Maternal characteristics associated with the obesogenic quality of the home environment in early childhood

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Abbreviations

DEBQ = Dutch Eating Behaviour Questionnaire
HEI = Home Environment Interview
SES = socioeconomic status

Abstract

The home environment is likely to influence children's diet and activity patterns and ultimately, their weight trajectories. Identifying family characteristics associated with a more 'obesogenic' home can provide insight into the determinants, and has implications for targeting and tailoring strategies to promote healthier lifestyles. The present study examined maternal characteristics associated with a more obesogenic home environment in 1113 families with preschool children. Primary caregivers (99% mothers) from the Gemini cohort completed the Home Environment Interview (HEI) when their children were 4 years old. Maternal demographics and BMI were assessed in the Gemini baseline questionnaire when the children were on average 8 months old. Maternal eating style was assessed when the children were on average 2 years old, using the Dutch Eating Behaviour Questionnaire (DEBQ). Responses to the HEI were standardized and summed to create a composite score of the obesogenic quality of the home; this was categorized into tertiles. Multivariate ordinal logistic regression showed that mothers who were younger (adjusted OR; 95% CI=0.96; 0.94–0.98), less educated (1.97; 1.40–2.77), and had lower incomes (1.89; 1.43–2.49) at baseline were more likely to live in an obesogenic home environment at 4 years, as were mothers who scored higher on the DEBQ External Eating scale (1.40; 1.16–1.70) at 2 years, and had a higher baseline BMI (1.05; 1.02–1.08). Using a novel, composite measure of the home environment, this study finds that families who are more socio-economically deprived, and where the mothers are themselves heavier and have a more food responsive eating style, tend to provide a home environment with the hallmarks of a higher risk of weight gain.

Keywords: home environment, obesity, childhood, parents

Introduction

Overweight and obesity are notoriously difficult to treat[1,2], and therefore identifying opportunities for early prevention is vital. The home environment is thought to be a key influence on childhood weight trajectories[3–5]. Parents create the child's home environment, and are often involved in weight management interventions[5,6]. Knowledge of parental characteristics that are associated with a more 'obesogenic' home environment may therefore help to understand the origins of the environmental effects and to target or tailor obesity prevention strategies.

The concept of an 'obesogenic' home environment incorporates influences from three domains: food, physical activity, and media[7,8]. This includes availability and accessibility of healthy and unhealthy foods, opportunities for physical activity, and availability of screen-based media, as well as social aspects such as modelling of eating and physical activity behaviours.

Several parental demographic characteristics have been associated with individual aspects of the home environment. Less educated parents are more likely to have energy-dense foods at home[9], have a TV in their child's bedroom[10], use inappropriate feeding practices such as permisiveness[11], and are less likely to model physical activity behaviour[12]. Family income is also potentially relevant[13,14]; although whether education and income contribute independently has not been studied. Maternal age has also been identified as relevant to parenting; with older mothers being able to draw on more established cognitive and emotional skills to create a supportive home environment[15]. In the context of risk for weight gain in early childhood, younger mothers tend to breastfeed for less time[16] and introduce solid foods earlier[17], including foods that are not recommended for young children[18,19]. These factors could be markers of a risky profile for a more obesogenic food environment as the children get older.

Other parental characteristics have been implicated in the quality of the home environment; though not in relation to obesity. Mothers living with a partner and with fewer children are more likely to provide environments that are supportive of their child's cognitive, emotional, and social development[20,21]. Smaller family size has also been associated with lower levels of

disorganisation within the home[22] . It is possible that these characteristics extend to aspects of the food and activity environment.

Obese parents are more likely to have obese children[23], although part of the explanation for familial resemblance is genetic[24]. However, parents whose eating and activity behaviours are characteristic of the obese population may also create a home environment that supports habits of overeating and being under-active. In line with this, parental energy-balance knowledge, and investment in weight-related issues, have been associated with having more fruit and vegetables in the home[25,26], using more restrictive feeding practices[27], and limiting access to media equipment[25]. No previous studies have directly examined the association between parental appetitive traits, in the form of external and emotional eating[28], and the obesogenic quality of the home environment.

