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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ABSTRACT

Background: Some research suggests that parent or carer feeding practices may influence children’s weight patterns, but longitudinal evidence is limited and inconsistent.

Objective: The aim of this study was to investigate the relation between various parent or carer feeding practices when a child is aged 7–8 y and proxy measurements of child adiposity at age 8–9 y (weight status, waist-to-height ratio, and body fat percentage).

Design: The study was a secondary analysis of data from the West Midlands Active Lifestyle and Healthy Eating in Schoolchildren (WAVES) Study comprising a diverse sample of parents and carers and their children from 54 primary schools in the West Midlands, England [n = 774 parent-child dyads (53% of the WAVES study sample)]. Information on feeding practices was collected with the use of subscales from the Comprehensive Feeding Practices Questionnaire, completed by the child’s main parent or carer (self-defined). Child height, weight, bioelectrical impedance, and waist circumference were measured and converted into 3 proxy measurements of adiposity (weight status, waist-to-height ratio, and body fat percentage). Associations between these measurements and parent or carer feeding practices were examined with the use of mixed-effects logistic regression models.

Results: Of the questionnaire respondents, 80% were mothers, 16% were fathers, and 4% were other carers. Median standardized subscale scores ranged from 1.7 (emotion regulation: IQR = 1.0) to 4.0 (monitoring and modeling: IQR = 1.5), and significantly different subscale scores were present between child weight statuses for emotion regulation, pressure to eat, and restriction for weight control. Logistic regression modeling showed that when baseline adiposity measures were included as covariates, all associations between parental feeding practices at age 7–8 y and measures of adiposity at age 8–9 y were attenuated.

Conclusions: Observed relations between various parental feeding practices and later adiposity may be mitigated by inclusion of the baseline adiposity measure. This finding lends support to the theory of reverse causation, whereby the child’s size may influence parental choice of specific feeding practices rather than the child’s subsequent weight status being a consequence of these feeding practices. *Am J Clin Nutr* 2018;108:1316–1323.

Keywords: obesity, feeding practices, eating behavior, children, parents, carers, weight

INTRODUCTION

Excess weight in children is an important public health concern, with adverse physical and psychosocial consequences in childhood, and increased risk of morbidity and mortality in later life (1, 2). Two recent reviews highlighted that common environmental factors, such as parent feeding practices, have a substantial effect on BMI from childhood through to adolescence (3), and that parental food habits and feeding practices are the most dominant family system determinants of children’s eating habits and food choices (4). There is also evidence of “inter-generational ripples,” whereby parents develop their feeding practices based on their own childhood feeding experience (5). Therefore, understanding the effect of parental feeding practices on children’s adiposity has been identified as a research priority.

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Supplemental Table 1 is available from the “Supplementary data” link in the online posting of the article and from the same link in the online table of contents at https://academic.oup.com/ajcn/.

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Abbreviations used: CEBQ, Child Eating Behaviors Questionnaire; CFPQ, Comprehensive Feeding Practices Questionnaire; IMD, Index of Multiple Deprivation; T, time; WAVES, West Midlands Active Lifestyle and Healthy Eating in Schoolchildren.

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because it could inform the development of interventions with potential impact beyond the current generation (6).

Parent feeding practices relate to the specific methods and behaviors that parents use to influence children’s behavior, health, or weight (7, 8) and are distinct from the more generalistic parent feeding style, which typifies the levels of demandingness and responsiveness a parent expresses in feeding and eating interactions (9, 10). Examples of parental feeding practices include pressuring children to eat certain foods, the use of food as a reward, or not allowing the child to eat certain foods. Evidence from a variety of studies suggests that certain parent feeding practices are associated with child weight status. For example, restrictive feeding practices are associated with higher weight status (11–16), whereas pressure to eat is related to lower weight status (11, 15–18). However, these findings are inconsistent and sometimes conflicting (18–22), particularly in relation to other parent feeding practices, such as the use of food as a reward (15, 16, 19, 20). A number of methodological limitations in previous studies have constrained potential interpretation. For example, most were cross-sectional in nature, and the measures of adiposity used have been limited, with few previous studies using multiple measures, such as waist-to-height ratio or body fat percentage. Additionally, previous studies have rarely considered how child characteristics influence parental feeding practices. Shloim et al. (10) noted in their systematic review of studies (n = 31) that where child characteristics were measured, the parental feeding practices used were responsive to the child. For example, more restriction was seen in children with greater adiposity or greater perceived food approach tendencies, and more pressure to eat was seen in thinner children or those perceived to be undereating. However, the direction of the proposed effect is still ambiguous. Therefore, it is important to consider the possibility of reverse causation, whereby parental use of specific feeding practices may be driven by a child’s weight status rather than subsequent child weight status being a consequence of them. Additionally, much of the research focus in this area has been on young children, so little is known about whether a relation between these factors exists in older children when they begin to exert some level of autonomy over their food decisions.

