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Ethnic differences in infant feeding practices and their relationship with BMI at 3 years of age – results from the Born in Bradford birth cohort study

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Abstract

The present study aimed to explore previously unreported ethnic differences in infant feeding practices during the introduction of solid foods, accounting for maternal and birth factors, and to determine whether these feeding patterns are associated with BMI at 3 years of age. An observational study using Poisson regression was carried out to investigate the relationship between ethnicity and infant feeding practices and linear regression was used to investigate the relationship between feeding practices and BMI at 3 years of age in a subsample of 1327 infants in Bradford. It was found that compared with White British mothers, mothers of Other ethnicities were less likely to replace breast milk with formula milk before introducing solid foods (adjusted relative risk (RR) – Pakistani: 0·76 (95 % CI 0·64, 0·91), Other South Asian: 0·58 (95 % CI 0·39, 0·86), and Other ethnicities: 0·50 (95 % CI 0·34, 0·73)). Pakistani and Other South Asian mothers were less likely to introduce solid foods early (<17 weeks) (adjusted RR – Pakistani: 0·92 (95 % CI 0·87, 0·96) and Other South Asian: 0·87 (95 % CI 0·81, 0·93)). Other South Asian mothers and mothers of Other ethnicities were more likely to continue breast-feeding after introducing solid foods (adjusted RR – 1·72 (95 % CI 1·29, 2·29) and 2·12 (95 % CI 1·60, 2·81), respectively). Pakistani and Other South Asian infants were more likely to be fed sweetened foods (adjusted RR – 1·18 (95 % CI 1·13, 1·23) and 1·19 (95 % CI 1·10, 1·28), respectively) and Pakistani infants were more likely to consume sweetened drinks (adjusted RR 1·72 (95 % CI 1·15, 2·57)). No association between infant feeding practices and BMI at 3 years was observed. Although ethnic differences in infant feeding practices were found, there was no association with BMI at 3 years of age. Interventions targeting infant feeding practices need to consider ethnicity to identify which populations are failing to follow recommendations.

Key words: **Ethnicity: Infant feeding: BMI: Cohort studies**

The WHO recommends that babies be exclusively breast-fed for the first 6 months of life, at which point complementary solid foods should be introduced with the continuation of breast-feeding during and after this time point or formula milk should be fed until 12 months of age if breast-feeding has ceased[1]. The current UK guidelines state that if parents choose to introduce solid foods before this time point, it should not be before four calendar months (17 weeks) of age and recommend that vegetables, fruits or cereals be introduced as first foods, but salt and sugar not be added[2]. Evidence suggests that short duration of breast-feeding, early introduction of solid foods, and consumption of sugary foods and drinks may be associated with an increased risk of overweight and obesity in childhood[3–6]. Childhood obesity is a growing problem; in the UK, over a fifth of children starting school are overweight or obese, and the prevalence of obesity is significantly higher in children of South Asian origin than in White children[7]. People of South Asian origin are also at a greater risk of obesity-related conditions such as type 2 diabetes and hypertension[8].

We have previously reported that mothers of Pakistani, Other South Asian and Other ethnic groups are more likely to initiate breast-feeding and breast-feed for longer periods compared with White British mothers. There is some evidence of ethnic differences in the age at which solid foods are introduced. A number of surveys have reported that White mothers introduce solid foods earlier than mothers of Asian origin[9–12], although none of them has accounted for maternal or child characteristics; however, their findings have been replicated in an adjusted analysis by Griffiths *et al.*[13]. It has been found that younger mothers, those from lower socio-economic groups and mothers who smoked during pregnancy are also more likely to introduce solid foods earlier[9–11,13–16]. Despite current guidance that

Abbreviations: BiB, Born in Bradford; RR, relative risk.

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breast-feeding should be continued during and after the introduction of solid foods, no studies describing adherence to these recommendations have been found.

The type and variety of foods consumed in the early years of a child's life influence longer-term eating behaviours, and inappropriate early dietary patterns that are established during the introduction of solid foods may persist into the second year of life and beyond[17,18]. Therefore, it is important to identify the characteristics of women who are less likely to follow infant feeding guidelines so that they can be targeted for additional support by health professionals and to improve our understanding of the implications of the feeding behaviours for child outcomes such as BMI.

