

1 Comparison of the eating behaviour and dietary consumption in older
2 adults with and without visual impairment

3
4 Comparing the dietary consumption of older adults with and without VI
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6 Nabila Jones¹

7 Affiliations Ophthalmic Research Group, School of Life & Health Sciences, Aston University,
8 Birmingham, B4 7ET, UK¹

9 Correspondence; Corresponding author. Vision Sciences Department, Aston University, Aston
10 Triangle, Birmingham, B4 7ET, UK. Tel.: +44 0121 204 4135 Fax: +44 0121 204 4048.

11 n.jones5@aston.ac.uk
12

13 Hannah Elizabeth Bartlett¹

14 Affiliations Ophthalmic Research Group, School of Life & Health Sciences, Aston University,
15 Birmingham, B4 7ET, UK¹

16 h.e.bartlett@aston.ac.uk
17

18 **Key words**

19 Dietary consumption, Eating behaviours, Visual Impairment, Activities of Daily Living

20 **Abbreviations**

21 Black Asian Ethnic Minority (BAME)

22 BMI (Body Mass Index)

23 Do Not Drive (DND)

24 Sight Impaired (SI)

25 Severely Sight Impaired (SSI)

26 Royal National Institute for the Blind (RNIB)

27 United Kingdom (UK)

28 Visual Impairment (VI)
29
30
31

32 **Abstract**

33 Globally a high prevalence of obesity and under-nutrition has been reported in people with
34 visual impairment (VI), who have reported multifactorial obstacles that prevent them from
35 achieving a healthy diet, such as having restricted shopping and cooking abilities. This study
36 is the first to investigate the relationship between VI and dietary consumption using a
37 representative sample size, standardised methods to categorise VI, and a detailed analysis of
38 dietary consumption. Ninety-six participants with VI and an age-matched control group of 50
39 participants were recruited from across the UK. All participants were aged 50 years or over.
40 Participants completed a 24 hour food recall for a period of three days. Participants also
41 answered questions about their abilities to shop for and cook food as well as their knowledge
42 of healthy eating. Participants with VI in this sample consumed significantly fewer calories
43 and other nutrients than is recommended for their age group and when compared to an age-
44 matched control group. Participants with VI mainly made food choices irrespective of
45 nutritional value. The results of this study highlight for the first time, that a large proportion of
46 older adults with VI in the UK are undernourished. These results suggest local and government
47 led initiatives should be implemented to support the diets of older adults in the UK, these
48 initiatives could include healthy eating workshops, café clubs or skills training and
49 rehabilitation.

50

51 **Introduction**

52 Previous studies have reported that people with visual impairment (VI) do not consume enough
53 dairy products, meats and wholegrains ⁽¹⁾ and do not consider the nutritional value of food
54 before purchase ^(2,3). It has been reported that people with macular degeneration in the United
55 Kingdom (UK) do not consume the recommended daily amounts of nutrients for their age
56 group⁽³⁾. It has also been reported that those with ocular conditions such as macular
57 degeneration and glaucoma do not have nutritious diets and are unsure about what foods they
58 should consume to maintain optimal eye health ⁽³⁻¹³⁾. The cost of malnutrition in the UK is
59 £19.6 billion annually ⁽¹⁴⁾, with £16 billion being related to being overweight or obese ⁽¹⁴⁾. It is
60 reported that malnourished adults account for 30% of hospital admissions and 35% of care
61 home admissions in the UK ⁽¹⁴⁾.

62 Studies that have investigated the impact of VI on nutritional status have concluded that
63 interventions are required to improve the diets and dietary habits of people with VI ⁽¹⁵⁻¹⁷⁾. These

64 studies have suggested that the interventions could take the form of skills training ⁽¹⁵⁾,
65 development training packages for the young ⁽¹⁶⁾ or rehabilitation packages for the elderly ⁽¹⁷⁾.
66 It has been reported that nutritional interventions save the National Health Service 172.2-229.2
67 million pounds due to reduced health care use ⁽¹⁴⁾.

68 Systematic review of the literature demonstrates that VI significantly impacts on nutritional
69 status ⁽¹⁸⁾. Previous studies have used a variety of methods to assess nutritional status, such as
70 nutritional screening tools to assess whether a person is at risk of undernutrition ⁽¹⁹⁾, measuring
71 BMI (Body Mass Index) ⁽²⁰⁻²²⁾ and qualitative and quantitative analysis on the ability to acquire,
72 cook and eat food ^(2, 15-17, 23-26). Some of these studies did not use representative sample size ^{(1,}
73 ^{15, 16, 21, 24-27)} and some used non-standardised methods to categorise participants as visually
74 impaired ^(19, 20). Two studies conducted a dietary consumption assessment; one carried out a
75 gross categorisation assessment of foods eaten into meat products, wheats and grains ⁽¹⁾; the
76 other carried out a detailed analysis of dietary consumption but the dietary consumption
77 assessment was conducted for school children and was not done in the UK ⁽²⁰⁾.

78 This study is the first to investigate the impact of VI on nutritional status in older adults and
79 whether dietary consumption is affected by shopping and cooking abilities.

80

81 **Materials and Methods**

82 **Survey design**

83 Following a systematic review of the literature ⁽¹⁸⁾ a 37 question, cross-sectional questionnaire
84 was designed to evaluate the impact of VI on dietary consumption, vision related quality of
85 life and activities of daily living ⁽²⁸⁾. The questionnaire was piloted and validated prior to the
86 start of the study. Full details of the validation process and questionnaire design are reported
87 elsewhere ⁽²⁸⁾.

88 **Sample size**

89 Using previously reported nutritional analysis data ⁽³⁾, sample sizes were calculated for
90 individual nutrients. The effect sizes chosen for each nutrient were based on published mean
91 and standard deviation data ⁽³⁾. The minimum sample size (*n*) required for a two tailed t-test
92 at an alpha error level of 0.05 and a power (1-β) of 80% was calculated (see Table 1).

Nutrients	unit	Mean	Difference to Detect (DD)	Standard deviation (SD)	Effect size (Cohens d) ES=(DD/SD)	Sample size for each group; (n) (two tailed test, power (1-β) 80%, α error level of 0.05) (16/(ES)²)
Calories	kcal	2074	687	±870	0.8	27
Carbohydrates	g	257	82	±86	0.95	19
Of which Sugars	g	62	14	±27.8	0.5	63
Protein	g	82	27.2	±28.8	0.94	19
Fat	g	82.3	18	±46	0.39	105
Saturated Fat	g	30.5	3.6	±18	0.25	394
Fibre	g	22.4	5.8	±6.2	0.94	31
Cholesterol	g	407	148	±348	0.42	88
Vitamin C	mg	82.2	25	±73	0.35	136
Vitamin D	IU	143	32	±153.8	0.20	364
Vitamin E	mg	6	1	±3.6	0.27	205
Calcium	mg	980	306	±496	0.61	43
Iron	mg	20.4	5.1	±8.8	0.57	48

94

95 *Mean Values for effect size calculations taken from STEVENS R., B. H., and COOKE R.
 96 2015. Dietary Analysis and nutritional behaviour in people with and without age-related
 97 Macular disease. *Clinical Nutrition*, Vol. 10 p. e112–e117

98

99 In total, 146 participants were recruited for this study. Ninety-six participants were recruited
 100 for the VI group and 50 participants for the control group.

