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Growing up in Australia:
The Longitudinal Study of Australian Children (LSAC)

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Longitudinal analysis of LSAC time diary data: considerations for data users

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1 Introduction

Growing up in Australia: the Longitudinal Study of Australian Children (LSAC) follows the development of two cohorts of children from urban and rural areas of all states and territories of Australia. At the commencement of the study in 2004, children in the birth (B) cohort were aged 0 to 1 years and children in the kinder (K) cohort were aged 4 to 5 years. Interviews with the families of these two cohorts of children are conducted every two years. Currently, four waves of data are available covering children aged 0 to 1 years up to 6 to 7 years in the B cohort and 4 to 5 up to 10 to 11 years in the K cohort. Conducted in partnership with the Department of Social Services (DSS), the Australian Institute of Family Studies (AIFS) and the Australian Bureau of Statistics (ABS), the study examines the impact of Australia's unique social and cultural environment on these two cohorts of children.[1] In tracking children over time, the study adds to our understanding of the individual, family, and broader social and environmental factors associated with consistency and change in developmental trajectories. The study will further understanding of child and adolescent development, inform social policy debate and be used to identify opportunities for intervention and prevention strategies in policy areas concerning children and families.

A significant component of LSAC is the collection of information about how children spend their time. These data provide insights into children's daily routines and activities and present an opportunity to explore the extent to which these are associated with a range of developmental outcomes. Time diary data allow us to combine what it is that children do with information about the children themselves, their families and their communities to gain a deeper understanding of the factors that promote positive child development.

The LSAC time diary component is especially important because it collects data on patterns of children's time use over time. This allows us to observe the development of children's daily routines and activities and to track these against developmental outcomes. Such data are extremely rare: the only other similar study in the world is the Child Development Supplement (CDS) of the Panel Study of Income Dynamic (PSID) in the United States of America.

To fully realise the potential of this longitudinal time diary data, it is important to assess its quality. This report focuses on a number of issues pertinent to the longitudinal analysis of the time diary data.

Chapter 2 addresses the harmonisation of activity, which is a core issue facing analysts seeking to conduct longitudinal time use analysis. The coding of activities has been relatively consistent across waves, but there have been some changes, especially in the most recent wave of data in the K cohort (Wave 4). This report explores differences in the coding of activities across waves and proposes a set of harmonised measures of children's time use.

Chapter 3 describes implications for longitudinal analysis that may arise from differences in the structure of the diary day across waves. 'Structure' here refers to the particular day of the week, whether it was a weekday or a weekend day and whether it was a school day or a non-school day.

Chapter 4 addresses non-response to the LSAC time diary component. Previous work has considered factors associated with non-response, and this report moves beyond this to focus on the implications of non-response for analysis. The report describes the extent of non-response across all waves and explores its consequences for the analysis of longitudinal patterns in children's time use. Some concluding comments are set out in Chapter 5.

2 Harmonising activities across waves in the LSAC time diary component

2.1 The time diary instrument

Information about children's activities is obtained from time diaries. In Waves 1 to 3, for the B and K cohorts, children's activities are recorded in a 'light diary'. This kind of diary has been used elsewhere to collect time use information about children (Hofferth et al. 1997) and is regarded as being an effective way to collect information about daily activities (Lader, Short & Gershuny 2006). A light diary contains a list of pre-coded activities from which the respondent (typically the study child's mother or the parental figure who knows the child best) can choose when recording children's activity patterns in blocks of 15 minutes throughout the day. In addition to recording activities, respondents report the child's location, mode of travel if relevant and other people who are present during the activity (co-present), also in 15-minute blocks of time. As with activities, the light diary included pre-coded categories for travel, location and co-presence. For the first three waves, respondents filled in diaries for a weekday and a weekend day.

The time diary component changed at Wave 4. Firstly, diaries were not collected from B cohort children at Wave 4 (age 6 to 7 years), but they will be collected at Wave 6 (age 10 to 11 years). Secondly, K cohort children aged 10 to 11 years (Wave 4) completed a time diary for a single day prior to an interview. Rather than using pre-coded activities, children were allowed to record the sequence of activities throughout the day in their own words. During a computer-assisted interview (CAI) with the child, interviewers then inputted information from the paper diary completed by the child, as well as obtaining further contextual information such as who the child was with and where the child was throughout the day. A coding framework for activities was devised to help interviewers code the children's activities, thus yielding a comparable set of activities across all children's diaries.

2.2 Harmonising activities across waves

This section describes the harmonisation of children's activities collected in the time diary instruments across waves. There is a strong tradition of harmonising activities from time use surveys conducted in different countries (for example, Fisher et al. 2012) and from different subpopulations collected over time within the same country (for example, Egerton, Fisher & Gershuny 2005). These efforts seek to provide a set of activities that are comparable across distinct national contexts or at different points in time within the same country. Here, interest centres on harmonising time use activities across time for the same children and the aim is to arrive at a set of activities that are meaningfully comparable across time. It is important to note, however, that there are natural, or normative, developmental changes in children's time use as they get older that may preclude some harmonisation over time. Moreover, certain types of activities are only meaningful at certain points in children's development. Examples of these issues will be highlighted below.

Children's activities are grouped into five broad categories. These are: (1) school or non-parental care, (2) necessary activities such as eating and sleeping, (3) leisure, (4) travel and (5) other activities. Below, each activity group is described separately, and issues relating to differences in the coding of activities within each group are discussed. In the following description, codes (numbers) derived from the order of the activities listed in the light diaries in Waves 1 to 3 are attributed to each activity. A different coding framework was developed for the Wave 4 diary, and these codes and corresponding labels are described below. Though it is not possible, or fruitful, to make recommendations that are appropriate for all analyses, where appropriate certain recommendations for harmonisation are suggested.

Preschool, school and non-parental care

Respondents across all waves—parents for Waves 1 to 3 and K cohort children for Wave 4—have the opportunity to record what the child was doing while in preschool, school or non-parental care. However, Baxter (2007), using K cohort Wave 1, showed that there was substantial missing activity data in the middle of the day on weekdays, when children who are 4 to 5 years are most likely to be at school or in non-parental care and/or when the parent is in paid work. In addition, though there was some data missing about children's location, Baxter showed that, for the majority of the time when activity data was missing, children were recorded as being in non-parental care (likely including preschool for many children aged 4 to 5 years). In contrast, children aged 10 to 11 years complete the diary themselves and the record of activities while at school is substantially more complete.

Therefore, harmonising activities while children are at school is problematic because of the extent of missing activity data in diaries completed by parents (for children younger than 10 to 11 years). Moreover, there is no specific code for 'classes' in any of the diaries completed by parents. That is, we have a measure of the time spent in classes at school for children aged 10 to 11 years only.

Though we cannot measure well activities when children are at preschool, school or non-parental care, we can use information about children's location to estimate the total time at preschool, school or non-parental care. Information about children's location ('where' information) is coded more consistently across waves and is less likely to be missing from the children's diaries collected by parents (Baxter 2007). Table 1 provides a summary of the information available relating to children's time in school or non-parental care across all waves.

Table 1: Labels of codes for time in school or non-parental care

Cohort	Age	Where (location) coding
B cohort	0–1 years and 2–3 years	Day care centre, playgroup
	4–5 years	Day care centre, playgroup, preschool, school
K cohort	4–5 years	Day care centre, playgroup
	6–7 years and 8–9 years	School, after/before school care
	10–11 years	School

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

Over time in the B cohort, the 'where' coding changed to reflect the fact that children aged 4 to 5 years were entering preschool or school, but the diary for K cohort children aged 4 to 5 years did not change. For children aged 6 to 7 and 8 to 9 years, non-parental care is focused on before or after school care, reflecting the types of non-parental care used for children at this stage in their growth. The 'where' coding in the diary completed by children aged 10 to 11 years does not specify whether children are in non-parental care. This is appropriate, as children aged 10 to 11 years are much less likely to be in before or after school care (Baxter & Hand 2012). Finally, as noted above, the diary of the child aged 10 to 11 years is the only one where data on children's time in class are explicitly recorded.

With respect to creating a harmonised measure of time at preschool, school or care, the omission of a specific reference to preschool or school in the diary for K cohort children aged 4 to 5 years is the most problematic issue, especially considering that around 95 per cent of responding parents in both the B and K cohorts reported that children aged 4 to 5 years were attending school, kindergarten, preschool or a long daycare centre at the time of the interview (Waves 3 and 1 for the B and K cohorts respectively). Therefore, we should reasonably expect that attendance at preschool, school or daycare would, as reported in the time diaries, be approximately equivalent for children aged 4 to 5 years in the B and K cohorts.

To consider this, Table 2 reports the proportion of B cohort children aged 4 to 5 years (Wave 3) who spent any time at 'daycare centre/playgroup/preschool/school' and K cohort children aged 4 to 5 years (Wave 1) who spent any time at 'daycare centre/playgroup', along with the average time spent at these locations for these children.[2] Any time parents were with the child at these locations was omitted from the measure.[3] Note that, for brevity, preschool and school are jointly referred to as 'school' throughout.

Table 2 shows that only 41 per cent of K cohort children aged 4 to 5 years are reported to spend time in non-parental care on weekdays, which is much lower than the 55 per cent of B cohort children aged 4 to 5 years. In addition, the K cohort children aged 4 to 5 years average slightly fewer hours in school or non-parental care (5.3 hours) than B cohort children aged 4 to 5 years (6 hours). This suggests that non-parental care time is under-reported for children aged 4 to 5 years in the K cohort diaries, which did not include a code for 'attending school'.

Table 2: Percentage of children with any time in preschool, school or non-parental care, and average time for those in school or non-parental care

	Children in school/care on weekday (%)	Mean hours (std. dev.) in school/ care on weekday	Number of children
K cohort Wave 1: children 4–5 years	41	5.3 (2.5)	1,070
B cohort Wave 3: children 4–5 years	55	6.0 (2.2)	1,461

Source: LSAC B cohort: Wave 3; K cohort: Wave 1.

There is clearly an issue with the omission of 'school' from the location code in the K cohort Wave 1 diaries, but we can use other information from the time diary to help address it. One further source of information is the 'where' code for 'other indoors', and a second source of information is the 'who with' code for 'with other adults'. As well as helping to correct for the under-reporting of time spent in non-parental care or school in the K cohort, this additional information is likely to help incorporate other forms of non-parental care, such as family day care, that are not included in the location codes in either the B or K cohorts.

To explore this, time spent at another location or with other adults (and not with parents) was added to the measure of time in non-parental care or school, but with some important restrictions. Firstly, the additional time was restricted to time between 8 am and 5 pm on a weekday. Secondly, it was restricted to days reported as 'ordinary'. Thirdly, it was restricted to a period of time in total that exceeded three hours. To summarise, to our estimate of time in non-parental care, we added time between 8 am and 5 pm when children were at another location or with another non-related adult for at least three hours on a typical weekday.

Results reported in Table 3 show that, after this adjustment, the K cohort estimate resembles the B cohort estimate (both in the proportion of children reported to be in school or non-parental care and in the average time spent in such care). The proportion is still lower, which suggests that there remains some school time which is not reported and not captured by information in other aspects of the diary. The B cohort estimate has increased slightly (both in the proportion of children now estimated to be in school or non-parental care and in average hours), possibly reflecting other forms of non-parental care not specifically coded, such as family day care. It follows that the adjusted K cohort estimate is likely to also contain this aspect of non-parental care. Future waves of B cohort data will provide insights into how time in school tracks over time across the two cohorts. What has been shown here is that the adjusted measure of time in non-parental care or school in the K cohort provides a more accurate baseline measure

from which to consider change over time in the K cohort. Note that there may be a variety of reasons why the estimates in the B and K cohorts differ for children of the same age which we do not consider. In addition, it is unlikely that research would consider such a comparison directly. Notwithstanding, comparing children of the same age across cohorts provides insights into how estimates of time use are sensitive to the way activities are coded.

