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Title of the article: Dietary intake in the early years and its relationship to BMI in a bi-ethnic group: the Born in Bradford 1000 study

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Dietary intake in the early years and its relationship to BMI in a bi-ethnic group: the Born in Bradford 1000 study

Abstract

Objective: To assess relationships between dietary intake at age 12, 18 and 36 months and body mass index (BMI) z-scores at age 36 months in a bi-ethnic group.

Design: A prospective cohort study comparing cross-sectional and longitudinal data. Exposures included dietary intake at 12, 18 and 36 months (Food Frequency Questionnaire) with an outcome of BMI z-score at age 36 months.

Setting: Born in Bradford 1000 study, Bradford, UK.

Subjects: Infants at age 12 months (n 722; 44% White British, 56% Pakistani), 18 months (n 779; 44% White British, 56% Pakistani) and 36 months (n 845; 45% White British, 55% Pakistani).

Results: Diet at age 12 months was not associated with BMI z-score at age 36 months. Higher consumption of vegetables at 18 and 36 months was associated with a lower BMI z-score at 36 months (-0.20 (95% CI (-0.36, -0.03)) and -0.16 (95% CI (-0.31, -0.02)) respectively). Higher consumption of high fat chips at age 36 months was associated with a lower BMI z-score at age 36 months (-0.16 (95% CI (-0.32, 0.00))). Overall, White British children had higher 36 month BMI z-scores than Pakistani children (adjusted mean difference of 0.21 (95% CI (0.02, 0.41))).

Conclusion: Our findings indicate that dietary intake at 18 and 36 months was somewhat related to BMI z-score at age 36 months and suggest the importance of early interventions aimed at establishing healthy eating behaviours.

Key words: Diet: Infant: Ethnicity: Obesity: BMI

Introduction

Although childhood obesity is levelling off in some populations, worldwide prevalence remains high[1,2] even at very young ages. The number of infants, toddlers and children (ages 0 to 5 years) who were overweight increased from 32 million globally in 1990 to 42 million in 2013. This figure is predicted to rise to 70 million by 2025[3].

In the UK, the most recent data provided by the National Child Measurement Programme (NCMP) including over one million children showed 9.3% of reception aged children (ages 4-5 years) were obese and another 12.8% were overweight[4]. Prevalence then increases further in the first few years of school; for Year 6 children (ages 10-11 years) 14.3% were overweight and a further 19.8% were obese[4]. It is estimated by 2020 that 20% of all boys and 33% of all girls will be obese[5]. Infant weight gain has a positive association with subsequent obesity risk[6,7]; highlighting the importance of research describing the aetiology of childhood obesity to support the development and implementation of effective policies and interventions.

Obesity prevalence assessed using body mass index (BMI) in the UK is significantly higher in children of South Asian origin compared with White British children[8,9] although this may in part be due to differences in body composition. Adults of South Asian origin are at greater risk of obesity-related conditions, such as type 2 diabetes[10], even at lower levels of obesity (measured using BMI) compared to White British populations. Children with obesity are more likely to become obese in adulthood and develop a variety of health problems, including cardiovascular disease, insulin resistance, musculoskeletal disorders, some cancers and disabilities[3]; and obesity in later childhood (ages 7 to < 18 years) and early adulthood (ages 18-30 years) is positively associated with risk of coronary heart disease[11]. In addition, overweight and obesity in childhood and adolescence have adverse consequences on premature mortality and physical morbidity in adulthood[12]. Overweight or obese adults who were obese as children have an increased risk of type 2 diabetes, hypertension, dyslipidaemia, and carotid-artery atherosclerosis[13]. Importantly, risk of adverse outcomes do not persist if children are no longer obese in adulthood[13]; highlighting the importance of early population-based interventions.

Optimizing a child's diet before the age of two years may be critical in preventing obesity and obesity-related diseases[14] as inappropriate early eating behaviours established during the complementary feeding period (weaning) and the first few years of life may persist[15,16]. It is important to understand the early risk factors for obesity and develop effective interventions for parents and their offspring supporting healthy weight behaviours[17]. With this in mind, we aimed to explore associations between dietary intake at age 12, 18 and 36 months with BMI z-score at age 36 months in a bi-ethnic sample of White British and Pakistani origin infants and children alongside examining ethnic differences in dietary intake and BMI z-score at age 36 months.

Methods

Participants and study design

The Born in Bradford (BiB) study is a longitudinal, multi-ethnic birth cohort study designed to examine the impact of environmental, psychological and genetic factors on maternal and child health and well-being(18). Bradford is the sixth largest city in the UK, with a population of about half a million and high rates of childhood morbidity and mortality(18). Compared to the national average infant mortality rate in 2003 of 5.5 deaths/1,000 live births, in Bradford it peaked at 9.4 deaths/1,000 live births(18). BiB was created in response to rising concerns about the high rates of childhood morbidity and mortality in Bradford. 12,453 women comprising of 13,776 pregnancies were recruited to the BiB cohort between March 2007 and December 2010. Mothers were recruited at 26-28 weeks gestation within Bradford Royal Infirmary while waiting for their routine glucose tolerance test.

The Born in Bradford 1000 cohort (BiB1000) is a sub-sample of the full BiB cohort specifically examining the determinants of childhood obesity(19). From August 2008 to March 2009, all mothers recruited to the full BiB cohort were eligible for participation in BiB1000. This study involved further assessments at 6, 12, 18, 24 and 36 months of age, including detailed measurements of anthropometry and social, behavioural and environmental factors that were hypothesized to relate to obesity development(19). Dietary data were collected when children were aged 12, 18 and 36 months.

Measurements

12 and 18 month dietary intake

Dietary data were collected when children were aged 12 and 18 months using a validated parent reported food frequency questionnaire (FFQ) from the Southampton Women's Survey cohort study(20). The questionnaire was adapted for BiB1000 to reflect dietary intake within the multi-ethnic population of Bradford, based on findings from 24 hour dietary recalls in the area and resulted in eight additional items (chapattis (white flour), chapattis (wholemeal flour), boiled rice, fried rice, semolina pudding, milk-based puddings, sponge puddings and other vegetables (e.g. okra, aubergine)). The resulting FFQ therefore included a list of ninety-eight food items, allowing the frequency of consumption and amounts consumed over the preceding month to be recorded(21). The response categories for each food were ‘never’ (recorded as 0), ‘less than once a week’ (recorded as 0.5), ‘food eaten weekly’ (recorded as the number of times per week) and ‘food eaten more than once a day’ (recorded as the number of times per day). An open response section in the same format is included to allow frequencies of consumption and amounts of any foods that are not listed in the ninety-eight foods. Flash cards were used to show the foods included in each food group, to promote standardized responses to the FFQ. Household utensils (tablespoons, teaspoons, bowls and feeding beakers) were used to estimate portion sizes and quantities of foods and drinks consumed. The FFQ was administered by a team of multilingual community research administrators, who were trained by dietitians.

For the purposes of analysis at 12 and 18 months, thirteen key indicator food categories were formed from the ninety-eight foods. The key indicator foods were defined as those consumed by this age group as identified through dietary surveys(22) and associated with high energy density (high fat, high sugar) and low energy density (high fibre, low fat, low sugar), and therefore assumed to have a plausible role in obesity development(23). The key indicator foods (Table 1) were selected on the basis of their contribution to dietary patterns associated with the development of obesity(21).