This study investigates the relation between parent feeding practices when children are aged 7–8 y and their adiposity measures at age 8–9 y in a socially and ethnically diverse sample of UK families. Adiposity was assessed through the primary outcome of weight status based on BMI z score and the secondary outcomes of waist-to-height ratio and body fat percentage.

METHODS

We conducted a secondary analysis of data collected between 2011 and 2014 at baseline [time (T) 0: children aged 5–6 y] and at the first (T1: children aged 7–8 y) and second (T2: children aged 8–9 y) follow-ups for the West Midlands Active Lifestyle and Healthy Eating in Schoolchildren (WAVES) Study, a cluster-randomized controlled trial evaluating the clinical and cost-effectiveness of an obesity-prevention program in an ethnically diverse population of children from the West Midlands, United Kingdom. National Health Service Research Ethics Committee approval for the WAVES study was obtained from the Black Country Research Ethics Committee (NHS REC no. 10/H1202/69), and the trial was registered with the ISRCTN registry as ISRCTN97000586 in May 2010.

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

Trained researchers, blinded to the WAVES study trial arm allocation, measured the height, weight, and waist circumference of each child in school at each time point with the use of validated instruments [Leicester Height Measure MK II (Harlow Healthcare) and Tanita BC-420MA Class 111 Body Composition Analyzer (Tanita)] and standard protocols (23). Child weight status was dichotomized into individuals with overweight (including individuals with obesity) or individuals without overweight with the use of the age- and sex-specific 85th centile cutoff from the UK 1990 growth reference charts (24). Waist-to-height ratio was calculated by dividing the child’s waist circumference (centimeters) by their height (meters) and was dichotomized into high or low risk, with a threshold of 0.5 (25, 26). Body fat percentage was calculated with the use of bioelectrical impedance (27) and was dichotomized with the use of the age- and sex-specific threshold for a high body fat percentage for each child provided by Tanita (28).

Data on parent feeding practices were collected through a self-administered questionnaire booklet sent to the home for completion by the child’s main parent or carer (self-defined) at T1. Subscales of the Comprehensive Feeding Practices Questionnaire (CFPQ) were used to assess a wide range of parent feeding practices (29). The CFPQ has been shown to be valid in children aged ≥12 y old (22, 29, 30) and in varied cultural contexts (30–32). To keep the respondent burden to a minimum, only the following subscales were included in the WAVES study parent questionnaire: child control, emotion regulation, environment, food as a reward, modeling, monitoring, pressure to eat, and restriction for weight control. Minor wording changes from the original questionnaire were applied to make the tool appropriate for a UK population (e.g., replacing “Soda” with “Fizzy pop”).

Likert scales ranging from 1 (never) to 5 (always) scored each item. For ease of interpretation, item scores were summed and then divided by the number of items in the subscale. Subscale scores were not calculated if there were missing data for >1 (3- to 5-item scales) or >2 (6- to 8-item scales) items. Where subscale scores were calculated with missing data, the subscale was standardized with the completed number of items as the denominator. Questionnaire subscale response rates ranged from 89% (modeling) to 92% (emotion regulation). All questionnaire subscales had moderate to good internal consistency, with Cronbach’s α values ranging from 0.6 (environment) to 0.9 (monitoring).

Parent-reported home postcodes, mapped to the English Index of Multiple Deprivation (IMD) 2007, were used as a measure of socioeconomic status (with the use of the quintile cutoffs for England) (33). Child eating behavior subscales of “food responsiveness,” “enjoyment of food,” and “emotional overeating” were collected from the Child Eating Behavior Questionnaire (CEBQ) embedded within the WAVES parent questionnaire booklet. Scoring of these subscales was conducted in the same manner as the CFPQ. Because these 3 CEBQ subscales all
represent eating behaviors that potentially lead to greater food intake, they were combined to create one “food-approaching eating behavior” score. Other relevant information [parent age and ethnicity, according to the UK Census ethnic group categories (34)] was also collected through the WAVES study parent questionnaire booklet. Where parent ethnicity was missing, child ethnicity obtained from their school records was used as a proxy.

