

An exploration of the longitudinal relation between parental feeding practices and child anthropometric adiposity measures from the West Midlands Active Lifestyle and Healthy Eating in Schoolchildren (WAVES) Study

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An exploration of the longitudinal relationship between parental feeding practices and child anthropometric adiposity measures from the WAVES study

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Short running head: Parent feeding, child eating, and weight status

Abbreviations:

BMI	Body Mass Index
CEBQ	Child Eating Behaviours Questionnaire
CFPQ	Comprehensive Feeding Practices Questionnaire
IMD	Index of Multiple Deprivation
WAVES	West Midlands ActiVe lifestyle and healthy Eating in School children study
UK	United Kingdom

1 *Abstract:*

2 **Background:** Some research suggests that parent/carer feeding practices may
3 influence children's weight patterns, but longitudinal evidence is limited and
4 inconsistent.

5 **Objective:** To investigate the relationship between various parent/carer feeding
6 practices when a child is 7-8 years and proxy measurements of child adiposity at 8-9
7 years (weight status, waist-to-height ratio, and body fat percentage).

8 **Design:** Secondary analysis of data from the West Midlands Active lifestyle and
9 healthy Eating in School children (WAVES) study comprising a diverse sample of
10 parents/carers and their children from 54 primary schools in the West Midlands,
11 England (n= 774 parent-child dyads (53% of the WAVES study sample)). Information
12 on feeding practices was collected using subscales from Comprehensive Feeding
13 Practices Questionnaire, completed by the child's main parent/carer (self-defined).
14 Child height, weight, body fat percentage, and waist circumference were measured
15 and converted into three proxy measurements of adiposity (weight status, waist-to-
16 height ratio, and body fat percentage). Associations between these measurements
17 and parent/carer feeding practices were examined using mixed-effects logistic
18 regression models.

19 **Results:** Of the questionnaire respondents, 80% were mothers, 16% were fathers
20 and 4% other carers. Median standardised subscale scores ranged from 1.7
21 (Interquartile Range=1.0; (emotion regulation)) to 4.0 (Interquartile Range =1.5;
22 (monitoring and modelling)) and significantly different subscale scores were present
23 between child weight statuses for emotion regulation, pressure-to-eat, and restriction

24 for weight control. Logistic regression modelling showed that when baseline
25 adiposity measures were included as covariates, all associations between parental
26 feeding practices at age 7-8 years and measures of adiposity at age 8-9 years were
27 attenuated.

28 **Conclusions:** Observed relationships between various parental feeding practices
29 and later are mitigated by inclusion of the baseline adiposity measure. This finding
30 lends support to the theory of reverse causation, whereby the child's size may
31 influence parental choice of specific feeding practices, rather than the child's
32 subsequent weight status being a consequence of these feeding practices.

33 **Introduction:**

34 Excess weight in children is an important public health concern, with adverse
35 physical and psychosocial consequences in childhood, and increased risk of
36 morbidity and mortality in later life (1, 2). Two recent reviews have highlighted that
37 common environmental factors, such as parent feeding practices, have a substantial
38 effect on Body Mass Index (BMI) from childhood through to adolescence (3) and that
39 parental food habits and feeding practices are the most dominant family system
40 determinants of children's eating habits and food choices (4). There is also evidence
41 of 'intergenerational ripples', whereby parents develop their feeding practices based
42 on their own childhood feeding experience (5). Therefore, understanding the effect of
43 parental feeding practices on children's adiposity has been identified as a research
44 priority, as it could inform the development of interventions with potential impact
45 beyond the current generation (6).

46 Parent feeding practices relate to the specific methods and behaviours that parents
47 employ to influence children's behaviour, health, or weight (7, 8) and are distinct
48 from the more generalistic parent feeding style which typifies the levels of
49 demandingness and responsiveness a parent expresses in feeding and eating
50 interactions (9, 10). Examples of parental feeding practices include pressuring
51 children to eat certain foods, using food as a reward, or not allowing the child to eat
52 certain foods. Evidence from a variety of studies suggests that certain parent feeding
53 practices are associated with child weight status. For example, restrictive feeding
54 practices are associated with higher weight status (11-16), whilst pressure to eat is
55 related to lower weight status (11, 15-18). However, these findings are inconsistent
56 and sometimes conflicting (18-22), particularly in relation to other parent feeding