36 month dietary intake

The 36 month validated FFQ was a modified version of the Survey of Sugar Intake among children in Scotland study(24). This FFQ included questions on 140 types of food and drink within sixteen categories. Parents were asked to describe their child’s diet over the previous two to three months, including all main meals, snacks and drinks. It also included any foods and drinks their child consumed outside their home (e.g. at school or nursery, out of school clubs, restaurants, cafes or with family and friends). Descriptions of portion sizes were provided to help parents estimate the quantities of their child’s food intake (e.g. small bowl, slice, teaspoon, small slice, medium glass and small glass). The response categories were ‘rarely or never’, ‘1-2 per week’, ‘1 per week’, ‘2-3 per week’, ‘4-6 per week’, ‘1 per day’, ‘2-3 per day’, ‘4-6 per day’ and ‘7 or more per day’ and these were recorded as 1-9 respectively. For the purposes of analysis the responses were converted to daily totals. As with the 12 and 18 month analysis, key indicator food categories were created; defined as those consumed by this age group as identified through dietary surveys(25) and associated with high energy density (high fat, high sugar) and low energy density (high fibre, low fat, low sugar), and therefore assumed to have a plausible role in obesity development(23) (Table 1). Of the 140 foods captured in the FFQ ninety-five were used for the analysis, in some cases the food groupings were those used in the FFQ, for example fruit, and in other cases foods from different categories were combined for consistency with the 12 and 18 month groupings, ‘cakes’ for example was a combination of 'biscuits and cakes', 'desserts' and 'sweets, chocolates and ice-cream'. Some foods were also split within their own categories, meat and fish for example were split into non-processed and processed foods. The list of key indicator foods were not identical to those used at 12 and 18 months due to the necessity of using a validated age appropriate FFQ.

Ethnicity

Maternal and child ethnicity was self-assigned by the mother at the baseline assessment (26-28 weeks gestation) using the same ethnic group classification as the 2001 UK census[26] and categorized into White British, Pakistani, Other South Asian (Indian, Bangladeshi) and Other ethnicities (White other, Black, mixed race, other unspecified). Due to the smaller numbers within the other ethnic groups in the sample, data are presented for the two larger groups at 12 months (White British (38%) and Pakistani (49%)), 18 months (White British (37%) and Pakistani (49%)) and at 36 months (White British (38%) and Pakistani (48%)).

BMI z-score

Weight (kg) and height (m) was measured by trained researchers when children were aged 36 months. Age and gender adjusted BMI (weight (kg) / height $(m)^2$) z-scores were then calculated based on World Health Organization (WHO) 2006 standards[27].

Data analysis

The frequencies of consumption of key indicator foods at age 12, 18 and 36 months were tabulated across children's BMI z-score at age 36 months for the full sample and by ethnic group; see Tables 2 and 3 for the median frequency and interquartile range (IQR) of consumption for each key indicator food by ethnic group. Although the FFQ assesses both frequency and quantity, we chose to evaluate frequency of consumption of foods as it was deemed more appropriate to identify and inform key public health messages. Quantitative recommended dietary intake guidelines do not currently exist for all of the key indicator foods for this age group in the UK, so it was not possible to categorize intake into those meeting or not meeting recommended intake levels. A pragmatic approach to defining cut-offs was therefore used to define high and low intakes; where intake were dichotomized into consumer/non-consumer (i.e. zero intake/any intake) and below and equal to/above the median intake for that key indicator food (i.e. lower intake/higher intake); see Table 1. Foods with a median intake of zero were those dichotomized into consumer/non-consumer and foods with a median intake of greater than zero were those dichotomized into below and equal to/above the median intake. Cross-tabulation of ethnicity against the categorizations (high and low consumption) of each food at 12, 18 and 36 months are shown in Supplementary Table 1. Also shown are p-values from chi-squared tests of independence between ethnicity and consumption for each food group, using a false discovery rate correction for multiple testing.

Multiple linear regression was used to model associations between consumption of key indicator foods at age 12, 18 and 36 months with BMI z-score at age 36 months, adjusted for ethnicity, gender and birthweight, with BMI z-score at age 36 months being the response variable and ethnicity, gender and birthweight plus key indicator food consumption variables being predictors in the models. Multiple logistic regression was used to model associations between ethnicity and consumption of key indicator foods at age 36 months. The coefficients for the key indicator foods in Tables 4, 5 and 6 represent the change in 36 month BMI z-score for children consuming those foods or those consuming those foods more than the median frequency time (i.e. an increased consumption). The intercept represents a baseline BMI z-score value and an effect for Pakistani children, the ethnicity variable represents the difference in BMI z-score for White British children. Ethnic differences in 36 month BMI z-score, adjusted for dietary intake, gender and birthweight was assessed using these linear regression models, utilising the coefficients and associated confidence intervals for ethnicity.

The statistical software package R version 2.15.1 (2012) was used for the analyses[28].

Results

1,735 (91%) mothers from 1,916 who were invited agreed to take part in BiB1000. For the current study, participants were excluded if they had multiple births (n 28 / 56 infants), missing child dietary data, missing child BMI z-score at age 36 months or were not of White British or Pakistani ethnicity. The sample therefore consists of 722 singleton infants with 12-month data, 779 children with 18-month data and 845 children with 36-month data.

Table 7 provides information on the characteristics of the sample. Data are presented for White British and Pakistani infants only as they form the largest ethnic groups in the population of interest. Birthweight (grams) and 36 month BMI z-scores have been summarized, split by ethnicity and gender for the three time points of interest. There were a number of statistically significant differences between ethnicity and gender with respect to 36 month BMI z-score and birthweight, therefore including ethnicity, gender and birthweight as confounders in the linear regression models was justified.

Exploring dietary intake and patterns between 12, 18 and 36 months

Table 3 presents the associations between consumption of the key indicator foods at 36 months and ethnicity. Odds ratios are presented for Pakistani infants compared with White British infants**.** There were a number of statistically significant differences at 36 months, with Pakistani infants more likely to consume high fat chips, processed fish, fruit and water (0.15 (95% CI (0.09, 0.24)), 0.32 (95% CI (0.20, 0.51)), 0.49 (95% CI (0.31, 0.76)) and 0.31 (95% CI (0.20, 0.48)) respectively) than White British infants. White British infants were more likely to consume low fat milk, low fat chips, non-processed meat, processed meat, low sugar drinks and low sugar cereals (2.70 (95% CI (1.73, 4.23)), 4.91 (95% CI (3.09, 7.93)), 3.23 (95% CI (2.08, 5.06)), 9.22 (95% CI (5.67, 15.42)), 3.22 (95% CI (2.11, 4.97)) and 1.76 (95% CI (1.15, 2.68)) respectively) than Pakistani infants.

<u>Associations between intake of key indicator food consumption at 12 months with 36 month BMI z-scores</u>

Table 4 shows the median frequency of consumption and associated IQR for the key indicator foods at age 12 months in White British and Pakistani infants (n 722) and associations between consumption of key indicator foods of infants aged 12 months with BMI z-score at age 36 months, adjusted for ethnicity, gender and birthweight. There were no significant associations between consumption of any key indicator food groups at age 12 months and BMI z-score at age 36 months.