To date, there have been no large-scale studies examining predictors of the home environment in early childhood, which is likely to be an important period for long-term overweight and obesity prevention[29]. Furthermore, none of the studies described above used a comprehensive indicator of the obesogenic home environment (incorporating food, activity, and media-related influences), although this should capture the overall level of risk for weight gain more effectively than any one aspect of the home environment; and most focused on a limited range of potential predictor variables. Recent findings from 1096 families participating in the Gemini birth cohort highlight the relevance of the obesogenic quality of the home environment in early weight trajectories, and the importance of obesity prevention strategies[30]. Preschool children living in more 'obesogenic' home environments had poorer diets (less fruit and vegetable consumption, and more energy-dense snack and sweetened drink consumption), lower levels of physical activity, and watched more TV than children living in lower-risk home environments[30].

Little is known about potential parental characteristics that may affect/substantiate the home environment. The aim of the present study was therefore to examine whether maternal demographic characteristics and weight-related traits are associated with the obesogenic quality of the home environment in early childhood.

Method

Sample

Data were from families taking part in the Gemini UK twin birth cohort (described in detail elsewhere[31]), who had completed the home environment interview when the children were aged 4 years (n = 1113). Because information was provided for both twins at the time of the interview (n = 2226), one twin was selected at random to avoid clustering effects.

The home environment

The Home Environment Interview (HEI) is a comprehensive measure of the food, activity, and media environment, developed for the study (and available on request), which was administered as a telephone interview with the primary caregiver (mothers in 99% of cases) when the children were 4 years old. The HEI was based on the Healthy Home Survey[32], which was the most comprehensive measure available at the time, had been psychometrically tested, and had been used with families with young children.

A composite score was created based on feedback from an international panel of 30 experts in pediatric obesity (see **Table 1)**. Constructs identified as being associated with lower risk of weight gain were reverse-scored so that a higher composite score would reflect higher obesogenic risk. Each variable was standardized using z-scores and they were summed. Missing values were recoded to 0 (the mean value for each standardized variable). There were few missing cases on home environment variables (15 for garden play equipment; 39 for emotional feeding, instrumental feeding, encouragement, and modelling of healthy eating; 40 for monitoring and covert restriction; 42 for restriction; 73 for partner TV viewing). Test-retest reliability over 7-19 days (mean = 9.6 days, SD = 3.4) of the home environment composite was high (ICC = 0.92; 95% CI = 0.86 – 0.96). Previously-reported associations between the home environment composite and child diet, physical activity, and TV viewing at 4 years were as expected; although associations with BMI were not apparent at this age[30].

170 **Table 1:** Constructs included in the home environment composite score
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Food-related constructs
Availability
Number of fruit types[1]
Number of vegetable types[1]
Number of energy-dense snack types
Presence of sugar-sweetened drinks
Accessibility (visibility)
Fruit on display[1]
Vegetables ready-to-eat[1]
Energy-dense snacks on display
Sugar-sweetened drinks on display
Accessibility (child can help him/herself)
Fruit[1]
Vegetables[1]
Energy-dense snacks
Sugar-sweetened drinks
Parental feeding practices
Emotional feeding
Instrumental feeding
Encouragement[1]
Modelling[1]
Monitoring[1]
Covert restriction[1]
Restriction[1]
Family meal frequency
Frequency child eats while watching TV
Physical activity-related constructs
Garden/outdoor space[1]
Garden play equipment[1]
Allowed to play indoors[1]
Allowed to play outdoors[1]
Parental modelling of physical activity[1]
Parental support of physical activity[1]
Media-related constructs
Number of media equipment
TV in the child's bedroom
Household rules around media use[1]
Maternal TV viewing
Partner TV viewing

172 [1] Variable was identified as being associated with decreased risk for weight gain.
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Maternal characteristics

The measured characteristics fell into two main categories: (i) maternal demographics and living circumstances (age, education, household income, number of other children living in the home, marital status); and (ii) maternal weight-related traits (BMI, eating style).