The aims of the present study were (i) to explore ethnic differences in infant feeding practices during the introduction of solid foods, taking into account maternal and birth factors, and (ii) to determine whether these feeding patterns are associated with BMI at 3 years of age.

Methods

Study design

Born in Bradford (BiB) is a longitudinal multiethnic birth cohort study aiming to examine the impact of environmental, psychological and genetic factors on maternal and child health and well-being[19]. Bradford is a city in the north of England with high levels of socio-economic deprivation and ethnic diversity. Approximately half the births in Bradford occur in mothers of South Asian origin. Women were recruited while waiting to undergo glucose tolerance test, a routine procedure offered to all pregnant women registered at the Bradford Royal Infirmary, at 26–28 weeks of gestation. For those consenting, a baseline questionnaire was completed via an interview with a study administrator. The full BiB cohort consisted of 12 453 women comprising 13 776 pregnancies between 2007 and 2010, and the cohort is broadly characteristic of the city's maternal population. The participants gave informed consent for data collection, and ethical approval was granted by the Bradford Research Ethics Committee (ref. 07/H1302/112).

A subsample of the BiB cohort (BiB 1000) recruited between August 2008 and March 2009 was invited to participate in a more detailed follow-up with further assessments when the child was about 6, 12, 18, 24 and 36 months of age, and this has been described elsewhere[20]. Briefly, 1916 women were eligible to be included in the substudy, and 1735 consented and were included. Singleton infants whose mothers had completed questions related to infant feeding practices in either the 6-month or the 12-month post-partum questionnaire were included in the study. Participants were excluded if they had multiple births (n 28) or missing obstetric (n 42), covariate (n 95) or infant feeding (n 243) data, giving a final sample size of 1327.

Data collection

Infant feeding practices. Data collected from the 6- and 12-month postnatal questionnaires included information on the duration of breast-feeding and the age at which formula milk, non-sweetened solid foods (e.g. baby rice, pureed vegetables, fruits or rice, and lentils/dhal), sweetened solid foods (e.g. egg custard, rice pudding, sweetened rusks, biscuits and cake), non-sweetened drinks (e.g. tap/mineral water, unsweetened tea or fruit juice, and diet drinks low in sugar such as diet cola) and sweetened drinks (e.g. cola, squash, lemonade, sweetened tea and pre-prepared 'baby' drinks) were introduced. Where data collected at both the 6- and 12-month visits were available, data collected at the 6-month visit were used in preference to those collected at the 12-month visit to reduce the likelihood of recall bias. If the infant had not been introduced to solid foods or drinks other than breast milk at the time of the 6-month visit, data collected at the 12-month visit were used to calculate the duration of breast-feeding and the age at which formula milk, other drinks and solid foods were introduced.

We examined five outcomes related to infant feeding practices: (i) whether breast milk was replaced with formula milk before introducing solid foods; (ii) early introduction to solid foods, defined as introducing solid foods before four calendar months (17 weeks); (iii) whether breast-feeding was continued after the introduction of solid foods, defined as any breast-feeding on or after the day the solid foods were introduced; (iv) whether sweetened foods were introduced as a first food (including sweetened and non-sweetened foods given together); (v) whether sweetened drinks were given before 17 weeks of age.

BMI. The BMI of the children was calculated from the height and weight recorded at 3 years of age and converted into age- and sex-adjusted z-scores relative to the WHO 2006 growth standard[21].

Ethnicity. Ethnicity was self-assigned by the mothers at the baseline questionnaire using the same ethnic group classification as the 2001 UK census[22] and categorised into White British, Pakistani, Other South Asian (Indian, Bangladeshi and other South Asian) and Other ethnicities (White other, Black, mixed race, Chinese and other unspecified).

