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1
2 **Examination of dietary intake of UK preschool children by varying carers: Evidence**
3 **from the 2008-2016 UK National Diet and Nutrition Survey**
4

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10
11 **Abstract**
12

13 Early years caregivers can play a key role in young children's eating and the prevention of
14 childhood obesity. The UK National Diet and Nutrition Survey (NDNS) is a large
15 representative survey collecting detailed food and nutrition consumption data. Using these data,
16 the aim of this study was to investigate the relationship between dietary intake of preschool
17 children in the UK aged two to four years old and accompanying adult/s. Nutrition consumption
18 data from 1,218 preschool children from years one to eight of the NDNS (2008 to 2016) were
19 accessed. Dietary data was captured using three or four day estimated food diaries. Regression
20 analyses were performed to explore the association between dietary intake and accompanying
21 adult. There were significant differences in consumption when children were not accompanied
22 by their parents. Compared to when children were with parents, children consumed
23 significantly more energy (15kcal, 95% CI 7-23kcal) sodium (-19mg, 95% CI 6-32mg) , added
24 sugars (0.6g, 95% CI 0.1-1.1g), vegetables (3g, 95% CI 1-4g), total grams (12g, 95% CI 3-
25 21g) and saturated fat (0.2g, 95% CI 0.1-0.4g) per eating occasion when accompanied by wider
26 family. When children were accompanied by a formal carer they consumed significantly less
27 added sugars (-1.6g, 95% CI -2.4- -0.8g) and more fruit (12g, 95% CI 3-21g) per eating
28 occasion than when they were with their parents. The results demonstrate that non-parental
29 caregivers might be an important target to promote healthy eating in young children. Further
30 research is needed to establish which caregivers would benefit most.
31

32 **Introduction**
33

34 Globally, in 2019, 38 million children under the age of five were overweight or obese ⁽¹⁾ and
35 poor dietary choices are partly responsible for this. Although the first few years of a child's life
36 are documented as a critical period for the development of healthy eating habits, in the UK,
37 preschool children are consuming over double the recommended amount of free sugars per day
38 and exceeding their recommended intake of saturated fat ⁽²⁾. Many children in England are also
39 failing to meet the recommended daily intake of fruit and vegetables⁽³⁾. Caregivers (e.g. parents,
40 family, childminders, nursery staff) of young children are nutritional gatekeepers, selecting the
41 types and amount of food and drinks they receive ⁽⁴⁾. There are a wealth of publications
42 exploring parental feeding ⁽⁵⁻⁸⁾ but few have investigated the influence of other caregivers, such
43 as other family members, nursery staff and childminders, on young children's eating. This may
44 be a key oversight in exploring the factors associated with early childhood obesity.
45

46 Over the last twenty years the employment rate of mothers has grown substantially and 73%
47 of couple families have both parents in employment in the UK ⁽⁹⁾. Consequently, parents rely
48 on both formal and informal caregivers for childcare. Formal childcare is government regulated
49 and can be provided free as part of the entitlement to early years provision or paid for directly
50 by parents. Formal childcare includes nurseries and registered childminders. Informal childcare
51 is the converse of formal childcare, often provided by family and friends. Children aged three
52 to four years old in the UK are entitled to 30 hours of free childcare per week with a formal
53 childcare provider, however, for children younger than this there is limited free provision and
54 therefore informal childcare is often used. In a recent survey of English parents of children
55 aged 0-14 years old, 62% had used formal childcare and 35% of families had used informal
56 childcare provided by family and friends. More specifically, 40% of preschool children up to
57 age two years, and 88% of children aged three to four years old had received formal childcare.
58 The data are not so clear with regards to informal childcare since it is likely to be used outside
59 of traditional working hours and school holidays ⁽¹⁰⁾. For children below school age this often
60 involves a full day of childcare involving multiple meals and snacks and therefore the influence
61 these caregivers are having on young children's diets requires more exploration.
62

63 Research into the provision of food and drink in formal childcare settings focuses mainly on
64 nurseries. In the past, there is evidence to suggest that nurseries were failing to develop healthy
65 eating habits in young children, providing meals deficient in energy, carbohydrate, iron and
66 zinc and exceeding the recommended sodium guidelines ⁽¹¹⁾. In another study, many nurseries
67 were not providing a single portion of fruit or vegetables with the children's main meal ⁽¹²⁾.
68 However, since the voluntary food and drink guidelines for early years settings were released
69 in 2012, nurseries started to serve food and beverages more consistent with the guidelines ⁽¹³⁾.
70 Although these studies go some way in demonstrating the dietary quality in nursery settings
71 there is still a lack of up to date data on food provision in UK nurseries. Research into the food
72 provision in childminder settings is scarce, however a qualitative study of eight childminders
73 found that although childminders were aware of key nutritional campaigns such as the 'five a
74 day' there was an over reliance on the provision of fresh and dried fruit as snacks and no
75 consistency in providing vegetables with meals ⁽¹⁴⁾. Most of the childminders were also
76 unaware of the voluntary food and drink guidelines for early years settings ⁽¹⁴⁾.
77

78 There is also a distinct paucity of evidence examining food provision by informal childcare
79 providers such as family members. Instead, research has focused on weight outcomes of
80 children in formal versus informal childcare, with mixed findings. For instance in a UK wide
81 cohort study of 12,354 three year olds children who were cared for in informal childcare
82 settings were significantly more likely to be overweight than those cared for by their parents,
83 whereas no significant relationship existed for those in formal childcare ⁽¹⁵⁾. Although there is
84 little evidence for the association between childcare type and weight status persisting beyond
85 the early years ^(16,17), it suggests that exploring the food provision by family members who are
86 not parents may be important.
87