Maternal demographics were assessed in the Gemini baseline questionnaire (when the children were on average 8 months old), but information on the number of other children in the home and marital status was updated at the time of the HEI. Maternal BMI was calculated from self-reported weight and height at baseline. Eating style was assessed when the children were on average 2 years old, using the Dutch Eating Behaviour Questionnaire (DEBQ)[28]. The three subscales measure restraint (e.g. 'how often do you refuse food or drink because you are concerned about your weight?'), emotional eating (e.g. 'do you have a desire to eat when you are feeling lonely?'), and external eating (e.g. 'if food smells and looks good, do you eat more than usual?'). There are five items per subscale, each scored on a 5-point scale (1 = never; 5 = very often). A mean score was calculated for each subscale, with higher scores indicating higher levels of the particular eating trait. Internal consistency (using Cronbach's alpha) for each scale was high in the study sample (all alpha's > 0.80).

Statistical analyses

There were some missing data among the predictors (2 for maternal age; 17 for maternal BMI; 34 for income; 143 for DEBQ restraint and DEBQ emotional eating; 144 for DEBQ external eating); these were assigned the mean score. This approach is said to provide a more accurate estimate of association than other methods of handling missing data[33]. However we also did a sensitivity analysis including only families with complete data (n = 925) and the results were the same.

For ease of interpretation, the home environment composite was categorised into tertiles, creating lower-, medium-, and higher-'risk' environment groups. Education level was categorised as high (university-level education), intermediate (vocational or advanced high-school education), or low (no qualifications or basic high-school education). Household gross annual income was categorised as lower (≤ £30,000) or higher (> £30,000) as this categorisation was close to the UK average for 2008 (the baseline assessment period)[34]. Marital status was categorised as married or cohabiting, or single. The number of other

children in the home was treated as a continuous variable. Maternal ethnicity was not included in the analyses as just 5% of mothers in the sample were from ethnic minority backgrounds with many ethnic sub-groups, which would make it difficult to draw meaningful conclusions.

Univariate and multivariate ordinal logistic regression analyses were used to examine associations between maternal characteristics and the obesogenic home environment. For the multivariate analyses, maternal demographics were entered simultaneously into a model (also adjusting for maternal BMI) to see which were independently associated with the home environment; as research has shown that these characteristics are interrelated. Maternal eating style scales were entered into separate multivariate models for ease of interpretation as they are conceptually interrelated. Each model adjusted for core demographic characteristics (maternal age, education, and income) plus maternal BMI.

Multicollinearity and the proportional odds assumption[35] were tested by examining correlations between the predictor variables and using the SPSS Test of Parallel Lines, respectively. Statistical analyses were conducted using SPSS version 18.0. A p value of < 0.05 was considered statistically significant.

Results

Sample characteristics

Characteristics of the study sample are shown in **Table 2**. At baseline, mothers were on average 34 years old, 48% had university-level education, and three-quarters (74%) were living in homes with an average annual income of at least £30,000. At 4 years, half the families (47%) had no children other than the twins, 38% had one other child, 10% had two other children, and 4% had three or more; 93% of mothers were married or cohabiting. Mean maternal BMI at baseline was 24.8 kg/m^2. Average scores for maternal restraint, emotional eating, and external eating at 2 years were close to the mid-points of the DEBQ scales; comparable to other population-based samples[36].

Table 2. Descriptive characteristics for the study sample (% (n), unless stated otherwise)

	N = 1113
Maternal demographics and living circumstances	
Age in years, mean (SD)	33.86 (4.74)
Education level	
Low	15.5 (173)
Intermediate	36.2 (403)
High	48.2 (537)
Household annual income	
< £30,000	26.4 (294)
≥ £30,000	73.6 (819)
Marital status	
Married or cohabiting	93.2 (1037)
Single	6.8 (76)
No. of other children living in the home, mean (SD)	0.53 (0.50)
Maternal weight-related traits, mean (SD)	
BMI	24.84 (4.54)
DEBQ[1] restraint	2.71 (0.89)
DEBQ emotional eating	2.13 (0.89)
DEBQ external eating	3.10 (0.60)

BMI = body mass index; DEBQ = Dutch Eating Behaviour Questionnaire. Education level categorised as: low (no qualifications or basic high-school education, intermediate (vocational or advanced high-school education), and high (university-level education). [1] Possible range = 1 – 5. Maternal demographics and BMI assessed when twins were 8 months old, living circumstances when twins were 4 years old, and weight-related traits when twins were 2 years old.

