Original Article

The nutrient intakes of mothers of low birth weight babies – a comparison of ethnic groups in East London, UK

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Abstract

The objective of this paper was to compare the nutrient intakes of mothers of different ethnic origins after they had given birth to a low birth weight (LBW) baby (<2.5 kg). A total of 165 participants from East London, UK completed a prospective 7-day diet diary using household measures, between 8 and 12 weeks post-partum. The data were originally collected as baseline data prior to two separate nutrition intervention studies and were combined and re-interrogated for the purpose of this paper. Folate and iron intakes were low in all ethnic groups compared to the Reference Nutrient Intakes (RNI). Half did not meet the RNI for folate and 88% did not meet the RNI for iron. Nearly a quarter of the group did not achieve the Lower Reference Nutrient Intake (LRNI) for iron. The mean vitamin D and calcium intakes were significantly different between the ethnic groups ($P = 0.007$, $P = 0.001$, respectively). African women had the highest vitamin D intakes (4.72 µg d^{-1}) and Caucasians and Asians the lowest (2.4 µg d^{-1}). Caucasians had the highest calcium intakes (780 mg d^{-1}) and Africans the lowest (565 mg d^{-1}). Over two-thirds of African, Asian and African-Caribbean women did not meet the RNI for calcium. Thirty-one per cent of Africans did not meet the LRNI for calcium. Our data show a high prevalence of inadequate nutrition among women who deliver LBW babies with differences in nutrient intake between ethnic groups. This information can be used to target specific appropriate dietary advice to ethnic minorities for the prevention or repetition of LBW.

Keywords: maternal nutrition, low birth weight, ethnic minorities, iron, folate.

Introduction

Low birth weight (LBW) babies weigh less than 2.5 kg at birth and are at increased risk of mortality and morbidity (WHO 1977). LBW may be as a result of preterm delivery and/or to intrauterine growth restriction (IUGR) – the causes of which vary and are

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uncertain. Risk factors such as social class, age, parity, maternal birth weight, past obstetric outcomes, race, nutrition, smoking and drug use are thought to be key determinants of the adverse outcome of pregnancy including the risk of having a LBW baby (Institute of Medicine 1985; Villar *et al*. 1986; Kramer 1987).

Previous work in Hackney, East London has identified high levels of poor nutritional intake and status amongst pregnant women (Doyle *et al*. 1989, 1990; Rees *et al*. 2002). A strong relationship was found between maternal nutritional intake in the first trimester of pregnancy and birth weight up to a birth weight of 3.3 kg, independent of other risk factors such as smoking. No such relationship was found in women who had babies weighing over the median birth weight of 3.3 kg (Doyle *et al*. 1990). Others have found associations between dietary intake and birth weight (Cann *et al*. 1987) and gestational age at birth (Scholl *et al*. 1997) in low-income women in developed countries. That is, both retrospective and prospective evidence suggest that poor maternal nutritional status at conception and inadequate maternal nutrition during pregnancy can result in poor intrauterine growth (Prada & Tsang 1996).

The LBW rate varies considerably in London with the lowest rate in affluent Kingston (5.8%) and the highest rate in East London (10.4%) – a deprived area with a large ethnic minority population. The average LBW rate for London (8.2%) is higher than that for England generally (7.6%) (ONS 2000). Generally Asian and black women in the UK experience a higher rate of LBW than white women (Asians 11%, black 9% and white 6%) (ONS 2002). In the US, African Americans have twice the rate of LBW (13.1%) compared to white Americans (6.7%, 1999–2001) (March of Dimes 2002).

The data to be presented here were originally collected as baseline data for two separate nutrition intervention studies. The aim of these original studies (Doyle *et al*. 1999, 2001) was to improve the nutrient intake of women who had delivered a LBW baby and planned to have more children. They were therefore at risk of having further LBW infants, and intervention during the interpregnancy interval if successful would help to prepare the woman nutritionally before the next conception.

The two sets of data have been combined and re-interrogated to compare the habitual nutrient intake of mothers of LBW infants of different ethnic origins. The objective was to assess the degree of nutritional risk, if identified, in the interpregnancy period in women intending to have another baby.