88 The National Diet and Nutrition Survey (NDNS) ⁽¹⁸⁾ is a representative survey collecting
89 detailed food consumption and nutrient intake data of individuals aged one and a half years and
90 over, from the UK. For children, parents are asked to complete food diaries, regarded as the
91 gold standard in dietary assessment methods ⁽¹⁹⁾, for all food and drinks consumed over three
92 days. Parents also document who the child is with when they consume these foods.
93 Consequently the NDNS may be an invaluable resource that can be utilised to explore the
94 dietary provision of formal and informal caregivers.
95

96 A previous study has explored the relationship between children's fruit and vegetable intake
97 and the eating context, including who the child was with, using data from the NDNS ⁽²⁰⁾.
98 Children aged one and a half to three years old were more likely to consume vegetables when
99 siblings were present, when they were with adult relatives and when with formal childcare
100 providers, such as nursery/kindergarten staff and childminders, compared to when they were
101 with their parents alone. Children were less likely to consume vegetables when alone and they
102 were also more likely to consume fruit when they were with their formal childcare provider
103 and when they were with friends. Although this study highlights the difference in fruit and
104 vegetable intake when children are with different adult figures it doesn't provide insight into
105 young children's overall diet provision when accompanied by different people. Doing so would
106 provide a greater insight into ways to improve children's diets.

107
108 There is also a need to consider socioeconomic factors when exploring children's dietary intake
109 when with different caregivers ⁽²¹⁾. Socioeconomic gradients in diets have been documented
110 widely for both adults and children, with lower income groups consuming lower quality diets
111 than higher income groups ⁽²²⁻²⁵⁾ and this is primarily due to reduced access and a higher cost
112 of more healthful diets ⁽²³⁾. Less is known about how the child's parental household income, a
113 proxy measure of socioeconomic status, might influence young children's dietary intake within
114 a caregiving environment.

115
116 The aim of this study is to investigate the relationship between dietary intake (energy (kcal),
117 total added sugars (g), total sodium (mg), energy density (kcal/g), total saturated fat (g), total
118 fruit (g), total vegetables (g) and total grams per eating occasion) of children aged two to four
119 years old in the UK and accompanying adult/s using data from the national diet and nutrition
120 survey. We will also explore the influence of the child's parental household income on
121 children's dietary intake when they are accompanied by different people.

122 123 124 **Method**

125 126 **Research Design**

127
128 This study is a secondary data analysis of quantitative data from a UK National cross-
129 sectional survey.

130 131 **Data Source**

132 The data were pooled data from the National Diet and Nutrition Survey (NDNS) years 1-8 ⁽¹⁸⁾.
133 The NDNS is a nationally representative cross-sectional survey assessing the diet and health
134 of households in Great Britain. Data was collected in three waves; wave one: 2008-2011, wave
135 two: 2012-2014 and wave three: 2014-2016. Across the three waves 39,524 households were
136 randomly selected to take part in the study. For each household either one adult (aged 19 years
137 and over) and one child (aged one and a half to 18 years) or one child only were randomly
138 selected to take part. Participants for the present study were 1,218 children aged two to four
139 years old and their caregivers who completed the dietary assessment for the children. The full
140 survey design and sampling methods of the NDNS survey have been published previously ⁽¹⁸⁾.
141 Anonymised data were obtained from the UK Data Archives (NatCen, Univeristy of Essex,
142 Colchester, Essex, UK). Ethical approval for the NDNS was obtained from Oxfordshire A
143 Research Ethics Committee.

144
145

146 Dietary Data

147 Across the three waves, three or four-day estimated food diaries were used to assess dietary
148 intake. Food diaries were completed by parents for children under the age of twelve and
149 detailed instructions for caregivers were also provided for when children were not with their
150 parents. To complete the food diaries, caregivers were asked to record all food and drink items
151 consumed, both in and out of the home, the time they ate and who they were with. Parents and
152 caregivers were requested to record only the food eaten, taking into consideration any leftovers
153 and they were provided with picture examples and given detailed instructions on how to
154 estimate portion sizes and were asked to record any weights from labels. Diary entries were
155 coded by trained coders and editors in the NDNS team. For each food item consumed, macro
156 and micronutrients were calculated in a modified version of the Diet in, Nutrients Out system;
157 a dietary recording and analysis system. The food composition data was taken from the
158 Department of Health's NDNS Nutrient databank.

159

160

161 Type of Caregiver

162

163 The NDNS coded 15 categories for who the child was with for each eating occasion and these
164 were recoded into a new variable containing six categories for the current analysis. Three of
165 these categories refer to types of caregivers; "parents", "formal childcare providers", and with
166 "wider family". The other three other categories suggested no obvious caregiver ("no adult
167 specified", "with others", and "not recorded") but were retained in the analysis for validity.
168 Any group that included parents was recoded as 'with parents' even if the category also referred
169 to being with a carer e.g. 'with parent/carers & siblings' as there was no way to distinguish those
170 within it. Exploratory analysis indicated that 94% of the eating occasions with parents/carers
171 were in the home environment, strengthening the assumption that the carer referred to here is
172 the parent figure. The category 'with family (including relatives)' was recoded as 'with wider
173 family'. One category referred to being with a carer without reference to parents (with carer
174 and other children) and exploratory analysis indicated that 82% of these eating occasions
175 accompanied by a carer were located at a nursery or kindergarten and 8% were located at a
176 carer's home indicating that these carers were nursery/kindergarten staff or childminders.
177 Consequently, this category was assumed to be "formal childcare providers" and will be
178 referred to this as such from this point onwards. When the NDNS categories included no
179 obvious accompanying adult e.g. 'with siblings', 'with friends' these were recoded as 'no adult
180 specified'. Three NDNS categories, referring to with others, were collapsed into a single
181 'others' category. Finally, the NDNS category 'not specified' whereby participants did not
182 enter into the diary who the child was with when consuming the food was coded as 'not
183 recorded'.