Table 3: Adjusted percentage of children with any time in preschool, school or non-parental care, and average adjusted time for those in school or non-parental care

	Children in school/care on weekday (%)	Mean hours (std. dev.) in school/ care on weekday	Number of children
K cohort Wave 1: children 4–5 years	56	5.6 (2.2)	1,653
B cohort Wave 3: children 4–5 years	61	5.9 (2.2)	1,798

Source: LSAC B cohort: Wave 3; K cohort: Wave 1.

Researchers using these data may wish to consider the impact of the omission of 'preschool/school' from the coding framework in the K cohort diary for children aged 4 to 5 years on cross-wave comparisons. If this is an issue, it has been shown here that information from other codes can be used to supplement the 'day care centre, playgroup' code to yield a measure of school or non-parental care that is more similar to comparable estimates from data containing a code that explicitly included 'school'.

Homework

In addition to time at school or non-parental care, researchers may be interested to know how much time children spend doing homework. Coding for home was introduced to the diaries for children aged 6 to 7 years and older. In the diaries for children aged 6 to 7 and 8 to 9 years, parents could indicate whether the activity they reported the child doing was 'done for or as part of homework'. Children aged 10 to 11 years reported whether they did 'homework (not on computer), including music practice' (58); used the 'computer for homework—internet' (61); or used the 'computer for homework—not internet' (62). As there are specific codes for homework in the diary for children aged 10 to 11 years, it is appropriate to overwrite the activity codes in the previous diaries with 'homework' when parents indicate that the activity was 'done for or as part of homework'. In the earlier diaries, it would be possible to combine information on the use of computers with information about whether this was done as part of homework to create comparable measures of homework with and without computers (though distinguishing between internet and non-internet use would not be feasible). For the analysis contained in this report, a single measure of total homework is created.

Necessary activities (not at school or non-parental care)

Activities that are necessary for basic wellbeing include sleeping, eating and personal care. Table 4 contains information about the labels and codes for necessary activities across all waves. The codes (numbers) shown in Table 4 are drawn from the order in which the activities were listed in the diaries for Waves 1 to 3 and from a coding framework developed for the diaries at Wave 4. For example, sleep was the second activity listed in the diaries for Waves 1 to 3 and is therefore coded '2'. In the coding framework developed for the Wave 4 diary, sleep was given the code '57'.

The coding of sleep is identical across all ages; the only exception is that there is no code for 'awake in bed' for children aged 10 to 11 years. Strictly, harmonising sleep time across all waves implies excluding

time when children are 'awake in bed/cot'. Children aged 10 to 11 years begin recording activities from the moment they wake up and it is possible that some activities happened when they were 'awake in bed', but this was not recorded as such. This means that, for children aged 10 to 11 years, sleeping clearly does not include time spent 'awake in bed'. The final chapter will show that time spent 'awake in bed' is minimal and including it, or not, has a negligible effect. Therefore, in the interests of minimising the residual 'other' category, it may be helpful to include it as part of sleep, though this may not be appropriate for some research purposes.

Table 4: Labels and codes of necessary activities

		B cohort		K cohort		
		0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
Sleeping	Sleeping, napping	2	2	2	2	57
	Awake in bed/cot	3	3	3	3	–
Eating	Breastfeeding	6	–	–	–	–
	Eating, drinking, being fed	7	4	4	–	–
	Eating and drinking	–	–	–	4	10
Personal care	Bathe/nappy change, dress/hair care	5	–	–	–	–
	Bathing, dressing, hair care, health care	–	5	5	5	–
	Personal care, health care	–	–	–	–	20
	Bathing, dressing, toileting, teeth brushing, hair care	–	–	–	–	21
	Dentist, doctor, chiropractor, physiotherapist, optometrist	–	–	–	–	22

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

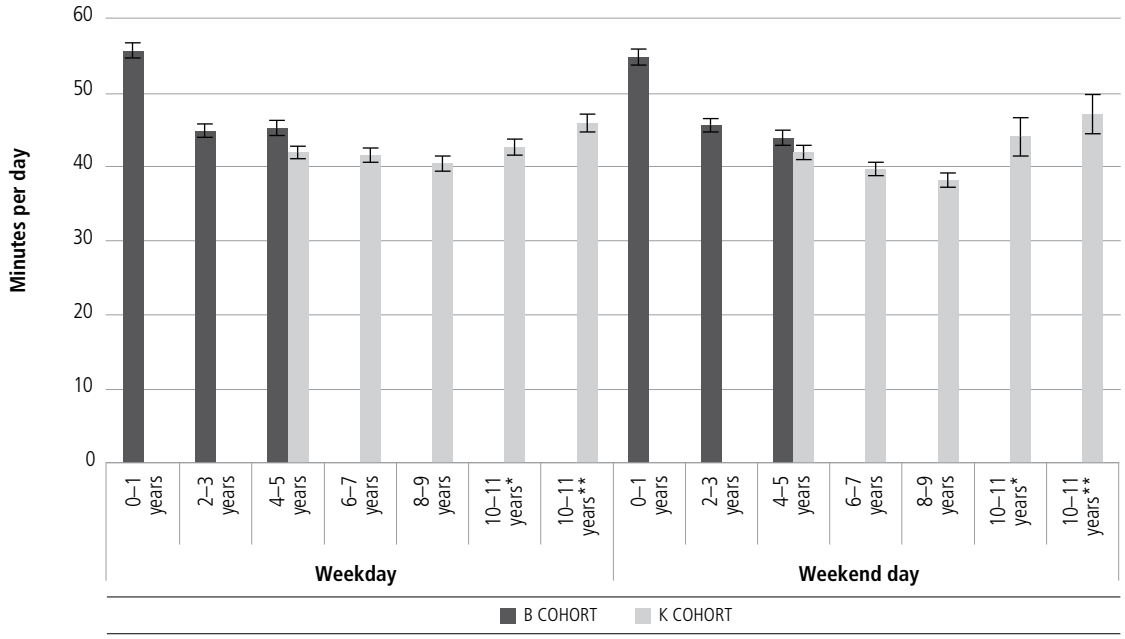
The coding for eating undergoes changes reflecting the developmental progress of children with respect to this activity. There is a code for 'breastfeeding' when children are 0 to 1 years only. In addition, the code for eating includes 'being fed' for children aged 0 to 1, 2 to 3 and 4 to 5 years that drops out for children aged 6 to 7, 8 to 9 and 10 to 11 years. This is a clear example of the coding of activities changing to reflect normative developmental patterns of change, while not adversely impacting on a meaningful comparison of the broader eating activity category as children grow. Therefore, we can simply aggregate these activity codes to create a measure of eating time comparable across waves.

There are some changes to the coding of personal care across waves. Personal care includes a reference to 'nappy change' in the diary for children aged 0 to 1 years but not in other waves. It is possible that this activity would apply to some children aged 2 to 3 years, but respondents would have had to include it in the 'bathing, dressing, hair care, health care' activity. A reference to 'health care' is added to the code in the diaries for children aged 2 to 3 and 8 to 9 years. Finally, the coding is more detailed for children aged 10 to 11. There is a general combined 'catch-all' code for personal care and health care, a code for specific activities relating to personal hygiene and a code relating to specific aspects of health care.

These differences in coding are not very substantial, but they may have a bearing on the extent to which this activity is strictly comparable over time. To explore this, Figure 1 shows average time spent on personal care for children aged 0 to 1 years through to 10 to 11 years. Broadly, patterns across time are very similar for weekdays and weekend days. The average time is greatest for children aged 0 to

1 years, which is not surprising considering the level of physical care babies require. Time in personal care decreases to around 45 minutes for B cohort children aged 2 to 3 years and 4 to 5 years, and it is around 40 minutes for K cohort children 4 to 5 years to 8 to 9 years. There is a slight increase of a few minutes in the average time spent in personal hygiene activities by children aged 10 to 11 years (43 minutes on a weekday, 44 minutes on a weekend day). When all personal care codes are aggregated, the average increases to 46 and 47 minutes for weekdays and weekend days respectively.

Figure 1: Average minutes in personal care activities: children aged 0 to 1 years to children aged 10 to 11 years



* Personal hygiene only.

** Sum of all personal care codes.

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

That there is an increase in the average time spent on personal hygiene for children aged 10 to 11 years suggests that this is not related to changes in coding. It is important to note that these types of activities increasingly occur away from parents as children in the middle years of childhood gain more privacy. Therefore, parents may under-report this activity for children in this period. Moreover, parents were restricted to reporting activities in 15-minute blocks of time and so may omit engagement in brief personal care activities that children would have had the opportunity to report.

The added catch-all personal or health care code (code 20) adds the most to the personal hygiene measure (2 and 3 minutes for weekdays and weekend days respectively). The more detailed health care code (code 22) adds a further 1.5 minutes to the weekday average and less than one minute to the weekend average. This is because it is a relatively infrequent activity that the vast majority of children (98 per cent) do not report at all.

Differences in coding have a relatively minor impact on the measures, and differences across time are more likely driven by children's development and the change in the reporting from parents to children themselves. Though the impact appears to be limited, there is some evidence that parents under-reported children's engagement in physical care, whereas children themselves were able to provide more detailed accounts.

Leisure (not at preschool, school or non-parental care)

After necessary activity time and time spent in school or non-parental care, the next most substantial component of children's time use is leisure. Leisure is the most heterogeneous activity group, comprising a broad range of different types of activity, from watching TV and playing sport to doing nothing. Table 5 shows the coding of different non active (or passive) leisure activities.

Watching TV and listening to music are coded very consistently across waves and are thus very straightforward to harmonise. There is no code for computer use when children are very young (0 to 1 years) but there is a consistent code for children aged 2 to 3 up to 8 to 9 years. For K cohort children aged 10 to 11 years, there is a large increase in the different codes relating to computer use. In some part, this reflects the increased usage of computers as children get older, not to mention rapid societal changes in the use of computers, and in tandem it is motivated by an increase in interest in children's use of computers. To the extent that this detail would have been captured in the previous, more general, code, then these codes can be aggregated to yield a total time spent using computers that is comparable with previous waves.

Table 5: Labels and codes of non-active leisure activities

		B cohort		K cohort		
		0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
TV and music	Watching TV, a video or a DVD	11	12	11	11	67
	Listening to tapes, CDs, radio, music	12	13	12	12	52
Computers	Using a computer/computer game	–	14	13	13	–
	Computer games—internet; computer games—not internet; Xbox, Playstation, Nintendo, Wii; internet not covered elsewhere	–	–	–	–	63, 64, 65, 66
Reading	Read a story, talked/sung to, sing/talk	13	15	14	14	–
	Reading or looking at book by self	–	–	–	15	–
	Reading/being read to	–	–	–	–	53
Doing nothing	Looking around/doing nothing	4	–	–	–	–
	Do nothing, bored/restless	–	6	6	6	–
	Doing nothing	–	–	–	–	56

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

From age 0 to 1 up to age 8 to 9 years, there is a code for time when children read a story or are being read, talked or sung to, and at age 8 to 9 years there is a distinct code for 'reading or looking at book by self'. Up to age 4 to 5, reading corresponds to being read to and it is combined with other forms of verbal interaction (talking or singing) between the child and another person. At age 6 to 7, a distinct code for reading by oneself is introduced. The code in the diary for K cohort children aged 10 to 11 years combines both being read to and reading by oneself, though we reasonably proceed on the basis that this is predominantly reading by oneself. This difference in the coding reflects changes in the nature of children's reading. Reading for younger children is most likely to be carried out with a parent, other adult or older sibling. As they get older, children develop more independent reading skills and read by themselves. Researchers considering the development of children's engagement with reading will have to contend with the inclusion of other aspects of verbal interactions with children along with reading in the earlier waves.

A further code relating to teaching children to read was included in the diaries for B cohort children aged 2 to 3 years and B and K cohort children aged 4 to 5 years. Unfortunately, this code also specifically referenced being taught to do chores and other unspecified activities. That is, it relates very generally to instances where the child is being taught to do something, including reading. We include this activity with 'chores' below (Table 9) because reading is given a specific code in earlier diaries and parents may be 'teaching' children through the act of reading with their children but not regard it as teaching. This is not a recommendation, and researchers who are interested in reading or chores will have to consider how this activity fits with their analysis, or if it fits with their analysis.

The final set of codes in Table 5 relate to 'doing nothing'. These are very comparable across waves, with only relatively minor changes to wording.