57 practices (for example, using food as a reward (15, 16, 19, 20)). A number of
58 methodological limitations in previous studies constrain potential interpretation. For
59 example, most were cross-sectional in nature, and the measures of adiposity used
60 have been limited, with few previous studies using multiple measures such as waist-
61 to-height ratio or body fat percentage. Additionally, previous studies rarely consider
62 how child characteristics influence parental feeding practices. Shloim *et al.* (2015)
63 noted in their systematic review of studies (n = 31) that, where child characteristics
64 were measured, the parental feeding practices employed were responsive to the
65 child. For example, more restriction was seen in children with greater adiposity or
66 greater perceived food approach tendencies and more pressure to eat in thinner
67 children or those perceived to be undereating (10). However, the direction of the
68 proposed effect is still ambiguous. Therefore, it is important to consider the
69 possibility of reverse causation, whereby parental use of specific feeding practices
70 may be driven by a child's weight status, rather than subsequent child weight status
71 being a consequence of them. Additionally, much of the research focus in this area
72 has been on young children and so little is known about whether a relationship
73 between these factors exists in older children when they begin to exert some level of
74 autonomy over their food decisions.

75 This study investigates the relationship between parent feeding practices when
76 children are aged 7-8 years, and their adiposity measures at 8-9 years, using a
77 socially and ethnically diverse sample of UK families. Adiposity is assessed through
78 the primary outcome of weight status based on BMI z-score and the secondary
79 outcomes of waist-to-height ratio, and body fat percentage.

80

81 Methods:

82 We conducted a secondary analysis of data collected between 2011 and 2014 at
83 baseline (T0: children aged 5-6 years), first (T1: children aged 7-8 years) and second
84 (T2: children aged 8-9 years) follow-up for the **West Midlands ActiVe** lifestyle and
85 healthy **Eating in School** children (WAVES) study; a cluster-randomised controlled
86 trial evaluating the clinical and cost-effectiveness of an obesity prevention
87 programme in an ethnically diverse population of children from the West Midlands,
88 UK. National Health Service Research Ethics approval for the WAVES study was
89 obtained from the Black Country Research Ethics Committee (NHS REC
90 no.10/H1202/69) and the trial was registered in May 2010 (ISRCTN97000586).

91 The WAVES study cohort was recruited from 54 state-funded primary schools in the
92 West Midlands, UK. Written informed consent was obtained from parents and verbal
93 assent was obtained from each child prior to measurements commencing. Further
94 information can be found in the WAVES study protocol (23).

95 Trained researchers, blind to the WAVES study trial arm allocation, measured the
96 height, weight and waist circumference of each child in school at each time point,
97 using validated instruments (Leicester Height Measure MK II (Harlow Healthcare,
98 UK) and Tanita BC-420MA Class 111 Body Composition Analyser (Tanita, Japan))
99 and standard protocols (23). Child weight status was dichotomised into individuals
100 with overweight (including individuals with obesity) or individuals without overweight
101 using the age and sex specific 85th centile cut-off from the UK 1990 growth reference
102 charts (24). Waist-to-height ratio was calculated by dividing the child's waist
103 circumference (cm) by their height (m) and dichotomised into high or low risk using a
104 threshold of 0.5 (25, 26). Body fat percentage was calculated using bioelectrical

105 impedance (27) and was dichotomised using the age and sex specific threshold for a
106 high body fat percentage for each child provided by Tanita® (28).

107 Data on parent feeding practices were collected through a self-administered
108 questionnaire booklet sent home for completion by the child's main parent or carer
109 (self-defined) at T1. Subscales of the Comprehensive Feeding Practices
110 Questionnaire (CFPQ) were used to assess a wide range of parent feeding practices
111 (29). The CFPQ has been shown to be valid in children up to twelve years old (22,
112 29, 30) and in varied cultural contexts (30-32). To keep respondent burden to a
113 minimum, only the following subscales were included in the WAVES study parent
114 questionnaire: child control; emotion regulation; environment; food as a reward;
115 modelling; monitoring; pressure to eat; and restriction for weight control. Minor
116 wording changes from the original questionnaire were applied to make the tool
117 appropriate for a UK population e.g. replacing 'Soda' with 'Fizzy pop'.