184

185 Other Variables

186

187 Alongside the food diaries, parents provided demographic information and trained field
188 workers measured the children's body weight and height. BMI was calculated from height and
189 weight and children were categorized as having a healthy weight, overweight or obesity using
190 the WHO child growth standards⁽²⁶⁾ for children aged two to three, and using the UK90⁽²⁷⁾ for
191 children aged four and above. Parents also recorded their child's age in years, their gender,
192 their ethnicity and the household income. For the present study we extracted the child's parental
193 Equivalised Household Income to use as an indication of socioeconomic status⁽²⁸⁾ since Indices
194 of Deprivation scores were not available for all survey waves and nations. Equivalised
195 Household Income is the total income of a household after tax and other deductions, divided

196 by the number of household members weighted by age. This variable will be referred to as
197 “household income” throughout.

198
199

200 Data Preparation & Outcomes

201 Food level dietary data, BMI, equivalised household income, ethnicity, gender and age data
202 extracted from each wave and combined into one data set. Energy (kcal), added sugars (g),
203 sodium (mg), saturated fat (g), fruit (g), vegetables (g) and grams from each food or drink item
204 consumed were aggregated based upon serial id, exact meal time and the day of the week to
205 create a total for each eating occasion. Energy density per eating occasion was calculated (total
206 calories/total grams).

207
208

209 Statistical Analysis

210

211 Means and standard deviations of energy (kcal), total added sugars (g), total sodium (mg),
212 energy density (kcal per gram), total saturated fat (g), total fruit (g), total vegetables (g) and
213 total grams (g) consumed per eating occasion when children were with the different
214 accompanying adults were calculated to explore any initial associations between intake and
215 accompanying adult. Regression analysis was then used to explore these associations further.
216 Separate models were used to examine the main effect of each level of the “WhoWith” variable
217 on each of the dietary outcomes (energy (kcal), total added sugars (g), total sodium (mg),
218 energy density (kcal per gram), total saturated fat (g), total fruit (g), total vegetables (g) and
219 total grams/eating occasion). Generalised linear models using clustered robust standard errors
220 were used to control for multiple responses per participant. Sampling weights were applied in
221 accordance with guidance from the NDNS. The models included gender, age, ethnicity (White,
222 Mixed Ethnic group, Black or Black British, Asian or Asian British and any other group),
223 equivalised household income (low \leq £17,500, middle $>$ £17,500 \leq £32,500 and high
224 $>$ £32,500), and child BMI (normal, overweight and obese) to control for these factors which
225 are known to influence dietary intake ^(22,24,25,29).

226

227 Over 10% of the sample (n= 291) had missing data for child BMI and/or household equivalised
228 income data, which equated to 7769 missing eating occasions. Assuming this data was missing
229 at random, multiple imputations (n=20) were performed for these two variables using the *mi*
230 *impute* function in stata with *regress* for the continuous household equivalised income variable
231 and *mlogit* for the categorical BMI variable. All variables used in the planned regression model
232 were included in the imputation model to preserve the relationship between the variables of
233 interest ⁽³⁰⁾. The regression analyses were conducted incorporating the average values from the
234 20 imputations for those with missing data in accordance with Rubin’s rules ^(31,32).

235

236 Sub-group analysis

237

238 We examined the influence of household income on dietary intake ⁽²⁵⁾ and the differences in
239 child intake when accompanied by different people. Although the indices of deprivation score
240 (IMD) would have been the optimal measure of socioeconomic status, as it takes into
241 consideration seven different facets of deprivation, IMD score was not available for all waves
242 and all nations. Consequently household income was used as a proxy for socioeconomic status
243 ⁽²⁸⁾. Household income was included in the model as a factor variable in addition to an
244 interaction term between the accompanying person/people and household income categories.
245 This was repeated for each nutritional element (energy (kcal), total added sugars (g), total

246 sodium (mg), energy density (kcal per gram), total saturated fat (g), total fruit (g), total
247 vegetables (g) and total grams (g)).

248

249 Sensitivity Analysis

250

251 As meal occasions (e.g. breakfast, lunch, evening meal, snack) vary in nutritional composition
252 ⁽³³⁾, ideally this should be controlled for in the regression analyses. However, the NDNS dataset
253 does not provide an indication of whether the food eaten is part of breakfast, lunch, the evening
254 meal or a snack, instead, participants record the time that the items were consumed. Although
255 participants' self-identification of meal occasion is frequently used in the literature to define
256 the meal occasion ⁽³⁴⁻³⁶⁾, where this data is lacking, time has been used as an approximation
257 ⁽³⁷⁾. Consequently, a sensitivity analysis was conducted making assumptions based on the time
258 items were consumed to control for meal type in the regression analyses. This assumed that
259 any eating occasion consumed between 6am and 8.59am was breakfast, between 12 noon and
260 1.59pm was lunch, between 5pm and 7.59pm was the evening meal and items consumed at all
261 other times were assumed to be snacks.

262

263 Data files and documentation for the survey were obtained from the UK Data Archive and
264 analysed using Stata version 16.1.