Characteristics associated with living in a higher-risk home environment

Results of the regression analyses are shown in **Table 3**. At the univariate level, younger age, lower education, and lower household annual income at baseline were associated with living in a higher-risk home environment at 4 years (p's < 0.001). The number of other children living in the home at 4 years was also associated with living in a higher-risk home environment ($p = 0.02$), but there was no association with marital status. Of the maternal weight-related traits, higher baseline BMI, and higher emotional and external eating at 2 years were associated with living in a higher-risk home environment at 4 years (p's ≤ 0.002). Maternal restraint was not associated with the quality of the home environment.

Multivariate analyses confirmed that all the maternal demographic characteristics (at baseline), except for the number of other children (at 4 years), were independently associated with a higher-risk home environment at 4 years (p's ≤ 0.001). Maternal baseline BMI and external eating at 2 years, but not emotional eating or restraint, were also independently associated with living in a higher-risk home environment at 4 years (p's ≤ 0.001).

Table 3. Maternal characteristics associated with living in a higher-risk home environment (N = 1113)

	Univariate results		Multivariate results	
	OR	**95% CI (p value)**	**OR**	**95% CI (p value)**
Demographics & living circumstances[1]				
Age (years)	0.95	0.92 – 0.97 (<0.001)	0.96	0.94 – 0.98 (0.001)
Education level				
High	1	–	1	–
Intermediate	2.13	1.67 – 2.71 (<0.001)	1.72	1.34 – 2.21 (<0.001)
Low	2.63	1.91 – 3.63 (<0.001)	1.97	1.40 – 2.77 (<0.001)
Household annual income				
≥ £30,000	1	–	1	–
< £30,000	2.73	2.12 – 3.52 (<0.001)	1.89	1.43 – 2.49 (<0.001)
Marital status				
Married or cohabiting	1	–	1	–
Single	1.48	0.96 – 2.28 (0.074)	1.06	0.67 – 1.65 (0.815)
Number of other children	1.16	1.03 – 1.32 (0.017)	1.08	0.95 – 1.23 (0.235)
Weight-related traits[2]				
BMI (per unit increase)	1.07	1.04 – 1.10 (<0.001)	1.05	1.02 – 1.08 (<0.001)
DEBQ restraint	0.98	0.87 – 1.10 (0.696)	0.90	0.79 – 1.03 (0.118)
DEBQ emotional eating	1.21	1.08 – 1.37 (0.002)	1.11	0.98 – 1.27 (0.111)
DEBQ external eating	1.39	1.16 – 1.67 (<0.001)	1.40	1.16 – 1.70 (0.001)

OR = odds ratio; 95% CI = 95% confidence interval; 1 denotes the reference group; BMI = body mass index; DEBQ = Dutch Eating Behaviour Questionnaire. [1] Variables entered simultaneously into the multivariate model (along with maternal BMI). [2] For each eating style, the multivariate model adjusted for core demographics (maternal age, education level, and household income) and maternal BMI.

Discussion

This study confirmed that markers of lower socioeconomic status (SES) (measured at baseline) were predictors of living in a more 'obesogenic' home environment in terms of food, physical activity, and media-related influences at 4 years. In addition, maternal weight (at baseline) and eating style (at 2 years) independently predicted a more obesogenic home environment at 4 years.