<u>Associations between intake of key indicator food consumption at 18 months with 36 month BMI z-scores</u>

Table 5 shows the median frequency of consumption and associated IQR for the key indicator foods at age 18 months in White British and Pakistani children (n 779) and associations between consumption of key indicator food groups of children aged 18 months with BMI z-score at age 36 months, adjusted for ethnicity, gender and birthweight.

Intake of vegetables at 18 months was associated with BMI z-score at age 36 months (coefficient of -0.20 (95% CI (-0.36, -0.03))), with children who consume vegetables more frequently than the median time (6.0 (IQR 4.0-7.0) times per day) at age 18 months being more likely to have a lower BMI z-score at age 36 months than children consuming vegetables less frequently than or equal to the median time. Intake of other key indicator foods at age 18 months was not related to BMI z-score at age 36 months.

With assessment of the same key indicator foods at 12 and 18 months, the effect sizes and confidence intervals can be directly compared over time (Figure 1). Confidence intervals to the right of the vertical dashed line at zero show variables which are associated with an increase in 36 month BMI z-score. Whereas those to the left show variables which are associated with a decrease in 36 month BMI z-score. The upper limit for the vegetables confidence interval at 18 months lies below zero indicating a negative association and therefore a higher consumption of vegetables at 18 months is associated with a lower BMI z-score at 36 months. In addition, the confidence intervals at 12 and 18 months for each key indicator food overlap substantially, indicating no inconsistent effects of diet at age 12 and 18 months on BMI z-score at 36 months.

Associations between intake of key indicator food consumption at 36 months with 36 month BMI z-scores

Table 6 shows the median frequency of consumption and the IQR for the key indicator foods at age 36 months in White British and Pakistani children (n 845) along with the associations between consumption of key indicator foods for children aged 36 months with BMI z-score at age 36 months, adjusted for ethnicity, gender and birthweight.

Children consuming high fat chips more frequently than the median frequency at age 36 months (0.4 (IQR 0.2-0.7) times per day) were more likely to have lower BMI z-scores at age 36 months than those consuming high fat chips less frequently or equal to the median frequency (coefficient of -0.16 (95% CI (-0.32, 0.00))). There remained an association between vegetable intake and 36 month BMI z-score (coefficient of -0.16 (95% CI (-0.31, -0.02))), with children consuming vegetables more frequently than the median frequency at age 36 months (2.4 (IQR 1.4-3.6) times per day) being more likely to have a lower BMI z-score at age 36 months than children consuming vegetables less frequently or equal to the median frequency. Intake of other key indicator foods at age 36 months was not related to BMI z-score at age 36 months, although a weak association was found between consumption of non-processed fish and 36 month BMI z-score, where children consuming non-processed fish more frequently than the median frequency at age 36 months (0.1 (IQR 0.0-0.3) times per day) were more likely to have higher BMI z-scores at age 36 months than those consuming non-processed fish less frequently or equal to the median frequency (coefficient of 0.14 (95% CI (-0.01, 0.29))).

Ethnic differences in 36 month BMI Z-scores

Ethnic differences in 36 month BMI z-scores were consistent regardless of which dietary data (12, 18 and 36 months) were included in the model. Figure 2 shows the comparison of the ethnicity effect sizes and confidence intervals on 36 month BMI z-score at 12, 18 and 36 months. These estimates were obtained from the linear regression models (Tables 4, 5 and 6) where ethnicity was used as a confounder and represents the difference in BMI z-score (White British - Pakistani children). White British children had a higher mean 36 month BMI z-score than Pakistani children when adjusted for gender, birthweight and dietary intake at age 12, 18 and 36 months (0.29 (95% CI (0.10, 0.49)), 0.21 (95% CI (0.03, 0.39)) and 0.21 (95% CI (0.02, 0.41)) respectively). These conclusions suggest ethnic differences in growth patterns such as BMI and weight which have shown to exist at birth are likely to continue to at least 36 months of age.

Discussion

In our study, White British children had higher BMI z-scores at age 36 months compared to Pakistani children, consistent with other data stating Pakistani infants are lighter and have shorter lengths than White British infants at birth[29-33]. This demonstrates that ethnic differences in growth characteristics (weight and height) are present from birth to at least 36 months of age. Our research also provides evidence that higher intake of vegetables at ages 18 and 36 months is associated with a lower BMI z-score at age 36 months. Previous literature in this area is inconsistent, which could be attributed to heterogeneity in populations, particularly differences in age groups. Inconsistent findings have been identified in a previous systematic review[34] indicating dietary patterns that are high in energy-dense, high-fat and low-fibre foods predispose young people to later overweight and obesity. This review also highlighted that examining multiple dietary factors within a dietary pattern may better explain obesity risk than individual nutrients or foods. Some literature suggests that the evidence of a relationship between vegetable consumption and body mass index is inconsistent, especially among children[35]; however others report negative associations between fruit and vegetable consumption and BMI/obesity[36,37]. On balance, early introduction of vegetables to infants diets is warranted, not only due to its possible association with a reduction in BMI z-score but also for its contribution towards a healthy balanced diet (high fibre, vitamin A, vitamin C and lower energy density for example). It is however unknown whether encouraging fruit and vegetable consumption displaces other high energy density foods in diets.

Dietary intakes for infants and children aged 12 and 18 months in this sample have been discussed previously[21], showing consumption of foods high in sugar and fat is evident in diets before age 36 months. Foods such as chips; roast potatoes and potato shapes; cakes, biscuits, chocolates and sweets; crisps and savoury snacks and processed meat products featured regularly in the diets of children. At 12 months Pakistani infants were more likely to consume fruit and chips or potatoes (adjusted odds ratios, 2.20 (95% CI (1.70, 2.85)) and 2.75 (95% CI (2.09, 3.62)) respectively) but less likely to consume processed meat products than White British infants (adjusted odds ratio, 0.11 (95% CI (0.08, 0.15)))[21]. At 18 months, Pakistani infants were more likely to consume fruit, chips or potatoes and water (adjusted odds ratios, 1.40 (95% CI (1.08, 1.81)), 2.26 (95% CI (1.50, 3.43)) and 3.24 (95% CI (2.46, 4.25)) respectively) but less likely to consume processed meat products than White British infants (adjusted odds ratio, 0.10 (95% CI (0.06, 0.15)))[21]. These patterns are shown to still be present at 36 months, indicating ethnic differences in food consumption start early (12 and 18 months) and continue at 36 months. Here we have shown additional dietary data at age 36 months (Table 6), indicating persistent patterns with median consumption of cakes and high sugar drinks of 2.1 and 2.0 times per day respectively. However there is evidence to suggest the five fruit and vegetables a day message may be starting to get through, with median consumption of 6.0 times per day (fruit 3.2 and vegetables 2.4). Although children eating fruit and vegetables on more than five occasions per day is encouraging we shouldn't confuse this result with five portions a day since the quantity eaten is not included in our analysis. Even so, five times a day is beneficial because this will hopefully displace other unhealthier foods at this young age[38-41]. We acknowledge that looking at dietary patterns, for example, a combination of foods consumed might be better at reflecting associations with weight rather than individual foods (or food groups), as has been previously suggested[34] but for consistency with the analysis performed at 12 and 18 months[21] and in order to perform comparisons, food groups (a combination of similar foods) were used instead.