Parents and children participating in the WAVES study were included in the present study if a questionnaire booklet was returned at T1 and any child anthropometric adiposity measurement (weight status, waist-to-height ratio, or body fat percentage) was available at T2. Statistical analysis was performed with the use of STATA 13 (StataCorp LP) and, due to multiple tests being performed, a conservative a priori significance level of 1% (2-sided) was used. Descriptive statistics to summarize participant characteristics are presented by child weight status. The internal validity of all questionnaire subscales was assessed with the use of Cronbach’s $\alpha$.

To account for the clustered nature of the sample, mixed-effects logistic regression models were used to evaluate the relation between CFPQ subscales and each anthropometric outcome measure. Three models were developed. Model 1 adjusted only for the WAVES study trial arm allocation (fixed effect) and school attended (random effect) to account for the data being collected after delivery of the WAVES study intervention and the clustered nature of the sample. Model 2 additionally adjusted for the sex of the child, child food-approaching feeding-behavior score, IMD score (deprivation index), and parent-level factors (age and ethnicity). Model 3 further adjusted for T0 values for the outcome measure (BMI $z$ score, waist-to-height ratio, or body fat percentage) to investigate whether any associations existed independently of baseline values.

To consider the impact of missing data on the relations investigated, all further adjusted models (model 3) were repeated on a data set where missing covariate information was imputed. Generation of imputed data sets was conducted in

FIGURE 1  Flow diagram of participants from the overarching WAVES study into the present study. T, time; WAVES, West Midlands Active Lifestyle and Healthy Eating in Schoolchildren.
TABLE 1
Participant characteristics, by weight status at T2 (ages 8–9 y)¹

<table>
<thead>
<tr>
<th></th>
<th>Not overweight or obese² (n = 626)</th>
<th>Overweight or obese² (n = 207)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child age (n = 833),³ y</td>
<td>7.7 ± 0.3</td>
<td>7.7 ± 0.3</td>
<td>0.389</td>
</tr>
<tr>
<td>Sex of the child (n = 833),⁴ n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>310 (73.5)</td>
<td>112 (26.5)</td>
<td>(Reference)</td>
</tr>
<tr>
<td>Female</td>
<td>316 (76.9)</td>
<td>95 (23.1)</td>
<td>0.237</td>
</tr>
<tr>
<td>Child ethnicity (n = 833),⁴ n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>320 (77.3)</td>
<td>94 (22.7)</td>
<td>(Reference)</td>
</tr>
<tr>
<td>South Asian</td>
<td>190 (74.8)</td>
<td>64 (25.2)</td>
<td>0.492</td>
</tr>
<tr>
<td>Black</td>
<td>30 (60.0)</td>
<td>20 (40.0)</td>
<td>0.020</td>
</tr>
<tr>
<td>Other or mixed</td>
<td>86 (74.8)</td>
<td>29 (25.2)</td>
<td>0.604</td>
</tr>
<tr>
<td>Average physical activity expenditure (n = 802),⁵ [kJ · kg⁻¹ · d⁻¹]</td>
<td>92.7 ± 25.5</td>
<td>87.5 ± 22.4</td>
<td>0.024</td>
</tr>
<tr>
<td>IMD quintiles (n = 824),⁴ n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quintile 1 (more deprived)</td>
<td>298 (72.9)</td>
<td>111 (27.1)</td>
<td>(reference)</td>
</tr>
<tr>
<td>Quintile 2</td>
<td>120 (77.4)</td>
<td>35 (22.6)</td>
<td>0.272</td>
</tr>
<tr>
<td>Quintile 3</td>
<td>72 (78.3)</td>
<td>20 (21.7)</td>
<td>0.230</td>
</tr>
<tr>
<td>Quintile 4</td>
<td>66 (75.9)</td>
<td>21 (24.1)</td>
<td>0.550</td>
</tr>
<tr>
<td>Quintile 5 (less deprived)</td>
<td>62 (76.5)</td>
<td>19 (23.5)</td>
<td>0.748</td>
</tr>
<tr>
<td>Main carer relationship to child (n = 828),⁴ n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td>509 (76.7)</td>
<td>155 (23.3)</td>
<td>(Reference)</td>
</tr>
<tr>
<td>Father</td>
<td>91 (69.5)</td>
<td>40 (30.5)</td>
<td>0.088</td>
</tr>
<tr>
<td>Other</td>
<td>22 (66.7)</td>
<td>11 (33.3)</td>
<td>0.200</td>
</tr>
<tr>
<td>Main carer age (n = 781),³ y</td>
<td>36.7 ± 6.6</td>
<td>37.0 ± 6.9</td>
<td>0.512</td>
</tr>
</tbody>
</table>

¹Values are means ± SDs unless otherwise indicated. IMD, Index of Multiple Deprivation; T, time; WAVES, West Midlands Active Lifestyle and Healthy Eating in Schoolchildren.
²Values generated from multinomial logistic 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.
³Values generated from mixed-effects 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.
⁴Values generated from mixed-effects linear regression models, fitting weight status as a continuous variable, controlling for WAVES study trial arm allocation as a fixed effect, and with the use of robust SEs to account for clustering.