The next group of activities, shown in Table 6, relate to organised activities and unorganised physical activity. The upper panel of Table 6 shows the labels and codes for organised activities, lessons and sport across waves. For B cohort children aged 0 to 1 years, parents could report the time the child spent in 'organised activities/playgroup' and this changed to 'organised lessons/activities' for B cohort children aged 2 to 3 years and 4 to 5 years. The wording of the code for K cohort children aged 4 to 5 years is identical to that for B cohort children aged 0 to 1 years. Therefore, across all waves of the B cohort and for the first wave of the K cohort, the coding of organised activities is very general.

Table 6: Labels and codes of organised activities, lessons and sport

		B cohort		K cohort		
		0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
Organised activities/ lessons/sport	Organised activities/ playgroup	15	–	26	–	–
	Organised lessons/activities	–	21	–	–	–
	Organised sport/physical activity (e.g. swim/dance/Auskick)	–	–	–	20	–
	Organised team sports and training: football, basketball, netball, cricket	–	–	–	–	41
	Organised individual sports and training: swimming, dancing, tennis, martial arts, gymnastics	–	–	–	–	42
	Other organised lesson/activity (e.g. music, drama)	–	–	–	21	–
	Non-active club activities: chess club, art/craft groups	–	–	–	–	55
	Private music, language or religion lessons, tutoring	–	–	–	–	51
	Scouts, girl guides, cadets, youth groups	–	–	–	–	45
Other physical activity	Crawl, climb, swing arms or legs	16	–	–	–	–
	Active free play (e.g. running, climbing, ball game)	–	18	–	17	–
	Other exercise: swim/dance/run about	–	–	19	–	–
	Ball games, riding bike/scooter/ skateboard, skipping, running, chasing	–	–	–	–	43

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

For K cohort children aged 6 to 7 and 8 to 9 years, there is a coding distinction between organised sport and other organised lessons and activities. For children aged 10 to 11 years, organised sport is further subdivided into team and individual sports, while other organised activities are divided into three distinct categories: non-active club activities (for example, chess club), tuition, and scouts or girl guides and so on. Recall that children aged 10 to 11 years record these activities in their own words, which helps explain the increase in the diversity of organised activities. At a broad level, these activities are comparable, but at a more specific level they become associated more with children's development at particular ages. In the K cohort, with the exception of children aged 4 to 5 years, measures of organised sport and other organised activities or lessons comparable over time are feasible. Moreover, research may utilise information about whether the activity took place indoors or outdoors to yield general measures of indoors and outdoors organised activities that are comparable over time.

The lower panel of Table 6 shows the labels and codes for other (unorganised) physical activity or exercise. There are modest differences in the wording of the codes for other physical activity but in general, across waves, these codes correspond to meaningfully comparable activities. One notable difference in the code for children aged 10 to 11 years is the inclusion of 'riding bike/scooter/skateboard'. In previous waves, this activity was included in a travel code. This will be discussed further when looking at the travel codes in the next subsection.

The labels and codes for the remaining leisure activities are shown in Table 7. By construction, this set of activities is very broad. Loosely, the upper panel of Table 7 corresponds to activities that most likely occur indoors. There are activity codes for the time younger children spend colouring and drawing, looking at books, and doing puzzles or playing educational games. There is a vague code 'other play, other activities' for B cohort children aged 0 to 1 years and K cohort children aged 4 to 5 years. Considering the explicit coding of other aspects of leisure, it could be assumed that this code covers things explicitly coded in diaries for other years (for example, board games, arts and craft, dress-ups). It may be, however, that this code also captures other activities. It seems reasonable to aggregate across the activities in the upper panel of Table 7, bearing in mind the relative vagueness of the 'other' category for the first diary in each cohort.

The lower panel of Table 7 contains two separate, though possibly related, sets of activities. For children aged 0 to 1 through to those aged 8 to 9 years, there are two activity codes that are identical across years. One code refers to being 'taken places with adult' and the other is 'visiting people, special event, party'. Note that the former code is placed along with the travel codes in the B and K cohort diaries at Waves 2 and 3. Depending on the research question, this code may or may not be viewed as a travel code, but it is important to be consistent in a longitudinal setting. For children aged 10 to 11 years, there is a set of codes relating to shopping and other non-home leisure activities or events. There is no question that the codes across waves excluding children aged 10 to 11 years are comparable. However, less clear is the extent to which the codes in the diaries for children aged 10 to 11 years are nested within these earlier codes. It is reasonable to suppose that some of the places a child could have been taken to with an adult (that is, in the 'taken places with adult' code) include church, museums, cinemas or sporting events. It is also likely that a 'special event' could encompass many of the activities specified in the diary for children aged 10 to 11 years. However, the vagueness of the codes in the earlier diariesleaves open the possibility of including activities perhaps coded as 'other' by children aged 10 to 11 years (see 'Other activities' below). This notwithstanding, it would not be unreasonable to combine these activities to form 'other leisure' or 'other non-home leisure', though the lack of specificity in this measure may temper its usefulness for particular research purposes.

Table 7: Labels and codes for other leisure activities

		B cohort		K cohort		
		0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
Other play/leisure	Colour/draw, look at book, puzzles	14	–	–	–	–
	Colour/draw, look at book, puzzles, educational games	–	16	15	–	–
	Other play, other activities	17	–	21	–	–
	Quiet free play (e.g. board games, craft, dress-ups)	–	17	–	–	–
	Quiet free play (e.g. jigsaw, craft, dress-ups)	–	–	–	16	–
	Board/card games, puzzles, toys, art and craft	–	–	–	–	54
Other non–home leisure time	Taken places with adult (e.g. shopping)	19	T6	25	T5	–
	Visiting people, special event, party	18	20	20	19	–
	Shopping	–	–	–	–	46
	Going to church, museums, cultural events, fairs, community events	–	–	–	–	47
	Cinema	–	–	–	–	48
	Going to live sporting events	–	–	–	–	49

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

Travel

The labels and codes for travel activities across waves are shown in Table 8. The coding for travel is relatively straightforward and meaningfully comparable across waves. The code for travel by pram or bicycle seat is not included in diaries for children beyond 4 to 5 years for obvious reasons. This code is available for all diaries in the B cohort and for the first diary in the K cohort only. The impact on the longitudinal analysis of total travel is, however, likely to be slight (though it is prudent to be mindful of this difference).

A more critical difference relates to the coding of walking or cycling. This code is available for children aged 2 to 3 years and older. For children aged 2 to 3 years up to 8 to 9 years, walking or cycling 'for travel' is combined with 'for fun', whereas for children aged 2 to 3 years these activities are restricted to 'for travel'. Recall that the code for other physical activity included cycling (for fun) as well as other aspects of physical activity (not excluding walking).

It is not possible to distinguish cycling or walking from the other types of physical activity in the leisure code. Therefore, it would seem optimal to add the codes for walking and cycling to the leisure code for other physical activity (discussed above), leaving a comparable measure of travel restricted to cars or public transport. This would also serve to enhance the comparability of the measure of other physical activity, as it includes walking or cycling for fun, coded for children aged 10 to 11 years, but coded as part of travel for younger children.

Table 8: Labels and codes for travel activities

	B cohort		K cohort		
	0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
Taken out in pram or bicycle seat	1	3	22	–	–
Travel in car/other household vehicle	2	4	23	3	93
Travel on public transport, ferry, plane	3	5	24	4	94
Walking (for travel or fun)	–	1	17	1	–
Ride bicycle, trike, etc. (for travel or fun)	–	2	18	2	–
Travel by foot	–	–	–	–	91
Travel by bike/scooter/skateboard	–	–	–	–	92

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

Other activities (not at preschool, school or non-parental care)

This final subsection on the harmonisation of activities in the time diaries across waves focuses on activities not covered above. Table 9 shows the labels and codes for all remaining activities, split into three panels. The first panel contains a list of activity codes relating to children's behaviour and interactions between parents and children centred on or associated with their behaviour. These include time when the child was emotionally upset and time when the child was angry. They also include time when the child was reprimanded or comforted. There are no comparable activities recorded in the diary for children aged 10 to 11 years.

The wording of these activity codes changes slightly across waves, reflecting normative changes as children grow up. For example, the word 'tantrum' was added to the diaries for children 2 years and over. Relatively minor changes to wording notwithstanding, these different activities are comparable across waves.

The second panel in Table 9 contains activities relating to housework. Obviously, there is no code in the diary for children aged 0 to 1 years, while in the diary for children aged 2 to 3 and 4 to 5 years there is a code for 'being taught to do chores, read, etc.'. Recall that this code was also relevant to reading, as it encompasses time when children are being taught to read. This code therefore clearly encompasses more than housework, and it is not strictly comparable with the time spent actually doing chores recorded in the diaries for children aged 8 to 9 years and 10 to 11 years.

In the Wave 4 diary completed by children aged 10 to 11 years, there is significantly more detailed coding for chores. There is no reason to suppose that the single code in the previous diary excludes any of the activities in this more detailed list. However, allowing children to record their engagement in different chores in their own words may have yielded a more accurate (larger) measure of children's engagement in this activity, which is possibly conflated with a reasonable expectation that children's engagement in chores would increase as they got older. Researchers should bear this in mind when considering changes in children's engagement in this activity over time.

The third panel in Table 9 contains codes relating to 'missing/not sure' time and 'other' time. The former are coded in the diaries for children aged 0 to 1 through to 8 to 9 years, while the latter is coded in the diary for children aged 10 to 11 years only. There is practically no missing time in the diary for children aged 10 to 11 years. Missing time is a problem for longitudinal analysis, as it implies an under-reporting

of unknown activities. Baxter (2007) considered the issue of missing time in the K cohort 4 to 5 years diary, finding that a large part of it was associated with children being away from parents in the middle of the day while at school or in non-parental care. Using information about location and co-presence to measure time in school, therefore, goes some distance to helping to address missing activity data (see 'Preschool, school or non-parental care' in subsection 2.2). Although we cannot state accurately for all time at school or non-parental care what the child was doing, we have a substantively meaningful measure that is comparable over time.

Table 9: Labels and codes for other activities and chores or housework

	B cohort		K cohort		
	0–1 years	2–3 & 4–5 years	4–5 years	6–7 & 8–9 years	10–11 years
Behaviour					
Crying, upset	8	–	–	–	–
Crying, upset, tantrum	–	7	7	7	–
Arguing, fighting	–	8	–	–	–
Destroy things, create mess	9	9	8	–	–
Arguing, fighting, destroy things	–	–	–	8	–
Being reprimanded, corrected	–	10	10	10	–
Held, cuddled, hugged, comforted, soothed	10	11	9	9	–
Chores/housework					
Being taught to do chores, read, etc.	–	19	16	–	–
Helping with chores, jobs	–	–	–	18	–
Making own bed, tidying own room; making/preparing own food; getting self ready, packing/unpacking own school/sports bag; cleaning, tidying other rooms; cooking, meal preparation, making lunch, setting table for others; washing dishes, stacking, emptying dishwater; gardening, putting out bin; taking care of siblings, other children; taking care of pets; taking pets for a walk	–	–	–	–	30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 44
Missing, other					
Not sure what child was doing	1	1	1	1	–
Missing	0	0	0	0	0
Other	–	–	–	–	99

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

We will return to the issue of missing time in the next chapter as we look at non-response, and show that these two issues are closely tied together. In the final chapter, we will also present some analysis exploring the sensitivity of longitudinal analysis to missing data.

To sum up, this chapter has presented details of the coding of different activities in the LSAC time diaries across different waves. Broad activities such as necessary activity time, leisure and time in school are comparable across waves, and the vast majority of more detailed activities are meaningfully comparable

across waves. There are some differences in coding that should be considered when looking at certain activities. For example, it is important to note that walking and cycling for fun and travel are combined in earlier diaries, but separated in the diary completed by children aged 10 to 11 years. Researchers interested in children's physical activity over time would need to consider this difference, and it would be advisable to combine these travel codes with the physical activity leisure codes to create a more comparable measure over time.