Our research suggests that relationships between 36 month BMI z-score and key indicator foods are present at 18 and 36 months, however, using cross-sectional data means causality cannot be established. This was apparent in anticipated foods such as vegetables but we also found other, more unexpected, associations between intake of non-processed fish (grilled or poached white fish, fired oily fish, smoked oily fish, tinned tuna, tinned salmon, sardines, mackerel, pilchards and prawns) and high fat chips at age 36 months and BMI z-score at age 36 months; related to higher and lower BMI z-scores respectively. These unexpected results could be attributed to our method of dietary assessment, however previous literature has reported high intake of fish products is associated with an increased body weight status in school aged children due to accumulation of fat-free mass[42]. We considered whether the level of breastfeeding in this age group was more important than diet but previous research in this sample has shown there are no associations between infant feeding practices and BMI at 3 years[43].

Research exists reporting that obese children eat chips more frequently than normal weight children[44], offering french fries and similar potato products in school meals more than once per week is associated with a significantly higher likelihood of obesity[45] and higher BMI z-scores are strongly associated with the consumption of high fat foods (including chips and french fries)[46] , our research appears to disagree with these results and goes against intuition. More research is warranted in this population to fully investigate the relationship between high fat chips consumption and obesity (BMI z-score).

Our identified relationships between diet and 36 month BMI z-score contribute to evidence highlighting the importance of appropriate diets for all children from a young age[34]. As promoting consumption of vegetables is notoriously more difficult than fruit[47], it is encouraging to report that in our sample, children aged 36 months were reported to consume vegetables on average almost two and a half times per day and fruit and vegetables six times per day. With inappropriate eating behaviours established early in life[15,16] the early introduction of foods associated with a decrease in BMI z-score are essential. The results presented regarding the association between vegetable consumption and 36 month BMI z-score leaves the question of what interventions could be encouraged? Examples are parents setting an example, the one bite rule and rewarding attempts to eat vegetables[48]. Repeated exposure is a simple effective technique that can be used to improve acceptance of novel vegetables[49]. Other aspects of a child's diet can be improved by eating a healthy breakfast, healthier snacks (i.e. fewer crisps and biscuits for example), making water the drink of choice, eating meals together and allowing children to get involved in the preparation of meals[50].

This study has highlighted ethnic differences in BMI z-score in early childhood; consistent with previous research on growth patterns[29,30]. Ethnic disparities in obesity prevalence are already present by the pre-school years, suggesting disparities in childhood obesity prevalence may have their origins in the earliest stages of life[51]. Previous research has shown associations between dietary intake during infancy and the early childhood period by ethnicity in the Born in Bradford sample[21]; with consumption patterns of processed meat products, fruit and chips or potatoes being evident in White British and Pakistani infants at 12 months and increasing by 18 months of age, with further consumption patterns in water and low sugar drinks being established at 18 months[21]. Research by the Avon Longitudinal Study of Parents and Children (ALSPAC) has also reported an impact of early nutrition on excess growth[52]. In one study, breastfeeding status was associated with later obesity, though this was predominantly observed later, when children were school aged[53]. It is possible that differences in the data between ALSPAC and BiB are due to differences in ethnicity between the cohorts (e.g. 71% of the ALSPAC participants were White). It is also possible that the trajectory of excess weight gain in BiB would continue to increase after school entry, but these data are not available to test this hypothesis.

We have identified associations between consumption of some foods and BMI z-score in early childhood. Further research is warranted to determine whether associations are maintained in later childhood.

Our study included a large bi-ethnic sample with longitudinal exposure data collected at 12, 18 and 36 months of age. Dietary data may have been affected by the use of parent reported FFQs[20,24], which may be prone to overestimation of some foods and underestimation of others. Assessment of dietary intake via FFQs in large cohort studies is common[54-56] and is a standard, feasible approach in large samples[57]. Further, two validated questionnaires were used[20,24]. To our knowledge, there is no systematic error in reporting within FFQs by ethnicity[58].

A limitation of this study is that only infants and children of White British and Pakistani ethnicity were included in the analysis, constituting only two ethnicities and one South Asian group. Due to the heterogeneous nature of this ethnic group, the data cannot be generalized to other South Asian infants and children. In addition, our study only used data from one UK geographical region, Bradford, and the results presented may not be generalizable to other areas. We accept that BMI z-score may not be the most appropriate measure to use as BMI does not directly measure adiposity[59]. Given that previous BiB literature[29,30] reporting differences in Pakistani and White British infants growth measurements exists, a more suitable indicator for obesity such as percent body fat could be used.

Stratified analysis by utilising two-way interaction terms in our linear regression models (ethnicity with each key indicator food) was considered. However, the two-way interaction terms were all insignificant meaning the stratified analysis provided equivalent conclusions to the models without interaction terms. Therefore, the simpler models were presented as they gave better estimates of the effect sizes by pooling the ethnicities, hence increasing the sample size giving smaller standard errors and more precise estimates.

It has been suggested that dietary patterns which emerge early[60] track through infancy[61] and into later childhood[62] persist into adulthood[63]. Findings in this study imply the importance of early life exposures, with some evidence of associations between dietary intake and 36 month BMI z-score being established early in life (18 and 36 months). This is an important conclusion as other studies which have shown relationships between food consumption and growth[64] have tended to focus on children of school age or older rather than pre-schoolchildren[65-67] or solely focused on growth characteristics[68,69] or diet[22,70]. These results should be used as a foundation to investigate relationships in other populations and links to BMI later in life. With the prediction that 20% of all boys and 33% of all girls will be obese by 2020[5] it is important to use the information from studies such as this one to develop tailored obesity prevention interventions aimed at pregnant women and new parents.

Conclusion

We found ethnic differences in BMI z-score at age 36 months in our sample, in addition we found some evidence that dietary intake during infancy and early childhood is associated with BMI z-score at age 36 months.

This information adds to the evidence base of the importance of diet in early childhood and supports the development of tailored interventions aimed to support parents and carers to optimize early healthy weight behaviours. Further research is required to establish the influence of these dietary patterns in infancy and early childhood on later health outcomes, including childhood obesity, across other ethnic groups.