118 Likert scales ranging from one (never) to five (always) scored each item. For ease of
119 interpretation, item scores were summed, and then divided by the number of items in
120 the subscale. Subscale scores were not calculated if there were missing data from
121 more than one (3-5 item scales) or two (6-8 item scales) item(s). Where subscale
122 scores were calculated with missing data, the subscale was standardised using the
123 completed number of items as the denominator. Questionnaire subscale response
124 rates ranged from 89% (modelling) to 92% (emotion regulation). All questionnaire
125 subscales had moderate to good internal consistency with Cronbach Alphas (α)
126 ranging from 0.6 (environment) to 0.9 (monitoring).

127 Parent reported home postcodes, mapped to the English Indices of Multiple
128 Deprivation 2007 (IMD), were used as a measure of socioeconomic status (using the

129 quintile cut offs for England) (33). Child eating behaviour subscales of 'food
130 responsiveness', 'enjoyment of food' and 'emotional over eating' were collected from
131 the Child Eating Behaviour Questionnaire (CEBQ) embedded within the WAVES
132 parent questionnaire booklet. Scoring of these subscales was conducted in the same
133 manner as the CFPQ. As these three CEBQ subscales all represent eating
134 behaviours that potentially lead to greater food intake, they were combined to create
135 one "food approaching eating behaviour" score. Other relevant information (parent
136 age and ethnicity (using the UK census ethnic group categories (34))) were also
137 collected through the WAVES study parent questionnaire booklet. Where parent
138 ethnicity was missing, child ethnicity from school records was used as a proxy.

139 Parents and children participating in the WAVES study were included in the present
140 study if a questionnaire booklet was returned at T1 and any child anthropometric
141 adiposity measurement (weight status, waist-to-height ratio or body fat percentage)
142 was available at T2. Statistical analysis was performed using STATA 13 (StataCorp
143 LP, US) and, due to multiple tests being performed, a conservative *a priori*
144 significance level of 1% (two-sided) was utilised. Descriptive statistics to summarise
145 participant characteristics are presented by child weight status. The internal validity
146 of all questionnaire subscales was assessed using Cronbach Alpha.

147 To account for the clustered nature of the sample, mixed-effects logistic regression
148 models were used to evaluate the relationship between CFPQ subscales and each
149 anthropometric outcome measure. Three models were developed. Model 1 was
150 adjusted only for the WAVES study trial arm allocation (fixed effect) and school
151 attended (random effect) to account for the data being collected after delivery of the
152 WAVES study intervention and the clustered nature of the sample. Model 2 was
153 additionally adjusted for the sex of the child, child food approaching feeding

154 behaviour score, IMD score (deprivation index), and parent level factors (age and
155 ethnicity). Model 3 was further adjusted for T0 values for the outcome measure (BMI
156 z-score, waist-to-height ratio or body fat percentage) to investigate whether any
157 associations exist independently of baseline values.

158 To consider the impact of missing data on the relationships investigated, all further
159 adjusted models (Model 3) were repeated on a dataset where missing covariate
160 information was imputed. Generation of imputed datasets was conducted in
161 REALCOM-Impute (35) to account for the clustered nature of the sample, imported
162 into STATA using the realcomImputeLoad command, and analysed in STATA 13.
163 Generation of imputed datasets included the following incomplete variables: T2
164 outcome of interest, T0 outcome measure, child food approaching eating behaviour
165 composite score, parent age, parent ethnicity (White, South Asian, Black African-
166 Caribbean and Mixed/Other ethnicities), deprivation score of household (IMD 2010).
167 Additionally, the following complete variables were included to improve the accuracy
168 of the imputation: sex of the child, WAVES study trial arm, school level free school
169 meal entitlement proportion, and school level ethnic mix (White, South Asian, Black
170 African-Caribbean and Mixed/Other ethnicities). The results of ten imputed datasets
171 were pooled to produce imputation estimates.

172 **Results:**

173 There were between 716-774 parent-child dyads included in these analyses (49-53%
174 of the WAVES study participants, **Figure 1**). Parents of White children were the most
175 likely to respond to the questionnaire (64%) and parents of Black children were least
176 likely to respond (44%). Additionally, there was a graded response rate across the
177 deprivation quintiles, with the highest responses coming from the least deprived

178 quintile (75%) and the lowest from the most deprived quintile (53%). There was no
179 difference in the response rates according to the age or sex of the child
180 **(Supplemental Table 1)**.