Previous studies examining individual aspects of the home environment have reported associations with indicators of lower SES[9–12]; the present study indicated that education and income both contribute. Parents with fewer financial resources may not be able to afford a wide variety of fruit and vegetables, which can cost more and have a higher wastage rate than energy-dense, processed foods[14]. They may also have less access to activity facilities[37]. Less educated parents may lack the health-related knowledge[38,39] to create a healthier home environment. Another possible explanation is that lower SES families have additional life stresses which demote health behaviours in terms of key day-to-day priorities[40].

Previous studies have found family structure (marital status, number of children) to be independently associated with the quality of the home environment[20–22]. However, these studies were concerned with the learning environment in particular or the overall level of organisation within the home rather than the energy-balance environment. In the context of obesity, there has been some evidence that the presence of older children encourages earlier introduction to non-recommended foods[19]. We did not find a direct effect of other children in the home, but early feeding practices could be markers of a risky profile for a more obesogenic environment as the children get older.

There is some evidence that parents with more energy-balance knowledge and greater investment in weight-related issues are more likely to have a home environment that supports a balanced diet and physical activity[25–27]. We had expected that maternal dietary restraint would be associated with a lower-risk home environment, in that more restrained mothers would make more of a conscious effort to limit obesogenic exposures for the children, but we did not see any evidence of this. We found that mothers who were external eaters - a trait that may increase risk of weight gain, were more likely to live in higher-risk home environments; and the association was independent of maternal BMI. This

finding suggests that young children who inherit 'high-risk' appetitive traits from their parents are also more likely to grow up in a more obesogenic home environment, placing them at greater risk of future overweight irrespective of their mother's actual weight status. In our sample, maternal weight was also an independent predictor of the home environment. Two previous studies had failed to find any such associations[41,42], but they were smaller studies and did not use a composite home environment measure. To further test the idea that obesity-prone mothers live in higher-risk home environments, it would be useful to have an independent instrumental variable such as genetic risk score, as an indicator of obesity risk.

The findings of this study provide some insight into potential mechanisms for the development of overweight and obesity. As several of the characteristics in this study have been identified as risk factors for child overweight and obesity, the obesogenic quality of the home environment may be a mediating factor. For example, the consistent association between maternal and child weight status[43,44] is largely explained by genetic inheritance, but heavier mothers may also expose their child to an obesogenic home environment. Heavier mothers may create or seek out home environments that are in line with their obesogenic tendencies, also known as active gene-environment correlation (*r*GE)[45].

Limitations

This is a study of associations, as are many of the previous studies, so it is not possible to assume that predictors 'caused' the home environment. However, they are markers that can be used to identify groups for whom guidance on creating a home environment that facilitates healthy child development would be useful.

This study focused on maternal characteristics as mothers are generally the main caregivers within the home environment. However, the home environment may be influenced by other family members, including partners and children. Research indicates that parenting practices are responsive to child characteristics including temperament[46,47], behaviour[48], and weight status[49,50]. Future research should further test the child-responsive model within the context of the obesogenic home environment; collecting data from all children living in the home.

It must be acknowledged that the maternal characteristics were measured at different time points prior to the HEI assessment. Whilst there is some evidence that weight-related traits are relatively stable[51,52], 100% temporal stability cannot be assumed. The test-retest reliability of the home environment composite was high, but the longitudinal stability is also unknown. However, the associations in this study do concur with those reported in other studies where aspects of the home environment and maternal characteristics were assessed at the same time. Moreover, it is likely that any instability in the predictor variables and home environment would lead to an underestimation of true associations. Nevertheless, to fully understand the nature of the associations in this study, and consider reverse and reciprocal causation, it would be important to assess the home environment and maternal characteristics at each time point.

It would have been useful to examine other potentially relevant characteristics such as parental health-consciousness and self-efficacy in creating a healthier home environment, but these variables were not available. Maternal ethnicity has been associated with aspects of the home environment[53,54], but this factor could not be examined as the study sample was almost exclusively white.

As in previous studies in this field, the home environment and maternal characteristics were assessed using parent report, which may be prone to bias. However, test-retest reliability of the home environment composite was high and previous research has provided some evidence for criterion validity[32]. The reliability and validity of the DEBQ[28,55] has also been demonstrated previously.

