0)	0/0.49 0 (0)	1/0.62 160 (159)	0/0.38 0 (0)	2/3.27 61 (60)
14	0/2.52 0 (0)	1/2.55 39 (36)	2/1.94 103 (94)	0/1.32 0 (0)	1/1.18 85 (78)	4/9.50 42 (39*)
15	0/0.20 0 (0)	0/0.39 0 (0)	0/0.08 0 (0)	0/0.06 0 (0)	0/0.33 0 (0)	0/1.07 0 (0)
16	2/1.52 132 (125)	0/0.81 0 (0)	2/0.72 277 (261)	0/0.37 0 (0)	2/0.25 803 (758)	6/3.67 163 (154)
17	6/2.18 275* (295*)	3/1.04 289 (310)	0/0.64 0 (0)	0/0.33 0 (0)	1/0.62 161 (173)	10/4.81 208 (224*)
18	10/9.64 104 (99)	8/5.25 152 (145)	10/3.10 322** (307**)	0/2.05 0 (0)	1/1.61 62 (59)	29/21.66 134 (128)
19	4/3.91 102 (86)	2/1.27 158 (132)	1/1.47 68 (57)	3/0.33 909** (764*)	1/0.42 239 (201)	11/7.39 149 (125)
Total	33/28.89 114 (108)	16/13.97 115 (108)	15/9.91 151 (142)	4/6.11 65 (62)	9/5.68 158 (149)	77/64.56 119 (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 169

Factory by length of employment (unexposed)

Mortality from diseases of the respiratory system (460–519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1–4 yrs	5–9 yrs	10–14 yr	15–19 yr	20+ yrs	Total
10	2/4.16 48 (43)	0/0.91 0 (0)	0/0.73 0 (0)	0/0.40 0 (0)	0/0.27 0 (0)	2/6.46 31 (28*)
11	5/3.46 145 (125)	1/1.16 86 (75)	0/0.65 0 (0)	0/0.53 0 (0)	0/0.29 0 (0)	6/6.09 99 (85)
12	1/1.53 65 (56)	0/0.16 0 (0)	1/0.19 518 (443)	1/0.10 1031 (881)	0/0.21 0 (0)	3/2.19 137 (117)
13	0/1.33 0 (0)	1/0.48 209 (225)	0/0.47 0 (0)	0/0.84 0 (0)	0/0.27 0 (0)	1/3.39 29 (32)
14	4/2.39 168 (133)	1/3.31 30 (24)	3/2.19 137 (109)	2/1.68 119 (94)	2/0.94 214 (170)	12/10.50 114 (91)
15	1/0.18 543 (425)	0/0.46 0 (0)	0/0.08 0 (0)	0/0.06 0 (0)	0/0.31 0 (0)	1/1.08 92 (72)
16	3/1.58 190 (158)	1/0.89 113 (94)	0/1.10 0 (0)	1/0.55 182 (152)	0/0.19 0 (0)	5/4.31 116 (97)
17	5/2.60 192 (183)	1/1.36 74 (70)	1/0.94 106 (101)	0/0.23 0 (0)	0/0.58 0 (0)	7/5.71 123 (117)
18	31/13.11 236*** (209***)	14/8.49 165 (146)	9/4.94 182 (161)	4/2.55 157 (139)	2/1.32 152 (134)	60/30.41 197*** (175***)
19	1/3.78 26 (26)	1/1.36 74 (73)	0/2.16 0 (0)	0/0.27 0 (0)	0/0.33 0 (0)	2/7.90 25* (25*)
Total	53/34.12 155** (139*)	20/18.56 108 (94)	14/13.45 104 (92)	8/7.21 111 (97)	4/4.70 85 (75)	99/78.04 127* (112)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 170

Mortality from all causes (000-999)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	81/75.59 107 (98)	102/89.74 114 (103)	85/88.53 96 (88)	31/24.70 126 (115)	299/278.6 107 (98)
5-9 yrs	41/42.45 97 (88)	62/46.70 133* (121)	36/39.65 91 (83)	9/10.93 82 (75)	148/139.7 106 (97)
10-14 yr	0/0.00 - -	60/56.02 107 (97)	29/34.52 84 (76)	8/7.36 109 (98)	97/97.90 99 (90)
15-19 yr	0/0.00 - -	24/25.35 95 (87)	25/24.10 104 (96)	7/6.96 101 (94)	56/56.41 99 .(92)
20+ yrs	0/0.00 - -	0/0.00 - -	31/33.74 92 (84)	17/13.49 126 (116)	48/47.23 102 (93)
Total	122/118.0 103 (94)	248/217.8 114* (104)	206/220.5 93 (85*)	72/63.43 114 (104)	648/619.8 105 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 171

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	20/18.34	24/22.58	20/22.63	10/6.57	74/70.12
	109	106	88	152	106
	(104)	(101)	(84)	(146)	(101)
5-9 yrs	8/10.65	12/11.33	10/9.30	1/2.87	31/34.16
	75	106	108	35	91
	(71)	(101)	(102)	(33)	(86)
10-14 yr	0/0.00	20/14.52	6/7.77	4/1.78	30/24.07
	-	138	77	225	125
	-	(130)	(73)	(212)	(118)
15-19 yr	0/0.00	7/6.90	4/6.10	2/1.56	13/14.56
	-	102	66	129	89
	-	(96)	(63)	(124)	(85)
20+ yrs	0/0.00	0/0.00	9/9.46	7/3.84	16/13.29
	-	-	95	182	120
	-	-	(91)	(174)	(115)
Total	28/28.99	63/55.33	49/55.26	24/16.61	164/156.2
	97	114	89	145	105
	(92)	(108)	(84)	(138)	(100)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 172

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	7/7.43	11/9.38	10/9.36	5/2.73	33/28.89
	94	117	107	183	114
	(89)	(110)	(101)	(173)	(108)
5-9 yrs	7/4.50	4/4.61	5/3.68	0/1.18	16/13.97
	156	87	136	0	115
	(146)	(82)	(128)	(0)	(108)
10-14 yr	0/0.00	9/6.20	4/3.01	2/0.70	15/9.91
	-	145	133	285	151
	-	(136)	(124)	(266)	(142)
15-19 yr	0/0.00	3/2.97	1/2.54	0/0.59	4/6.11
	-	101	39	0	65
	-	(95)	(37)	(0)	(62)
20+ yrs	0/0.00	0/0.00	5/4.05	4/1.64	9/5.68
	-	-	124	245	158
	-	-	(116)	(231)	(149)
Total	14/11.93	27/23.15	25/22.63	11/6.84	77/64.56
	117	117	110	161	119
	(110)	(110)	(104)	(152)	(112)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 173

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	5/2.46	3/2.56	0/2.26	2/0.61	10/7.89
	203	117	0	326	127
	(191)	(111)	(0)	(309)	(120)
5-9 yrs	0/1.36	1/1.30	3/0.94	1/0.27	5/3.87
	0	77	319	370	129
	(0)	(72)	(300)	(345)	(121)
10-14 yr	0/0.00	2/1.67	0/0.80	0/0.17	2/2.63
	-	120	0	0	76
	-	(112)	(0)	(0)	(71)
15-19 yr	0/0.00	0/0.74	1/0.64	0/0.15	1/1.53
	-	0	156	0	66
	-	(0)	(148)	(0)	(62)
20+ yrs	0/0.00	0/0.00	0/0.93	2/0.36	2/1.29
	-	-	0	552	155
	-	-	(0)	(516)	(145)
Total	5/3.83	6/6.26	4/5.56	5/1.56	20/17.21
	131	96	72	321*	116
	(123)	(90)	(68)	(302)	(109)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 174

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	20/8.79 228** (201**)	16/11.07 145 (129)	12/11.18 107 (96)	5/3.08 162 (146)	53/34.12 155** (139*)
5-9 yrs	7/5.03 139 (122)	6/6.33 95 (82)	6/5.79 104 (91)	1/1.41 71 (62)	20/18.56 108 (94)
10-14 yr	0/0.00 - -	7/6.89 102 (89)	6/5.46 110 (98)	1/1.10 91 (84)	14/13.45 104 (92)
15-19 yr	0/0.00 - -	2/2.63 76 (67)	4/3.40 118 (104)	2/1.18 169 (149)	8/7.21 111 (97)
20+ yrs	0/0.00 - -	0/0.00 - -	2/3.27 61 (53)	2/1.43 140 (123)	4/4.70 85 (75)
Total	27/13.82 195** (172*)	31/26.92 115 (101)	30/29.10 103 (92)	11/8.19 134 (120)	99/78.04 127* (112)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 175

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (unexposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	14/4.74 295***	11/5.85 188	6/4.96 121	0/1.21 0	31/16.76 185**
5-9 yrs	4/2.85 140	4/3.27 123	5/2.35 213	0/0.55 0	13/9.02 144
10-14 yr	0/0.00 -	4/3.82 105	5/2.17 231	0/0.38 0	9/6.38 141
15-19 yr	0/0.00 -	2/1.48 135	2/1.62 124	1/0.40 250	5/3.50 143
20+ yrs	0/0.00 -	0/0.00 -	1/1.68 60	2/0.64 314	3/2.32 129
Total	18/7.59 237**	21/14.42 146	19/12.77 149	3/3.18 94	61/37.97 161***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 176

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	30/25.79 116 (102)	53/41.15 129 (113)	43/45.11 95 (84)	12/12.72 94 (83)	138/124.8 111 (97)
5-9 yrs	19/15.87 120 (106)	35/21.25 165** (146*)	16/20.11 80 (70)	7/5.62 125 (109)	77/62.85 123 (108)
10-14 yr	0/0.00 - -	27/25.13 107 (95)	15/17.60 85 (74)	3/3.77 80 (69)	45/46.50 97 (85)
15-19 yr	0/0.00 - -	14/11.79 119 (106)	15/12.21 123 (111)	3/3.56 84 (77)	32/27.55 116 (105)
20+ yrs	0/0.00 - -	0/0.00 - -	16/17.02 94 (84)	7/6.97 101 (90)	23/23.98 96 (86)
Total	49/41.66 118 (103)	129/99.32 130** (114)	105/112.1 94 (83)	32/32.62 98 (87)	315/285.7 110 (97)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 177

Factory by length of employment (foundry subcohort)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	87/73.34 119 (110)	23/17.75 130 (120)	17/14.55 117 (108)	13/8.21 158 (147)	9/3.71 243* (225*)	149/117.6 127** (117)
11	73/67.49 108 (98)	23/16.05 143 (130)	14/11.16 125 (114)	10/8.91 112 (102)	7/6.53 107 (97)	127/110.1 115 (105)
12	23/21.85 105 (96)	12/11.17 107 (98)	5/8.87 56 (51)	6/3.04 197 (179)	2/3.01 66 (60)	48/47.95 100 (91)
13	24/21.16 113 (117)	10/11.07 90 (93)	5/4.90 102 (105)	1/1.62 62 (64)	1/4.08 24 (25)	41/42.83 96 (99)
14	121/101.3 119 (110)	54/44.01 123 (113)	45/30.35 148* (136)	22/16.04 137 (126)	24/21.82 110 (101)	266/213.5 125*** (114*)
15	18/19.78 91 (78)	9/12.68 71 (61)	3/6.72 45 (38)	3/1.72 175 (151)	9/3.26 276* (238*)	42/44.16 95 (82)
16	42/46.45 90 (81)	17/21.33 80 (72)	15/13.05 115 (104)	10/8.90 112 (101)	15/15.66 96 (86)	99/105.4 94 (85)
17	34/22.53 151* (149*)	9/12.23 74 (73)	7/7.37 95 (94)	6/5.54 108 (107)	4/8.12 49 (49)	60/55.79 108 (106)
18	113/103.6 109 (100)	37/28.68 129 (118)	25/20.65 121 (111)	13/15.53 84 (77)	9/8.76 103 (94)	197/177.3 111 (102)
19	29/23.15 125 (102)	16/8.88 180* (146)	8/7.85 102 (83)	4/4.30 93 (76)	1/2.43 41 (33)	58/46.61 124 (101)
Total	564/500.7 113** (103)	210/183.9 114 (105)	144/125.5 115 (105)	88/73.82 119 (109)	81/77.39 105 (96)	1087/961.2 113*** (103)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 178