Maternal and birth characteristics. Maternal and birth factors identified as potentially influencing infant feeding practices[13–15,23] were examined. Data on maternal age (at recruitment), highest level of maternal education (<5 GCSE (General Certificate of Secondary Education; or equivalent), ≥5 GCSE (or equivalent), A-level (or equivalent), higher than A-level (or equivalent) or other qualifications), marital status (married/living with partner or single/not living with partner) and smoking during pregnancy (yes or no) were collected at the baseline questionnaire; data on maternal BMI (at pregnancy booking), parity (primiparous or multiparous), preterm birth (<37 weeks), mode of delivery (vaginal or caesarean section) and low birth weight (<2·5 kg) were obtained from the hospital's electronic maternity record system.

Statistical analyses

Differences in baseline characteristics, cessation of breast-feeding and introduction of solid foods by ethnicity were examined using ANOVA for continuous variables and χ^2 tests

for categorical variables. Poisson regression with robust variance estimates[24] was used to investigate the relationship between ethnicity and infant feeding practices. Univariable models were used to examine the relationship between each infant feeding practice and ethnicity, with White British mothers as the reference category. Multivariable models adjusted for variables known to influence infant feeding practices: maternal age; educational level; marital status; maternal smoking during pregnancy; maternal BMI; parity; preterm birth; low birth weight; mode of delivery.

Due to missing data and insufficient numbers of participants in the Other South Asian and Other ethnic groups, the analysis of the association between infant feeding practices and BMI at 3 years of age was carried out on a restricted sample comprising only White British and Pakistani children (n 743). We first examined possible ethnic differences in associations between infant feeding practices and BMI z-scores using linear regression analysis to test for a difference between White British and Pakistani children (i.e. interaction tests between ethnicity and each infant feeding practice); if interactions were found, this would indicate that analyses stratified by ethnicity were necessary. Linear regression models were used to assess the association between early introduction to solid foods, the introduction of sweetened foods and consumption of sweetened drinks before 17 weeks of age with BMI. The first model adjusted for ethnicity; the second model additionally adjusted for maternal age, educational level, marital status, maternal smoking during pregnancy, maternal BMI, parity, preterm birth, low birth weight and mode of delivery; and the third model also adjusted for the duration of breast-feeding and other infant feeding practices. These models were also used to explore the association of replacing breast milk with formula milk before introducing solid foods and continuing breast-feeding after the introduction of solid foods with BMI, but were used for a sample restricted to those who initiated breast-feeding (n 557). Two-tailed P values of less than 0·05 were considered to be significant. We present relative risks (RR) with 95 % CI from Poisson regression models and means with 95 % CI from linear regression models. All statistical analyses were conducted using Stata/SE version 12.1 (StataCorp)[25].

Results

Table 1 summarises the baseline characteristics of the study sample stratified by ethnicity. There were statistically significant differences in maternal age, maternal BMI, highest education attainment, marital status, smoking during pregnancy and parity by ethnicity. Infant feeding practices by ethnicity are summarised in Table 2. White British mothers were more likely to replace breast milk with formula milk before introducing solid foods (50 %) compared with Pakistani mothers (37 %), Other South Asian mothers (25 %) and mothers of Other ethnicities (26 %). A higher proportion of White British mothers and mothers of Other ethnicities introduced solid foods by 17 weeks of age (37 and 36 %, respectively) compared with Pakistani (21 %) and Other South Asian (12 %) mothers. A smaller proportion of White British mothers (25 %) continued breast-feeding after introducing solid foods compared with Pakistani mothers (31 %), Other South Asian mothers (51 %) and mothers of Other ethnicities (54 %). There were significant differences in age at which

Table 1. Baseline characteristics of the study population by ethnicity
(Number of subjects and percentages; mean values and standard deviations)