101 For fats, saturated fats, cholesterol, vitamins C, D and E the sample size required to detect the
 102 desired effect sizes was large. This study was therefore underpowered for these nutrients at

103 powers (1- β) 0.6, 0.3, 0.6, 0.5, 0.2, and 0.4 respectively. It would have been time consuming
104 and impractical to collect data for these nutrients in order to detect the desired effect sizes.

105

106 **Inclusion and exclusion criteria**

107 For both the VI and the control participants, exclusion criteria were dietary restrictions
108 relating to conditions such as coeliac disease, inability to communicate in English, or
109 inability to hear well over the telephone.

110 Following the criteria for the certification of visual impairment (CVI), proposed by the Royal
111 National Institute for the Blind (RNIB) participants were categorised:

- 112 • Registered severely sight impaired (SSI) or sight impaired (SI)
- 113 • Eligible for SSI or SI registration but not actually registered
- 114 • Not eligible for SSI or SI registration, but experiencing a level of VI that precludes
115 driving. Or in other words, a reduction in vision that significantly impairs day to day
116 activities (RNIB, 2016b)

117 For the control group, participants were aged 50 years or over, and had to demonstrate
118 binocular visual acuity of at least better than 6/9.5; i.e. a visual acuity that would meet the level
119 of sight required to be able to drive legally.

120 **Participant recruitment and setting**

121 In all, 109 participants with VI were recruited from across the United Kingdom from October
122 2017 to July 2018. Advertisements were placed with the Macular Society, the Royal National
123 Institute for the Blind (RNIB), and Visionary a membership organisation for VI charities.
124 Participants were also recruited by being directly approached by the researcher at Focus and
125 Aston, low vision clinics in Birmingham. They were also approached by the researcher at Sight
126 Concern, a support group for those with VI in Worcestershire, New Outlook, a sheltered
127 accommodation in Birmingham, designed specifically for people with VI and at local macular
128 society support groups.

129 Participants responded to the advertisements in the Macular Society Sideview magazine. In all
130 written information the Macular Society use at least a size 16 font. They also produce
131 'accessible' versions of their publications in PDF form, which can be read aloud by screen
132 readers. There are other types of text processing and screen readers available as apps as well,

133 which people may use a mixture of. Additionally the Macular Society offer the option for
134 people to receive audio versions of publications – they provide this as a CD for their Sideview
135 magazine and their leaflets are available on their website as mp3 files. The study was also
136 advertised through RNIB Connect (radio) whereby participants provided their contact details
137 to the researcher via email and telephone. The researcher then called the participants and read
138 out the participant information sheet and arranged a convenient time and date to deliver a
139 structured telephone interview.

140 Of the 109 VI participants recruited, only 13 were aged under 50 years, and so although their
141 data was included in the qualitative analysis ⁽²⁸⁾; a decision was made to restrict the dietary
142 analysis to a subgroup of VI participants aged 50 years and over.

143 In all, 50 control group participants without VI were recruited from December 2018 to January
144 2019. The records of patients at the Aston University Eye Clinic who had given consent for
145 their records to be accessed and to be contacted for research and teaching purposes were
146 reviewed. Those that met the inclusion criteria were contacted by telephone and invited to take
147 part.

148 **Procedure for 24 hr food recall**

149 Participants were asked to recall over the telephone all the food and drink they had eaten over
150 the previous 24 hours for three days in the same week.

151 Studies using telephone interviews for 24-hr recalls have reported that they are comparable to
152 the standard in-person method ^(29, 30). Concerns about this method in the literature pertain to
153 non-covering bias i.e. excluding those unable to use a telephone or those without a telephone
154 ⁽³¹⁾ however studies have also reported that the dietary intake reported over the telephone is
155 comparable for participants of different ages, gender and BMI ⁽³²⁾.

156 The 24-hr food recall is a methodological tool often used in dietary consumption studies, but
157 presents advantages and limitations ⁽³³⁾. Advantages include short administration time, high
158 precision when performed three or more times and low literacy requirements ^(30, 33-35). Among
159 the limitations falls the cooperation of the interviewee and their memory, in the case of the
160 elderly this can be compromised⁽³⁶⁾. In addition, difficulty of estimating the size of portions⁽³⁷⁾
161 and recall bias can lead to over and under-reporting ^(33, 38).

162 **Method**

163 *Materials*

- 164 • A password protected file of the participant's names and contact details.
- 165 • A list of predefined questions for dietary analysis.
- 166 • A telephone equipped with a headset.
- 167 • Quiet surroundings.
- 168 • A digital voice recorder to collect verbal informed consent.

169 A spreadsheet to record dietary information (separated into morning, afternoon, evening and
170 snacks).

171 The interviewer received training on how to conduct the interview and input data into the
172 dietary analysis software A la calc by the project lead.

173 A telephone protocol was used in order to remain neutral and not react adversely to any
174 responses given. The interviewer had a list of predefined questions. These questions were
175 screened for clarity and wording by a focus group of six people with VI prior to the start of the
176 study. The same interviewer conducted the interview for each participant.

177 Participants quantified the portions of foods consumed using the Zimbabwe Hand Method ⁽³⁹⁻
178 ⁴²⁾, this method has been shown to be more accurate than using household measures when
179 measuring portion sizes ⁽⁴³⁾. The method was explained to participants at the start of the first
180 telephone call and they were reminded of how to quantify each food as they recalled each food
181 item. This step was then repeated at each telephone call. This 24 hr food recall exercise was
182 carried out on two week days and one weekend day of the same week to ensure precision and
183 validity of reporting ⁽⁴⁴⁾.