Factory by length of employment (foundry subcohort)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	17/7.12	3/1.84	0/1.42	0/0.96	4/0.47	24/11.82
	239**	163	0	0	844**	203**
	(230**)	(157)	(0)	(0)	(811**)	(195**)
11	12/7.06	7/1.79	3/1.26	2/1.01	3/0.83	27/11.94
	170	392**	239	198	363	226***
	(162)	(373**)	(227)	(189)	(345)	(215***)
12	4/2.36	2/1.11	1/0.89	1/0.29	0/0.36	8/5.00
	170	181	113	344	0	160
	(165)	(176)	(109)	(334)	(0)	(155)
13	2/2.26	0/1.00	0/0.43	0/0.19	0/0.51	2/4.40
	88	0	0	0	0	45
	(87)	(0)	(0)	(0)	(0)	(45)
14	17/11.24	10/5.04	7/3.31	7/1.90	3/2.54	44/24.03
	151	198	212	369**	118	183***
	(139)	(182)	(194)	(338*)	(108)	(168**)
15	1/2.14	0/1.26	0/0.67	0/0.20	1/0.39	2/4.65
	47	0	0	0	259	43
	(40)	(0)	(0)	(0)	(220)	(36)
16	7/4.84	2/2.24	3/1.46	3/1.04	3/1.93	18/11.51
	145	89	206	289	156	156
	(136)	(84)	(194)	(273)	(147)	(148)
17	2/2.43	2/1.37	1/0.66	0/0.66	1/0.97	6/6.09
	82	146	151	0	103	98
	(89)	(157)	(162)	(0)	(111)	(106)
18	13/10.73	8/3.07	3/2.16	0/1.75	2/1.06	26/18.77
	121	261*	139	0	188	139
	(115)	(248*)	(132)	(0)	(179)	(132)
19	5/2.44	1/0.96	1/0.90	0/0.45	0/0.31	7/5.05
	205	104	111	0	0	139
	(172)	(87)	(93)	(0)	(0)	(116)
Total	80/52.62	35/19.68	19/13.15	13/8.45	17/9.36	164/103.3
	152***	178**	144	154	182*	159***
	(143**)	(167**)	(135)	(145)	(172*)	(150***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 179

Factory by length of employment (foundry subcohort)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	15/9.94 151 (135)	4/2.33 172 (154)	4/2.16 185 (165)	4/1.07 372* (333)	0/0.36 0 (0)	27/15.87 170* (152*)
11	6/8.20 73 (63)	4/1.80 223 (192)	1/1.40 71 (61)	1/1.14 88 (76)	0/0.64 0 (0)	12/13.18 91 (79)
12	1/2.69 37 (32)	3/1.45 207 (177)	0/1.33 0 (0)	1/0.43 230 (196)	1/0.30 330 (282)	6/6.21 97 (83)
13	5/2.36 212 (227)	2/1.67 120 (129)	0/0.73 0 (0)	0/0.13 0 (0)	0/0.42 0 (0)	7/5.31 132 (142)
14	24/11.20 214** (170*)	9/5.14 175 (139)	7/3.89 180 (143)	2/1.78 112 (89)	3/2.52 119 (94)	45/24.54 183*** (146*)
15	4/2.29 175 (137)	1/1.65 60 (47)	0/0.95 0 (0)	1/0.17 602 (471)	0/0.36 0 (0)	6/5.42 111 (87)
16	5/5.42 92 (77)	1/2.57 39 (32)	2/1.47 136 (114)	2/0.93 214 (179)	2/1.56 128 (107)	12/11.94 100 (84)
17	9/2.55 353** (336**)	1/1.41 71 (67)	2/1.16 172 (164)	1/0.59 169 (161)	1/0.93 108 (103)	14/6.65 211* (201*)
18	11/12.11 91 (80)	4/3.26 123 (109)	3/2.73 110 (97)	4/2.04 196 (173)	0/0.86 0 (0)	22/21.00 105 (93)
19	2/2.79 72 (71)	1/1.01 99 (98)	1/0.99 101 (100)	0/0.61 0 (0)	1/0.22 459 (454)	5/5.62 89 (88)
Total	82/59.55 138** (119)	30/22.27 135 (116)	20/16.83 119 (103)	16/8.91 180* (156)	8/8.17 98 (84)	156/115.7 135*** (117)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 180

Mortality from all causes (000-999)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	124/111.3 111 (102)	191/159.5 120* (110)	181/176.5 103 (94)	68/53.43 127 (116)	564/500.7 113** (103)
5-9 yrs	51/50.26 101 (93)	84/60.40 139** (127*)	61/54.43 112 (103)	14/18.77 75 (68)	210/183.9 114 (105)
10-14 yr	0/0.00 - -	80/69.06 116 (106)	52/43.19 120 (110)	12/13.22 91 (83)	144/125.5 115 (105)
15-19 yr	0/0.00 - -	37/34.20 108 (99)	38/31.47 121 (110)	13/8.14 160 (146)	88/73.82 119 (109)
20+ yrs	0/0.00 - -	0/0.00 - -	52/54.10 96 (88)	29/23.29 125 (115)	81/77.39 105 (96)
Total	175/161.5 108 (99)	392/323.1 121*** (111*)	384/359.7 107 (98)	136/116.9 116 (107)	1087/961.2 113*** (103)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 181

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	40/26.55 151* (143*)	52/39.96 130 (124)	56/46.23 121 (115)	24/14.57 165* (157*)	172/127.3 135*** (129**)
5-9 yrs	15/12.61 119 (113)	27/15.15 178** (169*)	17/14.15 120 (114)	5/5.13 98 (92)	64/47.04 136* (129)
10-14 yr	0/0.00 - -	27/17.99 150 (142)	13/10.22 127 (121)	4/3.22 124 (118)	44/31.42 140* (133)
15-19 yr	0/0.00 - -	11/9.33 118 (112)	9/8.27 109 (104)	3/2.05 146 (140)	23/19.66 117 (111)
20+ yrs	0/0.00 - -	0/0.00 - -	15/15.25 98 (94)	9/6.44 140 (134)	24/21.69 111 (105)
Total	55/39.16 140* (133*)	117/82.43 142*** (135**)	110/94.11 117 (111)	45/31.41 143* (136)	327/247.1 132*** (126***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 182

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	17/10.45	20/16.61	29/19.44	14/6.12	80/52.62
	163	120	149	229**	152***
	(153)	(113)	(141)	(216*)	(143**)
5-9 yrs	9/5.27	17/6.34	8/5.93	1/2.15	35/19.68
	171	268***	135	47	178**
	(160)	(252**)	(127)	(44)	(167**)
10-14 yr	0/0.00	11/7.75	6/4.11	2/1.29	19/13.15
	-	142	146	155	144
	-	(133)	(137)	(145)	(135)
15-19 yr	0/0.00	6/4.09	6/3.52	1/0.84	13/8.45
	-	147	171	119	154
	-	(138)	(161)	(114)	(145)
20+ yrs	0/0.00	0/0.00	10/6.64	7/2.72	17/9.36
	-	-	151	257*	182*
	-	-	(142)	(244)	(172*)
Total	26/15.71	54/34.79	59/39.64	25/13.11	164/103.3
	165*	155**	149**	191**	159***
	(156*)	(146*)	(140*)	(180**)	(150***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 183

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	7/3.56	13/4.54	8/4.65	2/1.38	30/14.13
	197	286**	172	145	212***
	(184)	(267**)	(160)	(135)	(198***)
5-9 yrs	1/1.64	3/1.76	4/1.43	1/0.49	9/5.31
	61	171	280	206	169
	(57)	(159)	(260)	(189)	(157)
10-14 yr	0/0.00	6/2.12	1/1.06	1/0.30	8/3.47
	-	284*	95	330	230
	-	(263)	(88)	(303)	(214)
15-19 yr	0/0.00	2/1.02	1/0.87	0/0.20	3/2.09
	-	196	115	0	144
	-	(182)	(108)	(0)	(134)
20+ yrs	0/0.00	0/0.00	2/1.53	0/0.61	2/2.13
	-	-	131	0	94
	-	-	(122)	(0)	(87)
Total	8/5.20	24/9.44	16/9.53	4/2.97	52/27.14
	154	254***	168	135	192***
	(144)	(237***)	(156)	(125)	(178***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 184

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	18/12.50	21/19.27	37/21.33	6/6.45	82/59.55
	144	109	173**	93	138**
	(125)	(95)	(150*)	(80)	(119)
5-9 yrs	5/5.78	13/7.65	11/6.61	1/2.23	30/22.27
	87	170	166	45	135
	(75)	(147)	(145)	(38)	(116)
10-14 yr	0/0.00	11/8.34	9/6.51	0/1.97	20/16.83
	-	132	138	0	119
	-	(114)	(120)	(0)	(103)
15-19 yr	0/0.00	4/3.60	9/4.14	3/1.17	16/8.91
	-	111	218	258	180*
	-	(95)	(190)	(226)	(156)
20+ yrs	0/0.00	0/0.00	6/5.47	2/2.70	8/8.17
	-	-	110	74	98
	-	-	(93)	(64)	(84)
Total	23/18.27	49/38.86	72/44.07	12/14.52	156/115.7
	126	126	163***	83	135***
	(109)	(109)	(141**)	(71)	(117)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 185

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (foundry subcohort)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	10/6.48 154	15/10.06 149	22/9.93 222**	4/2.69 149	51/29.16 175***
5-9 yrs	2/3.16 63	10/4.09 244*	4/3.08 130	0/0.93 0	16/11.27 142
10-14 yr	0/0.00 -	8/4.68 171	6/2.77 217	0/0.69 0	14/8.14 172
15-19 yr	0/0.00 -	3/2.07 145	2/2.04 98	2/0.45 442	7/4.56 153
20+ yrs	0/0.00 -	0/0.00 -	3/2.89 104	0/1.17 0	3/4.05 74
Total	12/9.64 124	36/20.91 172**	37/20.70 179**	6/5.92 101	91/57.17 159***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 186