265

266 Results

267

268 Child Characteristics

269

270 Data from 1,218 children were included in the analysis, table 1 presents the child
271 characteristics. There were similar percentages of males and females in the sample and similar
272 percentages of children aged two or three years old however there were slightly less four-year
273 olds (29%). Although a similar number of children were from low- and high-income families
274 (31% and 32% respectively) there were slightly more from middle income families (38%). A
275 greater proportion of the sample were White British and of normal BMI but the distributions
276 of ethnicity and BMI closely reflect national statistics.

277

Table 1. Child characteristics (n =1218)		
	n	%
Child Gender		
Male	634	52%
Female	584	48%
Child Age		
2	426	36%
3	431	35%
4	351	29%
Child Ethnicity		
White or White British	1049	86%
Mixed Ethnic Group	41	3%
Black or Black British	27	2%
Asian or Asian British	72	6%
Other	29	2%
Household EquivInc		
Lowest <£17,500	375	31%
Middle £17,500-£32,499	459	38%
High >£32,500	384	32%
Child BMI		
Normal	847	70%

Over-weight	195	16%
Obese	176	14%

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Descriptive statistics of eating occasions

Across the 1,218 children, 30,652 eating occasions were included in the analysis. The child had most of the eating occasions accompanied by parents (47%) followed by occasions when no adult was recorded as present (18%) and when accompanied by wider family members (17%). The fewest meal occasions were accompanied by a formal childcare provider (2%) or others (3%). In 13% of the eating occasions the accompanying person/people were not recorded.

Table 2. No. of eating occasions by accompanying adult.

		No. of eating occasions	% of eating occasions
Accompanying person/people	Parents	14540	47%
	Wider family	5315	17%
	Formal childcare providers	638	2%
	No adult specified	5421	18%
	Other	862	3%
	Not recorded	3876	13%

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Table 3 presents the mean dietary intake for each nutritional outcome categorised by who the child was with. Children aged two to four years old consumed the greatest amount of energy (kcal), sodium (mg), total grams and vegetables (g) when accompanied by wider family members. The greatest amount of fruit was consumed when children were accompanied by parents. The most energy dense meals (kcal/g) were consumed when children were with wider family members and with others. The greatest amount of saturated fat and added sugars were also consumed when children were accompanied by others. Compared to when children were with parents, they consumed more or the same amount of all dietary outcomes when they were with wider family members. The least amount of energy, saturated fat, sodium, vegetables, total grams and the lowest energy density of meals were consumed when the accompanying people were not recorded by participants. The least amount of added sugars were consumed when children were accompanied by their formal childcare provider. The least amount of fruit was consumed when children were accompanied by wider family and when the accompanying people were not recorded.

Table 3. Mean child nutritional intake at an eating occasion when accompanied by different people.

	Accompanying Person/People (Number of eating occasions)					
	Parents (14,540)	Wider family (5,315)	Formal childcare provider (638)	No adult specified (5,421)	Other (862)	Not recorded (3,876)
Outcome Mean (Standard Deviation)						
Energy (Kcal)	187kcal (144)	205kcal (151)	182kcal (140)	178kcal (146)	209kcal (184)	140kcal (133)
Saturated Fat (g)	2.9g (3.2)	3.2g (3.5)	2.8g (3.0)	2.9g (3.2)	3.5g (3.9)	2.3mg (2.9)
Sodium (mg)	217mg (265)	248mg (283)	228mg (263)	195mg (250)	237mg (276)	141mg (216)
Added Sugars (g)	6.2g (8.9)	7.0g (9.3)	4.7g (7.6)	6.0g (8.8)	7.5g (12.0)	5.3g (8.6)
Total grams (g)	215g (179)	228g (154)	225g (139)	211g (139)	219g (155)	174g (133)
Energy density (kcal/g)	1.8 kcal/g (1.7)	1.9 kcal/g (1.7)	1.7cal/g (1.6)	1.7kcal/g (1.7)	1.9kcal/g (1.8)	1.6 kcal/g (1.8)
Fruit (g)	30g (0.5)	29g (0.7)	43g (2.5)	33g (0.8)	36g (2.9)	29g (0.9)
Vegetables (g)	12g (0.3)	15g (0.4)	13g (1.1)	8g (0.3)	9g (1.4)	7g (0.4)

307 **Regression results:** nutritional intake when accompanied by different caregivers
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Table 4. Results of the regression analyses of child nutritional intake when accompanied by different caregivers.

	Energy Density (kcal/g)		Energy (Kcal)		Sodium (mg)		Added Sugars (g)		Total Grams (g)		Saturated Fat (g)		Fruit (g)		Vegetables (g)	
	Coef. (95%CI)	P Value	Coef. (95%CI)	P value	Coef. (95%CI)	P Value	Coef. (95%CI)	P Value	Coef. (95%CI)	P Value	Coef. (95%CI)	P Value	Coef. (95%CI)	P Value	Coef. (95%CI)	P Value
Parents	Reference															
Family including relatives	0.04 (-0.06 - 0.14)	0.403	15 (7 - 23)	P<0.001	19 (6 - 32)	0.005*	0.6 (0.1 - 1.1)	0.024*	12 (3 - 21)	0.007*	0.2 (0.1 - 0.4)	0.006*	-1 (-3 - 3)	0.757	3 (1-4)	P<0.001
Formal childcare provider	-0.15 (-0.38 - 0.08)	0.204	0 (-23- 23)	0.982	26 (-25 - 78)	0.319	-1.6 (-2.4 - -0.8)	P<0.001	19 (-0.5 - 39)	0.056	-0.1 (-0.5 - 0.3)	0.593	12 (3 - 21)	0.01*	-1 (-5- 2)	0.374
No adults specified	-0.12 (-0.22 - -0.02)	0.016*	-12 (-20 - -4)	0.003*	-25 (-39 - -11)	P<0.001	-0.4 (-0.9 - 0.1)	0.104	-3 (-12 - 6)	0.498	-0.1 (-0.3 - 0.1)	0.169	4 (0 - 7)	0.042*	-4 (-6 - 03)	P<0.001
Other	0.01 (-0.16 - 0.19)	0.887	16 (0 - 32)	0.049*	13 (-11 - 36)	0.286	1.0 (0.1 - 2.0)	0.032*	0 (-15 - 16)	0.989	0.4 (0.1 - 0.7)	0.02*	7 (-1 - 14)	0.085	-3 (-7 - 1)	0.179
Not Recorded	-0.26 (-0.35 - -0.17)	P<0.001	-54 (-62 - -46)	P<0.001	-82 (-94 - -70)	P<0.001	-1.0 (-1.5 - -0.6)	P<0.001	-41 (-48 - -33)	P<0.001	-0.7 (-1.0 - -0.6)	P<0.001	1 (-2 - 4)	0.639	-6 (-7 - -5)	P<0.001