Subjects and methods

Subjects

Participants in the two studies had given birth to a LBW baby (<2.5 kg) at the Homerton Hospital in East London between 1994 and 1998 and planned to have further children. The first study was a feasibility study on preconception nutrition counselling of mothers (Doyle *et al*. 1999). Data were also obtained from a second study which tracked the nutritional status of mothers to monitor recovery of nutritional status post-partum (Doyle *et al*. 2001). Both of these studies used the same inclusion criteria and recruitment method and the diets of mothers were recorded 8–12 weeks post-partum before the interventions took place. Both studies were granted ethical approval from the East London Health Authority Research Ethics Committee.

In both studies, mothers were invited to join our nutrition and LBW programmes while still in the post-natal wards and informed consent was obtained. Criteria for exclusion from the study included women who had a multiple birth, those whose family was complete, those taking a dietary supplement or were unable to speak English. Those who had chronic medical problems such as diabetes, sickle cell diseases or who were known to be HIV positive were also excluded. Each participant defined their own ethnicity, which was then grouped into four main ethnic groups: Caucasian, Black African, Black African-Caribbean and Asian.

Dietary survey

Participants were contacted again at home, between 8 and 12 weeks post-partum. This gap was to allow time for mothers to adjust to the new baby. Participants were asked to keep a 7-day record of all food and drink consumed, using household measures. Instructions were given on how to complete the diary and a self-addressed stamped envelope was provided. The energy and nutrient content of their diets were calculated using FOODBASE© (Institute of Brain Chemistry and Human Nutrition, London Metropolitan University, London, N7 8DB, UK). This is a nutritional analysis programme based on *McCance and Widdowson's The Composition of Foods* (Holland *et al*. 1991) and supplements (including 'Immigrant Foods') plus enhanced fatty acid data produced by the Institute of Brain Chemistry and Human Nutrition. All research assistants were trained by the same experienced dietitian (W. D.) to assess the diaries, and input the data. Each diary was checked by a research assistant to clarify descriptions and quantities. Diaries were rejected during this process if information was incomplete. Recipes were analysed and added to the database of frequently consumed dishes not present in the original database. The research assistants were of various ethnicities to help ensure the food records were interpreted as accurately as possible.

Gestational age was assessed by maternal dates and paediatric clinical assessment supported where possible by an ultrasound scan. Birth weights were assessed as above (AGA, appropriate for gestational age) or below the 10th centile (SGA, small for gestational age) using standard percentile charts (Yudkin *et al*. 1987).

The Statistical Package for the Social Sciences (1999, SPSS Inc, Chicago, IL, USA) was used to analyse the data. Statistical analysis included means and standard deviations. One way ANOVA was used to test for significant differences between group means. Chi-squared test was used to test for the significance of differences between groups for categorical data.

Results

Out of approximately 380 LBW singleton births, 180 mothers were recruited. Reasons for non-recruitment included: refusal to complete dietary record (40%); non-English speaking (17%); discharged before seen (12%); bereavement from still birth/neonatal death (12%); taking supplements (10%); chronic illness (5%); family complete (3%); already pregnant at 12 weeks post-partum (1%). Fifteen were excluded because of incomplete food records. This left 165 completed dietary records.

Demographic and social data

Details describing the socio-demographic background of the subjects are given in Tables 1 and 2. Thirty-eight per cent of the participants were Caucasian, 26% African-Caribbean, 22% African, and 16% Asian. Analysis of variance showed that the mean age varied significantly between the ethnic groups ($F = 3.7, P = 0.014$), with the Asians having the lowest mean age. The mean body mass index (BMI) was also significantly different between the groups ($F = 4.9$, $P = 0.003$) with the African group having the highest BMI.

Thirty-three out of 165 women smoked (20%), most of whom were Caucasian or African-Caribbean (Table 1). Thirty-two per cent of Caucasians smoked compared to only 5% of Africans and 4% Asians. The African-Caribbean women had double the rate of unemployment (31%) compared to the Caucasians (15%). The Caucasians had double the proportion of professional/managerial/non-manual workers (54%) than the African-Caribbeans (26%) (Table 2).