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Table 1: List of key indicator foods and categorizations of consumption at 12, 18 and 36 months

12 and 18 Months		36 Months	
Key Indicator Food Group	Categorization	Key Indicator Food Group	Categorization
Baby formula milk (inc. all formula milk drinks)	Consumer/non-consumer	High fat milk	≤Median/>median
Baby savoury commercial foods (incl. dried, jars, tinned varieties)	Consumer/non-consumer	Low fat milk	Consumer/non-consumer
Baby sweet commercial foods (incl. dried, jars, tinned varieties)	Consumer/non-consumer	High fat chips	≤Median/>median
Chips, roast and potato shapes	≤Median/>median	Low fat chips	≤Median/>median
Processed meat products	≤Median/>median	Non-processed meat	≤Median/>median
Vegetables (incl. tinned and salad)	≤Median/>median	Processed meat	≤Median/>median
Fruit (incl. fresh, tinned and cooked fruit)	≤Median/>median	Non-processed fish	≤Median/>median
Sweet snacks (incl. cakes, biscuits, chocolate, sweets)	≤Median/>median	Processed fish	≤Median/>median
Savoury crisp-type snacks	≤Median/>median	Vegetables	≤Median/>median
Sugar-sweetened drinks	Consumer/non-consumer (12 months)	Fruit	≤Median/>median
	≤Median/>median (18 months)	Crisps	≤Median/>median
Pure fruit juices and baby fruit juices	Consumer/non-consumer (12 months)	Cakes	≤Median/>median
	≤Median/>median (18 months)	Chocolate	≤Median/>median
Low-sugar drinks (artificially sweetened)	Consumer/non-consumer	Water	≤Median/>median
Water	≤Median/>median	High sugar drinks	≤Median/>median
-	-	Low sugar drinks	≤Median/>median
-	-	Low sugar cereals	≤Median/>median
-	-	Sweetened cereals	≤Median/>median

Table 2: Key indicator food consumption at 12 and 18 months (median and IQR) split by ethnicity

	Frequency of consumption (per day or per week)							
	12 Months				**18 Months**			
	White British		**Pakistani**		**White British**		**Pakistani**	
Key Indicator Food Group	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
Key 1: Formula milk (frequency/day)*	0.0	0.0-2.0	0.0	0.0-2.0	0.0	0.0-0.0	0.0	0.0-0.0
Key 2: Commercial savoury baby foods (frequency/week)*	0.0	0.0-4.0	0.0	0.0-2.0	0.0	0.0-0.0	0.0	0.0-0.0
Key 3: Commercial sweet baby foods (frequency/week)*	0.0	0.0-0.0	0.0	0.0-2.0	0.0	0.0-0.0	0.0	0.0-0.0
Key 4: Chips, roast and potato shapes (frequency/week)†	0.5	0.0-2.0	1.0	1.0-2.0	7.0	7.0-7.0	7.0	7.0-7.0
Key 5: Processed meat products (frequency/week)†	2.0	0.5-3.5	0.0	0.0-1.0	21.0	14.0-28.0	7.0	0.0-7.0
Key 6: Vegetables (incl. tinned and salad) (frequency/day)†	1.7	1.1-2.3	1.9	1.0-2.7	6.0	4.0-7.0	5.0	4.0-7.0
Key 7: Fruit (incl. fresh, tinned and cooked) (frequency/day)†	1.5	0.9-2.4	2.1	1.3-3.1	5.0	3.5-6.0	5.0	4.0-6.0
Key 8: Cakes, biscuits, chocolate and sweets (frequency/day)†	0.7	0.4-1.2	0.6	0.2-1.1	3.0	2.0-4.0	3.0	2.0-4.0
Key 9: Crisps and savoury snacks (frequency/week)†	2.0	0.0-3.0	2.0	0.5-4.0	7.0	7.0-7.0	7.0	7.0-7.0
Key 10: Sugar-sweetened drinks (frequency/week)*/†	0.0	0.0-3.0	1.0	0.0-7.0	7.0	0.0-14.0	7.0	7.0-14.0
Key 11: Pure fruit juice (frequency/week)*/†	0.0	0.0-4.0	0.5	0.0-7.0	0.0	0.0-7.0	7.0	0.0-7.0
Key 12: Low-sugar drinks (frequency/week)*	0.0	0.0-2.0	0.0	0.0-0.8	0.0	0.0-14.0	0.0	0.0-7.0
Key 13: Water (frequency/day)†	2.0	1.0-3.0	2.0	1.0-3.0	1.0	0.0-3.0	3.0	1.8-4.0

IQR, interquartile range

* Consumption of any or none

† Consumption of > median or =< median

Table 3: Key indicator food consumption at 36 months (median and IQR) split by ethnicity with logistic regression model properties

	Frequency of consumption (per day)				Model Properties				
	White British		Pakistani						
Key Indicator Food Group/Intercept	**Median**	**IQR**	**Median**	**IQR**	**Log OR**	**95% CI**	**OR**	**95% CI**	**p-value**
Intercept	-	-	-	-	-0.87	(-1.48, -0.27)	0.42	(0.23, 0.76)	0.005
Key 1: High fat milk (frequency/day)†	1.0	0.4-2.5	2.5	1.0-2.5	-0.03	(-0.45, 0.40)	0.97	(0.63, 1.50)	0.90
Key 2: Low fat milk (frequency/day)*	0.0	0.0-1.0	0.0	0.0-0.0	0.99	(0.55, 1.44)	2.70	(1.73, 4.23)	< 0.001
Key 3: High fat chips (frequency/day)†	0.2	0.1-0.5	0.5	0.3-0.8	-1.92	(-2.45, -1.41)	0.15	(0.09, 0.24)	< 0.001
Key 4: Low fat chips (frequency/day)†	0.5	0.4-0.7	0.2	0.0-0.4	1.59	(1.13, 2.07)	4.91	(3.09, 7.93)	< 0.001
Key 5: Non-processed meat (frequency/day)†	0.6	0.4-1.0	0.4	0.1-0.8	1.17	(0.73, 1.62)	3.23	(2.08, 5.06)	< 0.001
Key 6: Processed meat (frequency/day)†	0.6	0.4-0.9	0.3	0.1-0.5	2.22	(1.73, 2.74)	9.22	(5.67, 15.42)	< 0.001
Key 7: Non-processed fish (frequency/day)†	0.2	0.0-0.3	0.1	0.0-0.3	0.11	(-0.35, 0.57)	1.12	(0.71, 1.76)	0.63
Key 8: Processed fish (frequency/day)†	0.3	0.1-0.4	0.4	0.1-0.6	-1.14	(-1.61, -0.67)	0.32	(0.20, 0.51)	< 0.001
Key 9: Vegetables (frequency/day)†	2.5	1.6-3.4	2.4	1.2-3.8	0.09	(-0.35, 0.53)	1.10	(0.70, 1.71)	0.69
Key 10: Fruit (frequency/day)†	2.9	1.7-4.7	3.7	2.2-5.3	-0.72	(-1.16, -0.28)	0.49	(0.31, 0.76)	0.001
Key 11: Crisps (frequency/day)†	0.5	0.3-0.8	0.7	0.4-1.1	-0.42	(-0.88, 0.04)	0.66	(0.41, 1.04)	0.08
Key 12: Cakes (frequency/day)†	1.9	1.1-3.0	2.3	1.3-3.9	-0.24	(-0.71, 0.23)	0.79	(0.49, 1.26)	0.31
Key 13: Chocolate (frequency/day)†	0.4	0.1-0.7	0.4	0.2-1.1	-0.25	(-0.71, 0.20)	0.78	(0.49, 1.23)	0.28
Key 14: Water (frequency/day)†	0.7	0.1-2.5	2.5	1.0-5.0	-1.16	(-1.60, -0.73)	0.31	(0.20, 0.48)	< 0.001
Key 15: High sugar drinks (frequency/day)†	1.7	0.8-3.5	2.1	1.1-3.6	-0.43	(-0.89, 0.02)	0.65	(0.41, 1.02)	0.06
Key 16: Low sugar drinks (frequency/day)†	1.7	0.5-5.0	0.3	0.0-1.0	1.17	(0.75, 1.60)	3.22	(2.11, 4.97)	< 0.001
Key 17: Low sugar cereals (frequency/day)†	1.0	0.4-1.1	0.7	0.4-1.0	0.56	(0.14, 0.99)	1.76	(1.15, 2.68)	0.01
Key 18: Sweetened cereals (frequency/day)†	0.1	0.0-0.4	0.1	0.0-0.4	-0.35	(-0.78, 0.08)	0.71	(0.46, 1.09)	0.11