Controlling for Child BMI, Child Age, Child Gender, Equivalised Household Income, Child Ethnicity

*Significant at p<0.05

310 The results from the regression analyses presented in table 4 (full regression results in appendix
311 1) indicate that, compared to when children were with parents, children consumed significantly
312 more energy, sodium, added sugars, total grams, saturated fat and vegetables per eating
313 occasion when accompanied by wider family. This equates to, on average, an additional 15
314 calories, 19mg of sodium, 0.6g of added sugars, 0.2g of saturated fat and 3g of vegetables per
315 eating occasion. Furthermore, children consumed an additional 12 grams of food per eating
316 occasion when accompanied by wider family members. No significant differences were found
317 between the energy density of eating occasions and the amount of fruit consumed when
318 children were with their parents versus when they were with wider family members.

319
320 When children were accompanied by a formal childcare provider, they consumed significantly
321 less added sugars (-1.6g) and significantly more fruit (12g) per eating occasion than when they
322 were with their parents. No significant differences were found between parents and formal
323 childcare providers for the other dietary outcomes.

324
325 When no adults were specified, children ate significantly less energy (-0.12kcal), sodium (-
326 25mg) and vegetables (-4g) and significantly more fruit (4g) per eating occasion than when
327 there were with their parents. They also consumed significantly lower energy-dense eating
328 occasions (-0.12kcal.g).

329
330 When who the child was with was not recorded, children ate significantly less energy (-54
331 kcal), sodium (-82mg), added sugars (-1.0g), saturated fat (-0.7g) and vegetables (-6g) than
332 when accompanied by parents. They also consumed significantly less weight in grams (-41g),
333 with significantly lower energy density (-0.26 kcal/g).

334
335 When children were accompanied by others they ate significantly more energy (16kcal), added
336 sugars (1.0g) and saturated fat (0.4g) per eating occasion compared to when they were
337 accompanied by their parents. When no adult was specified, children ate significantly less
338 energy (-12kcal) and sodium (-25mg) per eating occasions and of lower energy density (-0.12
339 kcal/g).

340
341 Influence of household income on child nutritional intake

342
343 Further analysis was conducted to explore the influence of household income on child intake.
344 Children in families in the high-income category (>£32,500 equivalised household income)
345 consumed significantly, less sodium (-32mg, p=0.001) and lower energy dense meals (-0.2
346 kcal/g, p=0.025) than children in the low-income category (£<17,500). Children in the middle-
347 income category (£17,500-£32,500) consumed less sodium (-27mg, p=0.006) and lower energy
348 dense meals (-0.1 kcal/g, p=0.025) compared with children in the low-income category
349 (£<17,500). Very few significant interactions were found between income and accompanying
350 people. Children from families in the high-income group (> £32,500) consumed significantly
351 higher energy dense meals when accompanied by wider family members (0.3 kcal/g, p=0.014)
352 compared with children in the low-income group (< £17,500) when accompanied by parents.
353 There were no other significant interactions between wider family members and income status
354 for other nutritional elements.

355
356 Significant interactions were found between the household income status and when children
357 were accompanied by formal childcare providers, when no adult was specified and when not
358 recorded. When children from the high-income group were accompanied by formal childcare

359 providers they consumed significantly more sodium (116mg, $p=0.033$) than children from
360 families in the low-income group when accompanied by parents. Also, when children from the
361 high-income group were with their formal childcare providers they consumed significantly
362 more vegetables (7g, $p=0.017$) than children from families in the low-income group when
363 accompanied by parents. When no adults were specified, children from families in the high-
364 income group consumed significantly fewer total grams per eating occasion (-28, $p=0.014$)
365 than children from families in the low-income group when accompanied by parents. When who
366 the child was with was not recorded, children from families in the high-income group
367 consumed significantly less total grams (-19g, $p=0.049$) than children from families in the low-
368 income group when accompanied by parents. When who the child was with was not recorded,
369 children from families in the middle-income group consumed significantly more vegetables
370 (14g, $p<0.001$) than children from families in the low-income group when accompanied by
371 parents. Full tables of results can be found in appendix 2.

372

373 **Results of the Sensitivity Analysis**

374

375 The sensitivity analysis used assumptions based on the time items were consumed to control
376 for meal type (i.e breakfast, lunch, evening meal or snack). Across the nutritional elements,
377 whether the results were significant or not did not change for most of the categories of
378 accompanying people. However, controlling for meal type led to some differences in the results
379 of the regression analyses for dietary intake when accompanied by formal childcare providers
380 and when no adult was specified. There was no longer a significant increase in children's
381 consumption of fruit when accompanied by formal childcare providers compared to parents
382 and unlike in the base case analysis, children consumed significantly more total grams (33g)
383 per eating occasion with formal childcare providers compared to with parents. There was no
384 longer a significant reduction in energy (kcal) or increase in fruit (g) intake when no adults
385 were specified. Additionally, the significant difference observed for sodium consumption or
386 vegetable consumption when accompanied by wider family were no longer evident. Full tables
387 of results can be found in appendix 3.