	All (n 1326)		White British (n 507; 38 %)		Pakistani (n 646; 49 %)		Other South Asian* (n 91; 7 %)		Other† (n 82; 6 %)		
	n	%	n	%	n	%	n	%	n	%	P‡
Maternal age (years)											0·001
Mean	27·2		26·7		27·3		29·1		26·9		
SD	5·6		6·1		5·1		5·1		5·9		
BMI (kg/m^2)											<0·001
Mean	26·0		27·0		25·3		26·1		25·0		
SD	5·8		6·3		5·4		6·1		4·7		
Education											<0·001
< 5 GCSE equivalent	289	21·8	100	19·7	162	25·1	16	17·6	11	13·4	
≥ 5 GCSE equivalent	434	32·7	185	36·5	210	32·5	20	22·0	19	23·2	
A-level equivalent	190	14·3	84	16·6	78	12·1	14	15·4	14	17·1	
> A-level equivalent	336	25·3	100	19·7	177	27·4	35	38·5	24	29·3	
Foreign unknown/other	77	5·8	38	7·5	19	2·9	6	6·6	14	17·1	
Marital status											<0·001
Married/living with partner	1143	86·2	380	75·0	611	94·6	88	96·7	64	78·1	
Single/not living with partner	183	13·8	127	25·0	35	5·4	3	3·3	18	22·0	
Smoked during pregnancy (yes)	216	16·3	167	32·9	26	4·0	3	3·3	20	24·4	<0·001
Parity											<0·001
Primiparous	519	39·1	243	47·9	199	30·8	36	39·6	41	50·0	
Multiparous	807	60·9	264	52·1	447	69·2	55	60·4	41	50·0	
Preterm birth (<37 weeks)	101	7·6	29	5·7	31	4·8	4	4·4	3	3·7	0·808
Low birth weight (<2500 g)	67	5·1	33	6·5	55	8·5	9	9·9	4	4·9	0·367
Caesarean section	285	21·5	118	23·3	123	19·0	22	24·2	22	26·8	0·170

GCSE, General Certificate of Secondary Education; A-level, Advanced level.
* Indian: n 56; Bangladeshi: n 27; and Other South Asian: n 8.
† White Other: n 24; Mixed: n 18; Black: n 21; and Other: n 19.
‡ Difference between the ethnic groups (χ^2 test or ANOVA as appropriate).

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Table 2. Infant feeding practices of the study population by ethnicity
(Number of subjects and percentages)

	All (*n* 1326)		White British (*n* 507; 38 %)		Pakistani (*n* 646; 49 %)		Other South Asian* (*n* 91; 7 %)		Other† (*n* 82; 6 %)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Replaced breast milk with formula milk before introducing solid foods‡	394	39·3	164	50·3	190	36·6	21	25·0	19	25·7
Early introduction to solid foods (<17 weeks)	362	27·3	188	37·1	133	20·6	11	12·1	30	36·6
Continued breast-feeding after introducing solid foods‡	324	32·3	80	24·5	161	31·0	43	51·2	40	54·1
Sweetened foods introduced as a first food	657	49·6	187	36·9	386	59·8	53	58·2	31	37·8
Sweetened drinks given at <17 weeks of age	133	10·0	47	9·3	74	11·5	6	6·6	6	7·3

* Indian: *n* 56; Bangladeshi: *n* 27; and Other South Asian: *n* 8.
† White Other: *n* 24; Mixed: *n* 18; Black: *n* 21; and Other: *n* 19.
‡ Denominator is the proportion of those who initiated breast-feeding (overall: *n* 1003; White British: *n* 326; Pakistani: *n* 519; Other South Asian: *n* 84; and Other ethnicities: *n* 74).

breast-feeding was stopped ($P<0·001$) and age at which solid foods were introduced ($P<0·001$) by ethnicity in women who initiated breast-feeding (Fig. 1). Around 60 % of Pakistani and Other South Asian women introduced sweetened foods as a first food compared with less than 40 % of White British mothers and mothers of Other ethnicities. Overall, 10 % of infants were given sweetened drinks before 4 months of age, with the highest rates being found in Pakistani infants (12 %) and the lowest rates in Other South Asian infants (7 %).