The overarching aim of this section of the report was to create meaningfully comparable time use activities across all waves of available data. Researchers may be interested in particular subsets of waves only, and this will open up the possibility of more detailed activities. Moreover, researchers may wish to combine certain activities set out above to form more general activity types. The main point is that researchers have a good degree of flexibility when constructing measures of children's activities, but it is important to be aware of differences and variation in the coding of activities across waves.

3 Different report day types

3.1 Introduction

As well as ensuring that different types of activities are comparable over time, it is important to ensure that reports from different types of days are comparable over time. The 'type' of the diary reporting day (or 'day type') distinguishes weekdays from weekend days and distinguishes between days of the week (or weekend). For school age children, day type also distinguishes between school and non-school days. Day type is important because of the sequencing of activities across the week—some activities happen on certain days or on weekdays or weekends. If the day is a school day, then this has a direct (obvious) effect on time in school but influences time spent in other activities as well.

These characteristics of the day will have a bearing on longitudinal comparisons of time use. For example, there will be a dramatic 'change' in children's time in school if we observe children on a school day at one point in time and on a non-school day at a second point in time (both on a weekday). Obviously, a substantial portion of this 'change' can be attributed to differences in day type. Similarly, we might observe an increase in leisure time between these two points in time, but this again would be, to some degree, a function of differences in the type of day.

School is a fairly obvious example. What about the actual day of the week? Would it matter, for example, if at one point in time a parent completed a child's diary for a Wednesday while at a second point in time it was completed for a Thursday? It would be a problem if a particular child routinely did a particular activity on a Wednesday for the entire period over which their time use was being reported. In this case, we would observe a decrease in the time this child spent in the activity that would be entirely a function of the manner in which the days were sampled at the two points in time. This issue may even overlap with the school day–non-school day distinction. For example, a child attends netball practice every Wednesday at 4.30 pm for 90 minutes but only during term time. Broadly, it is likely that this is more of a problem for very specifically defined activities and perhaps it is more problematic for organised activities. We will consider this in more detail below.

A more general issue with respect to the day of the week relates to whether the diary was kept for a weekday or a weekend day. The design of the LSAC time diary component across Waves 1 to 3 stipulated that parents complete a diary for one weekday and one weekend day. Respondents were randomly assigned a specific date to complete the diary to ensure that weekdays were sampled evenly and that Saturdays and Sundays were sampled equally for the weekend diaries. However, not all respondents completed the diary for the assigned date. Information about the date the diary was completed is available but, as Baxter (2007, p. 43 [emphasis in original]) points out, it is unclear whether 'this date refers to the date **for which** the diary was completed or the date **on which** the diary was completed'. Therefore, following Baxter (2007), we use the assigned date to derive information about the day of the week (and the associated weekday–weekend day distinction) for when the diary was completed.

At Wave 4, children completed a single diary for either a weekday (the majority) or a weekend day. For children who completed their diary for a weekday, the longitudinal sequence of weekend days ends at Wave 3. Similarly, the longitudinal sequence of weekdays ends at Wave 3 for the minority of children who completed a diary for a weekend day at Wave 4. As this aspect of the design is fixed for Wave 5 and likely to remain in all subsequent waves, we must understand more about its impact on longitudinal analyses of children's time use from early childhood through to adolescence.

This chapter explores the impact that these factors may have on the patterns of children's time use over time. It begins with a descriptive overview of the days of the week, weekdays and weekend days and discusses the use of day weights and other approaches to addressing differences in the distribution of days of the week across waves (section 3.2). In section 3.3, we examine the potential impact on patterns of children's time use over time arising from diaries being completed on the same day or different days,

and in section 3.4 we consider the impact of recording diaries on school or non-parental care days compared with non-school days.

In this analysis, 58 B cohort diaries (17 Wave 1, nine Wave 2 and 32 Wave 3) and 60 K cohort diaries (19 Wave 1, six Wave 2 and 35 Wave 3) are not included as they have no record of any activity throughout the day. These cases are viewed as effective non-response. The issue of non-response is left for the following chapter.

3.2 Days of the week

Distribution of weekdays, weekend days and individual days of the week

In this section, we present a descriptive overview of variation in the distribution of weekdays and weekend days, days of the week, and school days and non-school days, beginning with the distribution of weekday and weekend diaries. Table 10 reports the number of diaries for weekdays and weekend days across all waves of the LSAC time diary component. For the first three waves of the study, participants were asked to complete a diary for a weekday and a weekend day.

As shown in Table 10, the numbers of weekday and weekend diaries are very similar, though they are not exactly equal, reflecting instances where participants completed two weekday or weekend diaries or (more commonly) completed only a single diary for either a weekday or a weekend day. However, over 90 per cent of respondents completed a diary for both a weekday and a weekend day. The total number of diaries decreased as the study progressed as a result of increasing non-response to the time diary component. Chapter 4 will address non-response is more detail.

Children aged 10 to 11 years (K cohort Wave 4) completed a diary for a single day. As shown in Table 10, the vast majority of diaries correspond to weekdays, and about one in five diaries corresponds to a weekend day. Given that each diary day represents a single respondent, it is clear that the number of individuals providing time diary data has increased to levels observed at the outset of the study.

Table 10: Number of weekday and weekend diaries in the LSAC time diary component: children aged 0 to 1 years to children aged 10 to 11 years

		0–1 years	2–3 years	4–5 years	6–7 years	8–9 years	10–11 years
B cohort	Weekday	3,955	3,513	2,949	–	–	–
	Weekend day	3,810	3,388	2,913	–	–	–
	Day of week unknown	0	7	0	–	–	–
	Total diaries	7,765	6,908	5,862	–	–	–
K cohort	Weekday	–	–	3,808	3,487	2,940	3,105
	Weekend day	–	–	3,622	3,363	2,936	802
	Day of week unknown	–	–	0	2	1	0
	Total diaries	–	–	7,430	6,852	5,877	3,907

Note: The day of the week is unknown for seven B cohort diaries and three K cohort diaries; 87 diaries from children aged 10 to 11 years are not included due to errors with the sequencing of activities throughout the day.

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

Providing further detail, Table 11 shows the distribution of days of the week separately for weekdays and weekend days. Equal sampling of weekdays means that each weekday would have a one in five (20 per cent) chance of being selected. The actual distribution ranges from 17 per cent to 22 per cent across all waves, and no specific day is particularly over-represented or under-represented in the data.

Table 11: Distribution of days in the week in the LSAC time diary component: children aged 0 to 1 years to children aged 10 to 11 years

	0–1 years	2–3 years	4–5 years	6–7 years	8–9 years	10–11 years
			Weekdays			
Monday	17.7	18.3	20.2	–	–	–
Tuesday	18.5	18.9	19.3	–	–	–
Wednesday	21.5	21.6	18.6	–	–	–
Thursday	21.0	20.4	21.6	–	–	–
Friday	21.4	20.7	20.3	–	–	–
Total	100.0	100.0	100.0	–	–	–
Monday	–	–	19.7	17.6	17.3	20.8
Tuesday	–	–	20.5	19.6	20.3	22.4
Wednesday	–	–	20.0	20.2	20.3	21.2
Thursday	–	–	21.6	21.9	21.6	18.6
Friday	–	–	18.2	20.7	20.4	17.0
Total	–	–	100.0	100.0	100.0	100.0
			Weekend days			
Saturday	52.0	48.9	48.7	–	–	–
Sunday	48.0	51.1	51.3	–	–	–
Total	100.0	100.0	100.0	–	–	–
Saturday	–	–	56.0	47.9	50.1	21.4
Sunday	–	–	44.0	52.1	49.9	78.6
Total	–	–	100.0	100.0	100.0	100.0

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

Weekend days are oversampled relative to their occurrence in the week across the first three waves of the study. With this design, however, under equal sampling we would expect each weekend day to have a one in two (50 per cent) chance of being selected. In the B cohort, Saturdays are slightly more prevalent (52 per cent) in the first waves and slightly less prevalent in the second and third waves (49 per cent). In the K cohort, Saturdays are more prevalent in the first wave (56 per cent) and less prevalent in the second wave (48 per cent) and there is an equal distribution in Wave 3. However, Saturdays are significantly under-represented in the diary completed by children aged 10 to 11 years (21 per cent), with the remainder of weekend diaries being completed on a Sunday.

It is clear that this difference needs to be considered when making comparisons of time use across all four waves in the K cohort. Also, it is important to note that the design of future waves of the LSAC time diary component follows the K cohort Wave 4 design, which means that analysis of B cohort data over time as well as ongoing analysis of K cohort data over time must confront this issue.

Day weights

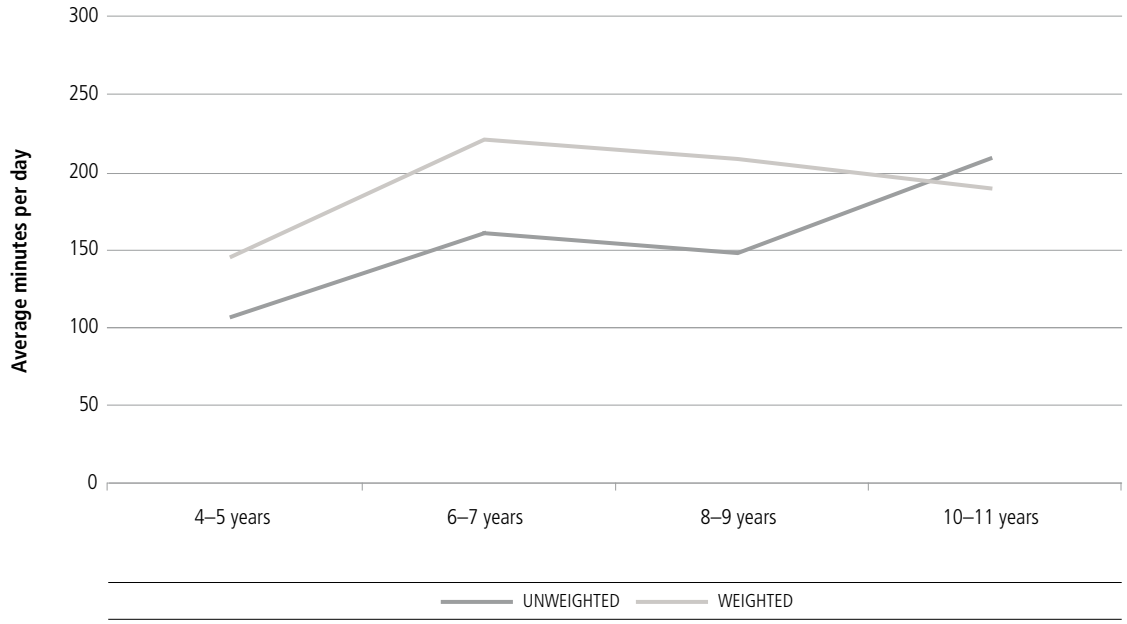
One relatively straightforward approach to the variation in the distribution of days in the week would be to apply weights to correct for the over-representation or under-representation of days in the week relative to their actual occurrence in the week. In broad terms, a day weight would have the effect of reducing the relative weight of weekend observations to weekday observations in the first three waves, and increasing the relative weight of weekend observations to weekday observations (though to a much lesser extent) for the fourth wave of the K cohort.

To calculate a day weight, we must first calculate the proportion of each day of the week in the sample to the total number of days of the week in the sample. Then we divide this proportion by one-seventh (that is, the proportion that each day occurs in the week). By construction, the day weight should have a mean of one and should sum to the total number of diary days in the sample. As the total number of diary days and the particular distribution of days across the week will vary depending on the sample drawn for the specific analyses, it is appropriate to compute a day weight tailored to each specific analysis.

To consider the impact of applying a day weight, we compare unweighted and weighted estimates of the average time children spend in school or non-parental care and unorganised physical activity. These activities were chosen because there are striking differences between weekdays and weekend days (results not shown). Across all waves, time in school or non-parental care is greatest on a weekday and time in unorganised physical activity is greatest on a weekend day. Figure 2 highlights the impact of using a day weight on the amount of time children spent in school or non-parental care and unorganised physical activity respectively, when averaged across all days of the week. The weighted average of time in school or non-parental care is greater than the unweighted average for children aged 4 to 5 years, 6 to 7 years and 8 to 9 years. This is simply because the weighted average corrects for the over-representation of weekend days, when most children record no time in school or non-parental care. Note that these averages (both weighted and unweighted) average across school and non-school weekdays as well as weekdays and weekend days. The weighted average for children aged 10 to 11 years is slightly less than the unweighted average, reflecting the modest over-representation of weekdays in the fourth wave.