184

- 185 • To aid co-operation verbal digitally recorded consent was taken at the start of each food
186 diary; participants were reminded they could withdraw at any time if they wished.
- 187 • The participants were first asked to recall foods eaten for breakfast, lunch, and supper
188 as well as any snacks consumed. They were asked about fluids they drank (alcohol,
189 coffees, fruit juice, teas, milk)
- 190 • To aid participants recall they were probed to check if they had missed any
191 information i.e. vitamin, supplements, or other foods.
- 192 • They were then asked to provide a detailed description of the food items. Examples of

193 the questions asked include; what type of milk (full fat, semi-skimmed, and
194 skimmed), whether milk, sugar and sweeteners were added to drinks, whether bread
195 was white, seeded, and wholemeal, whether cereal was fortified or unfortified and if
196 vegetables were fresh or frozen.

- 197 • Food quality was assessed where possible, participants were asked if spreads were
198 cholesterol reducing and low in and fat, as well as whether foods were baked or fried,
199 shop bought or homemade.
- 200 • To further support participant's recall, they were asked one final time if they might
201 have missed any other foods or drinks.

202

203 **Recommended Daily Allowance (RDA) analysis**

204 The three day 24 hour food recalls were analysed using nutritional software called A La Calc
205 (Red Hot Rails LLP, Doncaster, UK.). This software provided a detailed nutritional analysis
206 for each participant based on their self-reported food and drink consumption. This software has
207 been used in previous research ⁽³⁾ and has been designed to be used by nutritionists, schools,
208 consultants, manufacturers, and for research purposes. The software uses McCance and
209 Widdowson's composition of foods dataset to ensure an accurate breakdown of the nutrients
210 contained within each food item entered⁽⁴⁵⁾. This UK nutrient database is maintained by the
211 Food Standards Agency, and contains the nutritional information of foods commonly
212 consumed in the UK. All calculations are also compliant to the EC Directive 90/496/EEC ⁽⁴⁶⁾.
213 For each participant the mean dietary consumption across the three reported days was
214 calculated.

215

216 **Data analysis**

217 Statistical processing was performed using Microsoft Excel and exported to SPSS Software
218 version 23.0 (IBM UK Ltd, Portsmouth Hampshire). The descriptive analysis is demonstrated
219 in mean, standard deviation, median, and interquartile range.

220 Normally distributed data that had two independent variables and a continuous variable was
221 analysed using an independent t test $p < 0.05$. The t test was used to analyse if dietary intake
222 was influenced by gender both the control and VI group and living arrangements for the control
223 group (living with family/living on own). A one-way between groups ANOVA was used for
224 normally distributed data that included one independent variable (grouping variable) that had
225 three or more levels and one dependent continuous variable $p < 0.05$. Post hoc analysis was

226 performed using a Tukey's test. The one way between groups ANOVA test was used to analyse
227 dietary intake was influenced by shopping abilities (myself/myself with support/do not shop)
228 and cooking abilities (do not cook/cook with support/ cook myself), level of VI (DND/SI/SSI)
229 and if level of VI was influenced by living arrangements (sheltered
230 accommodation/family/living alone)

231

232 Where data was not normally distributed the non-parametric equivalents the Mann-Whitney
233 U test $p < 0.05$ and Kruskal Wallis test with Bonferroni corrections for multiple comparisons
234 was used $p < 0.02$. The Mann-Whitney U test was used to determine if there was a significant
235 difference between the ages of the two groups of this sample and the analysis of the dietary
236 intake for males and females. The Kruskal Wallis test was used to determine if living
237 arrangements, shopping and cooking abilities and level of VI influenced dietary intake for
238 nutrients that were not normally distributed.

239

240 Fishers exact test was used to determine if there was a relationship between level of VI and
241 ability to shop and cook $p < 0.05$.

242

243 **Results**

244

245 **Demographics**

246 Three-day 24-hour recalls were analysed for 64 females and 32 males with VI. Ages of those
247 with VI ranged from 51-96 years. The mean age was 76 ± 11.7 years. The majority of the
248 participants sampled were living with family members or on their own, were retired and were
249 Caucasian.

250 VI in this sample was caused by multiple factors. For example, participants had congenital
251 blindness due to measles, or lost sight due to neurological conditions such as stroke. They also
252 reported VI due to ocular trauma and retinal diseases such as diabetic retinopathy and macular
253 degeneration. Genetic causes were reported such as; ocular albinism, macular dystrophies, and
254 retinitis pigmentosa as well as corneal degenerations and optic nerve head disease i.e.
255 glaucoma.

256 Those that were classified as SSI had been affected for longer compared to the other VI
 257 participants (H 17.2) $p < 0.01$. In all 81% of the participants were registered SSI or SI with most
 258 being SSI, see Table 2.

259 *Table 2 Demographic characteristics of participants with and without visual impairment*

260 * These participants may have been eligible for SI registration #Not Applicable

Characteristic		Proportion of participants with visual impairment (%)	Proportion of participants in the control group (%)
Living Arrangement	on own	48	40
	with family	48	60
	sheltered accommodation	4	0
Level of visual impairment	Severely sight impaired (blind)	46	#
	Sight impaired (partially sighted)	35	#
	Not driving due to poor sight when fully corrected*	19	#
Employment status	Employed	8	20
	Unemployed	6	0
	Voluntary Employed	18	0
	Retired	68	80
Ethnicity	South Asian	4	0
	Caucasian	96	100

261

262

263 In all, 26 females and 24 males were recruited as part of the control group. The mean age was
 264 75.4 ± 7.2 years old. All the control participants were Caucasian and either lived with their

265 family or on their own. In comparison to the VI group a larger proportion of the control were
266 in paid employment; either fulltime, part time or ad hoc, see Table 2.

267 The mean age of females with and without VI was 77.0 ± 12 years and 75.1 ± 6.4 years
268 respectively with no significant difference between groups (U 1033), $p = 0.07$. The mean age
269 for males with and without VI was 74.9 ± 11.5 years and 75.5 ± 8.3 years respectively with no
270 significant difference between groups, (U 299), $p = 0.1$.

271 **Dietary consumption analysis**

272 *Dietary consumption compared to RDA*

273 Table 3 displays the three-day, mean and median results for macro and micro nutrients for
274 the females and males in each group. These are compared to the RDA for each constituent for
275 those aged over 74 years as reported by Public Health England⁽⁴⁷⁾.

276 Similar amounts of macro and micronutrients to RDA were found for the dietary consumption
277 of participants with and without VI. Both groups were consuming fewer amounts of
278 carbohydrates, dietary fibre, fats and vitamin D as recommended for their age group.
279 Both groups were consuming sugars, iron, protein, vitamin C and calcium in excess. The
280 control group exceeded the recommended daily amounts of saturated fat intake.

281 *Dietary consumption of participants with and without VI*

282 Females with VI consumed significantly fewer nutrients compared to their age-matched
283 counterparts, including, calories, fats, saturated fats, protein, salt, calcium, cholesterol and
284 vitamin C; see Table 3. Despite consuming fewer calories, the amounts of vitamin d (U 704),
285 $p= 0.29$, fibre (t 1.4), $p= 0.10$ and sugars (U 707), $p=0.26$ they consumed did not significantly
286 differ from the control group.