Finally, although families with twins may differ in some respects from non-twin families, the findings of this study are generally in line with those from non-twin samples, suggesting that differences are not sufficient to modify the overall conclusions.

Conclusion

This study found that maternal demographic characteristics and weight-related traits were independently associated with the obesogenic quality of the home environment in early childhood. Although further research is needed to fully understand the nature of associations, the present findings offer some insight into the development of child overweight and obesity and its prevention.

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References

1. Yanovski, J. A. & Yanovski, S. Z. (2003). Treatment of pediatric and adolescent obesity. *JAMA, 289*(14), 1851–1853.
2. Jeffery, R. W., Epstein, L. H., Wilson, G. T., Drewnowski, A., Stunkard, A. J., & Wing, R. R. (2000). Long-term maintenance of weight loss: current status. *Health Psychology*, *19*(Suppl. 1), 5–16.
3. Davison, K. K., & Birch, L. L. (2001). Childhood overweight: a contextual model and recommendations for future research. *Obesity Reviews*, *2*(3), 159–171.
4. Ebbeling, C. B., Pawlak, D. B., & Ludwig, D. S. (2002). Childhood obesity: public-health crisis, common sense cure. *Lancet*, *360*(9331), 473–482.
5. Golan, M., & Crow, S. (2004). Parents are key players in the prevention and treatment of weight-related problems. *Nutrition Reviews*, *62*(1), 39–50.
6. Golan, M., Kaufman, V., & Shahar, D. R. (2006). Childhood obesity treatment: targeting parents exclusively v. parents and children. *The British Journal of Nutrition*, *95*(5), 1008–1015.
7. Gattshall, M. L., Shoup, J. A., Marshall, J. A., Crane, L. A., & Estabrooks, P. A. (2008). Validation of a survey instrument to assess home environments for physical activity and

healthy eating in overweight children. *The International Journal of Behavioral Nutrition and Physical Activity*, *5*, 3.

8. Pinard, C. A., Yaroch, A. L., Hart, M. H., Serrano, E. L., McFerren, M. M., & Estabrooks, P. A. (2013). The validity and reliability of the Comprehensive Home Environment Survey (CHES). *Health Promotion Practice*, *15*(1), 109–117.
9. MacFarlane, A., Crawford, D., Ball, K., Savige, G., & Worsley, A. (2007). Adolescent home food environments and socioeconomic position. *Asia Pacific Journal of Clinical Nutrition*, *16*(4), 748–756.
10. Barr-Anderson, D. J., Van Den Berg, P., Neumark-Sztainer, D., & Story, M. (2008). Characteristics associated with older adolescents who have a television in their bedrooms. *Pediatrics*, *121*(4), 718–724.
11. Vereecken, C. A., Keukelier, E., & Maes, L. (2004). Influence of mother's educational level on food parenting practices and food habits of young children. *Appetite*, *43*(1), 93–103.
12. Bauer, K., Neumark-Sztainer, D., Fulkerson, J., & Story, M. (2011). Adolescent girls' weight-related family environments, Minnesota. *Preventing Chronic Disease*, *8*(3), A68.
13. Sobal, J. (1991). Obesity and socioeconomic status: a framework for examining relationships between physical and social variables. *Medical Anthropology*, *13*(3), 231–247.
14. Drewnowski, A., & Darmon, N. (2005). Food choices and diet costs: an economic analysis. *The Journal of Nutrition*, *135*(4), 900–904.
15. Belsky, J. (1984). The Determinants of Parenting: A Process Model. *Child Development*, *55*(1), 83–96.
16. Lande, B., Andersen, L. F., Baerug, A., Trygg, K. U., Lund-Larsen, K., Veierød, M. B., & Bjørneboe, G. E. A. (2003). Infant feeding practices and associated factors in the first six months of life: the Norwegian infant nutrition survey. *Acta Paediatrica*, *92*(2), 152–161.
17. Scott, J. A., Binns, C. W., Graham, K. I., & Oddy, W. H. (2009). Predictors of the early introduction of solid foods in infants: results of a cohort study. *BMC Pediatrics*, *9*(60).
18. Koh, G. A., Scott, J. A., Oddy, W. H., Graham, K. I., & Binns, C. W. (2010). Exposure to non-core foods and beverages in the first year of life: results from a cohort study. *Nutrition & Dietetics*, *67*(3), 137–142.
19. Schrempft, S., van Jaarsveld, C. H. M., Fisher, A., & Wardle, J. (2013). Family and infant characteristics associated with timing of core and non-core food introduction in early childhood. *European Journal of Clinical Nutrition*, *67*(6), 652–657.

