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Diet and overweight and obesity in populations of African origin: Cameroon, Jamaica and the UK

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Abstract

Objectives: To determine the relationship of diet to overweight and obesity among populations of African origin.

Design and setting: Cross-sectional data were obtained from adults aged 25–74 years in rural Cameroon ($n = 686$), urban Cameroon ($n = 975$), Jamaica ($n = 924$) and Afro-Caribbeans in the UK ($n = 257$). Dietary data were collected using food-frequency questionnaires specifically designed for each site. Body mass index (BMI) was used as a measure of overweight.

Results: The expected gradient in the distribution of overweight across sites was seen in females (rural Cameroon, 9.5%; urban Cameroon, 47.1%; Jamaica, 63.8%; UK, 71.6%); however, among males overweight was less prevalent in Jamaica (22.0%) than urban Cameroon (36.3%). In developing countries increased risks of overweight (BMI $\geq 25\,\mathrm{kg\,m^{-2}}$) were influenced by higher energy (urban Cameroonian men) and protein (Jamaican women) intakes. No dietary variables were associated with obesity (BMI $\geq 30\,\mathrm{kg\,m^{-2}}$) in Cameroon or Jamaica. In the UK, energy intakes were inversely related with overweight whereas increased risks of being overweight were associated with higher protein (men) and fat (women) intakes. Similarly, whereas higher protein and fat intakes in UK men and women were associated with obesity, carbohydrate intakes were associated with decreased risks of obesity in men.

Conclusions: Diet and overweight were associated in the UK but few dietary variables were related to overweight in Jamaica and the Cameroon. These findings suggest that associations between diet and overweight/obesity are not generalisable among populations.

Keywords
Diet
Overweight
African origin

Obesity in adult populations is recognised as a growing epidemic worldwide[1] and appears to be increasing more rapidly in developing countries[2]. Importantly, obesity is associated with non-communicable diseases, including non-insulin-dependent diabetes, hypertension, dyslipidaemia, cardiovascular diseases, certain types of cancers and psychological problems[1]. The disproportionate increase in the developing world has been attributed to the 'nutrition transition', a shift from traditional diets and lifestyle to the pattern of Western societies[2]. Its serious implications for the health of these populations are clear through the link between overweight and chronic non-communicable diseases.

Little is known about diet and its contribution to adiposity in the African Diaspora. We have previously reported on the variation in diet across three populations that share a common genetic ancestry but different environments – rural and urban Cameroon, Jamaica and Afro-Caribbeans the UK[3]. Our investigation of adult Jamaicans of African descent regarding the relationships between body mass index (BMI) and diet showed that BMI was not explained by energy and that higher protein intake was associated with increased BMI in females only[4]. In the present study we investigated the relationship of diet to overweight and obesity across these different populations.

It was hypothesised that, relative to the degree of Westernisation, a gradient in prevalence of excess weight would exist: rural Cameroonians would exhibit the lowest prevalence, followed by urban Cameroonians, Jamaicans and the UK sample. We also hypothesised that the macronutrient content of the diet, in particular dietary fat, would be independently related to weight status.

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Materials and methods

Sample and study design

The investigation was a multi-centre collaborative study of hypertension and diabetes in four populations of African origin. The sampling scheme has been described elsewhere[5]. In summary, in urban Cameroon, rural Cameroon and Jamaica (Spanish Town) communities were sampled according to the 'probability proportionate to size' method[6]. Equal proportions of men and women in four age categories (25–34, 35–44, 45–54 and 55–74 years), determined to be eligible (see eligibility criteria below), were approached to be included in the survey. Recruitment was done house to house. In the UK (Manchester) random samples of Afro-Caribbeans were recruited from population registers.

Subjects were recruited to the study if they were 25–74 years old, not pregnant and of African origin according to at least two of the following criteria: (1) ancestry – at least three grandparents should be black; (2) observed race – a subjective assessment by the interviewer; and (3) self-assignment.

The response rate in urban and rural Cameroon was 95% and 98%, respectively, 62% in Jamaica and 80% in the UK.

Measurements

Dietary assessment

Dietary intakes were assessed using previously validated food-frequency questionnaires (FFQs) developed to assess diets of adults in all sites[7,8]. Each site developed an FFQ to assess habitual nutrient intakes. All FFQs assessed diet over the previous year and were interviewer-administered. In Jamaica, the FFQ was validated against twelve 24-hour recalls over one year[7]. The UK questionnaire was calibrated by comparison with a 24-hour recall and 4-day weighed intake[8]. The validity of the questionnaires was comparable to those used in other populations[9,10].