Both weighted and unweighted results show an increase in time spent in school or non-parental care between 4 to 5 years and 6 to 7 years, mostly likely reflecting the fact that all children aged 6 to 7 years are required to be fully engaged in formal education. Both weighted and unweighted averages are relatively similar between 6 to 7 years and 8 to 9 years. The unweighted estimates show a sharp increase in school or non-parental care time between 8 to 9 years and 10 to 11 years, which is entirely a function of the dramatic loss of weekend observations. The weighted estimates correct for this.

Figure 2: Average unweighted and day-weighted minutes in school or non-parental care: children aged 4 to 5 years to children aged 10 to 11 years

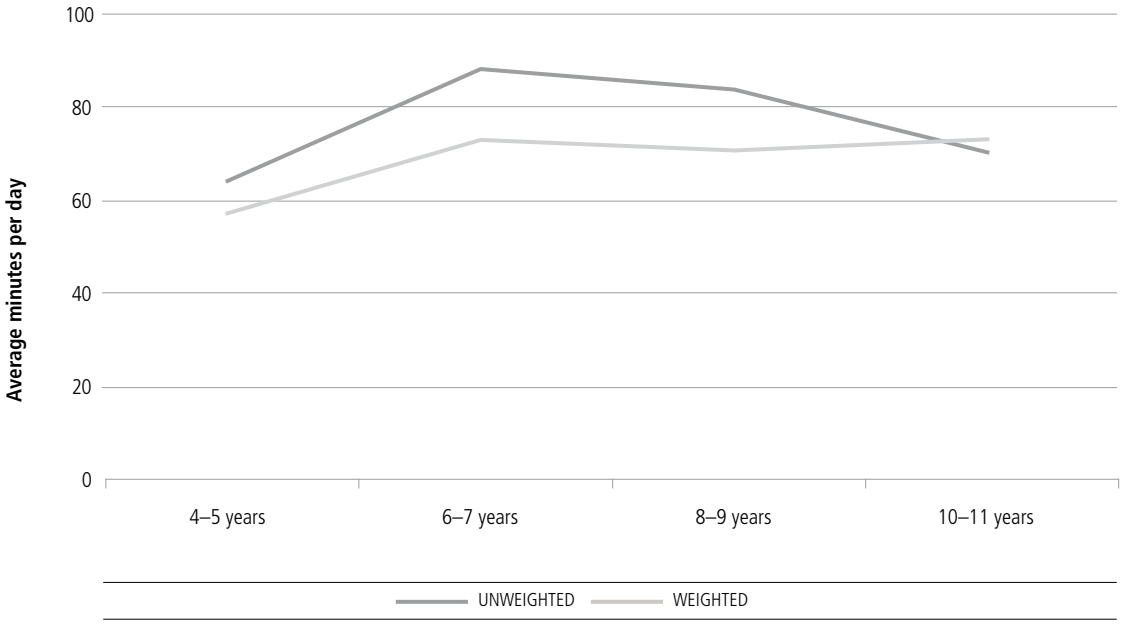


Source: LSAC K cohort: Waves 1 to 4.

Figure 3 shows unweighted and weighted estimates of children's average time in unorganised physical activity. For children aged 4 to 5 years, 6 to 7 years and 8 to 9 years, the weighted estimate of average unorganised physical activity is less than the unweighted estimate. The day weight is therefore correcting for the over-representation of weekend days (where children average more time in this activity) across the first three waves of the study. Weighting has much less impact on estimates of the average time spent in this activity by children aged 10 to 11 years, though the weighted estimate (which corrects for the under-representation of weekend days) is slightly higher.

Weighting also impacts on patterns over time. Both estimates show an increase between 4 to 5 years and 6 to 7 years. Between 6 to 7 years and 8 to 9 years, there is a slight decrease in the unweighted estimates, while the weighted estimates remain comparatively stable. There is a decrease in the unweighted estimates between 8 to 9 years and 10 to 11 years, but the weighted estimates remains similar.

Figure 3: Average unweighted and day-weighted minutes in unorganised physical activity: children aged 4 to 5 years to children aged 10 to 11 years



Source: LSAC K cohort: Waves 1 to 4.

For certain research purposes, the use of day weights may not overcome the extremely small number of Saturdays in Wave 4 relative to previous waves or to their occurrence in the week. This will not concern all analyses, but it is feasible that some analyses will need to address this, and the sensitivity of any analysis to this limitation should be considered. Another issue that day weights do not address is the use of weekly estimates of time use. The first three waves of the LSAC time diary component allowed for the creation of an estimate of weekly time use, which is not possible (at least in a straightforward fashion) with the fourth and future waves. There is potentially some scope for imputation to play a role here, and future research could explore this option.

3.3 Different days of the week across waves

This section explores the potential impact on time use patterns over time of diaries being completed on different days of the week. The design of the LSAC time diary component randomly allocated days of the week to respondents, and there was no stipulation that respondents complete the diary on the same day of the week across waves. Therefore, differences in time use between waves could arise because the time diaries were completed on different days. This may be especially problematic for leisure activities that are scheduled on certain days over the period where time use data is collected. For example, organised activities such as sport or dance class typically take place on a particular day of the week. This issue could also extend to special events or trips that take place on particular days in the week. Therefore, this section will focus on different aspects of children's leisure time. Specifically, the analysis focuses on children's time in organised activities, unorganised physical activity, watching TV, reading and non-home leisure activities such as cinema or sporting events (see Chapter 2 for details of the coding of these activities across waves). Taken together, these provide a broad range of different leisure activities, including those that are organised and unorganised, as well as leisure in the home and leisure outside the home.

To clearly illustrate the issue, this description focuses on changes between a number of two-wave periods: Wave pairs 1 and 2 and 2 and 3 for the B cohort, and Wave pairs 1 and 2, 2 and 3, and 3 and 4 for K cohort children. Therefore, this descriptive analysis is restricted to children with diary data at both time points for each of these pairs of observations. In addition, we exclude children with either two weekday observations or two weekend observations at any particular wave (B cohort: n=76; K cohort: n=96).

Table 12 shows the proportion of B and K cohort children with a different or same diary day across two waves for weekdays and weekend days. Across all two-wave pairs and for B and K cohort children, about one-fifth of weekday diaries are completed on the same day and four-fifths completed on a different day. The proportion of children with weekday diaries completed on the same day varies a little, ranging from 19.6 per cent for K cohort children in Waves 3 and 4 to 22.6 per cent for B cohort children in Waves 2 and 3. Despite this limited variation, these results strongly suggest that the distribution of weekdays within children (that is, across waves) is random. The results for weekend days suggest that the chance that a child has two weekend observations equals the chance that they have two different weekend days. Again, this indicates that the distribution of weekend days within children is random.

Table 12: Proportion of children with a different or same diary day of week across two waves: B and K cohort Waves 1 to 2 and Waves 2 to 3, and K cohort Waves 3 to 4

			Different diary day (%)	Same diary day (%)	Total (%)	N (%)
B cohort	Weekday	Wave 1–2	78.7	21.3	100.0	2,915
		Wave 2–3	77.4	22.6	100.0	2,578
	Weekend day	Wave 1–2	48.9	51.1	100.0	2,864
		Wave 2–3	50.1	49.9	100.0	2,562
K cohort	Weekday	Wave 1–2	78.8	21.2	100.0	2,842
		Wave 2–3	78.8	21.3	100.0	2,612
		Wave 3–4	80.4	19.6	100.0	2,121
	Weekend day	Wave 1–2	49.1	50.9	100.0	2,786
		Wave 2–3	48.9	51.1	100.0	2,595
		Wave 3–4	51.2	48.8	100.0	553

Source: LSAC B cohort: Waves 1 to 3; K cohort: Waves 1 to 4.

To consider whether completing the diary on the same day across waves—or not doing so—has any bearing on children's time spent in leisure activities over two waves, a series of simple regression analyses were conducted. A total of 50 separate regression analyses were conducted, and the results from all models are reported in Appendix A. These regressions included a variable indicating the second wave, a variable indicating whether or not the diary days were the same at both time points, and an interaction between these two variables to capture differences in the change across the two time points for those who completed a diary on the same day compared with those who did not. Controls for maternal employment, education, resident status with child's other parent and child gender were also added. We estimated models for weekdays and weekend days separately to focus completely on the issue of the specific day of the week.

In the vast majority of cases, there were no significant effects relating to whether the diary was completed on the same day or not, and no significant interactions between this and the wave. Though there were a couple of significant results, there was no consistent pattern. Note that the occurrence of statistically significant ($p < 0.05$) findings arising purely by chance is likely to be heightened due to the volume of models estimated here.

This section considered the potential impact on longitudinal comparisons of children's time use arising from completing the diaries on different days of the week at different points in time. Looking at the distribution of days of the week across waves, there was no evidence to suggest that respondents were 'sticking to' a particular day of the week, which is consistent with a design that randomly allocated days of the week to respondents. In fact, the proportion who completed a diary on the same day over two waves approximated the proportion that would arise if selection was random on both occasions. Moreover, nor was completing a diary on the same day significantly associated with a broad range of respondent characteristics. In the vast majority of instances considered here, completing the diary on the same day did not have a significant bearing on estimates of children's leisure activities, compared with respondents who completed the diary on a different day.

3.4 School days and non-school days

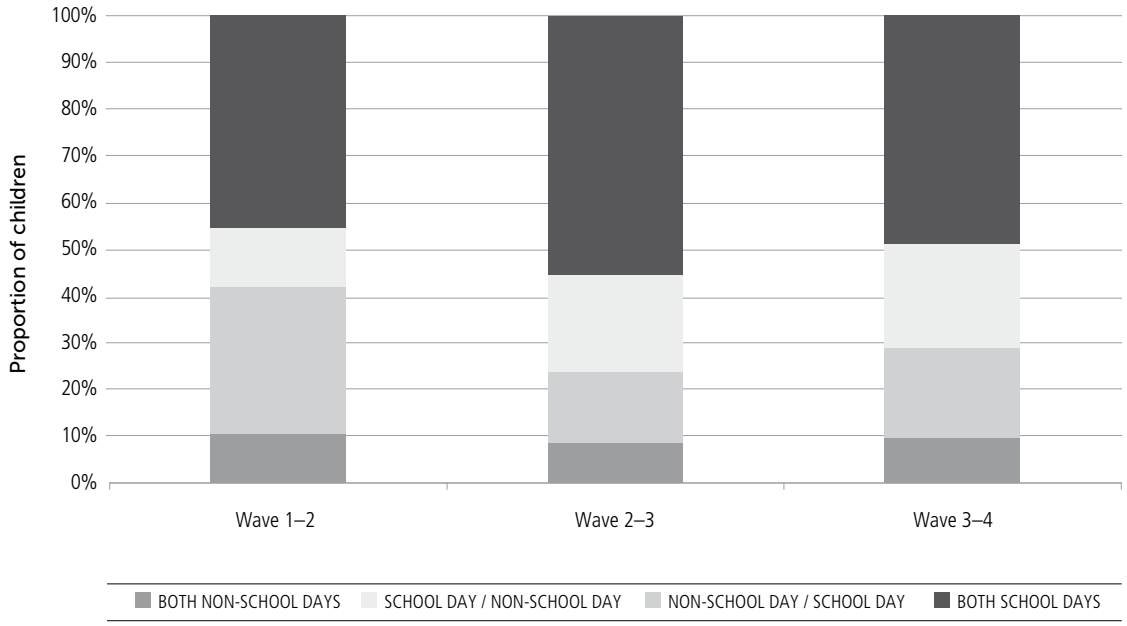
Another important feature of the sampled day relates to whether it is a school day or not. This is important for longitudinal research because it might change across waves, which could lead to misleading findings if not properly considered. More specifically, there is a risk of conflating changes in the time children spend in activities with differences in participation in school on the diary days across waves. This issue is not restricted to school, but it is most bluntly demonstrated with reference to school.

