Nutrient intakes of an adult Pakistani, European and African-Caribbean community in inner city Britain

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Abstract

Objectives To report nutrient intakes for three different ethnic groups living in inner city Manchester and explore under-reporting in each group.

Design Cross-sectional survey. All participants completed one of three food frequency questionnaires, specifically developed for each ethnic group, and took part in a larger international survey of risk factors for diabetes and hypertension.

Setting Participants were drawn randomly from seven GP registers in inner city Manchester, UK.

Participants Men and women aged 25–79 years, 86 European, 246 African-Caribbean origin and 84 Pakistani origin participants were included in the analysis.

Results Body mass index was highest in the Pakistani women, 30.2 kg m^{-2}. European participants had the highest reported energy intakes (EIs) for men and women (10.9 and 9.6 MJ, respectively). Pakistani men and women had the highest percentage of energy from fat (36.7 and 36.6%, respectively). Iron intakes were low in the African-Caribbean group and calcium intakes were low in the Pakistani group. Under-reporting [assessed as EI : basal metabolic rate (BMR) ratio <1.2] appeared to be high and occurred across all ethnic groups, with those apparently under-reporting having higher BMIs in all groups.

Conclusion The data provide nutrient intake estimates in three different ethnic groups using a similar method. Limitations include under-reporting across all ethnic groups in a similar pattern with under-reporters having higher BMIs in all groups, as found elsewhere.

Introduction

Attempts to assess dietary intake in different ethnic groups within the UK community have been few (Miller *et al.*, 1988; Sevak *et al.*, 1994; Simmons & Williams, 1997; Kamath *et al.*, 1999). Many studies have not distinguished between the very varied patterns found within and between

communities of Indian subcontinent origin, for example, between vegetarian or meat-eating Gujaratis, Halal-meat dishes for Muslim Pakistanis compared with Sikhs or Hindus from the Punjab, and the predominantly rice-based diet of Bangladeshis. Minority ethnic groups were not represented in the first National Diet and Nutrition Survey of British adults 10 years ago (Gregory *et al.*, 1990). Efforts to examine nutrition, health and disease relationships require valid estimates of both individual and population nutrient intakes (Willett, 1987).

There is little work available on directly comparable assessments of nutritional intake in different ethnic communities in the UK (Landman & Cruickshank, 2001). The Health Survey for England assessed dietary patterns among ethnic minorities but not in detail (HSE, 1999). Similarly, items needed for analysis of dietary data, such as food portion size and nutrient composition values of traditional dishes are only recently becoming available (Judd *et al.*, 2000) with little information on how food choice, composition and intake change over time.

In Britain, people of Pakistani origin, self-defined in the 1991 census, formed 1% of the total England population. In Manchester, the region's largest post-industrial conurbation, that proportion was 6.6%, compared with 1.5% for people of Indian or Bangladeshi origin (OPCS, 1993). The longer-established African-Caribbean community forms the second largest ethnic minority group in Britain (Cruickshank, 2000), approximately 1% of the England and Wales population. This is known to be an underestimate particularly for younger age groups but in central Manchester where this work was done, 16% self-defined themselves as Black Caribbean in the 1991 census (OPCS, 1993).

This paper examines the nutrient intake and dietary habits, assessed by carefully developed food frequency questionnaire (FFQ), of representative samples of adult Pakistanis and Europeans, resident in inner city Manchester, compared with previously published results among local African-Caribbeans (Sharma *et al.*, 1999). Other details of nutrient intake in this community have also been published (Sharma & Cruickshank, 2001; Sharma *et al.*, 2002).

FFQs measure habitual intake of foods over a period of time (usually 6–12 months), within a population. The issue of under-reporting in different ethnic groups is examined and the limitations of the method discussed.

Methods

A random sample of Pakistani, European and African-Caribbean participants stratified by sex within 10-year age bands between 25 and 54, and then from 55 to 79 years, was drawn from seven health centre registers in central Manchester where many Pakistani and African-Caribbean people live.