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (foundry subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	33/37.40	97/72.48	74/90.01	32/27.54	236/227.4
	88	134**	82	116	104
	(78)	(119)	(73**)	(103)	(92)
5-9 yrs	20/18.44	33/27.13	28/27.68	7/9.67	88/82.92
	108	122	101	72	106
	(96)	(108)	(91)	(64)	(95)
10-14 yr	0/0.00	37/30.44	26/21.98	8/6.78	71/59.21
	-	122	118	118	120
	-	(107)	(105)	(106)	(106)
15-19 yr	0/0.00	16/15.80	16/16.00	7/4.17	39/35.97
	-	101	100	168	108
	-	(90)	(88)	(148)	(96)
20+ yrs	0/0.00	0/0.00	21/27.36	18/12.00	39/39.36
	-	-	77	150	99
	-	-	(69)	(135)	(89)
Total	53/55.84	183/145.9	165/183.0	72/60.16	473/444.9
	95	125**	90	120	106
	(84)	(111)	(80**)	(106)	(94)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 187

Factory by length of employment (fettling subcohort)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	7/6.39 109 (101)	9/5.94 152 (140)	4/1.80 222 (206)	1/1.48 67 (62)	0/0.69 0 (0)	21/16.31 129 (119)
11	52/45.81 114 (103)	12/15.91 75 (69)	13/9.26 140 (128)	3/5.29 57 (52)	10/8.68 115 (105)	90/84.95 106 (96)
12	5/5.47 91 (83)	3/1.77 170 (154)	0/1.08 0 (0)	2/0.84 238 (217)	1/0.39 259 (236)	11/9.54 115 (105)
13	4/5.37 75 (77)	3/2.03 148 (153)	3/0.94 321 (331)	2/1.43 140 (145)	0/1.05 0 (0)	12/10.80 111 (115)
14	52/34.83 149** (137*)	32/23.92 134 (123)	22/16.44 134 (123)	12/15.38 78 (72)	19/15.20 125 (115)	137/105.8 130** (119)
15	29/26.84 108 (93)	16/16.80 95 (82)	17/9.40 181* (156)	6/6.04 99 (86)	7/8.46 83 (71)	75/67.54 111 (96)
16	21/16.85 125 (112)	8/7.13 112 (101)	3/2.25 133 (120)	1/1.89 53 (48)	7/6.66 105 (95)	40/34.77 115 (104)
17	8/7.78 103 (102)	2/1.80 111 (110)	1/1.75 57 (57)	0/1.09 0 (0)	3/2.23 134 (133)	14/14.65 96 (95)
18	51/47.34 108 (99)	21/12.12 173* (159)	12/7.67 157 (144)	7/5.97 117 (107)	5/5.98 84 (77)	96/79.09 121 (111)
19	22/15.15 145 (118)	9/6.20 145 (118)	7/2.94 238 (193)	1/1.86 54 (44)	4/1.99 201 (163)	43/28.14 153* (124)
Total	251/211.8 118** (107)	115/93.62 123* (111)	82/53.53 153*** (138**)	35/41.27 85 (77)	56/51.33 109 (99)	539/451.6 119*** (108)

Group: 1-4 yrs, 5-9 yrs, 10-14 yr, 15-19 yr, 20+ yrs

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 188

Factory by length of employment (fettling subcohort)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	2/0.74 272 (261)	2/0.69 292 (281)	1/0.22 459 (441)	0/0.16 0 (0)	0/0.09 0 (0)	5/1.89 264 (254)
11	7/4.84 145 (138)	0/1.60 0 (0)	5/1.06 472** (449*)	0/0.63 0 (0)	2/1.04 193 (184)	14/9.17 153 (145)
12	0/0.53 0 (0)	0/0.13 0 (0)	0/0.13 0 (0)	0/0.10 0 (0)	1/0.05 2000 (1942)	1/0.94 106 (103)
13	0/0.54 0 (0)	0/0.22 0 (0)	0/0.10 0 (0)	1/0.16 633 (627)	0/0.13 0 (0)	1/1.14 88 (87)
14	13/3.83 339*** (311***)	7/2.64 265* (243)	6/1.72 349* (320*)	1/1.77 56 (52)	4/1.88 213 (196)	31/11.84 262*** (240***)
15	3/2.91 103 (87)	5/1.88 267 (226)	4/1.05 381* (323)	1/0.69 146 (124)	1/1.07 93 (79)	14/7.59 184* (156)
16	2/1.83 109 (103)	1/0.69 145 (137)	0/0.21 0 (0)	1/0.20 508 (479)	0/0.83 0 (0)	4/3.76 106 (100)
17	0/0.89 0 (0)	0/0.19 0 (0)	0/0.19 0 (0)	0/0.13 0 (0)	0/0.27 0 (0)	0/1.68 0 (0)
18	5/5.20 96 (92)	1/1.38 72 (69)	2/0.85 234 (223)	2/0.73 276 (263)	1/0.75 134 (128)	11/8.90 124 (118)
19	2/1.62 123 (104)	1/0.56 180 (151)	1/0.33 299 (252)	0/0.23 0 (0)	1/0.25 394 (331)	5/2.99 167 (140)
Total	34/22.92 148* (138)	17/9.97 171 (157)	19/5.86 324*** (298***)	6/4.79 125 (115)	10/6.36 157 (145)	86/49.91 172*** (159***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 189

Factory by length of employment (fettling subcohort)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	2/0.65 308 (275)	2/0.71 283 (253)	0/0.24 0 (0)	0/0.22 0 (0)	0/0.06 0 (0)	4/1.88 213 (190)
11	8/5.67 141 (122)	0/2.12 0 (0)	5/1.08 463* (399*)	1/0.58 172 (148)	1/0.97 103 (89)	15/10.42 144 (124)
12	1/0.69 146 (125)	1/0.26 382 (326)	0/0.12 0 (0)	0/0.08 0 (0)	0/0.03 0 (0)	2/1.18 169 (144)
13	0/0.53 0 (0)	0/0.16 0 (0)	0/0.08 0 (0)	1/0.19 541 (581)	0/0.08 0 (0)	1/1.03 97 (105)
14	11/3.55 310** (246*)	6/2.66 225 (179)	5/1.88 266 (211)	5/1.70 293 (233)	3/1.48 202 (161)	30/11.28 266*** (211***)
15	6/3.14 191 (149)	2/1.98 101 (79)	1/1.25 80 (63)	2/0.76 265 (207)	1/0.86 116 (90)	12/7.98 150 (117)
16	3/1.53 197 (164)	1/0.82 122 (101)	1/0.22 452 (377)	0/0.14 0 (0)	1/0.58 173 (144)	6/3.29 183 (152)
17	0/0.87 0 (0)	0/0.23 0 (0)	0/0.23 0 (0)	0/0.13 0 (0)	1/0.27 369 (351)	1/1.72 58 (55)
18	9/4.86 185 (164)	2/1.17 171 (152)	1/0.87 115 (102)	1/0.61 165 (146)	0/0.55 0 (0)	13/8.05 161 (143)
19	0/1.56 0 (0)	2/0.88 227 (225)	0/0.28 0 (0)	0/0.18 0 (0)	0/0.18 0 (0)	2/3.08 65 (64)
Total	40/23.03 174** (149*)	16/10.99 146 (123)	13/6.24 208* (174)	10/4.58 218* (183)	7/5.07 138 (115)	86/49.91 172*** (146**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 190

Mortality from all causes (000-999)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	33/45.30	94/68.15	95/76.54	29/21.84	251/211.8
	73	138**	124*	133	118**
	(66*)	(124*)	(112)	(121)	(107)
5-9 yrs	19/25.48	45/29.72	37/30.89	14/7.53	115/93.62
	75	151*	120	186*	123*
	(67)	(136)	(108)	(167)	(111)
10-14 yr	0/0.00	58/33.21	21/16.62	3/3.70	82/53.53
	-	175***	126	81	153***
	-	(158**)	(114)	(73)	(138**)
15-19 yr	0/0.00	18/21.81	17/16.32	0/3.14	35/41.27
	-	83	104	0	85
	-	(75)	(95)	(0)	(77)
20+ yrs	0/0.00	0/0.00	40/35.89	16/15.43	56/51.33
	-	-	111	104	109
	-	-	(101)	(94)	(99)
Total	52/70.78	215/152.9	210/176.3	62/51.64	539/451.6
	73*	141***	119*	120	119***
	(66**)	(127***)	(108)	(109)	(108)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 191

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	10/10.68	23/17.65	24/20.85	6/6.04	63/55.23
	94	130	115	99	114
	(88)	(122)	(108)	(94)	(107)
5-9 yrs	1/6.34	11/7.61	11/7.94	7/2.10	30/23.98
	16*	145	139	333*	125
	(15*)	(135)	(129)	(309*)	(117)
10-14 yr	0/0.00	21/8.70	5/4.23	1/1.00	27/13.93
	-	241***	118	100	194**
	-	(225**)	(110)	(93)	(181**)
15-19 yr	0/0.00	6/5.99	3/4.37	0/0.82	9/11.18
	-	100	69	0	81
	-	(94)	(64)	(0)	(75)
20+ yrs	0/0.00	0/0.00	12/10.20	5/4.46	17/14.66
	-	-	118	112	116
	-	-	(110)	(105)	(108)
Total	11/17.02	61/39.94	55/47.59	19/14.42	146/119.0
	65	153**	116	132	123*
	(60)	(143**)	(108)	(124)	(115)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 192

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	5/4.07	10/7.41	14/8.90	5/2.55	34/22.92
	123	135	157	196	148*
	(113)	(125)	(146)	(184)	(138)
5-9 yrs	0/2.58	4/3.19	8/3.31	5/0.89	17/9.97
	0	125	242*	559**	171
	(0)	(115)	(222)	(511**)	(157)
10-14 yr	0/0.00	16/3.69	3/1.76	0/0.42	19/5.86
	-	433***	171	0	324***
	-	(399***)	(157)	(0)	(298***)
15-19 yr	0/0.00	4/2.59	2/1.86	0/0.34	6/4.79
	-	154	107	0	125
	-	(142)	(99)	(0)	(115)
20+ yrs	0/0.00	0/0.00	7/4.44	3/1.92	10/6.36
	-	-	158	156	157
	-	-	(146)	(144)	(145)
Total	5/6.65	34/16.88	34/20.26	13/6.12	86/49.91
	75	201***	168**	212*	172***
	(69)	(186**)	(155*)	(197*)	(159***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 193

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	4/1.37	2/1.97	1/2.08	0/0.57	7/5.99
	291	102	48	0	117
	(265)	(93)	(44)	(0)	(107)
5-9 yrs	0/0.81	3/0.87	1/0.79	0/0.20	4/2.67
	0	344	127	0	150
	(0)	(310)	(113)	(0)	(135)
10-14 yr	0/0.00	1/0.99	0/0.43	0/0.09	1/1.51
	-	102	0	0	66
	-	(91)	(0)	(0)	(59)
15-19 yr	0/0.00	1/0.63	0/0.45	0/0.08	1/1.15
	-	158	0	0	87
	-	(144)	(0)	(0)	(78)
20+ yrs	0/0.00	0/0.00	0/1.00	0/0.42	0/1.42
	-	-	0	0	0
	-	-	(0)	(0)	(0)
Total	4/2.18	7/4.46	2/4.75	0/1.35	13/12.74
	183	157	42	0	102
	(167)	(142)	(38)	(0)	(93)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 194