IQR, interquartile range

* Consumption of any or none

† Consumption of > median or =< median

Table 4: Key indicator food consumption at 12 months (median and IQR) and linear regression model properties and mean 36 month BMI z-scores

	Intake at 12 Months		Model Properties		
Key Indicator Food Group/Intercept/Ethnicity	**Median**	**IQR**	**Coeff**	**95% CI**	**p-value**
Intercept	-	-	-1.11	(-1.71, -0.52)	< 0.001
Ethnicity	-	-	0.29	(0.10, 0.49)	0.003
Key 1: Formula milk (frequency/day)*	0.0	0.0-2.0	0.08	(-0.08, 0.23)	0.33
Key 2: Commercial savoury baby foods (frequency/week)*	0.0	0.0-3.0	-0.02	(-0.19, 0.15)	0.82
Key 3: Commercial sweet baby foods (frequency/week)*	0.0	0.0-0.5	0.11	(-0.08, 0.30)	0.25
Key 4: Chips, roast and potato shapes (frequency/week)†	1.0	0.0-2.0	-0.04	(-0.21, 0.13)	0.65
Key 5: Processed meat products (frequency/week)†	0.5	0.0-2.0	0.01	(-0.16, 0.19)	0.88
Key 6: Vegetables (incl. tinned and salad) (frequency/day)†	1.7	1.1-2.6	-0.06	(-0.21, 0.10)	0.48
Key 7: Fruit (incl. fresh, tinned and cooked) (frequency/day)†	1.9	1.1-2.9	0.09	(-0.07, 0.25)	0.25
Key 8: Cakes, biscuits, chocolate and sweets (frequency/day)†	0.6	0.3-1.1	-0.05	(-0.21, 0.11)	0.54
Key 9: Crisps and savoury snacks (frequency/week)†	2.0	0.0-3.0	-0.02	(-0.18, 0.13)	0.76
Key 10: Sugar-sweetened drinks (frequency/week)*	0.0	0.0-0.5	0.07	(-0.08, 0.23)	0.36
Key 11: Pure fruit juice (frequency/week)*	0.0	0.0-0.5	-0.05	(-0.20, 0.10)	0.53
Key 12: Low-sugar drinks (frequency/week)*	0.0	0.0-1.0	0.09	(-0.08, 0.26)	0.32
Key 13: Water (frequency/day)†	2.0	1.0-3.0	-0.12	(-0.27, 0.04)	0.13
				Mean	**95% CI**
36 Month BMI z-scores	***White British***			0.76	(0.67, 0.86)
	Pakistani			0.40	(0.29, 0.52)
	Overall			0.56	(0.49, 0.64)

IQR, interquartile range
* Consumption of any or none
† Consumption of > median or =< median

Table 5: Key indicator food consumption at 18 months (median and IQR) with linear regression model properties and mean 36 month BMI z-scores

	Intake at 18 Months		Model Properties		
Key Indicator Food Group/Intercept/Ethnicity	**Median**	**IQR**	**Coeff**	**95% CI**	**p-value**
Intercept	-	-	-0.77	(-1.39, -0.14)	0.02
Ethnicity	-	-	0.21	(0.03, 0.39)	0.02
Key 1: Formula milk (frequency/day)*	0.0	0.0-0.0	0.05	(-0.15, 0.25)	0.61
Key 2: Commercial savoury baby foods (frequency/week)*	0.0	0.0-0.0	-0.08	(-0.34, 0.18)	0.56
Key 3: Commercial sweet baby foods (frequency/week)*	0.0	0.0-0.0	-0.04	(-0.31, 0.23)	0.76
Key 4: Chips, roast and potato shapes (frequency/week)†	7.0	7.0-7.0	-0.21	(-0.46, 0.03)	0.08
Key 5: Processed meat products (frequency/week)†	7.0	0.0-21.0	0.00	(-0.19, 0.18)	0.97
Key 6: Vegetables (incl. tinned and salad) (frequency/day)†	6.0	4.0-7.0	-0.20	(-0.36, -0.03)	0.02
Key 7: Fruit (incl. fresh, tinned and cooked) (frequency/day)†	5.0	4.0-6.0	-0.04	(-0.19, 0.11)	0.60
Key 8: Cakes, biscuits, chocolate and sweets (frequency/day)†	3.0	2.0-4.0	0.00	(-0.16, 0.15)	0.99
Key 9: Crisps and savoury snacks (frequency/week)†	7.0	7.0-7.0	-0.02	(-0.24, 0.20)	0.85
Key 10: Sugar-sweetened drinks (frequency/week) †	7.0	0.0-14.0	-0.01	(-0.18, 0.16)	0.91
Key 11: Pure fruit juice (frequency/week)†	7.0	0.0-7.0	-0.07	(-0.21, 0.08)	0.37
Key 12: Low-sugar drinks (frequency/week)*	0.0	0.0-7.0	0.11	(-0.04, 0.27)	0.15
Key 13: Water (frequency/day)†	2.0	1.0-4.0	-0.04	(-0.19, 0.12)	0.66
				Mean	**95% CI**
36 Month BMI z-scores	***White British***			0.76	(0.66, 0.85)
	Pakistani			0.41	(0.31, 0.52)
	Overall			0.56	(0.49, 0.64)

IQR, interquartile range

* Consumption of any or none

† Consumption of > median or =< median

Table 6: Key indicator food consumption at 36 months (median and IQR) with linear regression model properties and mean 36 month BMI z-scores