181 Child and parent characteristics at T2 (aged 8-9 years) are described by child weight
182 status in **Table 1**. Overall, 80% of responders were mothers, 16% fathers, and 4%
183 other relatives (e.g. grandmother, stepfather, or aunt). The mean parent age was
184 36.7 years (standard deviation (SD) 6.7 years). Additionally, almost a third of
185 children were identified with overweight (30.6%). A slightly higher proportion of boys
186 than girls had overweight and children of a mixed, Black or South Asian ethnicity
187 were more likely to have overweight than White children, which is in line with
188 England averages (36). However, there was only a significant difference in children
189 of a Black ethnicity.

190 High median scores were seen in the parent feeding practices of monitoring and
191 modelling (median scores 4.0 (Interquartile range (IQR) 1.5)), indicating that parents
192 employed these practices most frequently (**Figure 2**). Significant differences
193 between weight status groups were evident for the parent feeding practices of
194 emotion regulation, pressure to eat, and restriction for weight control, with parents of
195 children with overweight using more restriction and emotion regulation and less
196 pressure to eat.

197 ***Association with proxy measures of child adiposity***

198 Similar patterns emerged across all proxy measurements for adiposity (**Figure 3**). In
199 Models 1 (minimal adjustment) and 2 (which accounted for most covariates), a
200 significantly increased risk of overweight, central adiposity, or high body fat
201 percentage were found if parents employed restriction and a significantly decreased

202 risk if parents employed pressure to eat. However, after the inclusion of a baseline
203 measure for the adiposity outcome being considered (Model 3), the effect sizes were
204 reduced and these associations were no longer significant. Interestingly, a
205 significantly lower risk of adiposity, measured by all three outcomes (risk of
206 overweight, high waist to height ratio, or high body fat percentage), was seen with
207 greater use of food as a reward in Model 2, however in all cases, this association
208 was attenuated in the subsequent model that adjusted for baseline values. Multiple
209 imputation in Model 3 generated results which were similar to the main analyses,
210 whereby no parent feeding practice was significantly associated with any measure of
211 overweight at the 1% level.

212 **Discussion**

213 The aim of this study was to investigate the relationship between parental feeding
214 practices and three proxy measures of child adiposity a year later, in an ethnically
215 diverse sample of UK children. Although there were associations between certain
216 parental feeding practices and measures of child adiposity, inclusion of a baseline
217 adiposity measure attenuated the observed relationships. This finding has two
218 potential explanations. First, it may lend support to the theory of reverse causation,
219 whereby it is the child's level of adiposity that may lead to parental utilisation of
220 specific feeding practices, rather than being a consequence of them. However, it
221 may also be suggestive of a reduced impact of parental feeding practices on
222 adiposity in older children.

223 Before adjusting for baseline values we found significant associations between
224 'restriction for weight control' and 'pressure-to-eat' with child levels of adiposity,
225 which was consistent with previous research findings (13, 16). However, once we

226 included baseline adiposity in the models, the effect sizes approached null and the
227 associations were no longer statistically significant. This suggests that the use of
228 these feeding practices may be in response to initial child weight status (37, 38).
229 Thus, parents of higher weight children may be more likely to implement restrictive
230 feeding practices whilst parents of lower weight children may pressure their child to
231 eat. This complements a finding by Gregory et al. (2010; n = 156) which suggested
232 that mothers' feeding practices may influence children's eating behaviours, but not
233 their weight status after one year in children aged 2-4 years (39). Both the present
234 study and the study by Gregory et al. (2010) had relatively short follow-up periods
235 which limit the ability to capture the impact on weight status of altered eating
236 behaviours as a result of a parent feeding practice. However, Webber et al. (2010;
237 n= 113) also found no significant longitudinal associations between maternal feeding
238 practices and change in child adiposity three years later, in children aged 7-9 years
239 (40).

240 Our findings contradict a body of evidence that suggested restriction is associated
241 with increased child weight, both cross-sectionally (11, 14, 41, 42) and longitudinally
242 (40, 43). Mechanisms to explain why restriction may be a counterproductive feeding
243 practice relate to food becoming more desirable and so consumed in excess when
244 outside of the parent's control (44). Given the larger sample size and longitudinal
245 nature of our study, our findings challenge these previous theories; however, it is
246 important to note that the confidence intervals were wide in Model 3, and in some
247 cases, only just crossed the point of no significance. Additionally, it has been
248 hypothesised that the influence of parental feeding practices may be stronger at
249 younger ages (45-47), and therefore the pre-adolescent age range included in the
250 present study may indicate the point at which children begin to strive for greater

251 autonomy around their feeding and, as such, parental feeding practices begin to
252 have a lesser impact on subsequent child weight. Hence, the null findings in both the
253 present study and that of Webber et al. (2010) may be due to the age group studied
254 (40). Such information is important for future childhood obesity prevention strategies
255 and so further investigations of longitudinal relationships at various ages are needed.