Anthropometry

Body weight (without shoes) was measured in clothing to the nearest 0.5 lb on a bathroom type digital scale. Height was measured without shoes on a floor-standing stadiometer fitted with spirit level, to the nearest 0.1 cm. BMI was calculated and the World Health Organization's classification was used to determine overweight (BMI $\geq 25.00\,kg\,m^{-2}$) and obesity (BMI $\geq 30.00\,kg\,m^{-2}$). Information on age, education level, marital status and employment status was obtained by questionnaire.

Statistical analyses

Sociodemographic characteristics were compared according to weight status using chi-square statistics. Analysis of variance and non-parametric statistics (Mann–Whitney *U*-test) were used as appropriate.

Dietary intake variables were expressed as grams per day or as a percentage of total energy from fat, carbohydrate and protein. Alcohol was expressed as grams per day, percentage of energy or as a dichotomous variable (yes/no).

Nutrient intakes were adjusted for total energy by computing residuals from regression analyses, with energy intake as the independent variable and nutrient intake as the dependent variable[11]. Residuals were added to the expected nutrient value for the mean energy intake of the sample to obtain a score adjusted to the average energy intake. Energy intakes and adjusted mean intakes were grouped in tertiles.

Multiple logistic regression analyses were used to examine the effect of diet composition (tertiles of adjusted macronutrient intake and fibre as grams per day) and sociodemographic variables on the risk of overweight (BMI $\geq 25.00\,kg\,m^{-2}$) and obesity (BMI $\geq 30.00\,kg\,m^{-2}$) at each of the four sites. All analyses were conducted separately for men and women. Age and energy intakes were entered in all models; macronutrients, social and demographic variables (marital status, education and employment) offered stepwise. Final models were calculated with the combined sites, with site entered in the model. In the final model where diet and site were significant, we examined the effect of interaction between both on the odds of overweight and obesity. Statistical analyses were performed using the Statistical Package for the Social Sciences, version 12 (SPSS Inc., 2004). Statistical significance was achieved when $P < 0.05$.

Results

Exclusions

Using *a priori* exclusion criteria of energy intakes <800 or >5500 kcal, 155 subjects were excluded (rural Cameroon, $n = 59$; urban Cameroon, $n = 53$; Jamaica, $n = 39$; UK, $n = 4$). The final sample comprised: $n = 686$ subjects from rural Cameroon, $n = 975$ from urban Cameroon, $n = 937$ form Jamaica and $n = 257$ from the UK. The data were collected between 1992 and 1995.

Characteristics of the sample

Demographic and anthropometric characteristics of the study participants by gender are shown in Table 1. The mean age of men and women studied was 46 years, but was somewhat lower in urban Cameroonians (38 years). Fewer persons from rural Cameroon and Jamaica compared with those from the UK and urban Cameroon had attained a secondary education or higher. Jamaicans were less likely to be married or in a union. Among females, the prevalence of overweight and obesity was lowest in rural Cameroon and increased across the sites; however, among males the second lowest prevalence of overweight was found in Jamaica.

Table 1 Sociodemographic and anthropometric characteristics of four African populations

	Rural Cameroon	Urban Cameroon	Jamaica	UK
Males	$n = 406$	$n = 557$	$n = 372$	$n = 153$
Sociodemographic characteristics				
Age (years), mean ± SD*	46.3 ± 12.5	37.6 ± 9.3	46.0 ± 14.5	48.7 ± 13.1
Education (%)*†				
Primary or less	88.9	18.0	64.2	2.0
Secondary	8.6	41.3	27.8	70.0
Tertiary	2.5	40.8	8.1	28.0
Marital status: married/cohabiting (%)*†	66.7	84.0	61.5	72.5
Current smoker (%)	1.7	2.7	40.0	17.0
Anthropometry*†				
BMI ($kg\,m^{-2}$), mean ± SD	22.3 ± 3.3	27.0 ± 5.0	23.4 ± 4.3	28.6 ± 5.7
Overweight (BMI = 25.00–29.99 $kg\,m^{-2}$) (%)	12.8	36.3	22.0	34.4
Obese (BMI ≥ 30.00 $kg\,m^{-2}$) (%)	3.3	25.2	6.8	37.1
Females	$n = 280$	$n = 418$	$n = 565$	$n = 104$
Sociodemographic characteristics				
Age (years), mean ± SD*	46.4 ± 13.8	37.7 ± 8.9	46.0 ± 13.3	52.7 ± 13.2
Education (%)*†				
Primary or less	70.7	4.5	67.9	4.9
Secondary	23.6	25.8	23.2	66.7
Tertiary	5.7	69.6	8.9	28.4
Marital status: married/cohabiting (%)*†	80.7	95.0	53.5	75.7
Current smoker (%)	23.9	19.4	11.7	30.8
Anthropometry*†				
BMI ($kg\,m^{-2}$), mean ± SD	21.7 ± 2.6	25.0 ± 3.6	27.5 ± 6.4	27.3 ± 3.5
Overweight (BMI = 25.00–29.99 $kg\,m^{-2}$) (%)	8.8	37.1	33.4	50.0
Obese (BMI ≥ 30.00 $kg\,m^{-2}$) (%)	0.7	10.0	30.4	21.6