Again, to simply illustrate the issue, this description focuses on changes between three two-wave periods: Waves 1 to 2, 2 to 3 and 3 to 4 for K cohort children. Also, as the interest here is in preschool, school or care, we restrict attention to weekdays. We place K cohort children into one of four groups based on whether or not they were at school on a weekday at either of the two time points. Therefore, we have the following four groups of children: (1) not at school at either wave, (2) at school at the first wave but not at the second, (3) at school at the second wave but not at the first, and (4) at school at both waves. Figure 4 shows the proportion of children in different school and non-school configurations between Waves 1 and 2, 2 and 3, and 3 and 4.

According to diaries at Waves 1 and 2, 11 per cent of children were not at preschool or school, non-parental care on any day across both waves. A further 45 per cent were not reported in school or non-parental care when aged 4 to 5 years but were reported in school or non-parental care when aged 6 to 7 years. The reverse of this latter pattern holds for 12 per cent of children, while the remaining 32 per cent of children were in school or non-parental care across both time points. This means that around three-quarters of children aged 6 to 7 years were reported as being in school or non-parental care in their time diary. This echoes the results shown in the previous section highlighting an increase in the average time in school or non-parental care over the same period. If we look at patterns between Waves 2 and 3, a smaller

proportion of children are not in school or non-parental care (9 per cent) and a larger proportion are in school or non-parental care across both waves (55 per cent). Around one-third are either in school at Wave 3, having not been at Wave 2, or vice versa. Similar patterns hold looking at Waves 3 and 4.

Figure 4: Proportion of children in different school and non-school configurations: Waves 1 to 2, 2 to 3, and 3 to 4

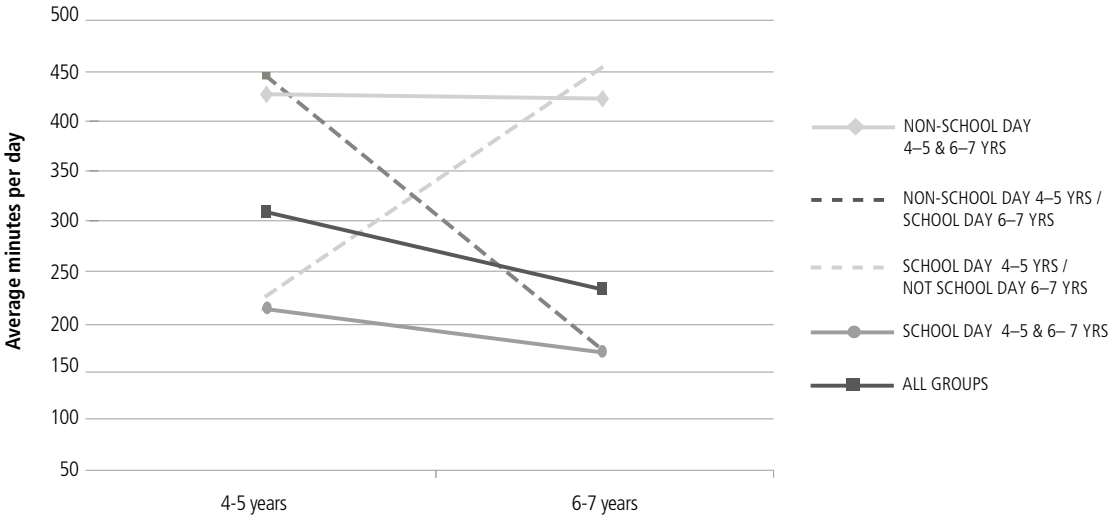


Source: LSAC K cohort: Waves 1 to 4.

Obviously, patterns in children's time in school across waves are directly governed by differences in school attendance on the diary day at each wave and this should be borne in mind when considering children's time in school across waves. It is important also, however, to be mindful of the impact this can have on other aspects of children's time use. To briefly explore this, Figure 5 shows the average time spent in all leisure activities (outside school) at Wave 1 (4 to 5 years) and Wave 2 (6 to 7 years) for children in different school and non-school configurations.

Across all children, there is a decrease in total leisure of around 80 minutes, which closely mirrors the increase in time at school or non-parental care. However, it is clear that this pattern is not typical and that there are very stark differences in leisure across these two time points for children with different school and non-school configurations. For example, leisure time is relatively stable across both time points for children who were not at school or in care on the diary day at Wave 1 (age 4 to 5 years) and Wave 2 (age 6 to 7 years). In contrast, there is a modest downward slope in leisure time for children who were in school or care on both diary days. Finally, there are striking differences in leisure time for children who spent one or other of the diary days in school or non-parental care.

Figure 5: Average time in leisure for children in different school and non-school configurations at Wave 1 (4 to 5 years) and Wave 2 (6 to 7 years)



Source: LSAC K cohort: Waves 1 to 2.

This section sought to highlight the importance of considering whether or not the child attended school or non-parental care on the diary day when comparing estimates of children's time use in various activities over time. There are clear differences in the intercepts (the average at the initial time point) between children in school or care and children not in school or care. Additionally, there are some differences in the slopes (changes between time points). This is most dramatic for children who are observed at school or care only at the first time point or the second. To some extent, these opposing groups will cancel each other out when averaged over all children, but researchers should be mindful of differences in the relative size of these groups. There are some modest differences in the slopes between children who were at school for both days and those not at school for either day.

It is clear that the structure of a child's day with respect to attending school or non-parental care impacts on changes over time in various activities. Researchers should consider whether this impact is trivial and a nuisance only or something more substantively important. Either way, when conducting analysis of change over time, it is worth explicitly addressing this issue.

4 Non-response to the LSAC time diary component

4.1 Introduction

In this section, we consider non-response to the LSAC time diary component. As this study is a component of LSAC, we refer to non-response as 'component non-response'. Previous reports have indicated levels of component non-response to the LSAC time diary exceed non-response to LSAC overall (Baxter 2007). A theoretical framework set out by Rubin (1976) can be applied to understand problems associated with missing data arising from non-response. This section briefly outlines the general features of this theory and provides some background to factors associated with missing data in the LSAC time diary component.

Rubin proposed that a missing data indicator (or indicators) is a random variable (or variables) and classified missing data based on the relationship of this variable to observed data on other variables and the unobserved values of the variable with missing data. Enders (2011) outlines the three major classifications of missing data arising from this theoretical foundation. Missing data are classified as missing not at random (MNAR) if they are related to both observed data for other variables even after controlling for other variables. Missing data are classified missing at random (MAR) if they are related to observed data for other variables only. Lastly, missing data are classified as missing completely at random (MCAR) if they were unrelated to both observed data for other variables and the unobserved values of the variable with missing data.

Previous research highlights that component and item non-response in the LSAC time diary component are not MCAR. Baxter (2007) considered factors related to component response and found that primary carers with higher levels of education were significantly more likely to complete and mail back the time diaries. In addition, primary parents who were employed full time or who did not live with the study child's other parent were less likely to complete the time diary component. Baxter and Smart (2010) analysed component non-response to the time diary component, pooling observations in the B and K cohorts across Waves 1 to 3, and found similar patterns with respect to parental education, employment and partner status. Moreover, they found that increasing numbers of older siblings were negatively associated with completion of the time diary.

Explanations for some of these results can be found in previous work on unit non-response more generally. Research has shown that respondents with a more positive attitude to the topic of a study are more likely to respond (Groves 2006). With respect to the LSAC time diary component, more educated parents may be more predisposed to complete the time diary because they have a stronger appreciation of the merits of doing so. It is important to bear in mind, however, that many of those who did not respond to the time diary component did respond to the main component of the study. Therefore, this issue pertains to variation in the relative engagement of respondents to all aspects of LSAC.

Another issue highlighted in previous work with time diary data is the extent to which individuals are too busy, or do not have the time, to complete the time diary (Abraham, Maitland & Bianchi 2006; Gershuny 2000; Robinson 1999). This is a potentially serious issue in that 'busyness' is directly related to time use, which implies that missingness is related to the substantive content of the study (that is, that missingness is related to the missing data). Studies have shown, though, that this is not a factor associated with unit non-response in time diary studies (Abraham, Maitland & Bianchi 2006; Gershuny 2000; Robinson 1999). However, the results outlined above show that factors closely associated with 'busyness' for parents (being in full-time paid employment, increasing numbers of children in the family, not living with the child's other parent) are significantly associated with time diary component non-response in LSAC.

It is possible that these factors interact with the mode of data collection. During the first three waves of LSAC data collection, the light time diary was left with the respondent (primary carer), who was requested to complete it for the prescribed days and return it by post. Non-response to mail-back surveys (of

which this can be counted) tends to be higher than for face-to-face interviewing (Bethlehem, Cobben & Schouten 2011). At Wave 4, however, children aged 10 to 11 years received a light diary to complete before their scheduled LSAC interview. As part of the main LSAC interview, the interviewer then reviewed and edited or completed the time diary as required. As will be highlighted below, the response rate at Wave 4 improved significantly, which is likely related to the change in mode of data collection, in terms of both collecting data directly from children and collecting data via a face-to-face interview.

If we know that missing data arising from component non-response is related to other observed covariates, the question then shifts to whether missingness is related to the unobserved time use of the non-respondents. If missingness is unrelated to unobserved values of the variable with missing data, then it is said to be MAR. With longitudinal data, this includes prior values of the variable with missing data. However, in cases with intermittent missing data (that is, missing data not attributed to drop-out or attrition), we cannot adequately assess the impact of prior values when these may themselves be missing (Rabe-Hesketh & Skrondal 2012). We will show below that there is intermittent missing data in the LSAC time diary component. If missingness is related to unobserved values of the variable with missing data, then missingness must be viewed as MNAR.

It is impossible to test whether the MAR assumption is valid, as the values of the missing data are unknown. Missingness tends to be MNAR in clinical studies of depression or substance abuse, where drop-out or intermittent observations are more likely to be strongly related to the outcome variables (Hedeker & Gibbons 1997; Enders 2011). Selection models and pattern mixture models are suggested approaches for dealing with missing data that are MNAR (Little 2008). Some have cautioned, however, against the routine use of these approaches, as they rest on equally untestable assumptions and may not be appropriate for many social science applications. Schafer and Graham (2002, p. 173) argue that in many social science applications 'the true cause [of missingness] is not the response but an unmeasured variable that is only moderately correlated with the response'. They do suggest, however, that these approaches could be used as part of a sensitivity analysis.

The two leading approaches to treating missing data are: (1) maximum likelihood (ML), and (2) multiple imputation (MI) (Schafer & Graham 2002). Both approaches assume that the missing data are MAR and observed correlates of missing data can be incorporated into these approaches, thereby improving the chance that the MAR assumption is valid (Enders 2010). Both are viewed as superior to traditional approaches such as listwise deletion of cases with any missing data (Enders 2010; Schafer & Graham 2002). A detailed exposition of these approaches is beyond the scope of this report. Below, first we describe patterns of component non-response across waves of the B and K cohorts. Then, to understand more about the potential impact of listwise deletion, we compare results from ML models using all valid responses (unbalanced models) with results from models restricted to cases with time diaries at all waves (balanced models) and argue that the former are preferable to the latter.

4.2 Component non-response patterns across LSAC waves

This section examines patterns of component non-response across each wave of LSAC for the B and K cohorts.[4] As the time diary study is a component of LSAC, we refer to non-response to the time diary as component non-response. Therefore, non-response to the time diary component arising from attrition from LSAC is not considered here. Table 13 describes the component non-response pattern across Waves 1 to 3 in the B cohort, and Table 14 provides similar data for Waves 1 to 4 of the K cohort.

Just under half of all B cohort Wave 1 respondents provided time diaries at all three waves, and 13 per cent provided none. A further 13 per cent responded to the time diary component at Wave 1 only, and a similar proportion provided diaries for Waves 1 and 2. The remaining cases are distributed relatively evenly across other response combinations, with most (8 per cent) not responding at Wave 1 but providing responses for Waves 2 and/or 3. The wave-specific response rates are reported in the last data row of Table 10. These are comparatively strong for Waves 1 and 2 but drop somewhat at Wave 3. However, the decrease in the actual number of diaries is broadly constant across waves.