Table 3 presents results from the Poisson regression models for the association between infant feeding practices and ethnicity. In the unadjusted model, women of all other ethnicities were significantly less likely to replace breast milk with formula milk before introducing solid foods compared with White British women, and this persisted in the adjusted model (adjusted RR 0·76 (95 % CI 0·64, 0·91), 0·58 (95 % CI 0·39, 0·86) and 0·50 (95 % CI 0·34, 0·73)) for Pakistani mothers, Other South Asian mothers and mothers of Other ethnicities, respectively. Pakistani and Other South Asian infants were less likely to have been introduced to solid foods early compared with White British infants, and this difference remained significant in the adjusted model (adjusted RR 0·92 (95 % CI 0·87, 0·96) and 0·87 (95 % CI 0·81, 0·93), respectively). Other South Asian mothers and mothers of Other ethnicities were more likely to continue breast-feeding after introducing solid foods compared with White British mothers (adjusted RR 1·72 (95 % CI 1·29, 2·29) and 2·12 (95 % CI 1·60, 2·81), respectively), but there was no significant difference in Pakistani mothers. Compared with White British mothers, Pakistani and Other South Asian mothers were more likely to introduce sweetened foods (alone or in combination with non-sweetened foods) as a first food (adjusted RR 1·18 (95 % CI 1·13, 1·23) and (1·19 (95 % CI 1·10, 1·28), respectively), but there was no difference in mothers of Other ethnicities. Pakistani mothers were also more likely to give their infants sweetened drinks compared with White British mothers (adjusted RR 1·72 (95 % CI 1·15, 2·57)).

Table 4 presents mean differences in BMI *z*-scores for each infant feeding practice. There was no statistical evidence that associations between infant feeding practices and BMI *z*-scores differed by ethnicity (all *P* values for interactions >0·1), and no significant differences in BMI *z*-scores and feeding practices were found.

Discussion

Summary of findings

In the cohort of the present study, we found that compared with White British mothers, mothers of all other ethnicities were significantly less likely to replace breast milk with formula milk before introducing solid foods and that mothers of Pakistani and Other South Asian origin were less likely to introduce complementary solid foods before 17 weeks of age. Other South Asian mothers and mothers of Other ethnicities were more likely to continue breast-feeding after introducing solid foods compared with White British mothers. Pakistani and Other South Asian mothers were more likely to introduce sweetened foods as a first food, and Pakistani infants were significantly more likely to have consumed sweetened drinks before 17 weeks of age. We did not find any association between early infant feeding practices and BMI at 3 years of age.

Comparison of findings with those of other studies

A smaller proportion of mothers in the study cohort introduced their infants to solid foods before 4 months of

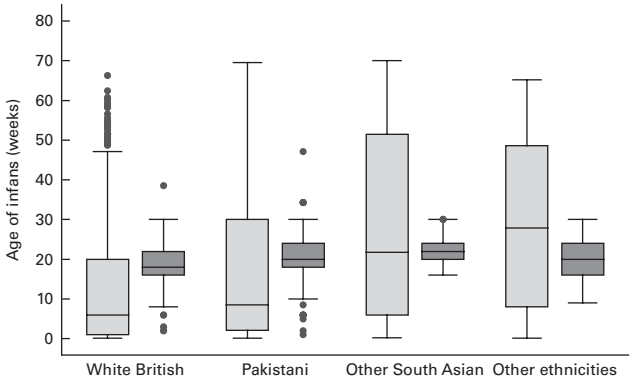

Fig. 1. Boxplot showing age at which breast-feeding was stopped □ and age at which infants were introduced to solid foods ■ by ethnicity in women who initiated breast-feeding.

Table 3. Relative risks from Poisson regression models for infant feeding practices

(Relative risks (RR) and 95 % confidence intervals)