Of the 165 live births, all were LBW, 58% were preterm and 52% were born below the 10th centile for gestational age. Thirteen per cent of the total were both preterm and below 10th centile for gestational age, and 39% were full term and below 10th centile. The proportion of preterm babies varied significantly between the groups ($\chi^2 = 23.9$, d.f. = 3, $P < 0.001$) with the African mothers having the highest proportion (92%) of preterm births and this contributed to a lower mean birth weight for this group (Table 1).

Dietary intakes

Table 3 compares the mean daily energy and nutrient intakes of the mothers of different ethnicities. African mothers had the lowest mean energy intake, although the means were not significantly different between the ethnic groups ($F = 2.3, P = 0.08$). Analysis of variance showed that the mean fat intake was signifi-

Table 1. Description of 165 women who had LBW babies, by ethnicity

Ethnic origin	Caucasian	African	Asian	African-Caribbean	Whole group
	$n = 63$	$n = 36$	$n = 26$	$n = 40$	$n = 165$
Mean age – years (SD)	29.5 (5.9)	29.8 (4.6)	25.6* (4.6)	29.0 (6.1)	28.8 (5.6)
Mean BMI (SD)	22.7 (3.6)	25.9† (4.4)	22.1 (4.0)	23.8 (4.2)	23.6 (4.2)
	$n = 51$	$n = 29$	$n = 21$	$n = 33$	$n = 134$
Number (%) of smokers	20 (32)	2 (5)	1 (4)	10 (25)	33 (20)
Number (%) preterm and LBW	33 (52)	33‡ (92)	9 (35)	21 (52)	96 (58)
Mean birth weight (g) (SD)	2066 (396)	1721§ (567)	2135 (572)	2030 (510)	1993(511)

*Mean age was significantly different between the groups (ANOVA, $F = 3.7$, $P = 0.014$).
†Mean BMI was significantly different between the groups (ANOVA, $F = 4.9$, $P = 0.003$).
‡The proportion of preterm babies varied significantly between the groups ($\chi^2 = 23.9$, d.f. = 3, $P < 0.001$).
§The mean birth weight was significantly different between the groups (ANOVA, $F = 4.9$, $P = 0.003$).
BMI, body mass index; LBW, low birth weight.

Table 2. Social class of mothers by ethnicity

	Caucasian *n* (%)	African *n* (%)	Asian *n* (%)	African-Caribbean *n* (%)
Professional/managerial/non-manual	32 (54)	11 (31)	10 (38)	10 (26)
Manual skilled and unskilled	18 (31)	17 (47)	13 (50)	17 (43)
Unemployed	9 (15)	8 (22)	3 (12)	12 (31)
Total = 160	59	36	26	39
Missing data	4	0	0	1

cantly different between the ethnic groups ($F = 4.8$, $P = 0.003$) with the Africans having the lowest mean intake. The mean calcium intake differed significantly between the groups ($F = 5.4$, $P = 0.001$) – the Caucasians had the highest intakes (780 mg d^{-1}) and Africans the lowest (565 mg d^{-1}). Analysis of variance showed that there was also a significant difference in mean vitamin D intake between the groups ($F = 4.1$, $P = 0.007$), with Africans consuming nearly twice the amount of the Caucasians and Asians. The mean iron intakes were similar ($F = 2.7$, $P = 0.05$) with all groups having iron intakes less than the Reference Nutrient Intakes (RNI). Asians had the highest intakes (11.7 mg d^{-1}) and Africans the lowest (9.6 mg d^{-1}).

The percentage energy obtained from macronutrients, and selected micronutrient intakes per 1000 kcal were calculated to adjust for energy intake (Table 4). The percentage of energy obtained from fat was significantly different between the groups and differences existed between groups for calcium, magnesium and iron intake per 1000 kcal (Table 4).

Intakes of calcium, magnesium and iron per 1000 kcal and per cent energy from fat were explored to see if there were significant differences in intake according to social class. There were no significant differences.