287 Males with VI consumed significantly lower amounts of most nutrients compared to males
288 from the control group see Table 3. The amounts of vitamin C (U 307), $p =0.20$, vitamin D (U
289 304), $p= 0.18$, vitamin E (t 1.2), $p=0.20$, and cholesterol (U 313), $p=0.24$ they consumed was
290 not significantly different from that consumed by males without VI.

291 *Table 3 Mean and Standard deviations and median and interquartile ranges of nutrients consumed by females and males with and without visual impairment*
 292 *aged over 50 years (VI) compared to the recommended UK government guidelines*
 293 *(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf)*

294 *STD Standard Deviation, IQR interquartile range

	Unit	Female VI n=64	STD/IQR	Female without VI n=26	STD/IQR	Test statistic and significance p<0.05 value	Male VI n=32	STD/IQR	Male without VI n=24	STD/IQR	Test statistic and significance p<0.05 value	RDA Females >74 years	RDA Males >74 years
Energy	Kcal	1384	±391	1673	±360	(t 3.2) p=<0.01	1600	±369	2023	±31	(t4.5) p=<0.01	1840	2294
Fat	g	50	±20.6	67	±28	(t 3) p=<0.01	58	±19	78	±23	(t3.6) p<0.01	72	89
Of which saturates	g	18	±7	25.6	±9	(t 4.1) p=<0.01	17.5	10.7 IQR	34	12 IQR	(U 139) p=<0.01	<23	<29
Carbohydrates	g	160	±55	187	±52	(t 2.1) p=<0.01	197	±56	235	±53	(t2.6) p= 0.01	245	306
Of which sugars	g	63	38 IQR	67	40 IQR	(U 707) p= 0.26	58	±27	77	±40	(t 2.1) p =0.03	25	31
Protein	g	59	±17	70	±14	(t 2.8) p=<0.01	65	±14	81	±17	(t3.6) p=<0.01	46.5	53.5
Fibre	g	16	±7	18	±6	(t 1.4) p= 0.10	15	±6	20.2	±7	(t2.7) p=<0.01	30	30
Salt	g	4	2 IQR	4.	2 IQR	(U 565) p =<0.01	4.4	±1	6	±2	(t-4) p=<0.01	<6	<6
Cholesterol	mg	155	134.9IQR	262	220 IQR	(U 442) p= <0.01	190.6	207 IQR	202	202IQR	(U 313) p=0.24	**	**
Calcium	mg	652	±214.2	850	154.3	(t 3.6) p=0.01	788	±325	1085	±661	(t2.2) p=0.03	700	700
Iron	mg	8	4.75 IQR	10	5 IQR	(U 624) p= <0.01	8.6	5 IQR	12	6 IQR	(U 212) p =<0.01	8.7	8.7
Vitamin D	µg	2	3 IQR	3	4 IQR	(U 704) p= 0.29	1.58	2 IQR	4	2IQR	(U 304) p= 0.18	10	10
Vitamin E	mg	5	5.26 IQR	7	5 IQR	(U 605) p= <0.01	4.9	±3	6.0	±3	(t1.2) p=0.20	**	**
Vitamin C	mg	59	62IQR	89	89 IQR	(U 519) p= <0.01	43	51IQR	49.2	69 IQR	(U 307) p =0.20	40	40

295 **data not provided

296 *Dietary consumption and living arrangements*

297 Living arrangements influenced the dietary consumption of participants with VI.
298 Those who lived with family members (M=1559 kcal \pm 406) or in sheltered accommodation
299 (M=1759 kcal \pm 385) had a higher intake of calories (F (2, 93) =5.7), $p < 0.01$ compared to
300 those living on their own (M=1327 kcal \pm 345). Those living independently were found to be
301 eating an average of 332 kcal less than those who lived in sheltered accommodation or with
302 family. Post hoc Tukey's test did not reveal any significant difference between those living
303 with family and sheltered accommodation. Those living with family were found to be eating
304 16g more fat (H 11.35), $p < 0.01$ and 25g more carbohydrates (H 11.52), $p < 0.01$ compared to
305 those living in their own home.

306 Among the control group, those living with family members showed no difference (t 1.8), p
307 = 0.08 than those living on their own.

308

309 *Dietary consumption and level of VI*

310 Participants classified as SSI consumed an average of 25.7 mg less vitamin c than other VI
311 participants (H 12), $p < 0.01$.

312 Ability to cook was affected by level of VI with more SSI participants being unable to
313 cook than other VI participants (Fishers Exact test: 25.9), $p < 0.01$.

314 A one-way between-groups ANOVA revealed VI participants that cooked with support
315 (M=1826 kcal \pm 396) consumed significantly $p < 0.05$ more calories (F (2, 93) 8.8), $p < 0.01$
316 than those who did not cook (M=1504kcal \pm 396) or cooked for themselves (M=1327kcal
317 \pm 334).

318 Post-hoc comparisons using the Tukey's HSD test revealed those that cooked with support
319 consumed an average of 411 kcal more calories, than the other groups. Cooking with support
320 also resulted in a higher dietary intake of carbohydrates (M=200g \pm 85), (F (2, 93) 4.8),
321 $p = 0.01$ when compared to not cooking (M=185g \pm 54) and when people with VI cooked by
322 themselves (M=154g \pm 47). The dietary intake of fats (F (2, 93) 3.8) $p = 0.03$ for those cooking
323 with support was higher (M=64.8g \pm 14) than those that did not cook (M=54g \pm 23) or cooked
324 independently (M=48g \pm 17).

325 Kruskal-wallis with Bonferroni corrections revealed that those that received support

326 consumed 6.7 mg more vitamin E (H 10.7), $p < 0.01$, and 93.6 mg more vitamin C (H 23.89),

327 p<0.01 than those who cooked by themselves or sourced ready meals.