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	3/4.54	15/7.49	15/8.48	7/2.52	40/23.03
	66	200*	177	278*	174**
	(56)	(172)	(151)	(239)	(149*)
5-9 yrs	4/2.73	7/3.50	4/3.90	1/0.87	16/10.99
	147	200	103	116	146
	(124)	(169)	(87)	(96)	(123)
10-14 yr	0/0.00	6/3.62	6/2.16	1/0.46	13/6.24
	-	166	278*	216	208*
	-	(139)	(232)	(181)	(174)
15-19 yr	0/0.00	4/2.11	6/2.04	0/0.43	10/4.58
	-	189	295*	0	218*
	-	(159)	(246)	(0)	(183)
20+ yrs	0/0.00	0/0.00	5/3.45	2/1.62	7/5.07
	-	-	145	123	138
	-	-	(122)	(103)	(115)
Total	7/7.26	32/16.72	36/20.02	11/5.90	86/49.91
	96	191**	180**	187	172***
	(82)	(162*)	(152*)	(157)	(146**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 195

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (fettling subcohort)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	2/2.21 90	10/4.03 248*	8/4.16 192	4/1.07 373*	24/11.47 209**
5-9 yrs	3/1.45 207	3/1.91 157	3/1.74 173	0/0.37 0	9/5.47 165
10-14 yr	0/0.00 -	3/1.98 152	3/0.98 307	0/0.20 0	6/3.15 191
15-19 yr	0/0.00 -	2/1.18 170	5/0.98 512**	0/0.17 0	7/2.32 302*
20+ yrs	0/0.00 -	0/0.00 -	1/1.77 56	1/0.73 136	2/2.50 80
Total	5/3.66 137	18/9.10 198*	20/9.62 208**	5/2.54 197	48/24.91 193***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 196

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (fettling subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	11/14.42	45/30.92	39/39.04	13/11.27	108/95.65
	76	146*	100	115	113
	(67)	(127)	(87)	(101)	(99)
5-9 yrs	10/9.26	19/13.32	20/15.81	5/3.88	54/42.27
	108	143	126	129	128
	(95)	(125)	(110)	(112)	(112)
10-14 yr	0/0.00	24/14.80	8/8.49	1/1.91	33/25.20
	-	162*	94	52	131
	-	(143)	(82)	(46)	(115)
15-19 yr	0/0.00	6/10.35	5/8.34	0/1.62	11/20.30
	-	58	60	0	54*
	-	(51)	(53)	(0)	(48**)
20+ yrs	0/0.00	0/0.00	21/18.28	8/7.97	29/26.25
	-	-	115	100	110
	-	-	(101)	(88)	(97)
Total	21/23.68	94/69.39	93/89.96	27/26.63	235/209.7
	89	135**	103	101	112
	(78)	(119)	(91)	(89)	(98)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 197

Factory by length of employment (maintenance subcohort)

Mortality from all causes (000-999)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	10/11.27 89 (82)	4/8.07 50 (46)	5/3.69 135 (125)	4/2.78 144 (133)	1/0.77 130 (120)	24/26.58 90 (84)
11	40/24.18 165** (150*)	6/6.61 91 (82)	3/4.64 65 (59)	3/2.24 134 (122)	2/1.52 131 (119)	54/39.20 138* (125)
12	2/3.59 56 (51)	1/0.66 152 (138)	2/0.85 235 (213)	0/0.10 0 (0)	0/0.00 - -	5/5.20 96 (87)
13	7/7.77 90 (93)	0/0.68 0 (0)	1/0.96 104 (108)	0/0.90 0 (0)	1/1.34 75 (77)	9/11.65 77 (80)
14	19/16.02 119 (109)	14/10.52 133 (122)	8/5.24 153 (140)	3/5.35 56 (51)	6/6.54 92 (84)	50/43.68 114 (105)
15	1/1.38 72 (62)	0/1.08 0 (0)	1/1.36 74 (63)	0/2.07 0 (0)	2/0.91 220 (189)	4/6.81 59 (51)
16	10/12.39 81 (73)	3/10.30 29* (26**)	5/3.70 135 (122)	4/3.34 120 (108)	2/3.85 52 (47)	24/33.58 71 (64*)
17	20/18.33 109 (108)	6/5.36 112 (111)	0/0.99 0 (0)	1/1.27 79 (78)	1/1.25 80 (79)	28/27.21 103 (102)
18	12/12.99 92 (85)	10/9.16 109 (100)	7/5.31 132 (121)	5/3.15 159 (146)	1/4.25 24 (22)	35/34.86 100 (92)
19	2/3.69 54 (44)	1/4.59 22 (18*)	5/3.38 148 (120)	1/0.53 190 (155)	1/1.58 63 (51)	10/13.76 73 (59)
Total	123/111.6 110 (102)	45/57.04 79 (72*)	37/30.12 123 (111)	21/21.73 97 (88)	17/22.02 77 (71)	243/242.5 100 (92)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 198

Factory by length of employment (maintenance subcohort)

Mortality from cancers of the trachea, bronchus and lung (162)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	1/1.14	2/0.72	0/0.41	0/0.18	0/0.10	3/2.54
	88	279	0	0	0	118
	(84)	(268)	(0)	(0)	(0)	(113)
11	6/2.74	0/0.71	0/0.54	1/0.25	0/0.19	7/4.43
	219	0	0	407	0	158
	(209)	(0)	(0)	(387)	(0)	(151)
12	0/0.36	0/0.07	0/0.10	0/0.01	0/0.00	0/0.55
	0	0	0	0	-	0
	(0)	(0)	(0)	(0)	-	(0)
13	0/0.86	0/0.08	0/0.11	0/0.11	0/0.16	0/1.32
	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
14	5/1.80	3/1.11	0/0.62	0/0.63	0/0.81	8/4.97
	278	270	0	0	0	161
	(255)	(248)	(0)	(0)	(0)	(148)
15	0/0.15	0/0.12	0/0.17	0/0.16	0/0.11	0/0.71
	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
16	0/1.34	1/1.03	1/0.40	0/0.35	1/0.46	3/3.58
	0	97	248	0	215	84
	(0)	(92)	(234)	(0)	(203)	(79)
17	2/1.87	2/0.54	0/0.12	0/0.14	0/0.16	4/2.83
	107	368	0	0	0	141
	(115)	(396)	(0)	(0)	(0)	(152)
18	0/1.32	2/1.06	2/0.61	0/0.37	0/0.53	4/3.89
	0	189	329	0	0	103
	(0)	(180)	(314)	(0)	(0)	(98)
19	1/0.39	1/0.37	0/0.36	0/0.06	1/0.19	3/1.37
	260	271	0	0	518	218
	(218)	(228)	(0)	(0)	(435)	(183)
Total	15/11.97	11/5.81	3/3.44	1/2.26	2/2.71	32/26.19
	125	189	87	44	74	122
	(121)	(179)	(81)	(41)	(69)	(116)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 199

Factory by length of employment (maintenance subcohort)

Mortality from diseases of the respiratory system (460-519)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, reg. corr.)

Factory	Group: 1-4 yrs	5-9 yrs	10-14 yr	15-19 yr	20+ yrs	Total
10	2/1.42 141 (126)	0/1.30 0 (0)	1/0.49 203 (181)	2/0.52 382 (341)	0/0.06 0 (0)	5/3.80 132 (118)
11	4/2.41 166 (143)	2/0.75 267 (230)	0/0.53 0 (0)	0/0.30 0 (0)	0/0.14 0 (0)	6/4.12 145 (125)
12	0/0.53 0 (0)	0/0.05 0 (0)	0/0.07 0 (0)	0/0.01 0 (0)	0/0.00 - -	0/0.66 0 (0)
13	0/0.94 0 (0)	0/0.06 0 (0)	0/0.09 0 (0)	0/0.09 0 (0)	0/0.16 0 (0)	0/1.34 0 (0)
14	3/1.75 172 (136)	2/1.31 153 (121)	1/0.53 188 (149)	0/0.57 0 (0)	1/0.67 150 (119)	7/4.83 145 (115)
15	0/0.16 0 (0)	0/0.11 0 (0)	0/0.15 0 (0)	0/0.40 0 (0)	1/0.11 943 (737)	1/0.93 108 (84)
16	2/1.42 141 (117)	1/1.40 72 (60)	1/0.44 229 (191)	2/0.43 469 (391)	0/0.43 0 (0)	6/4.11 146 (122)
17	1/2.31 43 (41)	1/0.75 133 (127)	0/0.10 0 (0)	0/0.14 0 (0)	0/0.11 0 (0)	2/3.41 59 (56)
18	1/1.38 72 (64)	1/0.97 103 (91)	0/0.60 0 (0)	2/0.36 551 (488)	0/0.39 0 (0)	4/3.71 108 (95)
19	0/0.30 0 (0)	0/0.64 0 (0)	0/0.51 0 (0)	0/0.05 0 (0)	0/0.18 0 (0)	0/1.68 0 (0)
Total	13/12.61 103 (91)	7/7.35 95 (83)	3/3.51 85 (75)	6/2.89 208 (177)	2/2.23 90 (77)	31/28.59 108 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 200

Mortality from all causes (000-999)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	27/25.66 105 (97)	48/37.17 129 (120)	39/37.85 103 (96)	9/10.94 82 (77)	123/111.6 110 (102)
5-9 yrs	7/14.13 50 (45*)	14/18.05 78 (71)	19/18.04 105 (96)	5/6.82 73 (67)	45/57.04 79 (72*)
10-14 yr	0/0.00 - -	20/19.83 101 (91)	13/8.19 159 (143)	4/2.10 191 (174)	37/30.12 123 (111)
15-19 yr	0/0.00 - -	13/9.37 139 (127)	5/9.22 54 (50)	3/3.13 96 (86)	21/21.73 97 (88)
20+ yrs	0/0.00 - -	0/0.00 - -	14/14.81 95 (86)	3/7.21 42 (38)	17/22.02 77 (71)
Total	34/39.78 85 (79)	95/84.43 113 (103)	90/88.12 102 (94)	24/30.20 79 (73)	243/242.5 100 (92)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 201

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	7/6.17 114 (109)	15/9.61 156 (151)	9/10.19 88 (85)	3/2.85 105 (102)	34/28.83 118 (114)
5-9 yrs	2/3.56 56 (53)	5/4.55 110 (105)	10/4.41 227* (215*)	2/1.61 124 (118)	19/14.14 134 (128)
10-14 yr	0/0.00 - -	8/5.29 151 (143)	4/2.17 184 (173)	1/0.58 172 (165)	13/8.04 162 (153)
15-19 yr	0/0.00 - -	1/2.56 39 (37)	0/2.26 0 (0)	0/0.63 0 (0)	1/5.45 18 (17*)
20+ yrs	0/0.00 - -	0/0.00 - -	2/4.21 48 (45)	1/2.05 49 (46)	3/6.26 48 (45)
Total	9/9.73 92 (89)	29/22.01 132 (126)	25/23.24 108 (103)	7/7.73 91 (87)	70/62.70 112 (107)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 202