RESULTS

There were between 716 and 774 parent-child dyads included in these analyses (49–53% of the WAVES study participants; Figure 1). Parents of white children were the most likely to respond to the questionnaire (64%) and parents of black children were the least likely to respond (44%). Additionally, there was a graded response rate across the deprivation quintiles, with the highest responses coming from the least-deprived quintile (75%) and the lowest from the most-deprived quintile (53%). There was no difference in the response rates according to the age or sex of the child (Supplemental Table 1).

Child and parent characteristics at T2 (ages 8–9 y) are described by child weight status in Table 1. Overall, 80% of responders were mothers, 16% fathers, and 4% other relatives (e.g., grandmother, stepfather, or aunt). The mean ± SD parent age was 36.7 ± 6.7 y. Additionally, almost one-third of children were identified with overweight (30.6%). A slightly higher proportion of boys than girls had overweight; and children of a mixed, black, or South Asian ethnicity were more likely to have overweight than white children, which is in line with the averages in England (36). However, there was only a significant difference in children of a black ethnicity.

High median scores were seen in the parent feeding practices of monitoring and modeling (median score = 4.0; IQR = 1.5), indicating that parents used these practices most frequently (Figure 2). Significant differences between weight-status groups were evident for the parent feeding practices of emotion regulation, pressure to eat, and restriction for weight control, with parents of children with overweight using more restriction and emotion regulation and less pressure to eat.

Similar patterns emerged across all proxy measurements for adiposity (Figure 3). In models 1 (minimal adjustment) and 2 (which accounted for most covariates), a significantly increased risk of overweight, central adiposity, or high body fat percentage

REALCOM-Impute (35) to account for the clustered nature of the sample, imported into STATA with the use of the realcomImputeLoad command, and analyzed in STATA 13. Generation of imputed data sets included the following incomplete variables: T2 outcome of interest, T0 outcome measure, child food-approaching eating-behavior composite score, parent age, parent ethnicity (white, South Asian, black African-Caribbean, and mixed or other ethnicities), and deprivation score of household (IMD 2010). Additionally, the following complete variables were included to improve the accuracy of the imputation: sex of the child, WAVES study trial arm, school-level free school meal entitlement proportion, and school-level ethnic mix (white, South Asian, black African-Caribbean, and mixed or other ethnicities). The results of 10 imputed data sets were pooled to produce imputation estimates.
was found if parents used restriction and a significantly decreased risk was found if parents used pressure to eat. However, after the inclusion of a baseline measure for the adiposity outcome being considered (model 3), the effect sizes were reduced and these associations were no longer significant. Interestingly, a significantly lower risk of adiposity, measured by all 3 outcomes (risk of overweight, high waist-to-height ratio, or high body fat percentage), was seen with greater use of food as a reward in model 2; however, in all cases, this association was attenuated in the subsequent model that adjusted for baseline values. Multiple imputation in model 3 generated results that were similar to the main analyses, whereby no parent feeding practice was significantly associated with any measure of overweight at the 1% level.

DISCUSSION

The aim of this study was to investigate the relation between parental feeding practices and 3 proxy measures of child adiposity 1 y later in an ethnically diverse sample of UK children. Although there were associations between certain parental feeding practices and measures of child adiposity, inclusion of a baseline adiposity measure attenuated the observed relations. This finding has 2 potential explanations. First, it may lend support to the theory of reverse causation, whereby it is the child’s level of adiposity that may lead to parental utilization of specific feeding practices rather than being a consequence of them. However, it may also be suggestive of a reduced impact of parental feeding practices on adiposity in older children.

Before adjusting for baseline values, we found significant associations of “restriction for weight control” and “pressure to eat” with child levels of adiposity, which was consistent with previous research findings (13, 16). However, once we included baseline adiposity in the models, the effect sizes approached null and the associations were no longer statistically significant. This suggests that the use of these feeding practices may be in response to initial child weight status (37, 38). Thus, parents of higher-weight children may be more likely to implement restrictive feeding practices, whereas parents of lower-weight children may pressure their child to eat. This complements a finding by Gregory et al. (39) \((n = 156)\), which suggested that mothers’ feeding practices may influence children’s eating behaviors, but not their weight status, after 1 y in children aged 2–4 y. Both the present study and the study by Gregory et al. (39) had relatively short follow-up periods, which limited the ability to capture the impact on weight status of altered eating behaviors as a result of a parent feeding practice. However, Webber et al. (40) \((n = 113)\) also found no significant longitudinal associations between maternal feeding practices and change in child adiposity 3 y later in children aged 7–9 y.