328

329 **Eating behaviours of participants with and without VI**

330

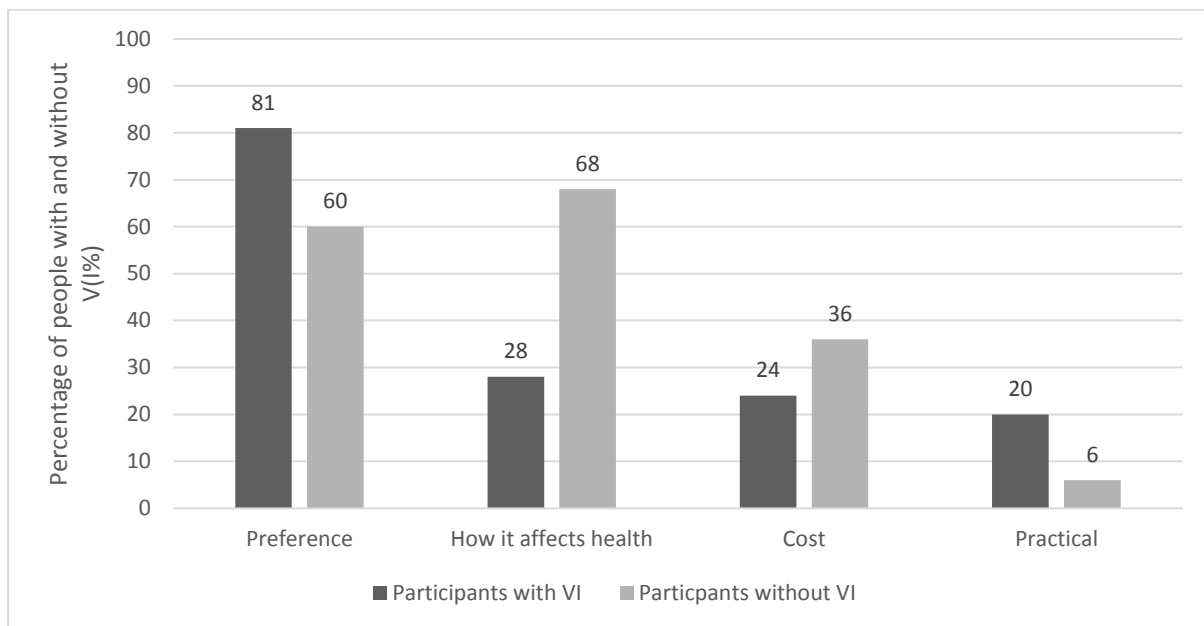
331 *Meal preparation and shopping*

332 All participants without VI stated they had no difficulty cooking and could cook a hot meal if
333 they were required to. The control group mainly reported no difficulty shopping, with 96%
334 stating they shopped independently. The 4% that required support reported that physical
335 limitations, such as arthritis, left them unable to lift heavy goods.

336 In contrast, 50% of the participants with VI in this sample could not cook food by
337 themselves. They required support, relied on a family member or purchased ready meals.

338 Only 29% of participants with VI shopped independently, 42% required support and 29% did
339 not shop but relied on family members or used meal delivery services. Level of VI affected
340 ability to shop with more participants that were SSI or SI being unable to do so or requiring
341 support (Fishers Exact test: 11.5), p=0.02. However, no relationship was found between
342 reported shopping ability and dietary consumption.

343 When asked about food choices, participants with VI stated preference as the primary factor.
344 Those without VI stated that perceived impact of foods on their health determined what they
345 purchased (see figure 1).



347

348 *Figure 1 Main factors deciding the choice of foods purchased in a sample of participants with*
 349 *and without visual impairment (VI).*

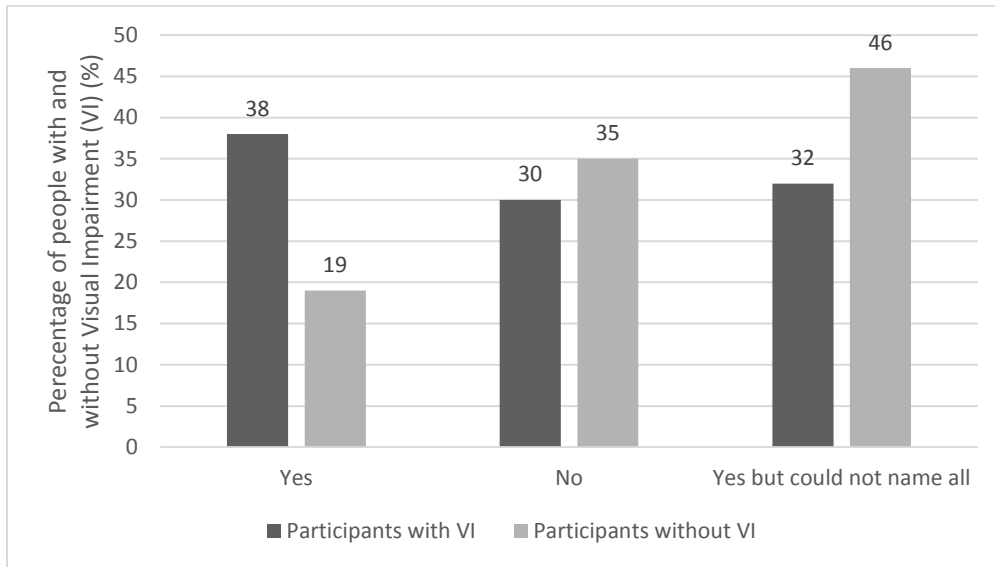
350

351 *Attitudes towards diet and knowledge of healthy eating*

352 In all, 59% of participants with VI and 94% without VI stated they were satisfied with their
 353 current health. In all, 61% of participants with VI stated they were happy with their diet, giving
 354 this as the reason for why they would not change it. The 39% that stated they would change
 355 their diets provided a variety of reasons. The main reasons given were “eat more fresh fruits,
 356 vegetables” “have a diet that was varied and be aware of foods available”, and “improve
 357 knowledge of healthy eating”. Similarly 62% of the control group stated they would not change
 358 their current diet. Of these 50% believed they had already adopted healthy eating behaviours
 359 and 12% stated they would not change their diet because they were happy with it. The 38% of
 360 participants without VI who reported they would like to change their diets stated they would
 361 mainly like to “eat healthier foods” or “be more disciplined with sugary foods”. Other reasons
 362 given were they would like to eat “more expensive foods like caviar” and would consider
 363 changing their diets if “healthier foods tasted nicer”.

364 Participants were asked “can you name the five food groups for a balanced diet”. More of the
 365 control group were able to name the food groups compared to those with VI (see figure 2). The
 366 participants without VI strongly agreed that the foods we eat affect our health. Of the

367 participants with VI, 18% stated that they believed that our health is not affected by the foods
368 we eat.



369

370 *Figure 2 Participant's ability to name the five food groups for a balanced diet.*

371

372 **Discussion**

373 This study is the first to report that older adults with and without VI are not meeting the
374 recommended daily requirements as recommended by Public Health England⁽⁴⁷⁾. This finding
375 suggests additional factors other than VI could play a role in the undernourishment of
376 participants in this study. Factors reported in previous studies that cause a compromised
377 nutritional status in older adults include physical changes associated with aging, as well as
378 cognitive, psychological, and social factors such as dementia, depression, isolation, and limited
379 income⁽⁴⁸⁾. Researchers have also found that older adults' have smaller appetites and feel that
380 portion sizes of foods in shops are inappropriately large⁽⁴⁹⁾.