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	3/2.44	5/4.05	5/4.30	2/1.18	15/11.97
	123	124	116	170	125
	(118)	(119)	(112)	(164)	(121)
5-9 yrs	1/1.49	4/1.90	6/1.79	0/0.63	11/5.81
	67	211	335*	0	189
	(63)	(200)	(317*)	(0)	(179)
10-14 yr	0/0.00	1/2.28	1/0.91	1/0.25	3/3.44
	-	44	109	408	87
	-	(41)	(102)	(387)	(81)
15-19 yr	0/0.00	1/1.10	0/0.93	0/0.23	1/2.26
	-	91	0	0	44
	-	(85)	(0)	(0)	(41)
20+ yrs	0/0.00	0/0.00	1/1.83	1/0.88	2/2.71
	-	-	55	114	74
	-	-	(51)	(107)	(69)
Total	4/3.94	11/9.33	13/9.76	4/3.16	32/26.19
	102	118	133	127	122
	(97)	(112)	(126)	(120)	(116)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 203

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	1/0.79 126 (120)	4/1.07 375* (357)	0/1.01 0 (0)	0/0.27 0 (0)	5/3.14 159 (152)
5-9 yrs	0/0.45 0 (0)	0/0.53 0 (0)	2/0.46 434 (404)	0/0.15 0 (0)	2/1.59 126 (118)
10-14 yr	0/0.00 - -	2/0.59 337 (314)	0/0.22 0 (0)	0/0.06 0 (0)	2/0.87 230 (213)
15-19 yr	0/0.00 - -	0/0.27 0 (0)	0/0.24 0 (0)	0/0.06 0 (0)	0/0.57 0 (0)
20+ yrs	0/0.00 - -	0/0.00 - -	0/0.42 0 (0)	0/0.20 0 (0)	0/0.61 0 (0)
Total	1/1.24 81 (76)	6/2.46 244 (230)	2/2.35 85 (80)	0/0.73 0 (0)	9/6.78 133 (125)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 204

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	1/2.69 37 (33)	7/4.22 166 (146)	5/4.26 117 (104)	0/1.44 0 (0)	13/12.61 103 (91)
5-9 yrs	1/1.56 64 (56)	2/2.28 88 (76)	2/2.47 81 (71)	2/1.05 191 (165)	7/7.35 95 (83)
10-14 yr	0/0.00 - -	2/2.29 87 (77)	1/0.98 102 (89)	0/0.24 0 (0)	3/3.51 85 (75)
15-19 yr	0/0.00 - -	2/0.95 212 (182)	2/1.35 148 (126)	2/0.59 337 (280)	6/2.89 208 (177)
20+ yrs	0/0.00 - -	0/0.00 - -	2/1.44 139 (120)	0/0.79 0 (0)	2/2.23 90 (77)
Total	2/4.25 47 (41)	13/9.74 134 (117)	12/10.50 114 (100)	4/4.11 97 (85)	31/28.59 108 (95)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 205

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (maintenance subcohort)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	0/1.36 0	3/2.27 132	5/2.05 244	0/0.56 0	8/6.24 128
5-9 yrs	0/0.86 0	2/1.23 163	1/1.13 89	0/0.36 0	3/3.58 84
10-14 yr	0/0.00 -	2/1.26 159	1/0.49 205	0/0.10 0	3/1.85 162
15-19 yr	0/0.00 -	1/0.53 190	2/0.63 320	1/0.18 559	4/1.33 301
20+ yrs	0/0.00 -	0/0.00 -	1/0.75 134	0/0.36 0	1/1.11 90
Total	0/2.22 0	8/5.29 151	10/5.04 199	1/1.56 64	19/14.10 135

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 206

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (maintenance subcohort)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	12/8.54	18/17.09	22/19.33	6/5.63	58/50.59
	141	105	114	107	115
	(126)	(95)	(103)	(97)	(103)
5-9 yrs	3/5.18	6/8.08	7/9.15	1/3.50	17/25.90
	58	74	76	29	66
	(51)	(66)	(67)	(25)	(58*)
10-14 yr	0/0.00	10/8.97	7/4.15	3/1.08	20/14.20
	-	111	169	277	141
	-	(98)	(146)	(246)	(123)
15-19 yr	0/0.00	7/4.36	3/4.68	1/1.60	11/10.64
	-	161	64	63	103
	-	(143)	(57)	(54)	(92)
20+ yrs	0/0.00	0/0.00	8/7.51	2/3.73	10/11.24
	-	-	106	54	89
	-	-	(95)	(48)	(79)
Total	15/13.71	41/38.50	47/44.83	13/15.53	116/112.6
	109	106	105	84	103
	(97)	(95)	(93)	(74)	(92)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 207

Mortality from all causes (000-999)
by years since first exposure and length of employment ("small towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	60/66.00	112/88.64	108/97.15	36/32.60	316/284.4
	91	126*	111	110	111
	(82)	(115)	(101)	(101)	(101)
5-9 yrs	24/35.43	43/48.68	47/50.94	22/15.87	136/150.9
	68	88	92	139	90
	(61*)	(80)	(84)	(125)	(82*)
10-14 yr	0/0.00	53/49.09	39/28.42	10/8.64	102/86.15
	-	108	137	116	118
	-	(97)	(124)	(106)	(107)
15-19 yr	0/0.00	24/27.69	19/22.78	9/6.82	52/57.30
	-	87	83	132	91
	-	(79)	(76)	(120)	(83)
20+ yrs	0/0.00	0/0.00	49/55.40	33/30.16	82/85.56
	-	-	88	109	96
	-	-	(81)	(100)	(88)
Total	84/101.4	232/214.1	262/254.7	110/94.09	688/664.3
	83	108	103	117	104
	(75**)	(98)	(94)	(107)	(94)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 208

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment ("small towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	2/5.97	8/9.37	12/11.09	7/3.80	29/30.23
	33	85	108	184	96
	(31)	(80)	(102)	(174)	(90)
5-9 yrs	2/3.57	7/4.95	7/5.03	3/1.81	19/15.36
	56	141	139	166	124
	(52)	(131)	(129)	(154)	(115)
10-14 yr	0/0.00	7/5.48	3/2.84	2/0.88	12/9.20
	-	128	106	228	130
	-	(118)	(97)	(214)	(121)
15-19 yr	0/0.00	5/3.28	1/2.55	1/0.66	7/6.49
	-	152	39	152	108
	-	(143)	(37)	(144)	(101)
20+ yrs	0/0.00	0/0.00	8/6.89	3/3.67	11/10.56
	-	-	116	82	104
	-	-	(110)	(78)	(98)
Total	4/9.55	27/23.09	31/28.41	16/10.81	78/71.84
	42	117	109	148	109
	(39*)	(109)	(102)	(140)	(101)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 209

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment ("small towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	2/1.98 101 (94)	2/2.51 80 (74)	1/2.62 38 (36)	0/0.85 0 (0)	5/7.95 63 (59)
5-9 yrs	1/1.11 90 (83)	3/1.41 213 (196)	3/1.26 237 (218)	1/0.40 249 (226)	8/4.19 191 (176)
10-14 yr	0/0.00 - -	3/1.47 204 (189)	0/0.72 0 (0)	0/0.20 0 (0)	3/2.39 125 (115)
15-19 yr	0/0.00 - -	1/0.82 123 (114)	1/0.62 162 (150)	0/0.15 0 (0)	2/1.59 126 (117)
20+ yrs	0/0.00 - -	0/0.00 - -	0/1.57 0 (0)	0/0.81 0 (0)	0/2.38 0 (0)
Total	3/3.09 97 (90)	9/6.21 145 (135)	5/6.79 74 (68)	1/2.42 41 (38)	18/18.51 97 (90)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 210

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment ("small towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	6/6.99	12/10.19	21/10.94	4/3.73	43/31.84
	86	118	192**	107	135
	(77)	(106)	(172*)	(94)	(121)
5-9 yrs	3/3.85	5/6.18	6/6.96	5/1.86	19/18.84
	78	81	86	269	101
	(70)	(73)	(77)	(228)	(90)
10-14 yr	0/0.00	4/5.60	8/4.05	0/1.23	12/10.89
	-	71	198	0	110
	-	(64)	(175)	(0)	(98)
15-19 yr	0/0.00	4/2.72	4/2.86	3/1.04	11/6.61
	-	147	140	290	166
	-	(131)	(124)	(248)	(147)
20+ yrs	0/0.00	0/0.00	9/5.44	2/3.31	11/8.75
	-	-	165	60	126
	-	-	(146)	(53)	(111)
Total	9/10.83	25/24.69	48/30.25	14/11.16	96/76.94
	83	101	159**	125	125*
	(75)	(91)	(142*)	(109)	(111)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 211

Mortality from all causes (000-999)
by years since first exposure and length of employment ("large towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	139/135.5	248/196.3	237/217.4	80/61.11	704/610.2
	103	126***	109	131*	115***
	(94)	(116*)	(100)	(120)	(106)
5-9 yrs	72/69.40	120/77.30	95/70.31	18/22.16	305/239.2
	104	155***	135**	81	128***
	(95)	(142***)	(124*)	(75)	(117**)
10-14 yr	0/0.00	132/96.22	66/52.38	13/13.87	211/162.5
	-	137***	126	94	130***
	-	(126*)	(115)	(86)	(119*)
15-19 yr	0/0.00	52/50.26	57/48.03	12/11.45	121/109.7
	-	103	119	105	110
	-	(95)	(109)	(96)	(101)
20+ yrs	0/0.00	0/0.00	79/72.66	33/28.64	112/101.3
	-	-	109	115	111
	-	-	(100)	(106)	(101)
Total	211/204.9	552/420.1	534/460.7	156/137.2	1453/1222.9
	103	131***	116***	114	119***
	(94)	(120***)	(106)	(104)	(109**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 212

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment ("large towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	24/12.72	31/20.92	40/24.31	15/6.95	110/64.91
	189**	148*	165**	216*	169***
	(178*)	(140)	(155*)	(205*)	(160***)
5-9 yrs	10/7.33	21/8.27	17/7.89	4/2.47	52/25.96
	136	254***	215**	162	200***
	(128)	(239***)	(202*)	(153)	(188***)
10-14 yr	0/0.00	26/10.92	10/5.31	1/1.44	37/17.67
	-	238***	188	70	209***
	-	(224***)	(178)	(65)	(197***)
15-19 yr	0/0.00	9/6.03	10/5.35	0/1.13	19/12.51
	-	149	187	0	152
	-	(140)	(176)	(0)	(143)
20+ yrs	0/0.00	0/0.00	12/8.92	8/3.44	20/12.36
	-	-	134	233*	162
	-	-	(126)	(218)	(151)
Total	34/20.06	87/46.14	89/51.79	28/15.42	238/133.4
	170**	189***	172***	182**	178***
	(160*)	(178***)	(162***)	(171*)	(168***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 213

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment ("large towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	10/4.33	19/5.64	8/5.76	2/1.57	39/17.29
	231*	337***	139	128	225***
	(215*)	(314***)	(129)	(119)	(210***)
5-9 yrs	1/2.28	3/2.26	5/1.88	0/0.56	9/6.98
	44	133	267	0	129
	(41)	(123)	(246)	(0)	(119)
10-14 yr	0/0.00	7/2.94	1/1.32	1/0.33	9/4.59
	-	238	76	299	196
	-	(221)	(70)	(276)	(182)
15-19 yr	0/0.00	2/1.49	2/1.32	0/0.27	4/3.08
	-	134	151	0	130
	-	(123)	(140)	(0)	(120)
20+ yrs	0/0.00	0/0.00	2/2.03	0/0.76	2/2.80
	-	-	98	0	72
	-	-	(90)	(0)	(66)
Total	11/6.60	31/12.33	18/12.31	3/3.50	63/34.74
	167	251***	146	86	181***
	(155)	(233***)	(135)	(80)	(168***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 214