SD – standard deviation; BMI – body mass index.
* Significantly different across sites (analysis of variance or chi-square test): $P < 0.001$.
† Significantly different between genders (analysis of variance or chi-square test): $P < 0.001$.

Energy, nutrients and BMI

Energy and macronutrient intakes were compared among BMI categories. Among males and females with BMI < 25 $kg\,m^{-2}$, total energy intake was highest among rural and urban Cameroonians and lowest in men from the UK and women in Jamaica (Table 2). With the exception of rural Cameroonian males with BMI of 25–29 $kg\,m^{-2}$ who reported slightly lower intakes of energy from fat and higher intakes of carbohydrate, males consumed similar proportions of macronutrients among the BMI categories. Macronutrient intakes were similar across BMI categories among females in Jamaica. Women in the UK reported diets in which energy from fat tended to increase and that from carbohydrate tended to decrease with increasing BMI. Only two women in rural Cameroon were obese (BMI ≥ 30 $kg\,m^{-2}$) and they were not considered in the analyses.

Factors associated with overweight within sites

Among men few dietary variables were associated with overweight. Increased energy intake in urban Cameroonian men increased the risk of being overweight but the relationship was inverse among men from the UK (Table 3). Protein was associated with overweight in UK men only, with the consumption of 80 g or more of protein daily (tertile 3) associated with increased risk of being overweight (odds ratio (OR) = 7.43; 95% confidence interval (CI) 2.23–15.76) compared with tertile 1 (72 g or less of protein daily) (Table 3). Middle-aged men in urban Cameroon and the UK were more likely to be overweight. Jamaican men who had attained tertiary education were 5.77 (95% CI 2.00–13.27) times more likely to be overweight than men with secondary education or less. No variables were related to overweight in rural Cameroonian men.

In all sites, women's energy intake was not associated with overweight. Jamaican women who consumed 87 g or more of protein daily (tertile 3) were at increased risk of being overweight (OR = 2.06; 95% CI 1.25–3.38) compared with those in tertile 1 (75 g or less daily), while women in the UK whose daily intake of fat exceeded 46 g (tertile 3) were more likely (OR = 8.06; 95% CI 1.45–29.31) to be overweight than those in tertile 1 (36 g or less). Urban Cameroonian women aged 41–59 years were more likely to be overweight than younger women (Table 3). Tertiary-educated women in rural Cameroon also showed increased risk of being overweight compared with women with secondary or less education.

Factors associated with obesity within sites

Table 4 shows the variables associated with risk of obesity. Dietary variables were associated with obesity only in the UK. Higher protein intakes (tertile 3) were related to increased risks of obesity in UK males, whereas carbohydrate intakes above 283 g (tertiles 2 and 3) lowered the risk of obesity among these men. Middle-aged (41–59 years) urban Cameroonian men were more

Table 2 Energy intakes and percentage contribution of macronutrients to energy by categories of BMI and site