Ethnic group was both self-reported from the 1991 census categories and also defined from grandparental origin, using three of four grandparents to classify each specific ethnic group, the latter being analysed here. Pakistani was defined as someone either born in or moved to, what has now become Pakistan at the time of Partition in 1947. Usually speaking Punjabi or Urdu, and of Muslim religious persuasion. African-Caribbean was defined as someone of Caribbean birth or origin and African descent, and specifically did not include people of direct African origin, whose cultural and nutritional habits are quite different. African-Caribbean participants were recruited from 1993 to 1996 and Pakistanis and Europeans were recruited from 1995 to 1998.

Of 2018 people eligible, 355 people refused to participate (18%); 1318 (65%) people attended clinics for blood tests and anthropometry. The remaining 345 (17%) people were thought to be resident at their given address and were sent letters for the full survey but did not attend >2 appointments either because they were no longer resident (which we could not ascertain), or could not participate due to work or other commitments. All respondents seen within the previous 18 months were then invited for the nutritional assessment with minimal refusal rates across each ethnic group; 416 respondents completed the nutritional assessments.

The study was approved by the Central Manchester Ethics Committee.

Food frequency questionnaires

Culturally appropriate FFQs were carefully developed for each ethnic group (available on request from the authors). Each subject attended their own GP practice and the FFQ was administered by interview, using portion models to aid description. All observations were made by trained interviewers using standardized techniques (Sharma *et al.*, 1993, 1996). The number of food items covered by the FFQ varied depending on the relevant foods for each group. The FFQ for the African-Caribbean participants included 108 food items, 162 items for the Pakistani group and 200 items for the European group. The difference in number of food items for each group is due to the varying contribution of foods in the diet. Details of the development of the African-Caribbean FFQ have been previously described (Sharma *et al.*, 1996). Similar methodology was employed for the development of both the Pakistani origin and the White European FFQs. In brief, a random subsample of participants from each ethnic group ($n = 20$) completed 3-day food diaries, comprising two week days and one weekend day. The diary detailed all food and drink items consumed during the 3-day period. Serving sizes were estimated using household measures, volume models, and pack sizes for quantification. Weights were assigned by trained interviewers (a nutritionist, and a dietitian), either by weighing similar portion sizes in the participants home, or by utilizing a food portion size book (Crawley, 1988). Diaries were then analysed using the 'Microdiet' nutritional analysis package to obtain mean nutrient intakes and to ascertain those foods that contributed to 90% of the total energy, fat, carbohydrate and protein. The 90% was chosen arbitrarily as a reasonable but not over-inclusive proportion of foods consumed (Sharma *et al.*, 1996).

This list of foods was subsequently used in the development of each FFQ, which was piloted, on a random subsample of participants from each ethnic group ($n = 20$). Participants were asked how often they consumed particular food items, together with details of cooking methods, frequency of milk, sugar and alcohol intake. Several 'cross-check' questions were also included within the FFQ.

Recipe collection, portion sizes and food weights

The nutritional composition of many traditional recipes frequently consumed by both the Pakistani origin and African-Caribbean communities were not available in the UK Food Composition tables. Thus several focus groups along with individual visits to participants homes were arranged to obtain a standard recipe for each dish, in conjunction with both male and female portion sizes. At least three (and up to six) recipes were collected for each individual composite dish, with the final standard recipe being the average of the nutritional composition calculated per 100 g for each version of a particular recipe.

Nutrient values for each FFQ were derived using a specifically designed SPSS syntax program. The participants' responses were expressed as weight of food consumed per day, week or month. This was then multiplied by the assigned specific portion size to give mean daily consumption of that particular food.

In order to estimate the validity of the FFQ, prediction equations (Schofield *et al.*, 1985) based on the weight, age, and sex of the participants were used, with subsequent calculation of the ratio of reported energy intake (EI) to basal metabolic rate (BMR). Statistical analyses were performed using the SPSS v6 program, with log transformation of variables if required and using *t*-tests and analysis of variance (ANOVA) where appropriate.