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment ("large towns", exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	16/14.59	32/22.73	41/25.56	12/7.47	101/70.36
	110	141	160**	161	144***
	(94)	(120)	(137)	(138)	(123)
5-9 yrs	12/7.87	23/9.43	11/8.20	2/2.81	48/28.33
	152	244***	134	71	169***
	(129)	(206**)	(113)	(60)	(143*)
10-14 yr	0/0.00	20/11.30	11/7.24	3/1.94	34/20.48
	-	177*	152	154	166**
	-	(150)	(129)	(129)	(140)
15-19 yr	0/0.00	7/5.22	16/6.42	3/1.74	26/13.38
	-	134	249**	172	194**
	-	(112)	(210*)	(147)	(164*)
20+ yrs	0/0.00	0/0.00	10/7.23	2/3.21	12/10.44
	-	-	138	62	115
	-	-	(115)	(52)	(96)
Total	28/22.47	82/48.69	89/54.65	22/17.18	221/143.0
	125	168***	163***	128	155***
	(106)	(143**)	(138**)	(109)	(131***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 215

Mortality from all causes (000-999)
by years since first exposure and length of employment ("small towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	15/21.31	33/29.42	37/28.73	10/7.09	95/86.54
	70	112	129	141	110
	(63)	(100)	(116)	(126)	(98)
5-9 yrs	14/10.89	10/11.28	13/11.65	3/4.50	40/38.30
	129	89	112	67	104
	(115)	(80)	(101)	(60)	(94)
10-14 yr	0/0.00	9/16.66	4/13.76	5/3.39	18/33.82
	-	54	29**	147	53**
	-	(48*)	(26**)	(130)	(47***)
15-19 yr	0/0.00	11/7.84	5/5.86	1/2.24	17/15.95
	-	140	85	45	107
	-	(129)	(82)	(43)	(100)
20+ yrs	0/0.00	0/0.00	8/11.91	9/4.84	17/16.76
	-	-	67	186	101
	-	-	(62)	(172)	(93)
Total	29/32.19	63/65.20	67/71.91	28/22.06	187/191.4
	90	97	93	127	98
	(81)	(87)	(84)	(115)	(88)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 216

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment ("small towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	1/1.94 51 (48)	3/3.13 96 (89)	6/3.22 186 (172)	3/0.83 360 (334)	13/9.13 142 (132)
5-9 yrs	2/1.12 178 (164)	1/1.13 89 (83)	2/1.19 168 (157)	0/0.53 0 (0)	5/3.97 126 (117)
10-14 yr	0/0.00 - -	2/1.86 108 (99)	1/1.23 82 (75)	0/0.31 0 (0)	3/3.40 88 (81)
15-19 yr	0/0.00 - -	3/0.93 323 (304)	1/0.61 163 (158)	0/0.18 0 (0)	4/1.72 233 (223)
20+ yrs	0/0.00 - -	0/0.00 - -	1/1.43 70 (66)	3/0.57 526* (499*)	4/2.00 200 (189)
Total	3/3.07 98 (90)	9/7.04 128 (118)	11/7.68 143 (134)	6/2.43 247 (232)	29/20.21 143 (133)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 217

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment ("small towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	2/0.64 312 (297)	0/0.83 0 (0)	0/0.76 0 (0)	0/0.18 0 (0)	2/2.41 83 (79)
5-9 yrs	0/0.33 0 (0)	0/0.31 0 (0)	0/0.30 0 (0)	1/0.12 847 (784)	1/1.06 94 (89)
10-14 yr	0/0.00 - -	0/0.49 0 (0)	0/0.32 0 (0)	0/0.08 0 (0)	0/0.88 0 (0)
15-19 yr	0/0.00 - -	0/0.22 0 (0)	0/0.15 0 (0)	0/0.04 0 (0)	0/0.42 0 (0)
20+ yrs	0/0.00 - -	0/0.00 - -	0/0.33 0 (0)	2/0.13 1575* (1481*)	2/0.45 442 (418)
Total	2/0.98 205 (195)	0/1.86 0 (0)	0/1.85 0 (0)	3/0.55 550* (523*)	5/5.23 96 (91)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 218

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment ("small towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	2/2.25 89 (84)	2/3.32 60 (57)	4/3.15 127 (123)	2/0.76 264 (252)	10/9.48 106 (101)
5-9 yrs	0/1.19 0 (0)	1/1.37 73 (68)	2/1.49 135 (126)	1/0.49 203 (179)	4/4.54 88 (82)
10-14 yr	0/0.00 - -	0/1.98 0 (0)	0/2.23 0 (0)	1/0.55 183 (178)	1/4.76 21 (20)
15-19 yr	0/0.00 - -	0/0.77 0 (0)	1/0.78 128 (126)	0/0.40 0 (0)	1/1.95 51 (49)
20+ yrs	0/0.00 - -	0/0.00 - -	0/1.16 0 (0)	0/0.51 0 (0)	0/1.67 0 (0)
Total	2/3.43 58 (55)	3/7.44 40 (38)	7/8.81 79 (76)	4/2.71 148 (138)	16/22.39 71 (68)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 219

Mortality from all causes (000-999)
by years since first exposure and length of employment ("large towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	66/54.29 122 (111)	69/60.32 114 (105)	48/59.81 80 (74*)	21/17.61 119 (110)	204/192.0 106 (97)
5-9 yrs	27/31.57 86 (78)	52/35.43 147* (135*)	23/28.01 82 (75)	6/6.43 93 (86)	108/101.4 106 (98)
10-14 yr	0/0.00 - -	51/39.35 130 (119)	25/20.76 120 (111)	3/3.97 76 (69)	79/64.08 123 (113)
15-19 yr	0/0.00 - -	13/17.52 74 (68)	20/18.23 110 (101)	6/4.71 127 (117)	39/40.46 96 (88)
20+ yrs	0/0.00 - -	0/0.00 - -	23/21.83 105 (97)	8/8.65 93 (85)	31/30.47 102 (93)
Total	93/85.85 108 (99)	185/152.6 121* (111)	139/148.6 94 (86)	44/41.37 106 (98)	461/428.5 108 (99)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 220

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment ("large towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	6/5.48 109 (104)	8/6.25 128 (122)	4/6.13 65 (62)	2/1.90 106 (101)	20/19.76 101 (96)
5-9 yrs	5/3.38 148 (140)	3/3.48 86 (81)	3/2.49 121 (114)	0/0.65 0 (0)	11/10.00 110 (104)
10-14 yr	0/0.00 - -	7/4.34 161 (152)	3/1.78 168 (159)	2/0.39 515 (485)	12/6.51 184 (174)
15-19 yr	0/0.00 - -	0/2.04 0 (0)	0/1.93 0 (0)	0/0.42 0 (0)	0/4.39 0* (0*)
20+ yrs	0/0.00 - -	0/0.00 - -	4/2.62 153 (144)	1/1.07 94 (89)	5/3.69 136 (128)
Total	11/8.86 124 (118)	18/16.11 112 (106)	14/14.95 94 (89)	5/4.42 113 (107)	48/44.34 108 (102)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 221

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment ("large towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	3/1.82	3/1.73	0/1.50	2/0.43	8/5.48
	165	174	0	463	146
	(154)	(163)	(0)	(437)	(137)
5-9 yrs	0/1.03	1/0.98	3/0.64	0/0.15	4/2.81
	0	102	467	0	143
	(0)	(94)	(437)	(0)	(133)
10-14 yr	0/0.00	2/1.18	0/0.48	0/0.09	2/1.75
	-	169	0	0	114
	-	(157)	(0)	(0)	(106)
15-19 yr	0/0.00	0/0.51	1/0.49	0/0.10	1/1.11
	-	0	205	0	90
	-	(0)	(190)	(0)	(84)
20+ yrs	0/0.00	0/0.00	0/0.60	0/0.24	0/0.84
	-	-	0	0	0
	-	-	(0)	(0)	(0)
Total	3/2.85	6/4.40	4/3.71	2/1.01	15/11.98
	105	136	108	197	125
	(98)	(127)	(101)	(185)	(117)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 222

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment ("large towns", unexposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
1-4 yrs	18/6.55	14/7.74	8/8.03	3/2.32	43/24.64
	275***	181	100	129	174**
	(238**)	(157)	(87)	(114)	(152*)
5-9 yrs	7/3.85	5/4.96	4/4.30	0/0.91	16/14.03
	182	101	93	0	114
	(156)	(86)	(80)	(0)	(98)
10-14 yr	0/0.00	7/4.91	6/3.24	0/0.55	13/8.69
	-	143	185	0	150
	-	(122)	(160)	(0)	(128)
15-19 yr	0/0.00	2/1.86	3/2.61	2/0.79	7/5.26
	-	107	115	254	133
	-	(91)	(98)	(218)	(113)
20+ yrs	0/0.00	0/0.00	2/2.11	2/0.92	4/3.03
	-	-	95	218	132
	-	-	(80)	(187)	(113)
Total	25/10.39	28/19.47	23/20.30	7/5.49	83/55.65
	241***	144	113	128	149***
	(208**)	(124)	(98)	(111)	(129*)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 223

Mortality from all causes (000-999)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	5/19.19 26*** (24***)	21/11.76 179* (165*)	16/11.83 135 (126)	2/2.14 94 (87)	44/44.92 98 (90)
1-4 yrs	101/103.6 98 (88)	193/153.8 125** (114)	183/184.5 99 (90)	77/56.35 137* (124)	554/498.2 111* (101)
5-9 yrs	48/50.90 94 (86)	81/64.03 126* (115)	77/70.03 110 (100)	26/20.90 124 (113)	232/205.9 113 (103)
10-14 yr	0/0.00 - -	94/69.48 135** (123)	54/38.55 140* (127)	10/9.47 106 (96)	158/117.5 134*** (122*)
15-19 yr	0/0.00 - -	27/40.39 67* (61**)	38/36.28 105 (95)	9/10.03 90 (82)	74/86.70 85 (77*)
20+ yrs	0/0.00 - -	0/0.00 - -	64/66.35 96 (88)	34/28.84 118 (107)	98/95.19 103 (94)
Total	154/173.7 89 (80**)	416/339.5 123*** (111*)	432/407.5 106 (97)	158/127.7 124* (113)	1160/1048.4 111*** (101)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 224