388

389

390 **Discussion**

391

392 This study explored the dietary intake of children aged two to four years old when accompanied
393 by different adults, using data from the UK National Diet and Nutrition Survey. The results
394 demonstrate that preschool children consume larger portion sizes of meals, containing more
395 vegetables, and higher in energy, salt, saturated fat and added sugar content when with wider
396 family members compared to when with parents. However, parents and wider family members
397 may provide similar amounts of fruit to preschool aged children as no differences in fruit intake
398 was found when children were with parents versus wider family members. In contrast,
399 preschoolers appear to be consuming more fruit when they are with their formal childcare
400 providers, since fruit intake was higher when children were with their formal childcare
401 providers compared to when they were with their parents. Formal childcare providers also
402 appeared to be providing foods significantly lower in added sugars compared to parents.

403

404 While the differences in nutrient intakes are relatively small, this study focused on individual
405 eating occasions and considering that children of this age are recommended to consume three
406 meals and two snacks per day⁽³⁸⁾, these differences can add up. For instance, in the current
407 study the difference of 15 calories per eating occasion found between parents and wider family
408 could equate to an additional 75 kcal per day or 525 kcal per week. It was already known that

409 children in the UK consume over double the recommended amount of added sugar per day ⁽²⁾
410 but our study shows that this is even more likely when accompanied by wider family members
411 versus by parents.

412

413 This study found that children were consuming significantly less energy, sodium and lower
414 energy dense meals when no adult was specified. This includes meal occasions accompanied
415 by friends and siblings. Similarly, it is also worth noting the significantly lower intakes found
416 for all dietary outcomes when who the child was with was not recorded. It is unknown why
417 this may be and indeed the results may reflect actual intake but they may also reveal
418 inaccuracies in the dietary assessment method. Underreporting is the most common
419 misreporting error in dietary assessment ⁽³⁹⁾ and may explain the significantly lower intakes
420 recorded. As participants forgot to record the 'who with' response parents may have been
421 distracted or busy when completing the diary, or it might indicate when they forgot to complete
422 the diary prospectively and completed it at another time point. Likewise, when no adult was
423 specified, children were accompanied by siblings or friends and may also have meant that
424 respondents were less focused on completing the diary. Any of these factors could impact upon
425 the accuracy of the food diary entries and consequently the validity of these results ⁽⁴⁰⁾.

426

427 The results of this study suggest that children are consuming more fruit when with formal
428 childcare providers compared to with parents. This finding reflects the existing literature
429 exploring childminders' food provision to preschoolers, whereby in a UK study of eight
430 childminders, childminders relied heavily on fruit as a snack food item ⁽¹⁴⁾. Children were also
431 consuming significantly less added sugars with formal childcare providers, which is in line
432 with previous research demonstrating that childminders can successfully identify foods high in
433 sugar and are confident in limiting unhealthy snacks and sugary drinks ⁽⁴¹⁾. Due to the paucity
434 of research carried out on food provision and eating behaviours in UK formal childcare settings,
435 the current findings also conflict with a previous piece of research on food provision in formal
436 childcare. Moore et al. reported that children were not frequently provided with fruit or
437 vegetables with the main meal in formal childcare settings ⁽¹²⁾. One explanation for this
438 discrepancy is that the previous study was conducted prior to the introduction of the Voluntary
439 Food and Drink Guidelines for Early Years Settings in England ⁽⁴²⁾ and that the current results
440 reflect the changes made by nursery settings in light of this guidance.

441

442 Our findings on fruit and vegetable intake align with a previous study exploring fruit and
443 vegetable consumption and the eating context using data from 2008-2010 of the NDNS ⁽²⁰⁾.
444 For instance, similar to the significantly greater intake of vegetables when accompanied by
445 wider family observed in our study, Mak et al. ⁽²⁰⁾ found that young children were more likely
446 to consume vegetables when with adult relatives. Likewise Mak et al. found that young children
447 were also more likely to consume fruit when they were with their formal childcare providers
448 and when they were with friends ⁽²⁰⁾; reflecting the significantly greater intake of fruit that we
449 found for children when with formal childcare providers and when no adult was specified, a
450 category which included being with friends. However some of our results differ from this study;
451 Mak et al. ⁽²⁰⁾ found that young children were more likely to consume vegetables when with
452 formal childcare providers compared to when they were with their parents alone but we found
453 no such differences in vegetable consumption. This difference may arise from the size of the
454 study, for instance our study combined data from three waves of the NDNS (2008-2011, 2012-
455 2014 and 2014-2016) and used multiple imputation to account for missing data, resulting in
456 over 30,000 eating occasions. In contrast Mak et al conducted a complete case analysis on data
457 from only two years' of the NDNS dataset resulting in less than 5000 eating occasions for
458 children aged 1.5 to 3 years old ⁽²⁰⁾.