Results

All three ethnic groups were of a similar age, with mean age of 52.5 years for men and 49.6 years for women (95% CI 50.5–54.4 and 48.1–51.2, respectively; Table 1). Mean duration of time spent in Manchester was, as expected highest in the European group, followed by that for African-Caribbeans, with the Pakistani participants having spent the least time of 18–19 years in Manchester. None of the Pakistani participants were born in the UK, whereas 16.5% of the African-Caribbean men and 18.5% of the African-Caribbean women had been. Reflecting Manchester's large Irish community 28.9% of the European men and 27.1% of the European woman were born in Eire.

Table 1 Characteristics of the three different ethnic groups (percentages or means and 95% confidence intervals)

	Men			Women		
	White European (n = 38)	African-Caribbean (n = 99)	Pakistani origin (n = 34)	White European (n = 48)	African-Caribbean (n = 147)	Pakistani origin (n = 50)
Age (years)	51.4 (47.7–55.5)	53.9 (51.1–56.6)	49.5 (45.6–53.4)	51.7 (48.6–54.8)	48.9 (46.7–51.1)	49.8 (46.9–52.6)
Mean duration of time in the Manchester (years)	40.8 (35.3–46.3)	30.5 (29.1–31.9)	19.0 (15-4-22.7)	33.8 (27.7–39.9)	29.7 (28.2–31.2)	18.4 (15.9–21.0)
Born in the UK (%)	68	17	0	71	19	0
Eire	29	–	–	27	–	–
Caribbean	–	84	–	–	76	–
Pakistan	–	–	100	–	–	96
Married (%)	63	52	94	35	39	84
Single (%)	16	20	0	21	31	0
Household income £10 000 or less (%)	42	62	55	59	63	19*
Age of leaving education (years)	16 (15–17)	17 (15–19)	21 (11–31)	17 (15–18)	17 (16–18)	24 (6–41)
Education level (%)						
Primary	5	5	18	2	2	18
Secondary	79	71	32	79	73	30
Vocational/professional	8	17	21	6	17	8
University/higher education	5	6	18	13	6	4
Body mass index (kg m^{-2})	29.7 (27.8–31.6)	27.0 (26.3–27.7)	27.2 (26.1–28.3)	27.1 (25.6–28.5)	28.7 (27.8–29.6)	30.2 (28.9–31.5)
Waist-to-hip ratio	0.96 (0.93–0.98)	0.91 (0.89–0.92)	0.94 (0.93–0.97)	0.80 (0.78–0.82)	0.82 (0.81–0.83)	0.88 (0.85–0.90)
Mean hip circumference (cm)	106.2 (102.9–109.4)	101.1 (99.8–102.3)	105.1 (101.5–108.6)	104.9 (101.6–108.2)	106.8 (104.9–108.8)	110.5 (107.7–113.3)
Mean waist circumference (cm)	102.0 (97.7–106.3)	92.0 (90.0–94.0)	99.6 (96.6–102.6)	83.2 (79.2–87.1)	87.8 (85.7–89.9)	96.0 (92.7–99.4)

*72.7% unaware of annual income of household.

The majority of the Pakistani sample (89%) were married, compared with both the African-Caribbean and European groups (45.2 and 49.3%, respectively). As expected in an inner city, about half of the European participants and just over 60% of the African-Caribbean participants reported an estimated total annual income of less than £10 000, 55% of Pakistani men reported a similar income. Some 18% of the Pakistani men had attended university or polytechnic; conversely the Pakistani women (4%) were the least likely to have reached higher education.

Body mass index (BMI) was highest in the European men and in the Pakistani women. The lowest BMIs were seen in the African-Caribbean men and the European women. Similar differences were seen for the waist and hip measurements and the waist to hip ratio.

Nutritional results (Table 2)

European men had the highest reported EI (mean 10.9 MJ day^{-1}, 95% CI 9.3–12.5), compared with the African-Caribbean and Pakistani men, whose intakes were lower but not significantly different (10.0 and 8.8 MJ day^{-1}, respectively). Similarly mean EIs were higher in the European women (9.6 MJ day^{-1}), significantly higher than those of African-Caribbean women (8.1 MJ day^{-1}), but not compared with women of Pakistani origin (8.3 MJ day^{-1}).