256 Several strengths and limitations are noteworthy within this study. First, whilst the
257 diverse nature of the West Midlands population, the purposeful oversampling of
258 schools with higher proportions of South Asian and Black children in the WAVES
259 study, and the availability of questionnaire responses from the main carer (including
260 mothers, fathers, and other guardians/carers), may have maximised the external
261 validity of the study findings, it also adds an element of heterogeneity to the sample
262 which may reduce the power to detect true effect estimates in certain sub-groups
263 (48). However, the models were developed to control for various demographic
264 factors to counteract this variability. Second, whilst all outcome data were objectively
265 measured by trained researchers, parent data were all self-reported, and child eating
266 behaviour was based on parent perception and therefore may be subject to some
267 social desirability bias. However, validation studies on both the CEBQ and CFPQ
268 have reported that the responses correlate well with observed practices and
269 behaviours and so these questionnaires allow a relatively quick and cost-effective
270 method of collecting this data on a large scale (29, 49). Third, some variables were
271 missing a substantial amount of data. To assess the impact of this missing covariate
272 data, multiple imputation sensitivity analyses were conducted and the results were
273 found to be very similar to the results of the main analyses, increasing the
274 confidence in our conclusions. Additionally, despite the researchers employing

275 numerous techniques to encourage questionnaire completion the parental response
276 rate was relatively low which may bias the results presented.

277 This study has allowed further exploration of a wide range of parent feeding
278 practices and their relationships with a number of proxy measurements for child
279 adiposity. It has extended the current evidence by allowing adjustment for the child's
280 previous level of adiposity and current eating behaviour. The pathway to which
281 parent feeding practices are often hypothesised to impact child adiposity is through
282 changes in dietary behaviour, for example the use of emotion regulation
283 inadvertently encouraging intake of energy dense, nutrient poor foods in times of
284 distress, leading to excess energy intake and overweight over time. Therefore, it
285 would be useful for future research to quantify the impact these feeding practices
286 may have on dietary intake. Additionally, qualitative studies, investigating why
287 parents adopt such feeding practices, would contribute to understanding the complex
288 relationship between feeding practices and weight status. Finally, the findings of this
289 study challenge the notion that parent feeding practices are associated with
290 adiposity, particularly in older children. However, further evidence is needed to
291 evaluate whether this is a result of reverse causation or an artefact of the changing
292 feeding relationship between parents and their growing children.

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298 This article presents independent research and the views expressed are those of the
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300 Health.

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317 **Conflict of Interest**

318 The authors declare no conflict of interest.

319 **Author contributions**

320 PA, MJP and ERL, alongside the WAVES study trial investigators, designed the
 321 original WAVES study research; KLH developed the research plan for this paper,
 322 conducted the data collection and wrote the paper, with significant input from PA,
 323 MJP, and ERL. All authors read and approved the final manuscript.

References

1. Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJH. Health consequences of obesity. *Arch Dis Child* 2003;88(9):748-52. doi: 10.1136/ad.88.9.748.
2. Friedlander SL, Larkin EK, Rosen CL, Palermo TM, Redline S. Decreased quality of life associated with obesity in school-aged children. *Arch Pediatr Adolesc Med* 2003;157(12):1206-11. doi: 10.1001/archpedi.157.12.1206.
3. Silventoinen K, Rokholm B, Kaprio J, Sorensen TI. The genetic and environmental influences on childhood obesity: a systematic review of twin and adoption studies. *Int J Obes (Lond)* 2010;34(1):29-40. doi: 10.1038/ijo.2009.177.
4. Scaglioni S, De Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors Influencing Children's Eating Behaviours. *Nutrients* 2018;10(6):706.
5. Brewis A, Gartin M. Biocultural construction of obesogenic ecologies of childhood: Parent-feeding versus child-eating strategies. *Am J Hum Biol* 2006;18(2):203-13. doi: 10.1002/ajhb.20491.
6. Bergmeier H, Skouteris H, Horwood S, Hooley M, Richardson B. Associations between child temperament, maternal feeding practices and child body mass index during the preschool years: a systematic review of the literature. *Obes Rev* 2014;15(1):9-18. doi: 10.1111/obr.12066.
7. Fisher JO, Birch LL. Restricting access to foods and children's eating. *Appetite* 1999;32(3):405-19. doi: <http://dx.doi.org/10.1006/appe.1999.0231>.
8. Hoerr SL, Hughes SO, Fisher JO, Nicklas TA, Liu Y, Shewchuk RM. Associations among parental feeding styles and children's food intake in families with limited incomes. *Int J Behav Nutr Phys Act* 2009;6:55. doi: 10.1186/1479-5868-6-55.
9. L. VR, Mobley AR. Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. A review. *Appetite* 2013;71:232-41.
10. Shloim N, Edelson LR, Martin N, Hetherington MM. Parenting styles, feeding styles, feeding practices, and weight status in 4-12 year-old children: A systematic review of the literature. *Front Psychol* 2015;6:1-20. doi: 10.3389/fpsyg.2015.01849.