459

460 It is unknown who the wider family members were in our study, however, a survey of childcare
461 in England found that informal childcare of children in the early years is mostly provided by
462 grandparents⁽¹⁰⁾ and our results are consistent with the qualitative literature on grandparent's
463 food provision to preschool aged children. For instance, parents frequently complain of
464 grandparents providing their preschool aged grandchildren unhealthy options, high in fat and
465 sugar^(21,43-45). Yet previously no study actually measured children's nutritional intake when in
466 the care of grandparents so it was unknown if these parental reports are accurate. Our findings
467 seem to support this by demonstrating that preschool aged children consume greater amounts
468 of saturated fat, sugar and salt when accompanied by wider family members. Additionally
469 parents often complain that grandparents provide large portions sizes to their preschool aged
470 children^(21,45-47). The provision of large portions prompts over consumption⁽⁴⁸⁾ and is a key
471 driver of weight gain in young children^(49,50). Children in this study consumed significantly
472 more total grams at a meal when with wider family members suggesting that the portion sizes
473 provided by family members could also be larger than those provided by parents.

474

475 One explanation for the increase in child consumption when accompanied by wider family
476 members compared to parents is the effect of social facilitation. This is where the more people
477 there are in a group eating, the more each individual will consume⁽⁵¹⁾. The social facilitation
478 effect on food consumption has been demonstrated widely in both adults and children and
479 increases with the familiarity of the group^(52,53). When with wider family members, it is
480 unknown how many people the children were accompanied by and therefore the increase in
481 consumption, of both energy (kcal) and portion size (g), may not be a direct result of the food
482 provision practices of family members but influenced by the social situation. The social
483 facilitation effect might also explain why children consumed more fruit when with formal
484 childcare providers as it's likely that children would have been accompanied by other children
485 in the childcare setting. Similarly it could be an effect of peer-modelling, whereby fruit and
486 vegetable consumption can be increased in children when they observe peers consuming such
487 items⁽⁵⁴⁾. However, contrary to these theories, no increase in consumption was found when
488 no accompanying adult was specified, which included times when children were with friends
489 and siblings. Highlighting the need for more detailed information on "who with" and "where"
490 eating occasions occur.

491

492 An income gradient was seen in children's consumption whereby children of higher income
493 families consumed less sodium, and lower energy dense meals than children of lower income
494 families. This is in line with previous studies which have demonstrated how children from
495 families of higher socioeconomic status consume more healthful diets than children from
496 families of lower socioeconomic status^(24,25). However, when the interaction between the
497 child's household income and who children were accompanied by was explored the results
498 were mixed. In line with the social gradient, children of higher income families consumed
499 significantly more vegetables when with their formal childcare providers compared to children
500 of low-income families when accompanied by their parents. However, contrary to this
501 gradient, we found that higher income was associated with the consumption of higher energy
502 dense meals when with wider family members, and more sodium when with formal childcare
503 providers compared to children of low-income families when accompanied by parents. Our
504 measure of income was for the child's household, we did not have the income details of the
505 people the children were accompanied by. Considering an intergenerational transmission of
506 socioeconomic status has been consistently demonstrated⁽⁵⁵⁾, it could be assumed that the wider
507 family members and parents would be of a similar status, but the same cannot be said for formal
508 childcare providers such as childminders. Future research should capture socioeconomic

509 indices of the accompanying caregivers rather than just those of the child and further consider
510 how socioeconomic status influences the relationship between caregiver type and child intake.
511
512

513 To the authors knowledge this is the first study to explore the association between young
514 children's nutritional intake and caregiver type in the UK, providing evidence that further
515 research is required in this area to effectively design targeted childhood obesity interventions.
516 The NDNS provides high quality data on food and nutrition consumption and benefits from a
517 large and representative sample. Consequently, the results provide a good indication of how
518 children in the UK consume diets of a differing quality depending on who is looking after them.
519 Nevertheless, several limitations are noteworthy. First, although the sample includes children
520 from a range of deprivation levels and ethnicities, representative of the UK population ^(56,57),
521 being UK specific, these findings may not generalize to outside of the UK. Nevertheless,
522 similarities can be seen with studies in the USA where preschoolers' consume more fruit and
523 vegetables in the childcare setting than at home ^(58,59).
524

525 Second, this study considers individual eating occasions, rather than investigating dietary
526 intake over a whole day. In the past, studies have found that young children self-regulate their
527 food consumption to keep their daily caloric intake constant ^(60,61), and therefore focusing on
528 individual eating occasions may fail to account for any compensatory behaviour. However
529 more recent evidence suggests there is large individual variability in self-regulation ⁽⁶²⁾ and that
530 by the time children reach the preschool years this ability has mostly diminished as eating
531 becomes more influenced by external cues ⁽⁶³⁻⁶⁵⁾. Importantly, looking at individual eating
532 occasions may be the most appropriate way to explore the influence of different caregivers on
533 young children's diets as children of this age may be fed by multiple caregivers across a 24-
534 hour period. Additionally, caregivers might influence children's consumption indirectly
535 through the feeding practices or behaviours they use to guide children's eating behaviour, such
536 as modelling healthy eating, restricting food and drink items or pressuring children to eat ⁽⁶⁵⁾.
537 Although some feeding practices can lead to positive dietary outcomes others can have
538 unintended and negative effects ⁽⁶⁶⁻⁶⁸⁾. Our recent work suggests that there are no differences
539 between parents and grandparents feeding practices when caring for preschool children ⁽⁶⁹⁾,
540 however differences in feeding practices between childcare staff and parents have been
541 identified ⁽⁷⁰⁾. Future work should aim to further explore how feeding practices of friends, other
542 family members and childminders might also differ to parents and potentially impact upon
543 preschoolers' consumption.
544