	Rural Cameroon	Urban Cameroon	Jamaica	UK
*Males**†				
BMI ≤ 24.99 kg m^{-2}	$n = 333$	$n = 214$	$n = 263$	$n = 43$
Energy (kcal)	3527 ± 1183	3148 ± 1085	3032 ± 1120	2285 ± 973
Carbohydrate (%E)	48.7 ± 13.0	48.9 ± 7.7	58.1 ± 7.6	56.2 ± 7.7
Protein (%E)	9.4 ± 1.7	10.5 ± 1.5	12.8 ± 2.3	12.8 ± 1.7
Fat (%E)	45.6 ± 11.4	42.6 ± 6.5	30.6 ± 5.8	32.7 ± 6.6
Alcohol (%E)	3.0 ± 3.9	0.6 ± 1.0	2.3 ± 3.6	1.3 ± 1.7
Fibre (g)	40.8 ± 17.8	32.0 ± 14.1	30.6 ± 14.8	23.7 ± 7.9
BMI = 25.00–29.99 kg m^{-2}	$n = 51$	$n = 202$	$n = 81$	$n = 52$
Energy (kcal)	3597 ± 1060	3204 ± 1028	2825 ± 1025	1950 ± 597
Carbohydrate (%E)	51.6 ± 14.3	48.9 ± 7.6	57.2 ± 6.9	55.3 ± 5.7
Protein (%E)	9.3 ± 1.6	10.5 ± 1.5	13.3 ± 2.2	14.4 ± 2.0
Fat (%E)	42.7 ± 12.1	42.9 ± 6.5	31.2 ± 5.2	32.3 ± 5.0
Alcohol (%E)	2.9 ± 3.9	1.0 ± 2.1	2.0 ± 4.0	1.1 ± 2.4
Fibre (g)	37.5 ± 16.6	34.5 ± 15.2	27.6 ± 14.7	21.9 ± 5.7
BMI ≥ 30.00 kg m^{-2}	$n = 13$	$n = 140$	$n = 25$	$n = 56$
Energy (kcal)	2965 ± 1498	3282 ± 1038	2818 ± 1148	1891 ± 733
Carbohydrate (%E)	49.7 ± 14.6	49.2 ± 7.5	54.8 ± 8.3	53.8 ± 6.5
Protein (%E)	9.3 ± 1.7	10.4 ± 1.3	13.6 ± 2.1	15.3 ± 2.0
Fat (%E)	45.4 ± 12.0	42.8 ± 6.3	32.5 ± 5.4	33.5 ± 6.1
Alcohol (%E)	4.1 ± 6.4	1.2 ± 2.2	2.7 ± 4.3	1.3 ± 2.2
Fibre (g)	33.5 ± 18.8	34.2 ± 13.4	25.8 ± 14.0	22.9 ± 7.7
*Females**†				
BMI ≤ 24.99 kg m^{-2}	$n = 247$	$n = 221$	$n = 202$	$n = 29$
Energy (kcal)	3578 ± 1242	3651 ± 1062	2389 ± 910	2613 ± 1000
Carbohydrate (%E)	47.6 ± 12.8	49.0 ± 8.3	60.4 ± 7.2	56.2 ± 7.4
Protein (%E)	9.6 ± 1.7	10.6 ± 1.5	12.6 ± 2.7	13.7 ± 2.3
Fat (%E)	48.9 ± 12.8	43.1 ± 7.1	30.4 ± 5.2	30.6 ± 4.9
Alcohol (%E)	7.4 ± 8.4	2.4 ± 5.0	0.3 ± 1.0	2.5 ± 3.8
Fibre (g)	39.6 ± 18.3	37.5 ± 13.8	23.9 ± 10.4	28.3 ± 12.9
BMI = 25.00–29.99 kg m^{-2}	$n = 24$	$n = 155$	$n = 188$	$n = 51$
Energy (kcal)	3567 ± 978	3456 ± 1100	2339 ± 948	2514 ± 1011
Carbohydrate (%E)	49.1 ± 16.9	48.9 ± 8.6	59.0 ± 8.1	53.4 ± 6.9
Protein (%E)	9.6 ± 1.9	10.8 ± 1.5	13.4 ± 3.4	14.4 ± 2.4
Fat (%E)	46.9 ± 15.5	43.4 ± 7.4	30.9 ± 5.4	32.7 ± 5.2
Alcohol (%E)	6.8 ± 4.4	3.4 ± 5.0	0.3 ± 1.0	2.4 ± 3.0
Fibre (g)	36.4 ± 14.4	35.9 ± 14.9	23.7 ± 11.6	27.3 ± 10.9
BMI ≥ 30.00 kg m^{-2}	$n = 2$	$n = 42$	$n = 173$	$n = 22$
Energy (kcal)	1999 ± 587	3677 ± 1051	2321 ± 1045	2433 ± 1126
Carbohydrate (%E)	54.2 ± 24.6	47.0 ± 7.8	59.5 ± 6.5	49.9 ± 7.8
Protein (%E)	12.3 ± 0.2	10.9 ± 1.3	13.3 ± 2.5	14.1 ± 2.2
Fat (%E)	40.6 ± 29.2	45.1 ± 6.8	30.6 ± 4.7	36.6 ± 9.3
Alcohol (%E)	7.9 ± 9.2	2.8 ± 3.9	1.9 ± 2.1	1.9 ± 2.1
Fibre (g)	14.9 ± 11.4	39.6 ± 15.9	22.3 ± 10.6	27.5 ± 21.7