Mortality from all causes (000-999)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	3/14.31 21*** (19***)	17/10.50 162 (149)	14/10.28 136 (127)	4/1.98 202 (187)	38/37.06 103 (95)
1-4 yrs	63/71.74 88 (80)	138/109.8 126* (114)	144/124.0 116 (106)	44/34.21 129 (117)	389/339.8 114** (104)
5-9 yrs	29/38.13 76 (69*)	68/47.63 143** (130*)	58/47.33 123 (112)	15/14.63 103 (93)	170/147.7 115 (105)
10-14 yr	0/0.00 - -	72/53.44 135* (123)	50/27.25 183*** (168***)	3/7.50 40 (36)	125/88.18 142*** (129**)
15-19 yr	0/0.00 - -	23/30.91 74 (68)	25/27.56 91 (83)	6/7.73 78 (71)	54/66.19 82 (74*)
20+ yrs	0/0.00 - -	0/0.00 - -	59/50.46 117 (107)	25/21.89 114 (104)	84/72.35 116 (106)
Total	95/124.2 77** (70***)	318/252.3 126*** (115*)	350/286.9 122*** (111*)	97/87.93 110 (101)	860/751.3 114*** (104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 225

Mortality from all causes (000-999)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	7/15.50 45* (41*)	19/11.64 163 (151)	18/11.43 158 (146)	1/2.43 41 (38)	45/41.00 110 (101)
1-4 yrs	78/77.83 100 (91)	153/114.3 134*** (121*)	135/140.3 96 (88)	64/44.13 145** (132*)	430/376.6 114** (104)
5-9 yrs	32/35.76 89 (81)	61/46.68 131 (120)	59/51.71 114 (104)	22/16.16 136 (124)	174/150.3 116 (106)
10-14 yr	0/0.00 - -	67/46.63 144** (130*)	31/24.46 127 (114)	8/7.97 100 (91)	106/79.06 134** (121)
15-19 yr	0/0.00 - -	27/29.09 93 (84)	31/26.71 116 (105)	7/6.76 104 (95)	65/62.56 104 (94)
20+ yrs	0/0.00 - -	0/0.00 - -	46/49.55 93 (84)	27/21.79 124 (113)	73/71.34 102 (93)
Total	117/129.1 91 (82*)	327/248.3 132*** (120**)	320/304.2 105 (96)	129/99.24 130** (118)	893/780.8 114*** (104)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 226

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	2/4.20	6/3.16	4/3.29	0/0.59	12/11.24
	48	190	121	0	107
	(45)	(182)	(116)	(0)	(102)
1-4 yrs	28/24.10	46/39.31	45/49.35	18/15.78	137/128.6
	116	117	91	114	107
	(110)	(111)	(86)	(108)	(101)
5-9 yrs	8/12.45	24/16.38	24/18.22	10/5.79	66/52.84
	64	146	132	173	125
	(61)	(138)	(124)	(163)	(118)
10-14 yr	0/0.00	33/18.12	13/9.89	4/2.62	50/30.63
	-	182**	131	153	163**
	-	(171**)	(124)	(143)	(154**)
15-19 yr	0/0.00	9/10.98	9/9.72	1/2.60	19/23.29
	-	82	93	38	82
	-	(77)	(87)	(37)	(77)
20+ yrs	0/0.00	0/0.00	18/18.81	10/8.32	28/27.13
	-	-	96	120	103
	-	-	(90)	(113)	(97)
Total	38/40.75	118/87.96	113/109.3	43/35.71	312/273.7
	93	134**	103	120	114*
	(88)	(127*)	(98)	(114)	(108)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 227

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/3.19 31 (30)	8/2.80 286* (273*)	3/2.83 106 (103)	1/0.57 175 (168)	13/9.39 138 (132)
1-4 yrs	15/16.98 88 (84)	46/28.70 160** (152**)	36/33.60 107 (101)	9/9.50 95 (90)	106/88.78 119 (113)
5-9 yrs	4/9.52 42 (40)	14/12.30 114 (108)	18/12.53 144 (135)	9/4.09 220* (207)	45/38.44 117 (110)
10-14 yr	0/0.00 - -	26/14.06 185** (174*)	13/7.08 184 (174)	0/1.93 0 (0)	39/23.07 169** (160**)
15-19 yr	0/0.00 - -	6/8.48 71 (67)	8/7.43 108 (101)	2/2.00 100 (95)	16/17.91 89 (84)
20+ yrs	0/0.00 - -	0/0.00 - -	18/14.32 126 (119)	8/6.22 129 (121)	26/20.54 127 (119)
Total	20/29.70 67 (64*)	100/66.34 151*** (142***)	96/77.77 123 (117)	29/24.31 119 (113)	245/198.1 124** (117*)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 228

Mortality from all malignant neoplasms (140-209)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/3.41	6/3.03	4/3.19	0/0.69	10/10.33
	0	198	125	0	97
	(0)	(189)	(120)	(0)	(92)
1-4 yrs	22/18.20	32/29.33	40/37.66	14/12.40	108/97.58
	121	109	106	113	111
	(114)	(103)	(101)	(108)	(105)
5-9 yrs	8/8.79	20/12.06	19/13.73	7/4.50	54/39.07
	91	166*	138	156	138*
	(86)	(157)	(131)	(147)	(131)
10-14 yr	0/0.00	22/12.23	8/6.50	4/2.21	34/20.94
	-	180*	123	181	162*
	-	(169*)	(115)	(169)	(152*)
15-19 yr	0/0.00	12/7.94	7/7.21	1/1.77	20/16.92
	-	151	97	57	118
	-	(142)	(92)	(54)	(112)
20+ yrs	0/0.00	0/0.00	13/14.03	6/6.28	19/20.31
	-	-	93	95	94
	-	-	(88)	(90)	(88)
Total	30/30.40	92/64.59	91/82.31	32/27.85	245/205.1
	99	142**	111	115	119**
	(93)	(135**)	(105)	(109)	(113)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 229

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/1.50	1/1.33	4/1.39	0/0.25	6/4.48
	66	75	287	0	134
	(62)	(71)	(275)	(0)	(127)
1-4 yrs	11/9.15	20/16.33	22/20.84	12/6.68	65/53.01
	120	122	106	180	123
	(112)	(114)	(99)	(169)	(115)
5-9 yrs	5/4.99	12/6.81	13/7.57	5/2.44	35/21.80
	100	176	172	205	161*
	(93)	(165)	(160)	(191)	(150*)
10-14 yr	0/0.00	22/7.62	8/4.07	1/1.10	31/12.79
	-	289***	197	91	242***
	-	(269***)	(183)	(84)	(225***)
15-19 yr	0/0.00	6/4.70	7/4.14	1/1.07	14/9.91
	-	128	169	93	141
	-	(119)	(157)	(88)	(132)
20+ yrs	0/0.00	0/0.00	13/8.13	7/3.58	20/11.70
	-	-	160	196	171*
	-	-	(149)	(183)	(160)
Total	17/15.64	61/36.79	67/46.14	26/15.12	171/113.7
	109	166***	145**	172*	150***
	(101)	(155**)	(136*)	(161*)	(141***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 230

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/1.17	2/1.19	2/1.20	1/0.24	5/3.81
	0	168	166	410	131
	(0)	(160)	(160)	(390)	(125)
1-4 yrs	7/6.50	20/12.05	21/14.29	7/4.01	55/36.85
	108	166*	147	175	149**
	(101)	(155)	(138)	(165)	(140*)
5-9 yrs	2/3.88	6/5.17	8/5.29	6/1.74	22/16.08
	51	116	151	345*	137
	(48)	(108)	(140)	(321*)	(127)
10-14 yr	0/0.00	17/5.99	6/2.95	0/0.80	23/9.73
	-	284***	203	0	236***
	-	(265***)	(191)	(0)	(221**)
15-19 yr	0/0.00	6/3.68	7/3.19	1/0.82	14/7.69
	-	163	220	122	182
	-	(152)	(205)	(115)	(170)
20+ yrs	0/0.00	0/0.00	11/6.22	5/2.66	16/8.88
	-	-	177	188	180*
	-	-	(165)	(175)	(168)
Total	9/11.55	51/28.07	55/33.13	20/10.28	135/83.03
	78	182***	166***	195**	163***
	(73)	(170***)	(155**)	(182*)	(152***)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 231

Mortality from cancers of the trachea, bronchus and lung (162)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/1.23	1/1.25	3/1.34	0/0.29	4/4.12
	0	80	224	0	97
	(0)	(76)	(213)	(0)	(92)
1-4 yrs	8/6.98	12/12.25	19/15.94	8/5.25	47/40.42
	115	98	119	152	116
	(107)	(92)	(112)	(144)	(109)
5-9 yrs	6/3.54	11/5.07	11/5.78	4/1.90	32/16.28
	170	217*	190	211	197***
	(158)	(203*)	(178)	(196)	(184**)
10-14 yr	0/0.00	15/5.17	5/2.74	1/0.93	21/8.84
	-	290***	183	108	238***
	-	(269**)	(169)	(99)	(220**)
15-19 yr	0/0.00	8/3.44	4/3.09	1/0.73	13/7.25
	-	233*	129	137	179
	-	(217)	(121)	(130)	(167)
20+ yrs	0/0.00	0/0.00	11/6.09	3/2.70	14/8.79
	-	-	181	111	159
	-	-	(169)	(104)	(149)
Total	14/11.75	47/27.18	53/34.97	17/11.81	131/85.70
	119	173***	152**	144	153***
	(111)	(162**)	(142*)	(135)	(143***)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 232

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/0.53	0/0.33	0/0.32	0/0.06	0/1.24
	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
1-4 yrs	6/3.08	12/4.37	6/4.90	2/1.48	26/13.83
	195	275**	123	135	188**
	(180)	(254**)	(114)	(126)	(174*)
5-9 yrs	1/1.55	5/1.84	4/1.81	1/0.54	11/5.73
	65	272	222	185	192
	(59)	(251)	(203)	(169)	(176)
10-14 yr	0/0.00	4/2.03	0/0.98	0/0.24	4/3.26
	-	197	0	0	123
	-	(181)	(0)	(0)	(113)
15-19 yr	0/0.00	2/1.16	0/1.00	0/0.25	2/2.40
	-	173	0	0	83
	-	(158)	(0)	(0)	(76)
20+ yrs	0/0.00	0/0.00	0/1.83	0/0.78	0/2.61
	-	-	0	0	0
	-	-	(0)	(0)	(0)
Total	7/5.16	23/9.73	10/10.83	3/3.35	43/29.06
	136	236***	92	90	148*
	(125)	(218**)	(85)	(83)	(137)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 233

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/0.40 0 (0)	1/0.30 329 (307)	0/0.28 0 (0)	0/0.05 0 (0)	1/1.03 97 (90)
1-4 yrs	4/2.15 186 (171)	6/3.16 190 (175)	4/3.33 120 (111)	0/0.90 0 (0)	14/9.54 147 (135)
5-9 yrs	0/1.20 0 (0)	4/1.39 288 (264)	3/1.24 241 (219)	0/0.39 0 (0)	7/4.22 166 (152)
10-14 yr	0/0.00 - -	3/1.59 189 (174)	1/0.71 141 (129)	0/0.18 0 (0)	4/2.48 161 (148)
15-19 yr	0/0.00 - -	0/0.89 0 (0)	0/0.76 0 (0)	0/0.19 0 (0)	0/1.85 0 (0)
20+ yrs	0/0.00 - -	0/0.00 - -	0/1.40 0 (0)	0/0.58 0 (0)	0/1.98 0 (0)
Total	4/3.75 107 (98)	14/7.34 191* (176)	8/7.73 104 (95)	0/2.29 0 (0)	26/21.10 123 (113)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 234