Our findings contradict a body of evidence that suggests that restriction is associated with increased child weight, both cross-sectionally (11, 14, 41, 42) and longitudinally (40, 43). Mechanisms to explain why restriction may be a counterproductive feeding practice relate to food becoming more desirable and so consumed in excess when outside of the parent’s control (44). Given the larger sample size and the longitudinal nature of our study, our findings challenge these previous theories; however, it is important to note that the confidence intervals were wide in model 3 and, in some cases, only just crossed the point of no significance. Additionally, it has been hypothesized that the influence of parental feeding practices may be stronger at younger ages (45–47). Therefore, the preadolescent age range included in the present study may indicate the point at which children begin to strive for greater autonomy around their feeding and,
as such, parental feeding practices begin to have a lesser impact on subsequent child weight. Hence, the null findings in both the present study and that of Webber et al. (40) may be because of the age group studied. Such information is important for future childhood obesity-prevention strategies, so further investigations of longitudinal relations at various ages are needed.

Several strengths and limitations are noteworthy within this study. First, although the diverse nature of the West Midlands population, the purposeful oversampling of schools with higher proportions of South Asian and black children in the WAVES study, and the availability of questionnaire responses from the main carer (including mothers, fathers, and other guardians or carers) may have maximized the external validity of the study findings, they also add an element of heterogeneity to the sample, which may reduce the power to detect true effect estimates in certain subgroups (48). However, the models were developed to control for various demographic factors to counteract this variability. Second, although all outcome data were objectively measured by trained researchers, parent data were all self-reported, and child eating behavior was based on parent perception and therefore may be subject to some social desirability bias. However, validation studies on both the CEBQ and CFPQ have reported that the responses correlate well with observed practices and behaviors, so these questionnaires allow a relatively quick and cost-effective method of collecting this data on a large scale (29, 49). Third, some variables were missing a substantial amount of data. To assess the impact of these missing covariate data, multiple imputation sensitivity analyses were conducted and the results were found to be very similar to the results of the main analyses, increasing the confidence in our conclusions. Additionally, despite the researchers using numerous techniques to encourage questionnaire completion, the parental response rate was relatively low, and this may bias the results presented.

This study has allowed further exploration of a wide range of parent feeding practices and their relations with a number of proxy measurements for child adiposity. It has extended the current evidence by allowing adjustment for the child’s previous level of adiposity and current eating behavior. The pathway to which parent feeding practices are often hypothesized to impact child adiposity is through changes in dietary behavior—for example, the use of emotion regulation inadvertently encouraging intake of energy-dense, nutrient-poor foods in times of distress, leading to excess energy intake and overweight over time. Therefore, it would be useful for future research to quantify the impact that these feeding practices may have on dietary intake. Additionally, qualitative studies investigating why parents adopt such feeding practices would contribute to understanding the complex relation between feeding practices and weight status. Finally, the findings of this study challenge the notion that parent...
feeding practices are associated with adiposity, particularly in older children. However, further evidence is needed to evaluate whether this is a result of reverse causation or an artifact of the changing feeding relationship between parents and their growing children.

The WAVES study trial investigators and collaborators are as follows—University of Birmingham: Peymane Adab, Tim Barrett, KK Cheng, Amanda Daley, Jonathan J Deeks, Joan L Duda, Emma Frew, Karla Hemming, Miranda Pallan, Jayne Parry; University of Warwick: Paramjit Gill; University of Cambridge, Cambridge MRC Epidemiology Unit/Norwegian School of Sports Sciences: Ulf Ekelund; University of Leeds: Janet E Cade; University of Edinburgh, Usher Institute of Population Health Sciences and Informatics: Raj Bhopal; Birmingham Community Healthcare NHS Trust: Eleanor McGee; Birmingham Services for Education: Sandra Passmore.

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The authors’ responsibilities were as follows—PA, MJP and ERL together developed the research plan for this study, conducted the data collection, and wrote the manuscript, with significant input from PA, MJP, and ERL; and all authors: read and approved the final manuscript. The authors declared no conflicts of interest.

REFERENCES