BMI – body mass index; %E – percentage of energy.
Data are expressed as mean ± standard deviation.
* Dietary intakes significantly different across sites (analysis of variance): $P < 0.001$.
† Dietary intakes significantly different among BMI categories (analysis of variance): $P < 0.001$.

likely to be obese than younger men. Jamaican men who were single were less likely to be obese.

Similar to men, risk of obesity increased with age in urban Cameroon women aged 41 years or older. No variables were associated with obesity among Jamaican women. Consumption of more than 36 g of fat per day (tertiles 2 and 3) among women in the UK was associated with increased risk of obesity.

Cross-site comparison

Aggregated analyses of all sites were conducted with a variable included for site. Obesity was rare in rural Cameroon and this site was omitted from analyses of obesity. Rural Cameroon was the reference category for analyses of overweight and urban Cameroon for analyses of obesity.

Among males, no dietary variables were related to overweight and obesity. Risks of both overweight and obesity were increased in the age range 41–59 years compared with younger men, and older men (60–74 years) had increased risk of obesity but not overweight (Table 5). Men in urban Cameroon, Jamaica and the UK were at increased risk of overweight compared with rural Cameroon. Compared with males in urban Cameroon, Jamaican men were at reduced risk of obesity whereas risk of obesity was not different in UK males.

Among women, increased risks of overweight were related to being 41–59 years of age, higher protein intakes

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Table 3 OR (95% CI) for the likelihood of overweight (BMI = 25.00–29.99 kg m^{-2}) by dietary and sociodemographic factors of adults of African populations

Variable*	Rural Cameroon	Urban Cameroon	Jamaica	UK
Males				
Age (years)				
25–40	1.00	1.00	1.00	1.00
41–59	0.60 (0.29–1.23)	1.80 (1.08–2.98)	1.47 (0.73–2.96)	8.37 (2.72–14.60)
60–74	0.74 (0.35–2.13)	0.40 (0.10–1.50)	1.81 (0.49–2.83)	3.58 (0.96–13.29)
Energy (kcal)				
Tertile 1	1.00	1.00	1.00	1.00
Tertile 2	0.91 (0.45–1.97)	1.58 (1.04–2.59)	2.30 (0.83–6.36)	0.93 (0.28–3.00)
Tertile 3	0.87 (0.37–1.95)	1.23 (0.74–2.04)	1.69 (0.60–4.79)	0.52 (0.10–0.93)
Protein (g)†				
Tertile 1	–‡	–	–	1.00
Tertile 2				1.71 (0.52–5.39)
Tertile 3				7.43 (2.23–15.76)
Education				
Primary	–	–	1.00	–
Secondary			0.70 (0.31–1.56)	
Tertiary			5.77 (2.00–13.27)	
Females				
Age (years)				
25–40	1.00	1.00	1.00	1.00
41–59	1.22 (0.45–2.39)	4.17 (2.57–6.80)	1.48 (0.92–2.36)	4.14 (0.97–7.60)
60–74	0.55 (0.13–2.34)	1.49 (0.23–9.25)	0.94 (0.52–1.69)	3.62 (0.90–8.72)
Energy (kcal)				
Tertile 1	1.00	1.00	1.00	1.0
Tertile 2	1.37 (0.47–4.03)	1.27 (0.71–2.27)	0.86 (0.53–1.41)	0.33 (0.05–1.90)
Tertile 3	0.72 (0.24–2.22)	0.88 (0.50–1.54)	1.01 (0.59–1.73)	0.61 (0.11–3.47)
Protein (g)†				
Tertile 1	–	–	1.00	–
Tertile 2			1.16 (0.69–1.94)	
Tertile 3			2.06 (1.25–3.38)	
Fat (g)†				
Tertile 1	–	–	–	1.00
Tertile 2				0.39 (0.78–1.94)
Tertile 3				8.06 (1.45–29.31)
Education				
Primary	1.00	–	–	–
Secondary	0.49 (0.13–1.86)			
Tertiary	3.81 (1.01–11.05)			

OR – odds ratio; CI – confidence interval; BMI – body mass index.
* Age and energy were entered in the model; carbohydrate, protein, fat, fibre, education and marital status were offered.
† Energy-adjusted nutrients as suggested by Willett[11].
‡ Non-significant variable; not included in the model.