The dietary intakes of micronutrients were compared to the RNI and Lower Reference Nutrient Intake (LRNI) for non-pregnant, non-lactating women aged 19–50 years (DoH 1991). (Only two women were breastfeeding at the time of the dietary assessment and both stopped shortly after.) Table 5 shows the number and percentage of women from the whole group and from the different ethnicities that did not meet the RNI and the LRNI for calcium, iron, magnesium, folate and riboflavin. These nutrients were chosen as they are important for pregnancy and a large proportion of women did not attain the RNI and in some cases the LRNI.

Table 3. Mean daily energy/nutrient intakes and significance of difference of mothers of LBW babies, by ethnic origin

	Caucasian *n = 63*	African *n = 36*	Asian *n = 26*	African-Caribbean n = 40	ANOVA *F* statistic	**P*-value
Energy						
kcal	1832	1586	1750	1740	2.3	0.08
mJ	7.68	6.65	7.33	7.30		
Protein (g)	68.0	62.1	67.5	65.4	0.9	0.5
Fat (g)	79.4	62.0	78.0	71.5	4.8	0.003
n-6 fatty acids (g)	10.5	9.40	11.6	9.06	2.6	0.057
n-3 fatty acids (g)	1.55	1.64	1.95	1.46		
Carbohydrate (g)	218	206	204	219		
Fibre (Englyst) (g)	10.9	9.02	10.2	9.31		
Calcium (mg)	780	565	629	658	5.4	0.001
Iron (mg)	10.7	9.64	11.7	9.77	2.7	0.046
Magnesium (mg)	236	223	222	207	1.4	0.25
Zinc (mg)	7.94	7.33	8.02	7.61		
Selenium (µg)	47.7	43.7	45.0	40.8		
Iodine (µg)	102	91.2	96.4	87.8		
Potassium (mg)	2479	2340	2317	2196		
Copper (mg)	1.15	1.20	1.28	1.13		
Thiamin (mg)	1.21	1.06	1.09	1.10		
Riboflavin (mg)	1.38	1.19	1.17	1.23		
Niacin equivalent (mg)	30.1	27.9	29.7	29.2		
Vitamin B_6 (mg)	1.66	1.71	1.49	1.58		
Vitamin B_{12} (µg)	4.07	5.39	5.61	4.79		
Folate (µg)	227	196	217	189	2.0	0.1
Vitamin C (mg)	69.8	89.8	81.1	80.9	1.0	0.4
Vitamin A (µg)	813	737	1036	749	0.8	0.5
Vitamin D (µg)	2.40	4.72	2.47	3.18	4.1	0.007
Vitamin E (mg)	7.50	6.94	7.55	6.20		

*Statistical tests were carried out on those nutrients showing a *P*-value. The nutrients to be tested were decided post hoc on examination of the data. *P*-values are given for significant and non-significant results.
LBW, low birth weight.

Table 4. Mean (SD) intakes of macronutrients and selected micronutrients expressed in relation to energy intake

	Caucasians	Africans	Asians	African-Caribbean	*F* statistic (ANOVA)	*P*-value
% energy from fat	38.9 (5.2)	34.9 (5.4)	40.0 (6.5)	36.3 (6.8)	5.7	$P = 0.001$
% energy from protein	14.9 (1.8)	15.8 (2.8)	15.5 (2.9)	15.2 (2.7)	1.2	$P = 0.3$
% energy from carbohydrate	44.8 (5.2)	48.9 (6.9)	43.8 (7.0)	47.7 (6.0)	5.7	$P = 0.001$
Calcium (mg) per 1000 kcal	428 (122)	355 (122)	357 (87)	378 (133)	3.9	$P = 0.01$
Magnesium (mg) per 1000 kcal	130 (30)	140 (23)	127 (29)	120 (29)	3.2	$P = 0.026$
Iron (mg) per 1000 kcal	5.9 (1.2)	6.0 (1.3)	6.8 (1.7)	5.7 (1.3)	3.8	$P = 0.012$

Discussion

Many of the mothers in our sample had intakes of nutrients less than the Dietary Reference Values. This was especially the case for iron, folate, magnesium and calcium. There were some differences in nutrient intakes between ethnic groups, which will be discussed below.