Pakistani-origin participants reported a greater percentage of dietary energy from fat than the other two groups, at 36.7% in men and 36.6% in women. African-Caribbean men had the lowest percentage of energy from fat (31.8%). African-Caribbean women also reported a lower (although not significantly lower) percentage of energy from fat than women of European or Pakistani origin. As expected, the energy deficit from the lower fat intakes was balanced by higher intakes of carbohydrates in the African-Caribbean group. Men and women in this group consumed around half of their energy from carbohydrate.

Assessment of iron intake showed lowest values in the African-Caribbean group and calcium intakes were lowest in the Pakistani group.

The main sources of energy in the diets of the three groups differed substantially (Table 3). However, bread featured in the top 10 energy contributing foods in each group. Potatoes, milk and butter were important contributors to energy in the European group. In contrast, chicken and lamb dishes were important in both the African-Caribbean and the Pakistani groups. Rice was a major contributor to energy for the African-Caribbean group and as expected chapatis were for the Pakistani group.

The mean ratio of EI to predicted BMR was 1.03 (95% CI 0.95–1.10) for men and for women 0.95 (0.89–1.01). It was lowest in the Pakistani group. An EI : BMR ratio of <1.2 (the ratio assumed to denote under-reporting of EI) was found in 73.6% of the men and 77.5 of the women. Table 4 shows the EI and BMI of participants apparently under-reporting (EI : BMR < 1.2) compared to those with EI : BMR 1.2 and above. For each ethnic group a similar pattern is seen. Those in the under-reporting category have higher BMI and lower reported EIs.

Discussion

This paper has compared the nutrient intakes of three different ethnic groups in an inner city population living in the UK. Due to local inner city mobility the response rate given above may be artificially reduced. We believe that the actual response rate may be as high as 75–80%, but it was not possible to trace the individuals to verify this. The Pakistani group had been born in either Pakistan or India, the majority of the African-Caribbean group had been born in the Caribbean, and over one quarter of the European group had been born in Eire. Poverty is common in British inner city areas (Blane *et al.*, 1997). Household annual incomes of less than £10 000 were seen in about half of the households, although a substantial number of the female participants in the Pakistani group did not know or did not report their household income. Available national figures of around the same time (1993) showed that only 18% of married couples had an annual income below £10 400 (OPCS, 1995).

Table 2 Nutrient intake per day across the three groups (percentages or means and 95% confidence intervals)