545 Nutritional composition can also vary across meals and snacks ⁽³⁴⁾ however, data on the specific
546 meal being consumed by children or whether foods were consumed as a snack was not
547 explicitly available within the NDNS dataset. Although this was attempted in the sensitivity
548 analysis using crude assumptions based on the times eating occasions occurred. Controlling for
549 meal type resulted in some differences in the regression analysis for dietary intake when
550 children were accompanied by formal childcare providers, and when no adult was specified,
551 compared to the base case analysis. There was no longer a significant increase in fruit intake
552 for formal childcare providers versus parents. However, it is likely that the change in fruit
553 intake when accompanied by formal childcare providers is due to formal childcare providers
554 offering a higher proportion of lunches and snacks compared to parents (data not shown). The
555 sensitivity analysis shows that lunches contain significantly more fruit and it is likely that the
556 base case analysis is capturing this and assigning it to the formal caregivers category. The
557 sensitivity analysis also demonstrates that children consumed approximately 33g more food
558 overall per eating occasion with formal childcare providers compared to parents. However,

559 rather than contradicting the findings of the base case analysis these findings confirm the
560 overall trend. Furthermore, there was no longer a significant reduction in energy consumed or
561 increase in fruit intake when no adults were specified. The changes to these findings are likely
562 also to be driven by the types of foods in specific meals or snacks consumed when no adults
563 are present. Differences in sodium and vegetable intake when accompanied by wider family
564 were no longer statistically significant in the sensitivity analysis. In both cases the magnitude
565 of the coefficient has reduced, however, the direction did not change. It is worth noting that
566 only a crude assumption of meal time was applied to the sensitivity analysis and therefore these
567 results should be interpreted with some caution since “time of day” categories of eating
568 occasions can eliminate foods consumed outside of traditional meal and snack patterns.
569 Similarly, if a “participant identified” approach to categorising meal times had been adopted
570 the data might be subject to bias from an individual’s interpretation of what constitutes a meal
571 or snack⁽⁷²⁾. This highlights the need for clearly defined, objective and accurate information
572 on meal times to be specified within the NDNS data set. This would allow researchers to
573 accurately define the food types that are consumed as part of specific meals and snacks.
574

575 A further limitation lies within the categories used to classify who the children were with when
576 consuming food and drink items. Although the authors have tried to categorize the
577 accompanying adults as best as possible, detailed information for the wider family category or
578 the formal childcare category were not available. For instance, although there were separate
579 categories for when children were with their parents it was not possible to distinguish between
580 different family members within the wider family category or different childcare types within
581 the formal childcare category. Consequently, the results cannot provide more detailed accounts
582 of who the children were with when consuming foods for instance an auntie versus a
583 grandparent. Additionally, it is unknown how many people the children were accompanied by
584 when eating and the data set only contained information on who the children were with, not
585 who specifically provided food to the children. There could have been occasions when parents
586 provided food for their child to take to formal childcare settings.
587

588 For a lack of more robust evidence, this study indicates significant differences in young
589 children’s dietary intake depending on which caregivers they are with. It demonstrates the need
590 for a more focused exploration of the diets of young children when cared for by people other
591 than parents. This includes different family members such as grandparents, aunties or uncles
592 as well as care providers such a childminders and nurseries. Further research is needed to
593 explore these differences in more detail and ensure that studies are designed to encompass more
594 than just a single food group to understand the overall influence these caregivers are having on
595 preschoolers’ diets. Adopting a measure of diet quality would also improve future studies since
596 these data would also allow for researchers to more easily identify those children at increased
597 risk of not consuming optimal diets. These data are also useful for comparing dietary intake of
598 specific groups, with different caregivers, to current dietary intake guidelines and
599 recommendations, and for evaluating the effectiveness of interventions. This study also does
600 not reveal anything about the frequency of food consumption when children are with different
601 caregivers. Although caregivers are encouraged to provide some snacks to children of this age,
602 the frequency in which young children consume snacks can have a significant effect on daily
603 energy intake ⁽⁷³⁾. Consequently, future work should also explore any differences in the
604 frequency of food provision between different caregivers.
605

606 Several implications for policy and practice have been highlighted in this study. The results
607 suggest that other caregivers may be an important target to promote healthy eating in young
608 children. To do so it will be necessary to understand what type of strategy is most appropriate

609 for reaching and engaging these caregivers. Although UK public health strategies, such as front
610 of pack labelling, exist to reduce young children's fat, sugar and salt intake, many young
611 children are consuming diets low in fruit and vegetables, high in energy, sodium and sugar ⁽²⁾,
612 and large portion sizes of high energy-dense snack food items^(74,75) . Current methods may not
613 be reaching these care providers or they might not realise they need support in their provision.
614 Non-parental caregivers may assume different feeding roles to that of parents and an awareness
615 of this is needed to design effective strategies.

616
617 In conclusion, this study takes a novel approach to explore the influence of different caregivers
618 on young children's diets. Using a large representative UK sample, we have demonstrated that
619 preschool children consume meals/snacks higher in energy, saturated fat, sugar and salt, but
620 containing greater amounts of vegetables, with wider family members compared to when they
621 are with their parents. Differences were also observed when preschool children were with
622 formal childcare providers; more fruit and less added sugars were consumed by preschool
623 children when with formal childcare providers compared to when they were with their parents.
624 Even though parents may be the primary caregiver to young children, other caregivers can play
625 a pivotal role in the dietary habits of young children. Nevertheless, further research should seek
626 to explore these differences in more detail.

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633
634

635 636 **Conflict of Interests Statement**

637
638 None

639 640 **Author Contributions**

641
642 Conceptualization: C.M., P.B. and S.J.C; Methodology: C.M., P.B. and S.J.C; Formal
643 Analysis: C.M.; Writing-Original Draft Preparation; C.M.; Writing-Review and Editing:
644 C.M., P.B and S.J.C.

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