381 For the first time using detailed dietary analysis, this study reports that people with VI are
382 consuming significantly fewer nutrients than age-matched controls. This study supports the
383 view that there are multifactorial obstacles that make it difficult for people with VI to maintain
384 healthy feeding, including difficulties shopping for, preparing and cooking food^(2, 3, 15, 27).
385 People with VI have reported having an aversion to cooking⁽¹⁵⁾ and report that meals could
386 take up to two hours to cook⁽²⁾. It has also been reported that people with VI eat more intuitively
387 and the loss of visual cues may drive a reduced appetite in people with VI⁽⁵⁰⁻⁵³⁾.

389 This study found that participants with VI who were living alone and cooking for themselves
390 consumed significantly less food sources of calories, fats, vitamin C, and vitamin E nutrients
391 than those with VI that lived with family or received support to cook. The reduction in calories
392 consumed by the participants with VI who were living alone (332kcal) almost equates to
393 missing an entire meal, such as breakfast (400kcal) as recommended by UK government
394 guidelines⁽⁵⁴⁾. The participants in the age-matched control group who were living alone also
395 consumed fewer calories (191kcal) than those living with family although this was not
396 significant. It has been previously documented that older adults living alone have less
397 favourable diets than those who live with family or receive support ^(55, 56). Bereavement has
398 been reported as a substantial change that has been linked to poor dietary intake and quality⁽⁵⁷⁾.
399 A recent Canadian study suggested eating alone might act as reminder of bereavement and
400 result in reduced pleasure from eating ⁽⁵⁸⁾. Another study reported British men who were
401 married and living with family had a better diet quality than those living alone⁽⁵⁷⁾. Lack of
402 motivation to cook has also been reported as a contributory factor in older women who had lost
403 their partner, who report preferring to cook less ⁽⁴⁹⁾. Other studies have reported that food
404 wastage when buying for one could play a role in participant food choices and food quality
405 with specific food groups being affected more so than others⁽⁵⁷⁾. Vegetables in particular were
406 reported as the food group that participants had the greatest difficulty with when buying for
407 one ⁽⁵⁷⁾.

408 Participants with VI in this study were less able to recall the five food groups for a balanced
409 diet. Those with VI were mainly making food choices irrespective of its nutritional value
410 whereas those without VI made food choices based on how healthy foods were. To improve
411 dietary consumption knowledge of where to obtain healthy ready meals, support with cooking
412 and supporting the knowledge of the recommended portion sizes of food may therefore be
413 helpful for people with VI. The results of this study suggest that interventions are required to
414 improve the nutritional awareness of people with VI. These could take the form of skills
415 training or rehabilitation ⁽¹⁵⁾ to support activities of daily living.

416

417 **Strengths**

418 Participants from across the United Kingdom took part in this study and so the study was not
419 restricted by geographical location. The method of using 24-hr hour recalls has been reported

420 to be affected by age and a trend of underreporting of foods consumed has been reported. In an
421 attempt to reduce this bias the 24 hr food recalls were collected for three non-consecutive days
422 as they have been reported to have precision and when multiple days are assessed validity ⁽⁴⁴⁾.
423 The 24 hr food recall was also the first question asked at the initial telephone call to attempt to
424 reduce this bias.

425 **Limitations**

426 The results of this study are subject to limitations. This study was performed over a three-day
427 period of the same week. This method would significantly influence the dietary intake analysis,
428 as this data was not representative of what participants ate throughout the year. Future studies
429 should perform the dietary analysis on multiple days throughout the year to capture the macro
430 and micronutrients consumed more completely.

431 The same interviewer collected the data for each participant the dietary analysis may therefore
432 be subject to interviewer bias. Participants also required notice for the 24-hr food re-calls and
433 therefore the recalls were not truly spontaneous; this time to prepare may have also influenced
434 the results of this study.

435 The 37-question item survey was disseminated prior to the second and third telephone calls.
436 The questions asked may have influenced the participants eating habits for the subsequent
437 phone calls although the researchers did not find a significant variation in the dietary
438 consumption reported at the follow up telephone calls.

439 Participants could not always report with accuracy about the quality of the food consumed, for
440 example, if they went to a pub or restaurant they could not report if the food was prepared with
441 heart healthy oil or not, this may have affected the accuracy of reporting and therefore the
442 dietary consumption analysis.

443 VI may have also affected the ability of participants to relay portion sizes accurately and
444 therefore have affected the dietary analysis for this group.

445 The aim of this study was to recruit participants from all ages and ethnicities however very few
446 participants who were under the age of fifty years, identified as BAME, and were in
447 employment participated.

448 Measurements such as BMI, waist circumference, and activity levels would be useful in future
449 studies to evaluate the nutritional status of people with VI more completely.

450 **Conclusion**

451 This study is the first to highlight that older adults with VI in the UK are eating fewer nutrients
452 when compared to their age matched counterparts. Both adults with and without VI are not
453 meeting the recommended amounts nutrients according to government guidelines. These
454 results suggest local and government led initiatives should be implemented to support the diets
455 of older adults in the UK, these initiatives could include healthy eating workshops, café clubs
456 or skills training and rehabilitation.

457

458 **Conflict of interests**

459 All authors declare they have no conflict of interest or financial interest.

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467

468 **Ethics**

469 This study was conducted according to the guidelines laid down in the Declaration of Helsinki
470 and all procedures involving human subjects/patients were approved by the Aston University
471 School of Life and Health Sciences Ethics Committee, #1398. Verbal informed consent was
472 obtained from all subjects/patients. Verbal consent was witnessed and formally digitally
473 recorded by the first author.

474 **Consent for publication**

475 All participants gave verbal digitally voice recorded, informed consent for their data to be
476 published.

477 **Author's contributions**

478 Nabila Jones contributed to the acquisition of data, analysis and interpretation of data. Hannah
479 Bartlett made substantial contributions to conception and design. Both authors participated in
480 drafting the article and revising it critically. Both authors gave final approval of the version to
481 be submitted for review.