	Men				Women			
	White European (n = 38)	African-Caribbean (n = 99)	Pakistani origin (n = 34)	ANOVA, P	White European (n = 48)	African-Caribbean (n = 147)	Pakistani origin (n = 50)	ANOVA, P
Energy (including alcohol) (MJ)	10.9 (9.3–12.5)	10.0 (9.2–10.8)	8.8 (7.7–9.9)	0.10	9.6 (8.8–10.4)	8.1 (7.6–8.6)	8.3 (7.2–9.4)	0.013
% Energy from								
Total fat	35.6 (33.8–37.5)	31.8 (30.7–32.9)	36.7 (34.5–38.9)	<0.0001	34.0 (31.6–36.3)	32.3 (31.4–33.1)	36.6 (34.5–38.7)	<0.0001
Saturated	13.6 (12.6–14.7)	11.1 (10.6–11.6)	10.2 (9.4–10.9)	<0.0001	13.8 (12.3–15.3)	11.4 (10.9–11.8)	10.4 (9.5–11.3)	<0.0001
Polyunsaturated	6.2 (5.5–6.9)	5.6 (5.3–5.8)	7.6 (6.8–8.4)	<0.0001	5.7 (5.2–6.2)	6.1 (5.8–6.3)	7.3 (6.73–7.8)	<0.0001
Carbohydrate	46.2 (43.9–48.5)	50.7 (49.4–52.1)	49.2 (46.9–51.4)	0.003	49.8 (47.5–52.2)	51.8 (50.9–52.8)	48.9 (46.4–51.3)	0.019
Protein	15.0 (14.2–15.9)	14.5 (14.0–14.9)	14.1 (13.4–14.6)	0.131	15.3 (14.6–16.0)	14.5 (14.2–14.9)	14.3 (13.6–15.0)	0.064
Fat (g)	102.7 (86.5–118.9)	86.6 (78.0–95.2)	86.4 (73.7–99.1)	0.13	88.3 (77.6–98.9)	70.7 (65.4–76.1)	83.9 (68.5–99.3)	0.009
P : S ratio	0.48 (0.42–0.55)	0.52 (0.49–0.56)	0.77 (0.66–0.88)	<0.0001	0.50 (0.42–0.57)	0.56 (0.53–0.59)	0.74 (0.68–0.81)	<0.0001
Carbohydrate (g)	324.4 (268.9–379.9)	318.6 (294.5–342.7)	278.7 (239.6–317.8)	0.20	304.8 (276.5–333.1)	264.7 (249.6–279.8)	246.4 (220.0–272.7)	0.009
Fibre (Southgate) (g)	26.7 (22.8–30.6)	25.9 (23.9–27.9)	25.2 (22.4–28.0)	0.001	27.6 (24.5–30.6)	22.3 (21.2–23.5)	23.5 (21.3–25.6)	<0.0001
Protein (g)	94.9 (83.5–106.3)	85.3 (78.5–92.2)	73.9 (64.3–83.4)	0.03	86.7 (79.5–93.9)	69.0 (65.2–72.8)	71.3 (59.9–82.8)	0.001
Vitamin C (mg)	108 (89–126)	125 (112–137)	107 (88–125)	0.18	128 (112–144)	128 (117–139)	127 (110–144)	0.99
Iron (mg)	15.5 (13.2–17.8)	12.1 (11.1–13.0)	14.8 (13.0–16.5)	0.001	14.8 (13.1–16.5)	10.1 (9.5–10.6)	14.1 (12.3–15.9)	<0.0001
Calcium (mg)	1133 (950–1316)	939 (854–1024)	605 (507–703)	<0.0001	1063 (931–1195)	828 (773–884)	601 (516–684)	<0.0001
EI : BMR	(0.85–1.14)	1.12 (1.04–1.20)	0.84 (0.69–1.00)	0.03	1.10 (0.97–1.23)	0.94 (0.85–1.02)	0.84 (0.73–0.97)	0.05

Table 3 Top 10 foods contributing to total energy intake across the three different groups

White European		African-Caribbean		Pakistani origin	
Food description	% Energy	Food description	% Energy	Food description	% Energy
White bread	6	Curried mutton/lamb	8	Wholemeal chapati	8
Mashed potatoes	4	Rice (polished)	5	White sugar	3
Chips	4	Rice and peas	4	White bread	3
Full cream milk	4	Fried chicken	4	Chicken curry	3
Butter	3	West Indian soup	3	banana	3
Polyunsaturated margarine	2	Roast chicken	3	Brown/wholemeal bread	2
Brown bread	2	Wholemeal bread	3	PUFA margarine	2
Wholemeal bread	2	Beer	3	Lamb curry	2
Semi-skimmed milk	2	Hard dough bread	2	Bombay mix	1
Jacket potato	2	Sugar	2	Lamb kebab	1

Body mass index was highest for the Pakistani women (30.2 kg m^{-2}) followed by the European men (29.7 kg m^{-2}). The BMI of African origin people has been shown to increase from Africa to the Caribbean, UK and the US (Mbanya *et al.*, 1999). Our African-Caribbean population had lower BMI than similar groups in the US (Long *et al.*, 1998) and nationally (Chinn *et al.*, 1996). The high BMI for the Pakistani women was also associated with well-known higher central obesity as assessed by waist–hip ratio, and is associated with increased rates of coronary heart disease and non-insulin dependent diabetes.