20. Baharudin, R., & Luster, T. (1998). Factors related to the quality of the home environment and children's achievement. *Journal of Family Issues*, *19*(4), 375–403.
21. Luster, T., & Dubow, E. (1990). Predictors of the quality of the home environment that adolescent mothers provide for their school-aged children. *Journal of Youth and Adolescence*, *19*(5), 475–494.
22. Dumas, J. E., Nissley, J., Nordstrom, A., Smith, E. P., Prinz, R. J., & Levine, D. W. (2005). Home chaos: sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child & Adolescent Psychology*, *34*(1), 93–104.
23. Whitaker, K. L., Jarvis, M. J., Beeken, R. J., Boniface, D., & Wardle, J. (2010). Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. *The American Journal of Clinical Nutrition*, *91*(6), 1560–1567.
24. Wardle, J., Carnell, S., Haworth, C. M. A., & Plomin, R. (2008). Evidence for a strong genetic influence on childhood adiposity despite the force of the obesogenic environment. *The American Journal of Clinical Nutrition*, *87*(2), 398–404.
25. Slater, M. E., Sirard, J. R., Laska, M. N., Pereira, M. A., & Lytle, L. A. (2011). Relationships between energy balance knowledge and the home environment. *Journal of the American Dietetic Association*, *111*(4), 556–560.
26. Boutelle, K., Birkeland, R., Hannan, P. J., Story, M., & Neumark-Sztainer, D. (2007). Associations between maternal concern for healthful eating and maternal eating behaviors, home food availability, and adolescent eating behaviors. *Journal of Nutrition Education and Behavior*, *39*(5), 248–256.
27. Francis, L. A., Hofer, S. M., & Birch, L. L. (2001). Predictors of maternal child-feeding style: maternal and child characteristics. *Appetite*, *37*(3), 231–243.
28. Van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. *International Journal of Eating Disorders*, *5*(2), 295–315.
29. Lawlor, D. A., & Chaturvedi, N. (2006). Treatment and prevention of obesity - are there critical periods for intervention? *International Journal of Epidemiology*, *35*(1), 3–9.
30. Schrempft, S., van Jaarsveld, C. H. M., Fisher, A., & Wardle, J. (2015). The obesogenic quality of the home environment: associations with diet, physical activity, TV viewing, and BMI in preschool children. *PloS One*, *10*(8), e0134490.
31. Van Jaarsveld, C. H. M., Johnson, L., Llewellyn, C. H., & Wardle, J. (2010). Gemini: a UK twin birth cohort with a focus on early childhood weight trajectories, appetite and the family environment. *Twin Research and Human Genetics*, *13*(1), 72–78.