	Intake at 36 Months		Model Properties		
Key Indicator Food Group/Intercept/Ethnicity	**Median**	**IQR**	**Coeff**	**95% CI**	**p-value**
Intercept	-	-	-0.90	(-1.42, -0.39)	< 0.001
Ethnicity	-	-	0.21	(0.02, 0.41)	0.03
Key 1: High fat milk (frequency/day)†	1.4	0.7-2.5	-0.02	(-0.17, 0.12)	0.77
Key 2: Low fat milk (frequency/day)*	0.0	0.0-0.4	0.07	(-0.09, 0.23)	0.39
Key 3: High fat chips (frequency/day)†	0.4	0.2-0.7	-0.16	(-0.32, 0.00)	0.05
Key 4: Low fat chips (frequency/day)†	0.4	0.1-0.5	-0.04	(-0.20, 0.12)	0.62
Key 5: Non-processed meat (frequency/day)†	0.5	0.2-0.9	-0.09	(-0.23, 0.06)	0.25
Key 6: Processed meat (frequency/day)†	0.4	0.2-0.7	-0.08	(-0.24, 0.08)	0.32
Key 7: Non-processed fish (frequency/day)†	0.1	0.0-0.3	0.14	(-0.01, 0.29)	0.07
Key 8: Processed fish (frequency/day)†	0.3	0.1-0.5	-0.07	(-0.22, 0.08)	0.38
Key 9: Vegetables (frequency/day)†	2.4	1.4-3.6	-0.16	(-0.31, -0.02)	0.03
Key 10: Fruit (frequency/day)†	3.2	1.9-5.0	-0.09	(-0.24, 0.05)	0.21
Key 11: Crisps (frequency/day)†	0.6	0.4-1.0	0.01	(-0.13, 0.16)	0.85
Key 12: Cakes (frequency/day)†	2.1	1.2-3.5	0.04	(-0.12, 0.19)	0.63
Key 13: Chocolate (frequency/day)†	0.4	0.1-0.7	0.00	(-0.15, 0.15)	1.00
Key 14: Water (frequency/day)†	1.0	0.4-2.5	0.07	(-0.07, 0.22)	0.32
Key 15: High sugar drinks (frequency/day)†	2.0	1.0-3.5	0.01	(-0.13, 0.16)	0.87
Key 16: Low sugar drinks (frequency/day)†	0.7	0.0-2.5	0.13	(-0.01, 0.28)	0.08
Key 17: Low sugar cereals (frequency/day)†	0.7	0.4-1.1	-0.07	(-0.21, 0.07)	0.31
Key 18: Sweetened cereals (frequency/day)†	0.1	0.0-0.4	-0.02	(-0.17, 0.12)	0.74
				Mean	**95% CI**
36 Month BMI z-scores	***White British***			0.74	(0.65, 0.83)
	Pakistani			0.39	(0.29, 0.49)
	Overall			0.55	(0.48, 0.62)

IQR, interquartile range
* Consumption of any or none
† Consumption of > median or =< median

Table 7: Characteristics of the sample

	36 Month BMI z-score for 12 Month Population			36 Month BMI z-score for 18 Month Population			36 Month BMI z-score in for Month Population		
	n	**Mean (Median)**	**SD (IQR)**	**n**	**Mean (Median)**	**SD (IQR)**	**n**	**Mean (Median)**	**SD (IQR)**
Ethnicity: White British	319	0.76 (0.74)	0.89 (0.17-1.36)	343	0.76 (0.74)	0.89 (0.17-1.36)	379	0.74 (0.71)	0.88 (0.15-1.36)
Ethnicity: Pakistani	403	0.40 (0.33)	1.14 (-0.29-1.08)	436	0.41 (0.32)	1.14 (-0.29-1.11)	466	0.39 (0.30)	1.12 (-0.29-1.07)
Sex: Male	334	0.53 (0.51)	1.01 (-0.14-1.23)	361	0.52 (0.48)	1.02 (-0.14-1.23)	391	0.51 (0.48)	1.00 (-0.13-1.21)
Sex: Female	388	0.59 (0.52)	1.08 (-0.15-1.26)	418	0.60 (0.54)	1.08 (-0.13-1.27)	454	0.58 (0.50)	1.06 (-0.15-1.25)
Total	722	0.56 (0.51)	1.05 (-0.14-1.25)	779	0.56 (0.51)	1.05 (-0.14-1.25)	845	0.55 (0.50)	1.03 (-0.14-1.23)
	Birthweight (grams) in 12 Month Population			**Birthweight (grams) in 18 Month Population**			**Birthweight (grams) in 36 Month Population**		
	n	**Mean (Median)**	**SD (IQR)**	**n**	**Mean (Median)**	**SD (IQR)**	**n**	**Mean (Median)**	**SD (IQR)**
Ethnicity: White British	319	3346.53 (3360.0)	534.26 (3050.0-3670.0)	343	3327.94 (3340.0)	567.82 (3020.0-3660.0)	379	3320.64 (3340.0)	572.05 (3000.0-3665.0)
Ethnicity: Pakistani	403	3145.19 (3120.0)	494.87 (2820.0-3450.0)	436	3130.56 (3110.0)	504.05 (2800.0-3422.5)	466	3127.99 (3105.0)	501.93 (2800.0-3415.0)
Sex: Male	334	3289.73 (3280.0)	560.70 (2980.0-3637.5)	361	3274.44 (3280.0)	591.41 (2980.0-3640.0)	391	3277.60 (3280.0)	590.27 (2960.0-3640.0)
Sex: Female	388	3186.30 (3180.0)	481.77 (2840.0-3520.0)	418	3168.27 (3140.0)	490.11 (2820.0-3497.5)	454	3159.97 (3140.0)	492.36 (2820.0-3480.0)
Total	722	3234.15 (3220.0)	521.97 (2900.0-3560.0)	779	3217.47 (3220.0)	541.67 (2860.0-3560.0)	845	3214.40 (3203.0)	542.73 (2860.0-3560.0)

IQR, interquartile range

Figure Legends

Figure 1: Comparison of Effect Sizes and 95% Confidence Intervals at 12 and 18 Months

Figure 2: Comparison of the Ethnicity Effect Sizes (White British – Pakistani Children) and Confidence Intervals on 36 Month BMI z-score

Figure 1: Comparison of Effect Sizes and 95% Confidence Intervals at 12 and 18 Months