Risk factors for long-term chronic disease from the groups studied are highest in the Pakistani women. This group had the highest BMI overall and the highest waist–hip ratio for the women, with the greatest percentage energy from fat and low calcium intakes although reported total EIs in the Pakistani groups were not high. This latter possibly reflects methodological limitations, under-reporting or truly low intakes. Nevertheless, considerable levels of obesity suggest that not only were EIs higher than requirements in the group but also physical activity, and hence total energy expenditure was lower. South Asian populations in the UK have high rates of coronary heart disease and non-insulin-dependent diabetes (Cruickshank *et al.*, 1980, 1991; Sevak *et al.*, 1994; Landman & Cruickshank, 2001). Reducing fat intake and increasing physical activity levels, if achievable, may decrease overall and regional adiposity, thereby improving serum lipid profiles and risk of coronary heart disease, as found in other UK data and in similar groups elsewhere (Kamath *et al.*, 1999).

Rates of diabetes and hypertension were 18 and 28%, respectively, in the African-Caribbean populations in Britain and they are nutrition-related disorders (Mbanya *et al.*, 1999; Cruickshank *et al.*, 2001). Hence, the importance of direct comparison of diets within a community could help to tailor nutrition and health education effectively (Sharma & Cruickshank, 2001; Sharma *et al.*, 2002).

The study aimed to assess habitual nutrient intakes and the instrument chosen was a FFQ, which while relatively imprecise, characterizes groups rather than individuals effectively (Willett, 1990). Different FFQs, which focused on the relevant foods, were used for each ethnic group. These FFQs had all been developed using a similar procedure. However, there may be limitations to this method in a study of this kind which aims to characterize populations with different food intakes and food habits rather than comparing groups within a population with similar food habits. Particularly, there were difficulties in assessing portion size; grouping of mixed dishes on the questionnaire; missing data from the food composition tables; potential under-reporting. These issues are discussed in more detail below.

The development of FFQs using food diaries from 20 randomly selected participants, in each group may have been a limiting factor for this study. It is also possible that some food items, which contributed to the nutrients of interest, were not included or that the portion sizes assumed were not appropriate. The issue of

Table 4 Characteristics of under-reporting by ethnic group (percentages or means and 95% confidence intervals)

	Men						Women					
	White European		African-Caribbean		Pakistani		White European		African-Caribbean		Pakistani	
	EI : BMR <1.2 (n = 29)	EI : BMR 1.2+ (n = 8)	EI : BMR <1.2 (n = 60)	EI : BMR 1.2+ (n = 38)	EI : BMR <1.2 (n = 27)	EI : BMR 1.2+ (n = 7)	EI : BMR <1.2 (n = 30)	EI : BMR 1.2+ (n = 17)	EI : BMR <1.2 (n = 111)	EI : BMR 1.2+ (n = 34)	EI : BMR <1.2 (n = 37)	EI : BMR 1.2+ (n = 10)
Total energy intake (MJ day^{-1})	9.9 (8.9–10.8)	14.6 (7.2–22.0)	8.2 (7.6–9.0)	12.6 (11.2–14.1)	8.0 (6.9–9.1)	12.0 (9.4–14.5)	8.1 (7.5–8.8)	12.5 (11.3–13.6)	7.2 (6.8–7.6)	11.0 (9.8–12.2)	6.9 (6.2–7.5)	14.1 (11.1–17.0)
BMI (kg m^{-2})	30.6 (28.4–32.8)	26.3 (22.8–29.8)	27.9 (27.0–28.7)	25.5 (24.4–26.6)	27.8 (26.7–28.8)	25.1 (21.6–28.5)	28.5 (26.5–30.4)	24.7 (23.0–26.4)	30.1 (29.1–31.1)	24.1 (22.5–25.7)	31.1 (29.7–32.5)	26.7 (24.5–28.9)
% Under-reporters*	78		61		79		64		77		79	

*Based on Schofield equations.

portion sizes was of particular concern within the Pakistani group where recipe and portion size information needed to be collected to develop the FFQ. Individual portion sizes recorded varied widely by age and sex within this group (data not shown).

Obtaining accurate reports for foods eaten in mixed dishes is problematic (Cade *et al.*, 2001). The Pakistani group consumed a large variety of such mixed dishes and the FFQ inevitably had to group some of these dishes together. This could have lead to under-reporting.