32. Bryant, M., Ward, D., Hales, D., Vaughn, A., Tabak, R., & Stevens, J. (2008). Reliability and validity of the Healthy Home Survey: a tool to measure factors within homes hypothesized to relate to overweight in children. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 23.
33. Little, R. J. A. & Rubin, D. B. (2002). *Statistical analysis with missing data*. Hoboken, NJ: Wiley.
34. Office for National Statistics. (2010). The effects of taxes and benefits on household income, 2008/09 (Data file). Retrieved from http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-169927
35. Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London: Sage.
36. Van Strien, T., Herman, C. P. & Verheijden, M. W. (2012). Eating style, overeating and weight gain. A prospective 2-year follow-up study in a representative Dutch sample. *Appetite*, *59*(3), 782–789.
37. Estabrooks, P. A., Lee, R. E., & Gyurcsik, N. C. (2003). Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? *Annals of Behavioral Medicine*, *25*(2), 100–104.
38. Parmenter, K., Waller, J. & Wardle, J. (2000). Demographic variation in nutrition knowledge in England. *Health Education Research*, *15*(2), 163–174.
39. Wardle, J., & Steptoe, A. (2003). Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology and Community Health*, *57*(6), 440–443.
40. Pepper, G. V. & Nettle, D. (2014). Perceived extrinsic mortality risk and reported effort in looking after health. *Human Nature, 25*(3), 378–392.
41. Sallis, J. F., Broyles, S. L., Frank-Spohrer, G., Berry, C. C., Davis, T. B., & Nader, P. R. (1995). Child's home environment in relation to the mother's adiposity. *International Journal of Obesity and Related Metabolic Disorders*, *19*(3), 190–197.
42. Wardle, J., Sanderson, S., Guthrie, C. A., Rapoport, L., & Plomin, R. (2002). Parental feeding style and the inter-generational transmission of obesity risk. *Obesity Research*, *10*(6), 453–462.
43. Agras, W. S., Hammer, L. D., McNicholas, F., & Kraemer, H. C. (2004). Risk factors for childhood overweight: a prospective study from birth to 9.5 years. *The Journal of Pediatrics*, *145*(1), 20–25.

44. Reilly, J. J. (2005). Early life risk factors for obesity in childhood: cohort study. B*ritish Medical Journal*, *330*(7504), 1357–1359.
45. Rutter, M. (2007). Gene-environment interdependence. *Developmental Science*, *10*(1), 12–18.
46. Kiff, C. J., Lengua, L. J., & Zalewski, M. (2011). Nature and nurturing: parenting in the context of child temperament. *Clinical Child and Family Psychology Review*, *14*(3), 251–301.
47. Wasser, H., Bentley, M., Borja, J., Goldman, B. D., Thompson, A., Slining, M., & Adair, L. (2011). Infants perceived as 'fussy' are more likely to receive complementary foods before 4 months. *Pediatrics*, *127*(2), 229–237.
48. Webber, L., Cooke, L., Hill, C., & Wardle, J. (2010a). Associations between children's appetitive traits and maternal feeding practices. *Journal of the American Dietetic Association*, *110*(11), 1718–1722.
49. Webber, L., Hill, C., Cooke, L., Carnell, S., & Wardle, J. (2010). Associations between child weight and maternal feeding styles are mediated by maternal perceptions and concerns. *European Journal of Clinical Nutrition*, *64*(3), 259–265.
50. Webber, L., Cooke, L., Hill, C., & Wardle, J. (2010b). Child adiposity and maternal feeding practices: a longitudinal analysis. *The American Journal of Clinical Nutrition*, *92*(6), 1423–1428.
51. Ashcroft, J., Semmler, C., Carnell, S., van Jaarsveld, C. H. M., & Wardle, J. (2007). Continuity and stability of eating behaviour traits in children. *European Journal of Clinical Nutrition, 62*(8), 985–990.
52. Heo, M., Faith, M. S., & Pietrobelli, A. Resistance to change of adulthood body mass index. (2002). *International Journal of Obesity, 26*(10), 1404–1405.
53. Chuang, R.-J., Sharma, S., Skala, K., & Evans, A. (2013). Ethnic differences in the home environment and physical activity behaviors among low-income, minority preschoolers in Texas. *American Journal of Health Promotion*, *27*(4), 270–278.
54. Skala, K., Chuang, R.-J., Evans, A., Hedberg, A.-M., Dave, J., & Sharma, S. (2012). Ethnic differences in the home food environment and parental food practices among families of low-income Hispanic and African-American preschoolers. *Journal of Immigrant and Minority Health*, *14*(6), 1014–1022.
55. Wardle, J. (1987). Eating style: a validation study of the Dutch Eating Behaviour Questionnaire in normal subjects and women with eating disorders. *Journal of Psychosomatic Research*, *31*(2), 161–169.