482 **References**

- 483 1. Roebathan BV. Preliminary assessment of nutritional status in a group of persons with visual
484 impairments. *Nutrition Research*. 1999;19(12):1731-40.
- 485 2. Kostyra E, Zakowska-Biemans S, Sniegocka K, Piotrowska A. Food shopping, sensory
486 determinants of food choice and meal preparation by visually impaired people. *Obstacles and*
487 *expectations in daily food experiences*. *Appetite*. 2017;113:14-22.
- 488 3. Stevens R. BH, Cooke R. Dietary Analysis and nutritional behaviour in people with and without
489 age-related Macular disease. *Clinical Nutrition*. 2015;Vol. 10 (3):p. e112–e7
- 490
- 491 4. Braakhuis A, Raman R, Vaghefi E. The Association between Dietary Intake of Antioxidants and
492 Ocular Disease. *Diseases*. 2017;5(1):3.
- 493 5. Appleby PN, Allen NE, Key TJ. Diet, vegetarianism, and cataract risk. *Am J Clin Nutr*.
494 2011;93(5):1128-35.
- 495 6. Ersoy L, Ristau T, Lechanteur YT, Hahn M, Hoyng CB, Kirchhof B, et al. Nutritional risk factors
496 for age-related macular degeneration. *BioMed research international*. 2014;2014:413150.
- 497 7. Chong EW, Simpson JA, Robman LD, Hodge AM, Aung KZ, English DR, et al. Red meat and
498 chicken consumption and its association with age-related macular degeneration. *American journal of*
499 *epidemiology*. 2009;169(7):867-76.
- 500 8. Theodoropoulou S, Samoli E, Theodossiadis PG, Papathanassiou M, Laggiou A, Laggiou P, et al.
501 Diet and cataract: a case-control study. *International ophthalmology*. 2014;34(1):59-68.
- 502 9. Chong ET, Robman LD, Simpson JA, et al. Fat consumption and its association with age-related
503 macular degeneration. *Archives of Ophthalmology*. 2009;127(5):674-80.
- 504 10. S. S, A. D. Healthy ageing: the role of nutrition and lifestyle – a new British Nutrition
505 Foundation Task Force Report. *Nutrition Bulletin*. 2009;34(1):58-63.
- 506 11. Seddon JM, Rosner B, Sperduto RD, et al. Dietary fat and risk for advanced age-related macular
507 degeneration. *Archives of Ophthalmology*. 2001;119(8):1191-9.
- 508 12. Cumming RG, Mitchell P, Smith W. Diet and cataract: the Blue Mountains Eye Study.
509 *Ophthalmology*. 2000;107(3):450-6.
- 510 13. Wong MYZ, Man REK, Fenwick EK, Gupta P, Li LJ, van Dam RM, et al. Dietary intake and diabetic
511 retinopathy: A systematic review. *PloS one*. 2018;13(1):e0186582.
- 512 14. University Hospital Southampton. The cost of malnutrition in the UK economic report 2017
513 [Available from: [http://uhs.nhs.uk/ClinicalResearchinSouthampton-Biomedical-Research-](http://uhs.nhs.uk/ClinicalResearchinSouthampton-Biomedical-Research-Centre/Ourresearchimpacts/impactcasestudies/ThecostofmalnutritionintheUKeconomicreport.aspx)
514 [Centre/Ourresearchimpacts/impactcasestudies/ThecostofmalnutritionintheUKeconomicreport.aspx](http://uhs.nhs.uk/ClinicalResearchinSouthampton-Biomedical-Research-Centre/Ourresearchimpacts/impactcasestudies/ThecostofmalnutritionintheUKeconomicreport.aspx).
- 515 15. Bilyk MC, Sontrop JM, Chapman GE, Barr SI, Mamer L. Food Experiences and Eating Patterns
516 of Visually Impaired and Blind People. *Canadian Journal of Dietetic Practice and Research*.
517 2009;70(1):13-8.
- 518 16. Smyth CA, Spicer CL, Morgese ZL. Family Voices at Mealtime: Experiences With Young Children
519 With Visual Impairment. *Topics in Early Childhood Special Education*. 2014;34(3):175-85.
- 520 17. Gopinath B, Liew G, Burlutsky G, Mitchell P. Age-related macular degeneration and 5-year
521 incidence of impaired activities of daily living. *Maturitas*. 2014;77(3):263-6.
- 522 18. Jones N, Bartlett H. The impact of visual impairment on nutritional status: A systematic review.
523 *British Journal of Visual Impairment*. 2018;36(1):17-30.

- 524 19. Muurinen SM, Soini HH, Suominen MH, Saarela RKT, Savikko NM, Pitkala KH. Vision
525 impairment and nutritional status among older assisted living residents. *Archives of Gerontology and*
526 *Geriatrics*. 2014;58(3):384-7.
- 527 20. Montero P. Nutritional assessment and diet quality of visually impaired Spanish children.
528 *Annals of Human Biology*. 2005;32(4):498-512.
- 529 21. Acil D, Ayaz S. Screening of Visually Impaired Children for Health Problems. *Asian Nursing*
530 *Research*. 2015;9(4):285-90.
- 531 22. Magdalena W, Urzedowicz B, Motylewski S, Zeman K, Pawlicki L. Body mass index and waist-
532 to-height ratio among schoolchildren with visual impairment A cross-sectional study. *Medicine*.
533 2016;95(32).
- 534 23. De Faria MD, Da Silva JF, Ferreira JB. The visually impaired and consumption in restaurants.
535 *International Journal of Contemporary Hospitality Management*. 2012;24(4-5):721-34.
- 536 24. Nakamura K, Otomo A, Maeda A, Kikuchi S, Motohashi Y, Tanaka M, et al. Evaluation of
537 complex activities in daily living of elderly Japanese with visual impairment. *Aging-Clinical and*
538 *Experimental Research*. 1999;11(2):123-9.
- 539 25. Gladstone M, McLinden M, Douglas G, Jolley E, Schmidt E, Chimoyo J, et al. 'Maybe I will give
540 some help.... maybe not to help the eyes but different help': an analysis of care and support of children
541 with visual impairment in community settings in Malawi. *Child: Care, Health and Development*.
542 2017:n/a-n/a.
- 543 26. Pardhan S, Latham K, Tabrett D, Timmis MA. Objective Analysis of Performance of Activities
544 of Daily Living in People With Central Field Loss. *Investigative Ophthalmology & Visual Science*.
545 2015;56(12):7169-78.
- 546 27. Baker SM. Consumer normalcy: Understanding the value of shopping through narratives of
547 consumers with visual impairments. *Journal of Retailing*. 2006;82(1):37-50.
- 548 28. Jones N, Bartlett H, Cooke R. An analysis of the impact of visual impairment on activities of
549 daily living and vision-related quality of life in a visually impaired adult population. *British Journal of*
550 *Visual Impairment*. 2018.
- 551 29. Yanek LR, Moy TF, Raqueño JV, Becker DM. Comparison of the Effectiveness of a Telephone
552 24-hour Dietary Recall Method vs an In-person Method among Urban African-American Women.
553 *Journal of the American Dietetic Association*. 2000;100(10):1172-7.
- 554 30. Galasso R, Panico S, Celentano E, Del Pezzo M. Relative validity of multiple telephone versus
555 face-to-face 24-hour dietary recalls. *Annals of Epidemiology*. 1994;4(4):332-6.
- 556 31. Kyrø C, Skeie G, Dragsted LO, Christensen J, Overvad K, Hallmans G, et al. Intake of whole grain
557 in Scandinavia: Intake, sources and compliance with new national recommendations. *Scandinavian*
558 *Journal of Public Health*. 2011;40(1):76-84.
- 559 32. Bogle M, Stuff J, Davis L, Forrester I, Strickland E, Casey PH, et al. Validity of a Telephone-
560 Administered 24-Hour Dietary Recall in Telephone and Non-Telephone Households in the Rural Lower
561 Mississippi Delta Region. *Journal of the American Dietetic Association*. 2001;101(2):216-22.
- 562 33. Castell GS, Serra-Majem L, Ribas-Barba L. What and how much do we eat? 24-hour dietary
563 recall method. *Nutr Hosp*. 2015;31:46-8.
- 564 34. Foster E, Bradley J. Methodological considerations and future insights for 24-hour dietary
565 recall assessment in children. *Nutrition Research*. 2018;51:1-11.
- 566 35. Sharma M, Rao M, Jacob S, Jacob CK. Validation of 24-hour dietary recall: A study in
567 hemodialysis patients. *Journal of Renal Nutrition*. 1998;8(4):199-202.
- 568 36. Caliendo MA. VALIDITY OF THE 24-HOUR RECALL TO DETERMINE DIETARY STATUS OF ELDERLY
569 IN AN EXTENDED CARE FACILITY. *Journal of Nutrition For the Elderly*. 1981;1(2):57-66.
- 570 37. Souverein OW, de Boer WJ, Geelen A, van der Voet H, de Vries JH, Feinberg M, et al.
571 Uncertainty in Intake Due to Portion Size Estimation in 24-Hour Recalls Varies Between Food Groups.
572 *The Journal of Nutrition*. 2011;141(7):1396-401.
- 573 38. Macdiarmid J, Blundell J. Assessing dietary intake: Who, what and why of under-reporting.
574 *Nutrition research reviews*. 1998;11(2):231-53.