The food composition tables used contain a limited amount of information on specific ethnic foods. This type of missing data has been shown to have a limited effect on diets of mainly European populations (Cowin & Emmett, 1999). However, this could have more impact on diets where nutrient composition values of not only particular foods but complex recipes have been much less studied.

The European group had the highest EIs. This was also shown in a study comparing European and South Asian men in London. The EI of our European origin men was very similar to that in the London study (10.9 MJ our study versus 10.8 MJ London men) however, the results for our Pakistani men showed lower EIs (8.8 MJ our study versus 9.5 MJ London South Asian men) (Sevak *et al.*, 1994). Percentage of energy from fat was similar between these studies for the Pakistani/South Asian men although the European men differed, our study showing a rather lower percentage of energy from fat (35.6 our study versus 39.2 London men). Other work has also differentiated between different South Asian groups (Simmons & Williams, 1997). This study showed that the Pakistani origin groups are least likely of the South Asian groups studied to consume alcohol. This may have affected overall EI leading to lower energy consumption in this group. Pakistani groups were least likely to use home-made ghee which may also have affected the P : S ratio which was highest in this ethnic group. An occupational sample of 'Asian' men of mixed ethnic origin including Pakistani comparable with ours here was studied with similar results by Smith *et al.* (1993) in Bradford, where the P : S ratio was highest in the Hindu group, as found previously in mainly

vegetarian Gujaratis in north-west London (Miller *et al.*, 1988; Thompson & Cruickshank, 1990). Details of the African-Caribbean data have been discussed previously (Sharma *et al.*, 1999).

The Pakistani group had the lowest reported calcium intakes. Although a degree of this is due to under-reporting; this issue had previously been highlighted in the 1980s following reports of low calcium intakes in specific subgroups, including pregnant women, its binding by phytate in specific types of flour and high rates of osteomalacia in several parts of Britain (Pacy, 1989). Asian immigrants to Ontario have been shown to be at higher risk of low calcium, protein and iron intakes compared with non-immigrants (Pomerleau *et al.*, 1998). It is possible that missing data in the food composition tables for relevant foods in this group also contributed to differences in micronutrients seen in this study.

Under-reporting is an issue for all dietary intake studies. In the National Diet and Nutrition Survey of British adults (Gregory *et al.*, 1990) a third of men and half of the women had intakes consistent with under-reporting. About three-quarters of our sample had EI to BMR ratios below 1.2. This could reflect a weakness in the method as discussed above, although EI levels compare favourably with other studies (Gregory *et al.*, 1990; Sevak *et al.*, 1994), or reflect a high degree of under-reporting in these groups.

Interestingly, we have shown that the tendency for participants who under-report to have higher BMIs is seen across all ethnic groups and for both men and women (Mennen *et al.*, 2000). This is despite differences which have been observed between African-Caribbean and white European groups in body size perception. Adolescent African-Caribbean females in the US have been less likely to perceive themselves as overweight (Neff *et al.*, 1997). This could have suggested that our overweight African-Caribbean participants might be less inclined to under-report their dietary intake, although we did not find that this was the case. Other studies which have shown that a higher BMI is associated with increasing under-reporting have been carried out in largely European origin populations (Voss *et al.*, 1997; Gnardellis *et al.*, 1998; Heerstrass *et al.*, 1998; Johansson *et al.*, 1998). This is the first study to explore this issue in a multi-ethnic population in the UK.

Conclusion

This study has shown that it is possible to assess nutrient intakes in three different ethnic groups using specifically designed FFQs. The paper supplies directly comparable detailed dietary intakes between three ethnic groups in British inner city for the first time, although the sample sizes are not large. The method, as with all nutritional assessments, had some limitations. BMI was highest in European men and Pakistani women. European participants had the highest EIs and Pakistani participants the highest percentage of energy from fat. Iron intakes were low in the African-Caribbeans participants and calcium intakes were low in the Pakistani group. Under-reporting may have occurred widely across all three ethnic groups with more possible under-reporting seen for participants with a high BMI in all the ethnic groups.

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