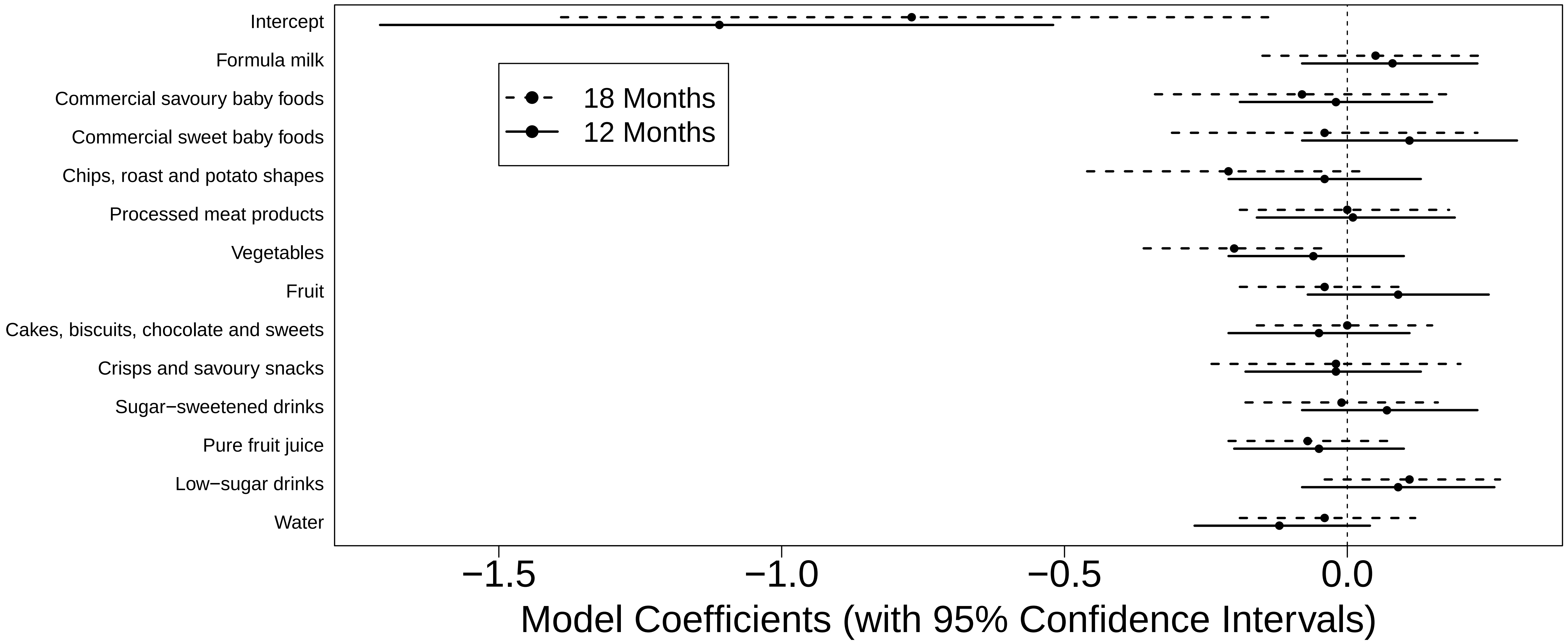
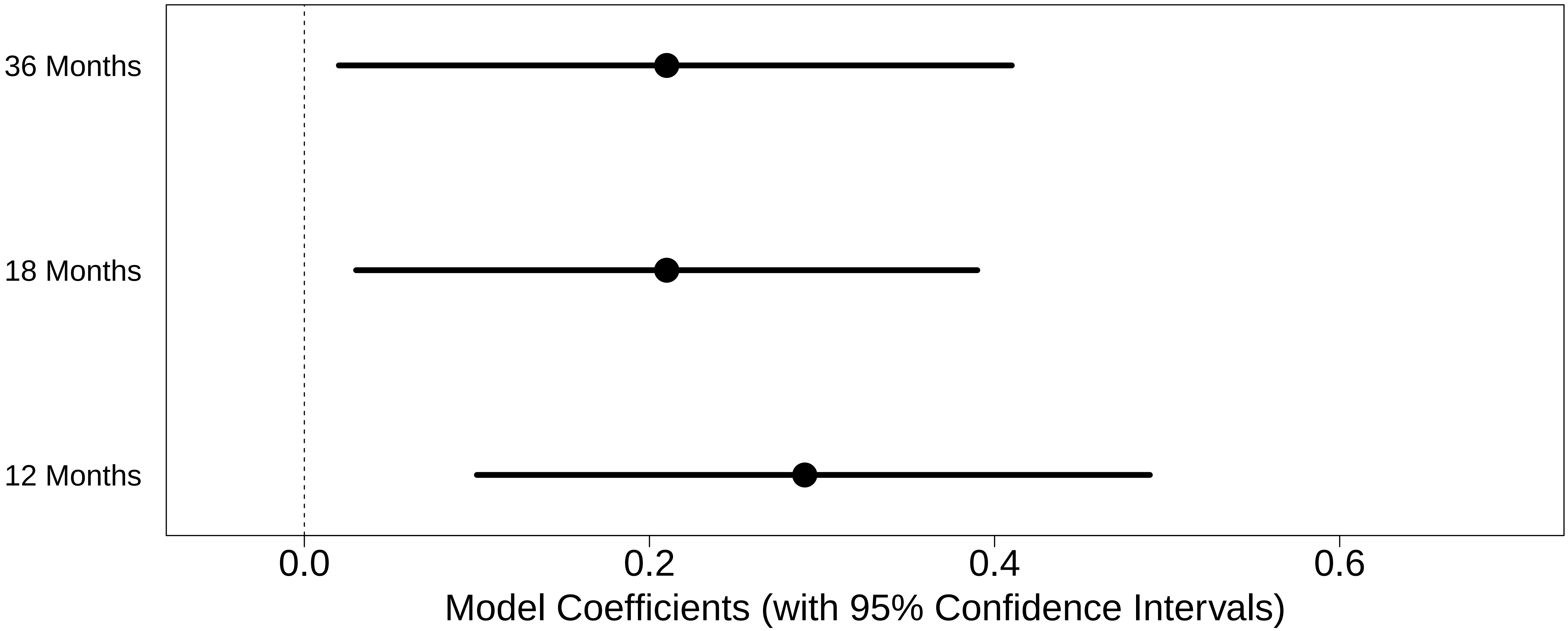


Figure 2: Comparison of the Ethnicity Effect Sizes (White British − Pakistani Children) and Confidence Intervals on BMI z−score



Supplementary Table 1: Frequency tables of ethnicity and dietary intake including a multiple testing procedure

12 Months

		Formula milk		Commercial savoury baby foods		Commercial sweet baby foods		Chips, roast and potato shapes		Processed meat products		Vegetables	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	243	160	275	128	268	135	98	305	253	150	181	222
	White British	208	111	169	150	258	61	165	154	60	259	159	160
p-value		0.28		< 0.001		< 0.001		< 0.001		< 0.001		0.28	

		Fruit		Cakes, biscuits, chocolate and sweets		Crisps and savoury snacks		Sugar-sweetened drinks		Pure fruit juice		Low-sugar drinks	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	160	243	209	194	175	228	184	219	189	214	295	108
	White British	189	130	148	171	152	167	188	131	192	127	228	91
p-value		< 0.001		0.27		0.34		0.001		0.001		0.67	

		Water	
		Low	High
Ethnicity	Pakistani	141	262
	White British	119	200
p-value		0.62	

18 Months

		Formula milk		Commercial savoury baby foods		Commercial sweet baby foods		Chips, roast and potato shapes		Processed meat products		Vegetables	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	383	53	406	30	385	51	31	405	180	256	157	279
	White British	272	71	307	36	331	12	57	286	24	319	89	254
p-value		0.002		0.10		< 0.001		< 0.001		< 0.001		0.005	

		Fruit		Cakes, biscuits, chocolate and sweets		Crisps and savoury snacks		Sugar-sweetened drinks		Pure fruit juice		Low-sugar drinks	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	170	266	182	254	39	397	102	334	166	270	308	128
	White British	163	180	121	222	66	277	136	207	182	161	194	149
p-value		0.02		0.08		< 0.001		< 0.001		< 0.001		< 0.001	

		Water	
		Low	High
Ethnicity	Pakistani	109	327
	White British	189	154
p-value		< 0.001	

36 Months

		High fat milk		Low fat milk		High fat chips		Low fat chips		Non-processed meat		Processed meat	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	207	259	367	99	185	281	343	123	287	179	318	148
	White British	237	142	174	205	252	127	129	250	143	236	109	270
p-value		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001		< 0.001	

		Non-processed fish		Processed fish		Vegetables		Fruit		Crisps		Cakes	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	289	177	196	270	240	226	203	263	200	266	206	260
	White British	183	196	245	134	184	195	222	157	223	156	217	162
p-value		< 0.001		< 0.001		0.43		< 0.001		< 0.001		< 0.001	

		Chocolate		Water		High sugar drinks		Low sugar drinks		Low sugar cereals		Sweetened cereals	
		Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Ethnicity	Pakistani	217	249	184	282	225	241	310	156	270	196	239	227
	White British	216	163	253	126	205	174	132	247	159	220	234	145
p-value		0.004		< 0.001		0.11		< 0.001		< 0.001		0.004	