	Model 1†		Model 2‡	
	RR	95 % CI	RR	95 % CI
Replaced breast milk with formula milk before introducing solid foods§				
White British (Ref.)	1·00		1·00	
Pakistani	0·73**	0·62, 0·85	0·76**	0·64, 0·91
Other South Asian	0·50**	0·34, 0·73	0·58**	0·39, 0·86
Other	0·51**	0·34, 0·76	0·50**	0·34, 0·73
Early introduction to solid foods (<17 weeks)				
White British (Ref.)	1·00		1·00	
Pakistani	0·88**	0·85, 0·92	0·92**	0·87, 0·96
Other South Asian	0·82**	0·76, 0·87	0·87**	0·81, 0·93
Other ethnicities	1·00	0·92, 1·08	1·02	0·94, 1·11
Continuing breast-feeding after introducing solid foods§				
White British (Ref.)	1·00		1·00	
Pakistani	1·26*	1·00, 1·59	1·11	0·88, 1·39
Other South Asian	2·09**	1·57, 2·78	1·72**	1·29, 2·29
Other ethnicities	2·11**	1·63, 2·93	2·12**	1·60, 2·81
Sweetened foods introduced as a first food				
White British (Ref.)	1·00		1·00	
Pakistani	1·17**	1·12, 1·21	1·18**	1·13, 1·23
Other South Asian	1·16**	1·08, 1·24	1·19**	1·10, 1·28
Other ethnicities	1·01	0·93, 1·09	1·02	0·94, 1·11
Sweetened drinks given at <17 weeks of age				
White British (Ref.)	1·00		1·00	
Pakistani	1·24	0·87, 1·75	1·72**	1·15, 2·57
Other South Asian	0·71	0·31, 1·62	1·16	0·51, 2·65
Other ethnicities	0·79	0·35, 1·79	0·96	0·42, 2·21

Ref., reference.
Relative risk values were significantly different: * $P<0·05$, ** $P<0·01$.
† Model 1: unadjusted.
‡ Model 2: adjusted for maternal age, educational level, marital status, maternal smoking during pregnancy, maternal BMI, parity, preterm birth, low birth weight and mode of delivery.
§ Restricted to women who initiated breast-feeding, *n* 1003.

age compared with that reported in other studies[9–13]. Generally, there appears to be a trend over time for introducing solid foods at a later age; in 1991, 90 % of infants had been given solid foods by 4 months of age[12], and this had fallen to 29 % by 2010[11]. By contrast, only 27 % of infants in the study cohort were introduced to solid foods by 4 months of age. This low rate may reflect the large proportion of South Asian mothers in the study cohort who tend to introduce solid foods later, as the rates in White British and Other ethnicities (37 %) are comparable to those reported from the Millennium Cohort Study[13]. Our finding that early introduction of solid foods is more prevalent in White British women than in those belonging to other ethnic groups is consistent with the findings of other studies[12,13]. With regard to the type of

Table 4. Mean difference in BMI *z*-scores in children aged 3 years from two ethnic groups (White British and Pakistani, *n* 743) from linear regression models*

(Mean differences and 95 % confidence intervals)

	Model 1†		Model 2‡		Model 3§	
	Mean difference	95 % CI	Mean difference	95 % CI	Mean difference	95 % CI
Early introduction to solid foods (<17 weeks)	0·08	−0·09, 0·25	0·03	−0·15, 0·20	0·04	−0·14, 0·21
Sweetened foods given as a first food	0·00	−0·15, 0·16	0·03	−0·12, 0·18	0·03	−0·12, 0·19
Sweetened drinks given at <17 weeks of age	−0·06	−0·32, 0·20	−0·09	−0·35, 0·17	−0·10	−0·36, 0·16
Replaced breast milk with formula milk before introducing solid foods‖	−0·03	−0·21, 0·15	−0·02	−0·20, 0·16	−0·07	−0·30, 0·15
Continuing breast-feeding after introducing solid foods‖	−0·04	−0·23, 0·16	−0·06	−0·25, 0·14	−0·06	−0·26, 0·14

* All outcomes are dichotomised as yes/no, with no as the reference.
† Model 1: adjusted for ethnicity.
‡ Model 2: model 1 + additionally adjusted for maternal age, educational level, marital status, maternal smoking during pregnancy, maternal BMI, parity, preterm birth, low birth weight, and mode of delivery.
§ Model 3: model 2 + additionally adjusted for the duration of breast-feeding and all other infant feeding practices.
‖ Sample is restricted to White British and Pakistani women who initiated breast-feeding (*n* 557).