11. Jansen PW, Roza SJ, Jaddoe VWV, Mackenbach JD, Raat H, Hofman A, Verhulst FC, Tiemeier H. Children's eating behavior, feeding practices of parents and weight problems in early childhood: results from the population-based Generation R Study. *Int J Behav Nutr Phys Act* 2012;9(130):1-11.
12. Birch LL, Fisher JO. Mothers' child-feeding practices influence daughters' eating and weight. *Am J Clin Nutr* 2000;71(5):1054-61.
13. Musher-Eizenman DR, de Lauzon-Guillain B, Holub SC, Leporc E, Charles MA. Child and parent characteristics related to parental feeding practices. A cross-cultural examination in the US and France. *Appetite* 2009;52(1):89-95. doi: 10.1016/j.appet.2008.08.007.
14. Joyce JL, Zimmer-Gembeck MJ. Parent feeding restriction and child weight. The mediating role of child disinhibited eating and the moderating role of the parenting context. *Appetite* 2009;52(3):726-34. doi: 10.1016/j.appet.2009.03.015.
15. Webber L, Hill C, Cooke L, Carnell S, Wardle J. Associations between child weight and maternal feeding styles are mediated by maternal perceptions and concerns. *Eur J Clin Nutr* 2010;64(3):259-65. doi: 10.1038/ejcn.2009.146.
16. Rodgers RF, Paxton S, Massey R, Campbell KJ, Wertheim EH, Skouteris H, Gibbons K. Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: a prospective study. *Int J Behav Nutr Phys Act* 2013;10(24):1-10.
17. Spruijt-Metz D, Lindquist CH, Birch LL, Fisher JO, Goran MI. Relation between mothers' child-feeding practices and children's adiposity. *Am J Clin Nutr* 2002;75:581-6.
18. Carnell S, Wardle J. Associations between multiple measures of parental feeding and children's adiposity in United Kingdom preschoolers. *Obesity* 2007;15(1):137-44. doi: 10.1038/oby.2007.513.
19. Montgomery C, Jackson DM, Kelly LA, Reilly JJ. Parental feeding style, energy intake and weight status in young Scottish children. *Br J Nutr* 2007;96(6):1149-53. doi: 10.1017/bjn20061968.
20. Haycraft EL, Blissett JM. Maternal and paternal controlling feeding practices: reliability and relationships with BMI. *Obesity* 2008;16(7):1552-8. doi: 10.1038/oby.2008.238.
21. Brown KA, Ogden J, Vogele C, Gibson EL. The role of parental control practices in explaining children's diet and BMI. *Appetite* 2008;50(2-3):252-9. doi: 10.1016/j.appet.2007.07.010.
22. Baughcum AE, Powers SW, Johnson SB, Chamberlin LA, Deeks CM, Jain A, Whitaker RC. Maternal feeding practices and beliefs and their relationships to overweight in early childhood. *J Dev Behav Pediatr* 2001;22(6):391-408.
23. Adab P, Pallan MJ, Lancashire ER, Hemming K, Frew E, Griffin T, Barrett T, Bhopal R, Cade JE, Daley A, et al. A cluster-randomised controlled trial to assess the effectiveness and cost-effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6-7 year old children: the WAVES study protocol. *BMC Public Health* 2015;15(1):488-98. doi: 10.1186/s12889-015-1800-8.

24. Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Arch Dis Child* 1995;73:25-9.
25. Martin-Calvo N, Moreno-Galarraga L, Martinez-Gonzalez MA. Association between Body Mass Index, Waist-to-Height Ratio and Adiposity in Children: A Systematic Review and Meta-Analysis. *Nutrients* 2016;8(8). doi: 10.3390/nu8080512.
26. Ashwell M. Obesity risk: importance of the waist to height ratio. *Nurs Stand* 2009;23(41):49-54.
27. Talma H, Chinapaw MJ, Bakker B, HiraSing RA, Terwee CB, Altenburg TM. Bioelectrical impedance analysis to estimate body composition in children and adolescents: a systematic review and evidence appraisal of validity, responsiveness, reliability and measurement error. *Obes Rev* 2013;14(11):895-905. doi: 10.1111/obr.12061.
28. Tanita. Internet: <https://tanita.eu/help-guides/understanding-measurements> (accessed 12/10/17).
29. Musher-Eizenman D, Holub S. Comprehensive Feeding Practices Questionnaire: Validation of a New Measure of Parental Feeding Practices. *J Pediatr Psychol* 2007;32(8):960-72. doi: 10.1093/jpepsy/jsm037.
30. Melbye EL, Ogaard T, Overby NC. Validation of the Comprehensive Feeding Practices Questionnaire with parents of 10-to-12-year-olds. *BMC Med Res Methodol* 2011;11(113):1-12. doi: 10.1186/1471-2288-11-113.
31. Blissett J, Bennett C. Cultural differences in parental feeding practices and children's eating behaviours and their relationships with child BMI: a comparison of Black Afro-Caribbean, White British and White German samples. *Eur J Clin Nutr* 2013;67(2):180-4. doi: 10.1038/ejcn.2012.198.
32. Powell FC, Farrow CV, Meyer C. Food avoidance in children. The influence of maternal feeding practices and behaviours. *Appetite* 2011;57(3):683-92. doi: 10.1016/j.appet.2011.08.011.
33. Payne RA, Abel GA. UK indices of multiple deprivation - a way to make comparisons across constituent countries easier. *Health Stat Q* 2012;53:22-37.
34. Office for National Statistics. Harmonised concepts and questions for social data sources. Primary principles: Ethnic group. 2015.
35. Carpenter JR, Goldstein H, Kenward MG. REALCOM-IMPUTE software for multilevel multiple imputation with mixed response types. *J Stat Softw* 2011;45(5):1-14.
36. Niblett P, Team LS. National Child Measurement Programme: England, 2014/15 school year. [Online]: Health and Social Care Information Centre, 2015.
37. Faith MS, Berkowitz RI, Stallings VA, Kerns J, Storey M, Stunkard AJ. Parental feeding attitudes and styles and child body mass index: prospective analysis of a gene-environment interaction. *Pediatrics* 2004;114:429 - 36. doi: 10.1542/peds.2003-1075-L.