Table 13: Component non-response patterns for the time diary component of LSAC: B cohort

	Wave 1	Wave 2	Wave 3	n	%	Cum. %
1	■	■	■	2,491	48.8	48.8
2				671	13.1	61.9
3	■			664	13.0	74.9
4	■	■		653	12.8	87.7
5	■		■	217	4.2	92.0
6		■	■	186	3.6	95.6
7		■		162	3.2	98.8
8			■	63	1.2	100.0
All TUD *n*	4,025	3,492	2,957	5,107	100.0	–
LSAC *n*	5,107	4,606	4,386	–	–	–
TUD response	78.8	75.8	67.4	–	–	–

Notes: Dark shading indicates response. TUD=time use diary.

Source: LSAC B cohort: Waves 1 to 3.

Table 14 shows response patterns for the K cohort. The proportion of K cohort respondents providing diaries across all four waves is slightly lower (46 per cent), though the proportion providing no diaries across all four waves is substantially lower (7 per cent). This is largely because of the relatively high response rate for Wave 4. Note that the proportion of cases with only a Wave 4 diary is 6 per cent. If we considered responses across Waves 1 to 3 only, the pattern of complete non-response would be very similar. For example, 12 per cent provided a response at Wave 1 but not Waves 2 and 3, and approximately the same proportion provided a response at Waves 1 and 2 but not Wave 3.

The picture for the K cohort shows that the patterns of component non-response became considerably more diffuse with the addition of Wave 4. We can reasonably assume that similar patterns will arise in the B cohort with the addition of further waves of time diaries when they move on to the self-complete diary accompanied by interviewer in-home follow-up, as the K cohort has in Waves 4 and 5. As with the B cohort, response declined substantially in Wave 3 (67 per cent). However, it rose dramatically at Wave 4 (94 per cent).

There is a lot of variation in response patterns to the LSAC time diary component. Analyses focusing only on complete or balanced responses would therefore throw away a substantial amount of usable data and risk seriously biasing results. In contrast, a relatively small group of respondents provide no time diary data. As noted, this is smaller in the K cohort due to the increase in responses at Wave 4. In the next section, we compare the results from balanced and unbalanced ML regression analyses and highlight the risks posed by the former.

Table 14: Component non-response patterns for the time diary component of LSAC: K cohort

	Wave 1	Wave 2	Wave 3	Wave 4	n	%	Cum. %
1	■	■	■	■	2,309	46.3	46.3
2	■	■		■	446	9.0	55.2
3					353	7.1	62.3
4	■			■	314	6.3	68.7
5				■	313	6.3	75.0
6	■				284	5.7	80.7
7	■	■	■		189	3.8	84.4
8		■	■	■	185	3.7	88.2
9	■		■	■	153	3.1	91.2
10	■	■			141	2.8	94.1
11		■		■	130	2.6	96.7
12			■	■	57	1.1	97.8
13		■			35	0.7	98.5
14	■		■		29	0.6	99.1
15		■	■		27	0.5	99.6
16			■		18	0.4	100.0
All TUD n	3,865	3,462	2,967	3,907	4,983	100.0	–
LSAC n	4,983	4,464	4,431	4,169	–	–	–
TUD response %	77.6	77.6	67.0	93.7	–	–	–

Notes: Dark shading indicates response. TUD=time use diary.

Source: LSAC K cohort: Waves 1 to 4.

4.3 Random intercept maximum likelihood estimation

In this section, we compare results from a series of random intercept maximum likelihood (ML) regressions on a range of time use activities using a balanced sample (complete responses) and an unbalanced sample (all valid responses). We conduct regressions on time spent sleeping, watching TV, reading and travelling. Though clearly not an exhaustive list of activities, it serves to highlight the issue. In all models, we control for the following factors shown in previous work to be associated with component non-response:

- parent education (No degree=0[reference]; degree=1)
- parent employment (Not in paid work=0[reference]; in paid work=1)
- partner status (Living with study child's other parent=0[reference]; not living with study child's other parent=1)
- number of siblings.

We also control for child gender (boy=0[reference]; girl=1) and day type (not at school/non-parental care=0[reference]; school/care day=1). The models capture change over time with individual dummy variables for all cases after Wave 1 (the reference wave). For simplicity, we use only one observation from each wave and restrict the analysis to weekdays. A number of options for estimation are available (mixed effects; random effects; structural equation modelling) and all yield very similar results. We report the results from maximum likelihood random intercept regressions (estimated using xtreg with the MLE option in STATA 12.1) in Table 13 for the B cohort and Table 14 for the K cohort.

In the B cohort results (Table 13), mostly the variables indicating changes over time are statistically significant and of a similar magnitude in both the balanced and unbalanced regressions. One exception relates to reading, where the balanced model suggests that the reading of children aged 4 to 5 years is not significantly different from the reading of children aged 0 to 1 years, but the unbalanced model reveals a statistically significant finding. It is important to note, however, that the confidence intervals for these coefficients overlap strongly, implying that the difference in the coefficients is not statistically significant. Therefore, the lack of significance in the balanced model may partly be a result of a loss of efficiency resulting from the lower sample size. It is important to note that a substantively different conclusion would be drawn from the balanced model compared with the unbalanced model.

There are more apparent differences according to whether balanced or unbalanced samples were used in the models for K cohort children (see Table 14). These regressions include observations from Wave 4 and thus greatly increase the number of cases in the unbalanced models relative to the balanced models. As a fourth time diary will be added to the B cohort in Wave 5, these results provide some indication of the future impact of non-response on longitudinal analysis with B cohort data.

Results indicating change over time (that is, as children age) are very similar for the balanced and unbalanced models up to 8 to 9 years. However, they diverge somewhat when comparing children aged 10 to 11 years to children aged 4 to 5 years. This is not surprising, as the balanced models restrict the Wave 4 responses to those with responses in prior waves. The difference is most noticeable in the models for sleeping and watching TV. Though the results are statistically significant in all models (that is, the substantive findings are equivalent), the balanced model tends to overstate the difference in sleep time and understate the difference in time spent watching TV. The confidence intervals for these estimates overlap, so the differences are not statistically different.

There are also some substantive differences in the results for other covariates in the model. Parental employment is a significant factor in the unbalanced models for TV and travel but not in the balanced models for these activities. In addition, the covariate indicating whether the parent lives with the study child's other parent is significant in the unbalanced models for reading and travel but not in the balanced models. Previous research has found these factors to be significant predictors of component non-response. Confidence intervals for these estimates overlap across balanced and unbalanced models, suggesting that the differences in the magnitude of the coefficients are not statistically significant and that the differences arise due to an efficiency loss in the balanced models. However, these results show that the substantive conclusions drawn from a balanced model could be different to those drawn from an unbalanced model and that research should be sensitive to this.

Component non-response is not a trivial matter, but it is not an insurmountable obstacle either. This brief analysis serves to highlight differences between using balanced and unbalanced samples in the analysis of change over time in children's time use. State-of-the-art advice on missing data is unequivocal about the dangers of a balanced design (Enders 2010; Schafer & Graham 2002). Using unbalanced data with maximum likelihood is considered a best practice approach to treating missing data (Schafer & Graham 2002). The results shown here highlight the relative strengths of an unbalanced approach in the presence of data that are MAR.

Table 15: Coefficients from balanced and unbalanced maximum likelihood random intercept models on B cohort children's time (minutes per day) in sleep, TV, reading and travel

	Sleep		TV		Reading		Travel	
	B	UB	B	UB	B	UB	B	UB
2–3 years	–64.8***	–61.2***	58.1***	57.4***	–5.1***	–2.9***	–38.0***	–36.8***
	[–70.3, –59.4]	[–65.8, –56.5]	[55.0, 61.2]	[54.8, 60.0]	[–7.1, –3.0]	[–4.5, –1.2]	[–41.8, –34.3]	[–40.0, –33.6]
4–5 years	–89.8***	–85.9***	71.6***	70.1***	1	3.5***	–40.8***	–38.7***
	[–95.9, –83.7]	[–91.3, –80.4]	[68.1, 75.1]	[67.1, 73.2]	[–1.3, 3.2]	[1.6, 5.4]	[–45.0, –36.7]	[–42.3, –35.1]
Girl	4.1	3.7	–1.6	–0.7	0.1	0.2	–2.1	–1.4
	[–1.1, 9.3]	[–0.8, 8.3]	[–4.7, 1.5]	[–3.3, 1.8]	[–1.7, 1.8]	[–1.3, 1.6]	[–5.3, 1.1]	[–4.1, 1.4]
Parent 1: degree	–4.8	–4.9*	–13.6***	–12.0***	8.2***	8.1***	2.5	3.7*
	[–10.1, 0.5]	[–9.7, –0.2]	[–16.8, –10.4]	[–14.7, –9.4]	[6.4, 10.0]	[6.6, 9.7]	[–0.8, 5.8]	[0.8, 6.6]
Parent 1: employed	0.4	–1.8	–8.4***	–8.5***	–0.3	0	3.4*	4.3**
	[–4.7, 5.5]	[–6.2, 2.6]	[–11.4, –5.4]	[–11.0, –6.1]	[–2.1, 1.5]	[–1.5, 1.4]	[0.1, 6.7]	[1.5, 7.1]
Study child has parent living elsewhere	–12.1*	–9.2*	0.5	1.5	–0.9	–2.2	1.3	2
	[–22.3, –1.9]	[–17.1, –1.3]	[–5.6, 6.6]	[–2.9, 6.0]	[–4.5, 2.7]	[–4.8, 0.5]	[–5.3, 7.8]	[–3.0, 7.0]
Number of siblings	–4.4**	–3.9**	–1.7	–2.1**	–1.7**	–2.2***	4.7***	3.9***
	[–7.4, –1.3]	[–6.5, –1.4]	[–3.6, 0.1]	[–3.6, –0.7]	[–2.7, –0.6]	[–3.1, –1.4]	[2.7, 6.6]	[2.3, 5.5]
School day	–39.2***	–47.1***	–39.8***	–38.6***	–10.8***	–10.6***	–9.4***	–7.5***
	[–44.6, –33.7]	[–52.0, –42.1]	[–43.0, –36.7]	[–41.4, –35.9]	[–12.7, –8.8]	[–12.3, –8.9]	[–13.0, –5.8]	[–10.8, –4.3]
Intercept	783.5***	784.6***	42.6***	42.4***	25.8***	24.2***	87.9***	83.4***
	[776.9, 790.1]	[779.0, 790.1]	[38.6, 46.5]	[39.3, 45.6]	[23.5, 28.2]	[22.4, 26.0]	[83.7, 92.1]	[79.9, 86.9]
Number of observations	7,128	10,235	7,128	10,235	7,128	10,235	7,128	10,235

Notes: B=Balanced; UB=Unbalanced; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Source: LSAC B cohort: Waves 1 to 3.