Almost 90% of all women did not meet the RNI for iron and 22% did not achieve the LRNI. Our Asian

Table 5. The number and percentage of women not meeting the RNI and LRNI for selected micronutrients, by ethnicity

Nutrient	RNI/LRNI	Whole group *n* (%) *n* = 165	Caucasian *n* (%) *n* = 63	African *n* (%) *n* = 36	Asian *n* (%) *n* = 26	African-Caribbean *n* (%) *n* = 40
Calcium	RNI (700 mg d^{-1})	98 (59)	30 (48)	24 (67)	18 (69)	26 (65)
	LRNI (400 mg d^{-1})	19 (12)	1 (2)	11 (31)	2 (8)	5 (13)
Iron	RNI (14.8 mg d^{-1})	146 (88)	58 (92)	32 (89)	20 (77)	36 (90)
	LRNI (8.0 mg d^{-1})	36 (22)	8 (13)	12 (33)	5 (19)	11 (28)
Magnesium	RNI (270 mg d^{-1})	120 (73)	44 (70)	26 (72)	20 (77)	30 (75)
	LRNI (150 mg d^{-1})	24 (15)	7 (11)	6 (17)	2 (8)	9 (23)
Folate	RNI (200 µg d^{-1})	85 (52)	28 (44)	16 (44)	17 (65)	24 (60)
	LRNI (100 µg d^{-1})	10 (6)	2 (3)	5 (14)	0	3 (8)
Riboflavin	RNI (1.1 mg d^{-1})	65 (39)	21 (33)	15 (42)	11 (42)	18 (45)
	LRNI (0.8 mg d^{-1})	36 (22)	8 (13)	13 (36)	4 (15)	11 (28)

RNI, Reference Nutrient Intakes; LRNI, Lower Reference Nutrient Intake.

group had the highest iron intake (11.7 mg d^{-1}), and the African and African-Caribbean group the lowest (9.6 mg d^{-1}, 9.8 mg d^{-1}, respectively). It was unexpected for Asian women to have the highest iron intake. However only three were vegetarian in our sample, they were of a higher socio-economic status than the Africans or African-Caribbean women, and their intake was still much lower than recommended. Women in our sample had a lower iron intake than found by Vyas *et al*. (2003). Vyas *et al*. used food frequency questionnaires and found Pakistani women in Manchester to have a similar iron intake to Europeans (14.1 and 14.8 mg d^{-1}, respectively) with the African-Caribbean women also having the lowest iron intake (10.1 mg d^{-1}). A likely explanation for the low iron intake in all groups is the consumption of chicken and fish in place of red meat.

Caucasian women had more calcium in their diet than all other ethnic groups mainly because of inclusion of more dairy products in the diet. The importance of calcium in the diet of pregnant women has been well established and has been the subject of several reviews (Villar *et al*. 1998). Calcium supplementation in the prevention of preterm delivery is controversial. A Cochrane review of 11 randomised placebo controlled trials of at least 1 g d^{-1} of calcium during pregnancy concluded that calcium supplementation is beneficial for women at high risk of gestational hypertension and in communities with a low dietary calcium. They found a modest reduction in high blood pressure and pre-eclampsia, and a reduction in the number of babies born LBW (Hofmeyr *et al*. 2002). It is interesting that in our study the lowest calcium intake was seen in the Africans: 67% did not meet the RNI for calcium; 31% did not meet the LRNI; 92% of their LBW babies were preterm.

Asian and Caucasian women had the lowest intakes of vitamin D. Asians are at increased risk of vitamin D deficiency because of high skin pigmentation and limited exposure of skin to sunlight. For this reason it is important that Asians in particular receive supplementation with vitamin D during pregnancy.

Africans had the lowest energy, and fat intake, but highest BMI. It could be that the Africans are more metabolically efficient or that their past diet histories may have been different. An alternative explanation is that the energy and fat intake were underestimated for the African women in particular. This may have been as a result of underestimation of cooking oil, which is used liberally in African cuisine, as this is difficult to quantify if not measured exactly. Vyas *et al*. (2003) found that under-reporting of food consumed was evident in Pakistani, African-Caribbean and European groups and under-reporters had the highest BMIs in all groups.