38. Rifas-Shiman SL, Sherry B, Scanlon K, Birch LL, Gillman MW, Taveras EM. Does maternal feeding restriction lead to childhood obesity in a prospective cohort study? *Arch Dis Child* 2011;96(3):265-9. doi: <http://dx.doi.org/10.1136/adc.2009.175240>.
39. Gregory JE, Paxton SJ, Brozovic AM. Maternal feeding practices, child eating behaviour and body mass index in preschool-aged children: a prospective analysis. *Int J Behav Nutr Phys Act* 2010;7:55-65. doi: 10.1186/1479-5868-7-55.
40. Webber L, Cooke L, Hill C, Wardle J. Child adiposity and maternal feeding practices: a longitudinal analysis. *Am J Clin Nutr* 2010;92(6):1423-8. doi: <http://dx.doi.org/10.3945/ajcn.2010.30112>.
41. Dev DA, McBride BA, Fiese BH, Jones BL, Cho H. Risk Factors for Overweight/Obesity in Preschool Children: An Ecological Approach. *Child Obes* 2013;9(5):399-408. doi: 10.1089/chi.2012.0150.
42. de Lauzon-Guillain B, Musher-Eizenman D, Leporc E, Holub S, Charles MA. Parental feeding practices in the United States and in France: relationships with child's characteristics and parent's eating behavior. *J Am Diet Assoc* 2009;109(6):1064-9. doi: 10.1016/j.jada.2009.03.008.
43. Anzman SL, Birch LL. Low inhibitory control and restrictive feeding practices predict weight outcomes. *J Pediatr* 2009;155(5):651-6. doi: 10.1016/j.jpeds.2009.04.052.
44. Clark HR, Goyder E, Bissell P, Blank L, Peters J. How do parents' child-feeding behaviours influence child weight? Implications for childhood obesity policy. *J Public Health* 2007;29(2):132-41. doi: 10.1093/pubmed/fdm012.
45. Campbell K, Andrianopoulos N, Hesketh K, Ball K, Crawford D, Brennan L, Corsini N, Timperio A. Parental use of restrictive feeding practices and child BMI z-score. A 3-year prospective cohort study. *Appetite* 2010;55(1):84-8. doi: 10.1016/j.appet.2010.04.006.
46. Tschann JM, Martinez SM, Penilla C, Gregorich SE, Pasch LA, de Groat CL, Flores E, Deardorff J, Greenspan LC, Butte NF. Parental feeding practices and child weight status in Mexican American families: a longitudinal analysis. *Int J Behav Nutr Phys Act* 2015;12:66. doi: 10.1186/s12966-015-0224-2.
47. Derks IPM, Tiemeier H, Sijbrands EJG, Nicholson JM, Voortman T, Verhulst FC, Jaddoe VVW, Jansen PW. Testing the direction of effects between child body composition and restrictive feeding practices: results from a population-based cohort. *Am J Clin Nutr* 2017;106(3):783-90. doi: 10.3945/ajcn.117.156448.
48. Hansen WB, Collins LM. Seven ways to increase power without increasing N. *NIDA Research Monograph* 1994;142:184-95.
49. Wardle J, Guthrie CA, Sanderson S, Rapoport L. Development of the children's eating behaviour questionnaire. *J Child Psychol Psychiatry* 2001;42(7):963-70.

Tables

Table 1: Participant characteristics, by weight status at T2 (aged 8-9 years)

	Not overweight/ Obese ¹ (n=626)	Overweight/ Obese ¹ (n=207)	p-value
Child Age (years) N=833, mean (SD) ²	7.7 (0.3)	7.7 (0.3)	0.389
Sex of the child (N=833, n (%)) ³			
Males	310 (73.5)	112 (26.5)	(reference)
Females	316 (76.9)	95 (23.1)	0.237
Child Ethnicity (N=833, n (%)) ³			
White	320 (77.3)	94 (22.7)	(reference)
South Asian	190 (74.8)	64 (25.2)	0.492
Black	30 (60.0)	20 (40.0)	0.020
Other/Mixed	86 (74.8)	29 (25.2)	0.604
Average physical activity energy expenditure (kJ/kg/day; mean (SD); N=802) ²	92.7 (25.5)	87.5 (22.4)	0.024
IMD quintiles (N=824, n (%)) ³			
Quintile 1 (more deprived)	298 (72.9)	111 (27.1)	(reference)
Quintile 2	120 (77.4)	35 (22.6)	0.272
Quintile 3	72 (78.3)	20 (21.7)	0.230
Quintile 4	66 (75.9)	21 (24.1)	0.550
Quintile 5 (less deprived)	62 (76.5)	19 (23.5)	0.748
Main carer relationship to child (N=828, n (%)) ³			
Mother	509 (76.7)	155 (23.3)	(reference)
Father	91 (69.5)	40 (30.5)	0.088
Other	22 (66.7)	11 (33.3)	0.200
Main carer age ((years) N=781, mean (SD)) ²	36.7 (6.6)	37.0 (6.9)	0.512

¹ Based on the UK 1990 growth reference data (UK90);

² p-values generated using mixed effect linear regression models, fitting weight status as a continuous variable, , controlling for WAVES study trial arm allocation as a fixed effect, and school attended as a random effect

³ p-values generated using multinomial logistic regression models, fitting weight status as a continuous variable, controlling for WAVES study trial arm allocation as a fixed effect, and using robust standard errors to account for clustering

Figures

Figure 1: Flow diagram of participants from the over-arching WAVES study into the present study

Figure 2: Median scores for each parent feeding practice by child weight status at T2 (aged 8-9 years) and p-for-trends generated using mixed-effects linear regressions. Children without overweight/obesity, n=626, children identified with overweight and obesity, n= 207.

Figure 3: Mixed effects logistic regression generated odds ratios (and 99% confidence intervals) to show the association between parent feeding styles and three proxy measures for child adiposity. Maximum number included in models, n=716, minimum number included in models, n=549.