Table 16: Coefficients from maximum likelihood random intercept models on K cohort children's time (minutes per day) in sleep, TV, reading and travel

	Sleep		TV		Reading		Travel	
	B	UB	B	UB	B	UB	B	UB
6–7 years	–10.7***	–7.9***	–12.8***	–14.8***	–2.5*	–2.8***	–9.0***	–9.3***
	[–15.3, –6.2]	[–11.4, –4.5]	[–17.4, –8.2]	[–18.1, –11.5]	[–4.4, –0.6]	[–4.2, –1.4]	[–12.4, –5.6]	[–11.8, –6.8]
8–9 years	–25.0***	–24.3***	–7.0**	–7.3***	–4.6***	–4.7***	–5.8***	–7.3***
	[–29.6, –20.4]	[–28.0, –20.7]	[–11.6, –2.4]	[–10.7, –3.9]	[–6.6, –2.7]	[–6.1, –3.2]	[–9.2, –2.4]	[–9.9, –4.8]
10–11 years	–30.3***	–25.4***	16.6***	19.9***	–4.5***	–5.2***	–4.4*	–4.4***
	[–34.8, –25.7]	[–29.0, –21.8]	[12.0, 21.2]	[16.5, 23.3]	[–6.4, –2.6]	[–6.7, –3.8]	[–7.9, –1.0]	[–7.0, –1.9]
Girl	3.7	6.7***	–4.9*	–6.5***	1.6	2.2***	–1.5	0.2
	[–0.1, 7.6]	[3.8, 9.6]	[–9.0, –0.8]	[–9.5, –3.6]	[–0.1, 3.2]	[1.0, 3.4]	[–4.3, 1.3]	[–1.8, 2.3]
Parent 1: degree	–1.2	–1.3	–14.0***	–14.5***	7.9***	8.4***	0.3	1.8
	[–5.2, 2.7]	[–4.5, 1.8]	[–18.2, –9.7]	[–17.6, –11.3]	[6.2, 9.7]	[7.1, 9.7]	[–2.6, 3.1]	[–0.3, 4.0]
Parent 1: employed	0	–0.1	–1.2	–4.9**	–3.6***	–2.6***	0.7	3.8***
	[–4.2, 4.1]	[–3.3, 3.0]	[–5.5, 3.1]	[–7.9, –1.8]	[–5.4, –1.8]	[–3.9, –1.4]	[–2.4, 3.8]	[1.6, 6.0]
Study child has parent living elsewhere	–6.1	–3.4	7.5*	6.5**	–2.1	–4.1***	0.3	–5.0**
	[–12.3, 0.1]	[–7.7, 0.9]	[1.1, 13.9]	[2.3, 10.7]	[–4.8, 0.6]	[–5.8, –2.4]	[–4.3, 4.8]	[–8.0, –2.0]
Number of siblings	0.3	–1.2	1.3	1.5	–0.7	–1.0**	1	1
	[–2.0, 2.7]	[–2.9, 0.6]	[–1.2, 3.8]	[–0.2, 3.3]	[–1.7, 0.4]	[–1.8, –0.3]	[–0.7, 2.8]	[–0.2, 2.3]
School day	–12.7***	–13.6***	–63.8***	–60.1***	–7.5***	–7.6***	–10.5***	–10.9***
	[–16.3, –9.1]	[–16.4, –10.8]	[–67.5, –60.2]	[–62.8, –57.4]	[–9.0, –6.0]	[–8.7, –6.5]	[–13.2, –7.9]	[–12.9, –8.9]
Intercept	649.3***	648.2***	132.6***	133.3***	28.5***	27.8***	66.3***	63.0***
	[642.9, 655.6]	[643.4, 653.0]	[126.0, 139.3]	[128.6, 138.0]	[25.8, 31.2]	[25.9, 29.8]	[61.6, 71.0]	[59.7, 66.4]
Number of observations	6,936	13,125	6,936	13,125	6,936	13,125	6,936	13,125

Notes: B=Balanced; UB=Unbalanced; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Source: LSAC K cohort: Waves 1 to 4.

5 Conclusion

This report has considered three broad issues relevant for the longitudinal analysis of time use data available with LSAC. The first issue related to the harmonisation of activity variables across waves; the second issue dealt with differences in the structure of the diary day across waves; and the third issue addressed non-response to the time diary component of LSAC. The first and third issues are important for all types of longitudinal analysis—that is, longitudinal data analysis is premised on measures that are meaningfully comparable across time, and longitudinal data analysis must routinely address non-response. The second issue is more specific to time use data.

The second chapter of the report focused on harmonising activities across waves. The coding of most activities was very similar, if not identical, across waves, but there are a number of differences that researchers should note. To begin with, time spent in school or non-parental care for K cohort children aged 4 to 5 years is not explicitly coded. This report showed that time spent with other adults can be combined with time in daycare or playgroup to estimate time spent in school or non-parental care. With this approach, estimates of time spent in school or care for K cohort children aged 4 to 5 years were comparable with estimates for B cohort children aged 4 to 5 years for whom time in school was explicitly coded.

This report highlighted some changes with respect to walking and cycling. In Wave 4, walking and cycling for 'travel' were partitioned from walking or cycling for 'fun'. These were included in play, whereas in the previous waves these activities were coded as 'for travel or fun'. It was not possible to isolate walking or cycling for fun from other aspects of unorganised physical activity and so it was suggested that walking and cycling in previous waves be included in the measure of unorganised physical activity. The report also showed that, as children got older, a more nuanced coding framework was used to capture time in organised activities. Researchers wishing to analysis specific waves or subsets of waves may exploit this added detail, but researchers wishing to analyse children's time use over a broader time period will have to use a more general measure of time in organised activities.

The third chapter of the report examined three aspects of the diary day that may impact on longitudinal analyses. The first related to the distribution of weekdays and weekend days across waves. The report considered the impact of the change in the design at Wave 4, where a single diary was collected for a weekday or a weekend day rather than two diaries—one for a weekday and one for a weekend day—which was the cases across Waves 1 to 3. It highlighted the importance of using day weights to correct for this difference in the design and explored the potential of drawing samples from Waves 1 to 3 to reflect the distributions of weekdays and weekend days at Wave 4. With the latter approach, a day weight simply corrected for a straightforward under-representation of weekend days across all waves rather than also correcting for differences in the weekday–weekend day distribution across waves. Therefore, with the latter approach, analyses could control for day type explicitly in their models and dispense with the need for a day weight. This is potentially advantageous, as some methods for the analysis of longitudinal data do not allow for intrapersonal weights.

This section of the report also considered differences in estimates of change over time between respondents who completed diaries on the same day of the week and those who did not. There was no evidence that respondents had a preference for completing the time diary on the same day of the week across waves. Indeed, the occurrence of responses with the same diary day across discrete two-wave periods closely approximated the expected outcome from a random draw. There were some differences in children's time use associated with completing the diary on the same day compared with completing it on different days, but these were small and not consistently repeated both across and within cohorts.

Finally, this section of the report looked at the impact that differences in school or non-parental care attendance have on comparisons of children's time use across waves. This is not causal in any sense; rather,

it highlights the importance of considering variation in the structure of a child's day across waves. The report showed clearly that overall patterns across waves mask significant differences between children based on whether or not they attended school or non-parental care consistently across waves.

The fourth chapter of the report looked at non-response to the LSAC time diary component. Building on previous work, the report considered the implications of non-response for longitudinal analyses. In particular, the report highlighted the potential risks to inference arising from complete cases analysis (that is, listwise deletion of cases with any non-response) and highlighted the usefulness of maximum likelihood estimation on unbalanced data, assuming the data are missing at random (MAR). The report demonstrates that, although missing data is not trivial, it does not represent an insurmountable obstacle to longitudinal analyses of the time diary component of LSAC.

The time diary component of LSAC offers an unparalleled opportunity to understand more about children's time use patterns over time and how these relate to children's development more generally. Researchers seeking to use these data must confront several issues, which this report has described. The report is not prescriptive in making recommendations, as each analysis will have unique attributes. Rather, the report emphasises, in broad terms, some of the issues researchers conducting longitudinal analysis of LSAC time diary data will have to address.

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Appendix A

Table A1: Coefficients from random intercept models on B cohort children's time (minutes per day) in organised activities, unorganised physical activity, TV, reading, cinema, sporting events, etc.

	Weekday		Weekend	
	Wave 1 & 2	Wave 2 & 3	Wave 1 & 2	Wave 2 & 3
Number of observations	**5,830**	**5,156**	**5,728**	**5,124**
			Organised activities	
Wave 2	1.17	–	2.85***	–
Wave 3	–	7.58***	–	5.60***
Same day	1.05	–2.09	0.10	0.20
Wave* same day	–0.88	–0.70	0.07	–1.30
Intercept	4.08***	5.93***	1.29**	4.10***
			Unorganised physical activity	
Wave 2	25.98***	–	56.97***	–
Wave 3	–	–13.70***	–	3.40
Same day	–1.27	1.37	–0.43	–2.90
Wave* same day	–1.70	–4.39	–3.70	3.80
Intercept	49.38***	74.40***	56.26***	112.30***
			TV	
Wave 2	49.80***	–	56.82***	–
Wave 3	–	1.49	–	17.50***
Same day	2.16	0.06	3.04	1.00
Wave*same day	–2.85	–0.61	–2.78	5.20
Intercept	26.11***	75.69***	23.07***	78.00***
			Reading	
Wave 2	–7.23***	–	–8.60***	–
Wave 3	–	2.43**	–	5.50***
Same day	–3.86*	–0.16	–2.24	–0.30
Wave* same day	5.03*	1.18	1.99	1.30
Intercept	26.26***	19.21***	26.72***	18.30***
			Cinema, sporting event, etc.	
Wave 2	4.80***	–	24.39***	–
Wave 3	–	–4.82**	–	7.60*
Same day	2.75	–1.75	–0.32	–5.80
Wave* same day	–4.39	–0.18	–0.52	3.60
Intercept	20.81***	26.98***	28.42***	55.50***

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Source: LSAC B cohort: Waves 1 to 3.

Table A2: Coefficients from random intercept models on K cohort children's time (minutes per day) in organised activities, unorganised physical activity, TV, reading, cinema, sporting events, etc.

	Weekday			Weekend		
	Wave 1 & 2	Wave 2 & 3	Wave 3–4	Wave 1 & 2	Wave 2–3	Wave 3–4
Number of observations	**5,684**	**5,224**	**4,242**	**5,572**	**5,190**	**1,106**
			Organised activities			
Wave 2	–1.46	–	–	14.71***	–	–
Wave 3	–	9.51***	–	–	8.90***	–
Wave 4	–	–	4.59*	–	–	–5.59
Same day	0.49	–0.02	0.47	–0.33	–0.58	–4.51
Wave* same day	3.62	–0.62	0.94	1.55	0.80	1.90
Intercept	17.87***	17.13***	26.76***	10.37***	26.19***	38.36***
			Unorganised physical activity			
Wave 2	5.10**	–	–	46.57***	–	–
Wave 3	–	2.25	–	–	–13.17***	–
Wave 4	–	–	2.52	–	–	–18.48*
Same day	–0.87	3.22	–1.18	0.89	–7.65	1.08
Wave* same day	–1.34	1.32	9.44	–4.32	4.36	2.09
Intercept	45.45***	49.43***	52.92***	82.64***	129.52***	116.41***
			TV			
Wave 2	–25.40***	–	–	–5.41	–	–
Wave 3	–	7.98***	–	–	21.09***	–
Wave 4	–	–	28.28***	–	–	31.68***
Same day	0.98	–4.28	–0.90	–3.98	0.08	–8.17
Wave* same day	–6.97	5.20	–8.88	6.15	–6.82	–7.26
Intercept	91.13***	65.33***	74.37***	109.29***	105.15***	128.79***
			Reading			
Wave 2	–5.25***	–	–	–2.83*	–	–
Wave 3	–	–2.57**	–	–	–3.58**	–
Wave 4	–	–	–0.55	–	–	3.96
Same day	–0.27	–2.18	–0.38	0.44	–0.65	0.22
Wave* same day	2.52	1.38	2.63	–1.95	1.19	–1.56
Intercept	24.35***	20.64***	18.55***	24.81***	22.51***	17.63***
			Cinema, sporting event, etc.			
Wave 2	–7.05***	–	–	–0.76	–	–
Wave 3	–	3.35	–	–	8.52	–
Wave 4	–	–	–11.01***	–	–	–47.60***
Same day	–0.55	–0.16	–1.00	2.16	6.78	–20.29*
Wave* same day	0.16	1.03	0.57	4.67	–9.98	23.82*
Intercept	31.55***	25.22***	28.42***	82.69***	80.19***	94.34***

Notes: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Source: LSAC K cohort: Waves 1 to 4.

Endnotes

1 The findings and views contained in this report are those of the author and should not be attributed to DSS, AIFS or the ABS.

2 In this section, as the B cohort sample (aged 4 to 5 years) is from Wave 3, the K cohort Wave 1 sample (aged 4 to 5 years) is restricted to those who also responded at Wave 3 so as to minimise differences between cohorts arising from attrition.

3 Parents are mostly with children at playgroups, so omitting time with parents while reporting this location code most likely removes time in playgroup.

4 Respondents who returned a blank diary (with no activity information) are regarded as effective non-respondents.