- 575 39. Kinshuck D. Portion size 2017 [updated 2017. Available from:
576 <http://www.diabeticretinopathy.org.uk/prevention/portionsize.htm>.
- 577 40. The College of Family Physicians Canada. The Zimbabwe Hand Method, Portion control is in
578 your hands 2016 [Available from:
579 http://www.familyhealthonline.ca/fho/diabetes/DI_ZimbabweHandJive_MDab15.asp.
- 580 41. University of Massachusetts Medical School. The Zimbabwe Hand Jive, A simple method of
581 portion control [Available from: [https://www.umassmed.edu/dcoe/diabetes-](https://www.umassmed.edu/dcoe/diabetes-education/understanding-diabetes/nutrition/zimbabwe-hand-jive/)
582 [education/understanding-diabetes/nutrition/zimbabwe-hand-jive/](https://www.umassmed.edu/dcoe/diabetes-education/understanding-diabetes/nutrition/zimbabwe-hand-jive/).
- 583 42. Mash R. Diabetes education in primary care: A practical approach using the ADDIE model.
584 Continuing Medical Education. 2010;28:485-7.
- 585 43. Gibson AA, Hsu MSH, Rangan AM, Seimon RV, Lee CMY, Das A, et al. Accuracy of hands v.
586 household measures as portion size estimation aids. J Nutr Sci. 2016;5:11.
- 587 44. Resnicow K, Odom E, Wang T, Dudley WN, Mitchell D, Vaughan R, et al. Validation of Three
588 Food Frequency Questionnaires and 24-Hour Recalls with Serum Carotenoid Levels in a Sample of
589 African-American Adults. American journal of epidemiology. 2000;152(11):1072-80.
- 590 45. Red Hot Rails LLP. A La Calc, Nutritional analysis made easy! 2011-2019 [Available from:
591 <https://www.alacalc.com/?locale=en>.
- 592 46. A la Calc A la Calc users manual 2019 [Available from:
593 file:///C:/Users/jonesn5/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/Temp
594 State/Downloads/a%20la%20calc%20Users'%20Manual.pdf.
- 595 47. England PH. Government dietary recommendations 2016 [Available from:
596 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf)
597 [/618167/government dietary recommendations.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/618167/government_dietary_recommendations.pdf).
- 598 48. Mangels AR. CE: Malnutrition in Older Adults. AJN The American Journal of Nursing.
599 2018;118(3):34-41.
- 600 49. Bloom I, Lawrence W, Barker M, Baird J, Dennison E, Sayer AA, et al. What influences diet
601 quality in older people? A qualitative study among community-dwelling older adults from the
602 Hertfordshire Cohort Study, UK. Public health nutrition. 2017;20(15):2685-93.
- 603 50. Linne V, Barkeling B, Rossner S, Rooth P. Vision and eating behavior. Obesity Research.
604 2002;10(2):92-5.
- 605 51. Wadhwa D, Capaldi-Phillips ED. A review of visual cues associated with food on food
606 acceptance and consumption. Eating Behaviors. 2014;15(1):132-43.
- 607 52. Boswell RG, Kober H. Food cue reactivity and craving predict eating and weight gain: a meta-
608 analytic review. Obesity Reviews. 2016;17(2):159-77.
- 609 53. Steenhuis I, Poelman M. Portion Size: Latest Developments and Interventions. Current obesity
610 reports. 2017;6(1):10-7.
- 611 54. England PH. Behind the headlines: calorie guidelines remain unchanged 2017.
- 612 55. Davis MA, Randall E, Lee ES, Forthofer RN, Margen S. Living Arrangements and Dietary
613 Patterns of Older Adults in the United States¹. Journal of Gerontology. 1985;40(4):434-42.
- 614 56. Robinson CO, Ritchie CS, Roth DL, Locher JL, Burgio KL. The Effect of the Presence of Others
615 on Caloric Intake in Homebound Older Adults. The Journals of Gerontology: Series A.
616 2005;60(11):1475-8.
- 617 57. Whitelock E, Ensaff H. On Your Own: Older Adults' Food Choice and Dietary Habits. Nutrients.
618 2018;10(4):413.
- 619 58. Atkins JL, Ramsay SE, Whincup PH, Morris RW, Lennon LT, Wannamethee SG. Diet quality in
620 older age: the influence of childhood and adult socio-economic circumstances. Br J Nutr.
621 2015;113(9):1441-52.

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