Mortality from cancer of the stomach (151)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/0.43	0/0.32	0/0.31	0/0.06	0/1.12
	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)
1-4 yrs	4/2.33	11/3.25	7/3.74	2/1.17	24/10.49
	172	338**	187	172	229***
	(159)	(313**)	(173)	(160)	(212**)
5-9 yrs	1/1.10	3/1.36	3/1.37	0/0.43	7/4.25
	91	220	219	0	165
	(83)	(204)	(201)	(0)	(151)
10-14 yr	0/0.00	3/1.38	0/0.64	0/0.21	3/2.23
	-	217	0	0	134
	-	(199)	(0)	(0)	(123)
15-19 yr	0/0.00	2/0.85	0/0.74	0/0.17	2/1.76
	-	235	0	0	114
	-	(216)	(0)	(0)	(105)
20+ yrs	0/0.00	0/0.00	0/1.38	0/0.59	0/1.97
	-	-	0	0	0
	-	-	(0)	(0)	(0)
Total	5/3.87	19/7.16	10/8.18	2/2.62	36/21.82
	129	265***	122	76	165**
	(120)	(245***)	(113)	(71)	(152*)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 235

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/1.77	4/1.13	2/1.17	1/0.23	8/4.30
	56	354	172	431	186
	(48)	(303)	(147)	(370)	(159)
1-4 yrs	11/10.50	20/17.06	28/20.95	14/6.29	73/54.80
	105	117	134	223*	133*
	(91)	(102)	(116)	(191*)	(116)
5-9 yrs	10/5.29	13/7.33	11/8.32	1/2.37	35/23.31
	189	177	132	42	150*
	(162)	(154)	(113)	(35)	(129)
10-14 yr	0/0.00	10/7.46	12/4.77	1/1.06	23/13.30
	-	134	251**	95	173*
	-	(114)	(216*)	(80)	(148)
15-19 yr	0/0.00	5/3.88	10/4.48	2/1.36	17/9.72
	-	129	223*	147	175*
	-	(110)	(192)	(126)	(150)
20+ yrs	0/0.00	0/0.00	7/6.18	3/2.97	10/9.16
	-	-	113	101	109
	-	-	(96)	(85)	(92)
Total	22/17.56	52/36.86	70/45.87	22/14.28	166/114.6
	125	141*	153**	154	145***
	(108)	(122)	(131*)	(131)	(125**)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 236

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/1.32 0 (0)	1/1.11 90 (77)	1/1.11 90 (79)	1/0.21 488 (422)	3/3.74 80 (69)
1-4 yrs	6/7.01 86 (74)	20/11.72 171* (147)	24/13.87 173* (149)	11/3.92 281** (241*)	61/36.52 167*** (144**)
5-9 yrs	6/4.03 149 (127)	11/5.45 202* (174)	6/5.56 108 (91)	2/1.68 119 (100)	25/16.71 150 (127)
10-14 yr	0/0.00 - -	7/5.82 120 (102)	11/3.36 328** (279**)	1/1.02 98 (84)	19/10.20 186* (159)
15-19 yr	0/0.00 - -	4/2.99 134 (112)	4/3.39 118 (99)	1/1.07 94 (78)	9/7.45 121 (101)
20+ yrs	0/0.00 - -	0/0.00 - -	9/4.83 186 (157)	2/2.40 83 (70)	11/7.23 152 (128)
Total	12/12.36 97 (83)	43/27.09 159** (136)	55/32.11 171*** (146**)	18/10.29 175* (148)	128/81.84 156*** (134**)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 237

Mortality from diseases of the respiratory system (460-519)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	2/1.46	4/1.19	4/1.08	1/0.25	11/3.97
	137	337	371*	405	277**
	(119)	(290)	(314)	(349)	(238*)
1-4 yrs	8/7.97	13/12.67	18/15.92	11/4.89	50/41.45
	100	103	113	225*	121
	(87)	(89)	(98)	(194)	(104)
5-9 yrs	5/3.71	11/5.30	8/5.96	0/1.83	24/16.80
	135	208*	134	0	143
	(116)	(181)	(116)	(0)	(123)
10-14 yr	0/0.00	7/4.93	5/2.86	1/0.92	13/8.71
	-	142	175	109	149
	-	(122)	(151)	(92)	(128)
15-19 yr	0/0.00	4/2.84	9/3.27	1/0.91	14/7.02
	-	141	275*	110	200*
	-	(120)	(238*)	(96)	(172)
20+ yrs	0/0.00	0/0.00	6/4.74	2/2.27	8/7.01
	-	-	127	88	114
	-	-	(108)	(75)	(97)
Total	15/13.14	39/26.94	50/33.83	16/11.06	120/84.95
	114	145*	148*	145	141***
	(99)	(125)	(127)	(124)	(122*)

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 238

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (dust exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/0.79 127	3/0.61 493*	1/0.57 176	0/0.10 0	5/2.07 242
1-4 yrs	6/5.16 116	13/9.03 144	14/9.90 141	5/2.72 184	38/26.81 142*
5-9 yrs	5/2.77 181	5/3.94 127	5/3.78 132	0/1.00 0	15/11.49 131
10-14 yr	0/0.00 -	6/4.05 148	8/2.13 376**	0/0.44 0	14/6.63 211*
15-19 yr	0/0.00 -	3/2.15 140	5/2.20 227	2/0.54 368	10/4.90 204
20+ yrs	0/0.00 -	0/0.00 -	1/3.19 31	2/1.35 148	3/4.54 66
Total	12/8.72 138	30/19.78 152*	34/21.77 156*	9/6.16 146	85/56.43 151***

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 239

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (fume exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	0/0.59 0	1/0.61 165	0/0.53 0	0/0.09 0	1/1.82 55
1-4 yrs	3/3.40 88	13/6.31 206*	12/6.66 180	5/1.67 300	33/18.04 183**
5-9 yrs	4/2.14 187	6/2.96 203	4/2.58 155	1/0.72 139	15/8.40 179
10-14 yr	0/0.00 -	4/3.19 126	5/1.54 324*	0/0.39 0	9/5.12 176
15-19 yr	0/0.00 -	2/1.67 120	3/1.67 180	1/0.43 235	6/3.76 160
20+ yrs	0/0.00 -	0/0.00 -	2/2.49 80	1/1.06 95	3/3.54 85
Total	7/6.12 114	26/14.73 177**	26/15.47 168*	8/4.35 184	67/40.67 165***

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Appendix C: Table 240

Mortality from bronchitis, emphysema & asthma (490-493)
by years since first exposure and length of employment (silica exposed)

KEY: Obs./Exp.
SMR

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/0.66 152	2/0.63 316	2/0.52 385	0/0.11 0	5/1.92 260
1-4 yrs	5/3.95 126	9/6.73 134	11/7.56 145	4/2.14 187	29/20.38 142
5-9 yrs	2/1.93 104	6/2.89 208	4/2.82 142	0/0.78 0	12/8.41 143
10-14 yr	0/0.00 -	5/2.67 187	3/1.33 225	0/0.39 0	8/4.39 182
15-19 yr	0/0.00 -	3/1.59 188	5/1.62 309*	1/0.36 275	9/3.57 252*
20+ yrs	0/0.00 -	0/0.00 -	1/2.47 41	0/1.03 0	1/3.49 29
Total	8/6.54 122	25/14.51 172*	26/16.31 159*	5/4.80 104	64/42.17 152**

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 241

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (dust exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	2/5.26	8/5.44	10/6.05	0/1.10	20/17.85
	38	147	165	0	112
	(34)	(133)	(151)	(0)	(101)
1-4 yrs	39/32.73	104/69.62	90/94.00	38/29.08	271/225.4
	119	149***	96	131	120**
	(104)	(131**)	(84)	(115)	(106)
5-9 yrs	18/18.01	32/28.60	36/35.64	13/10.77	99/93.02
	100	112	101	121	106
	(88)	(99)	(90)	(107)	(94)
10-14 yr	0/0.00	42/30.66	25/19.58	5/4.88	72/55.12
	-	137	128	102	131*
	-	(121)	(113)	(90)	(115)
15-19 yr	0/0.00	10/18.88	13/18.45	5/5.15	28/42.49
	-	53*	70	97	66*
	-	(47*)	(62)	(86)	(58**)
20+ yrs	0/0.00	0/0.00	31/33.66	20/14.89	51/48.54
	-	-	92	134	105
	-	-	(81)	(119)	(93)
Total	59/56.01	196/153.2	205/207.4	81/65.87	541/482.5
	105	128**	99	123	112**
	(93)	(113)	(87)	(108)	(99)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 242

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (fume exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	1/4.04	6/4.88	9/5.25	1/1.02	17/15.19
	25	123	171	98	112
	(22)	(110)	(156)	(89)	(101)
1-4 yrs	21/23.03	57/50.08	71/63.31	21/17.66	170/154.1
	91	114	112	119	110
	(81)	(101)	(99)	(104)	(98)
5-9 yrs	16/13.89	34/21.44	31/24.15	3/7.54	84/67.02
	115	159*	128	40	125
	(102)	(141)	(114)	(35)	(111)
10-14 yr	0/0.00	30/23.96	23/13.90	2/3.86	55/41.71
	-	125	165*	52	132
	-	(111)	(147)	(46)	(117)
15-19 yr	0/0.00	9/14.63	10/14.07	3/3.97	22/32.67
	-	62	71	76	67
	-	(55)	(63)	(68)	(60*)
20+ yrs	0/0.00	0/0.00	25/25.70	14/11.29	39/36.99
	-	-	97	124	105
	-	-	(87)	(110)	(94)
Total	38/40.96	136/115.0	169/146.4	44/45.33	387/347.7
	93	118	115	97	111*
	(82)	(105)	(103)	(86)	(99)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix C: Table 243

Mortality from diseases of the circulatory system(390-458)
by years since first exposure and length of employment (silica exposed)
SMRs based on national population and corrected for region

KEY: Obs./Exp.
SMR
(SMR, Reg. Corr.)

Group	Years since first exposure: 1 - 9	10 - 19	20 - 29	30 +	Total
<1 yr	4/4.30	8/5.37	9/5.84	0/1.26	21/16.77
	93	149	154	0	125
	(83)	(136)	(141)	(0)	(113)
1-4 yrs	32/24.77	91/51.71	60/71.45	33/22.78	216/170.7
	129	176***	84	145	127***
	(113)	(154***)	(74*)	(127)	(111)
5-9 yrs	10/12.60	18/20.82	29/26.32	13/8.32	70/68.07
	79	86	110	156	103
	(70)	(77)	(98)	(138)	(91)
10-14 yr	0/0.00	30/20.41	16/12.43	3/4.11	49/36.94
	-	147	129	73	133
	-	(129)	(112)	(64)	(116)
15-19 yr	0/0.00	7/13.55	11/13.57	4/3.48	22/30.60
	-	52	81	115	72
	-	(45*)	(71)	(102)	(63*)
20+ yrs	0/0.00	0/0.00	22/25.12	18/11.24	40/36.36
	-	-	88	160	110
	-	-	(77)	(141)	(97)
Total	46/41.67	154/111.9	147/154.7	71/51.19	418/359.4
	110	138***	95	139*	116**
	(97)	(121*)	(84*)	(122)	(103)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001

Appendix D

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