foods and drinks given, the present results reflect those reported by Thomas & Avery[12], who found that White mothers were more likely to consider the sugar content of their infant's food and to avoid foods that were bad for their child's teeth or would encourage development of a sweet tooth, whereas Pakistani mothers were more likely to give sweetened water at an early age. Although no questions regarding the introduction of sweetened drinks in young infants were asked in the 2005 and 2010 Infant Feeding Surveys, the 2000 survey found that at 4–5 months of age, 5% of mothers had given their babies water sweetened with honey or sugar and 1% had given shop-bought drinks containing added sugar/glucose[10]. There was no ethnic breakdown of these results, but the results of the present study indicate that a much higher proportion of children were given sweetened drinks at this age, with 10% of all infants being under 4 months of age and with the highest proportion being of Pakistani origin. In addition, compared with White British infants, we found that infants of Pakistani and Other South Asian origin were significantly more likely to be given sweetened foods as a first food. These practices may be a reflection of cultural traditions, for example, the Muslim birth custom of rubbing honey or dates on the infant's upper palate soon after birth[26] or the Hindu custom of writing a symbolic word on the neonate's tongue with jaggery dipped in ghee[27].

We found no association between the infant feeding practices that we examined and BMI at 3 years of age, but this is perhaps not surprising, given that there is conflicting evidence on the association between obesity and the age at which solid foods are introduced[18] or the types of foods introduced[4]. Research suggests that it is high intakes of energy and protein that could be associated with BMI rather than the introduction of particular types or groups of foods[4]. It is also possible that the study cohort is too young to find an association between infant feeding practices and weight.

Strengths and limitations

The main strength of the present study is that we report previously under-investigated infant feeding practices in a multiethnic cohort. Although previous studies have reported some aspects of ethnic differences in infant feeding practices[9–13], to our knowledge, this is the first time that ethnic differences in the replacement of breast milk with formula milk, the continuation of breast-feeding during and after the introduction of solid foods, and the introduction of sweetened foods as a first food have been explored. This is also the first study to explore the relationship between ethnicity and several infant feeding practices and their association with BMI in early childhood. Furthermore, we examined the associations between ethnicity, feeding patterns and BMI adjusting for important maternal and birth-related characteristics.

A potential limitation of the study is that infant feeding data were self-reported. Where possible, we used infant feeding data collected when the child was 6 months of age, but in some cases we had to use data collected at 12 months. However, we found high levels of agreement in the data collected at both 6 and 12 months, so this is not thought to have introduced significant recall bias in the present results. Due to the small numbers of subjects, we had to combine Other South Asian mothers and mothers of Other ethnicities into two overarching categories, and it is acknowledged that the small numbers of mothers and the heterogeneity of ethnic background in these Other South Asian and Other ethnicities categories mean that these results may not be generalisable to other populations with different ethnic group distributions. A further limitation of the present study, and indeed all observational studies, is that it is not possible to determine the causality of relationships between infant feeding practices and BMI, although we were able to examine associations between these variables.

Implications for practice and further research

Although the trend of fewer mothers introducing their infants to solid foods early may be a reflection that the Department of Health guidelines are reaching their target audience, undesirable feeding behaviours persist and these appear to differ by ethnicity. It is projected that by 2051 minority ethnic communities will make up 20% of the UK population, with the number of people of South Asian origin, in particular, growing rapidly[28]. Our findings that White British mothers tend to replace breast milk with formula milk and introduce solid foods earlier and are less likely to continue breast-feeding after introducing solid foods and Pakistani and South Asian mothers tend to introduce sweetened foods earlier highlight the importance of identifying ethnic differences in the dietary intake of infants to identify which populations are failing to follow recommendations so that they can be targeted with appropriate advice and support.

Conclusions

We found that important infant feeding practices vary by ethnicity, but that these behaviours are not associated with the BMI of children at 3 years of age. Appropriate interventions targeting undesirable feeding behaviours such as early introduction to solid foods and infant consumption of sweetened foods and drinks need to be tailored to ethnicity, and the importance of continuing breast-feeding during and after the introduction of solid foods should be reinforced.

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The authors' contributions are as follows: G. S. and L. F. designed the study; G. S. analysed the data with support

from L. F.; G. S. drafted the manuscript. All authors contributed to and approved the final manuscript.

None of the authors has any conflicts of interest to declare.

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