Our study has several limitations which should be considered when interpreting the results. One of the main limitations is the recruitment and retention of participants. Our sample was not totally representative of the population as we were unable to recruit non-English speakers and some women (especially Asians) were less likely to speak English. Also we examined the diets of a relatively small number of women compared to the total number of women available. Therefore the generalizability of our study may be limited. This is an important issue, but practically this is a difficult population to research as motivation to join and remain in studies is low.

Other limitations of our study include the absence of controls as we recruited only those with a LBW baby for the original intervention studies. However, in a previous paper (Doyle *et al*. 1999) we compared the nutrient intake of 41 of these mothers who had delivered a LBW baby to the nutrient intake of 165 women in the first trimester of pregnancy who subsequently had an 'optimum' birth weight baby of 3.5–4.5 kg (mortality and morbidity are at their lowest in this range of birth weight). Nutrient intakes in the 'optimum' birth weight group were higher than in all of the ethnic groups presented here for calcium (953 mg), iron (12.9 mg), magnesium (283 mg), zinc (10.2 mg).

Also the analysis of the data did not take into account the known risk factors for LBW, as we were simply looking at differences between women of different ethnicities who had delivered LBW babies. This was a heterogenous group of mothers, some whose babies were term but SGA, and some whose babies were preterm. The risk factors are likely to be different for preterm births than for SGA. For example infection may play a greater role in preterm delivery than in babies born at term with restricted growth. Unravelling how much of a risk factor nutrition is to different types of LBW to women of different ethnic origins is complex and was not attempted from our data.

The African mothers had the highest proportion of preterm births (92%). We can not explain why this is so different to the African-Caribbean women who had a preterm rate of 52%, as did the Caucasians. The African women had slightly less unemployment and more women in professional jobs than the African-Caribbean women and so the difference does not seem to be explained by socio-economic status. Both the African and Asian groups had very low rates of smoking compared to the Caucasians and African-Caribbean women. All infants in this study regardless of their ethnicity were classified as LBW if they weighed less than 2.5 kg, as below this weight infant mortality starts to rise. WHO uses 2.5 kg to designate LBW worldwide (Kramer 1987).

There was much variability in diet and ethnicity within groups – for example the Caucasians were not all British and included women from Eastern Europe and the Mediterranean. The African and Asian women were also from many different countries, some were born in the UK and some were not. Grouping together was necessary to provide sufficient numbers in each group to allow for analysis.

The diets of women in our study were assessed at 8–12 weeks post-partum and so it could be argued that their diets were different whilst pregnant. It is possible that 8–12 weeks post-partum was not long enough for some women to settle in to normal eating habits, although all were at home with their babies.

The most appropriate method for accurate dietary assessment in communities with ethnic diversity is still not known. Vyas *et al*. (2003) found that specially developed food frequency questionnaires had limitations including under-reporting. Estimations of food portion sizes using descriptions or a photographic food atlas can also be inaccurate (Frobisher & Maxwell 2003). All methods will have limitations that need to be recognized when interpreting findings.

Prospectively recording food consumption in a diary as we have done reduced recall bias, however, it limited our sample to those who could speak and write in English. Underestimation of food consumed is still a possibility when converting household measures and portion sizes to weight in grams. Where ever possible we matched the ethnicity of the research assistant to the participant in an attempt to fully interpret the diaries and all researchers were trained by the same experienced researcher to reduce interobserver error.

Therefore the results of our study must be viewed with the limitations of the heterogenous population, generalizability and dietary survey methodology in mind.

The emotional, social and financial costs of LBW are high and so effective public health interventions should be pursued. The Health Development Agency has recently published a review of the evidence and recommendations for further research into the prevention of LBW by nutritional interventions (HDA 2003). The lack of research targeting ethnic minorities, who are most at risk, was highlighted.

Our data show that there is a high prevalence of inadequate nutrition among women who deliver LBW babies. Our data may help alert health professionals as to the likely nutrient deficiencies in different ethnic groups so that specific, practical and culturally appropriate advice can be given at the earliest opportunity.

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