(89 g or more daily) and having attained a secondary level education. Assessment of interaction terms revealed that the effect of protein intake on the odds of being overweight did not differ with site. Women in the second tertile of energy consumption were at lower risk of overweight. Women in urban Cameroon were seven times more likely, and Jamaica and the UK 10 and 17 times more likely, respectively, to be overweight than women in rural Cameroon. Females aged 41–59 years were at greater risk of obesity than younger women and when compared with urban Cameroonian women, women from Jamaica and the UK were at increased risk of being obese.

Discussion

The present study is the first of which we are aware to examine the influence of diet and sociodemographic factors on risks of overweight and obesity in adults of African origin in environments ranging from rural Africa to Western society. Dietary intakes were generally not related to overweight and obesity in developing countries but appeared to influence the risks of excess adiposity in the UK. Associations of macronutrients with risks of overweight and obesity differed between genders and across countries.

Diet and excess weight

Sustained imbalance between energy intake and energy expenditure for extended periods contributes to the onset of weight gain[12,13]. Energy intakes differed among the sites but were associated with overweight among men only. Energy intake was positively associated with overweight in urban Cameroon but negatively associated in the UK and sites aggregated. The inverse relationship of energy intake and overweight observed in the UK may be due to the underestimation of energy intake[14] or dieting[15,16] by

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Table 4 OR (95% CI) for the likelihood of obesity (BMI ≥ 30.00 kg m^{-2}) by dietary and sociodemographic factors of adults of African populations*

Variable†	Urban Cameroon	Jamaica	UK
Males			
Age (years)			
25–40	1.00	1.00	1.00
41–59	3.75 (2.19–6.39)	2.38 (0.71–7.94)	7.17 (1.76–24.07)
60–74	1.53 (0.52–4.54)	0.72 (0.14–3.57)	12.39 (2.16–28.78)
Energy (kcal)			
Tertile 1	1.00	1.00	1.00
Tertile 2	2.32 (0.22–4.09)	0.78 (0.23–2.58)	0.30 (0.07–1.22)
Tertile 3	1.77 (0.98–3.20)	0.29 (0.07–1.14)	0.14 (0.03–1.69)
Protein (g)‡			
Tertile 1	–§	–	1.00
Tertile 2			1.11 (0.29–4.13)
Tertile 3			10.98 (2.40–17.18)
Carbohydrate (g)‡			
Tertile 1	–	–	1.00
Tertile 2			0.11 (0.20–0.56)
Tertile 3			0.31 (0.06–1.50)
Marital status			
Union	–	1.00	–
Not in union		0.22 (0.04–0.93)	
Females			
Age (years)			
25–40	1.00	1.00	1.00
41–59	5.96 (2.66–13.37)	1.62 (0.93–2.84)	0.97 (0.12–7.39)
60–74	9.11 (1.33–26.32)	0.89 (0.43–1.81)	1.79 (0.21–9.79)
Energy (kcal)			
Tertile 1	1.00	1.00	1.00
Tertile 2	2.43 (0.75–7.87)	0.66 (0.36–1.19)	0.14 (0.01–1.63)
Tertile 3	1.82 (0.60–5.58)	0.93 (0.49–1.73)	0.42 (0.05–3.43)
Fat (g)‡			
Tertile 1	–	–	1.00
Tertile 2			4.39 (1.56–30.25)
Tertile 3			18.06 (4.86–32.19)

OR – odds ratio; CI – confidence interval; BMI – body mass index.
* Rural Cameroon excluded from analyses.
† Age and energy were entered in the model; carbohydrate, protein, fat, fibre, education and marital status were offered.
‡ Energy-adjusted nutrients as suggested by Willett[11].
§ Non-significant variable; not included in the model.

overweight subjects. Of note, in an earlier report we showed that underreporting, as determined by varying levels of the ratio of energy intake to estimated basal metabolic rate (EI/BMR_{est})[17], ranged from 4 to 13% in urban Cameroon but showed high levels in the UK (28–66%)[18]. Underreporting may therefore have contributed to the negative association of energy intake and overweight found in the UK and sites combined. The absence of associations between energy intakes and overweight and obesity in rural Cameroon and Jamaica is in agreement with other cross-sectional investigations[19,20] but in contrast with experimental diet studies. In cross-sectional studies weight status may influence intakes and obscure any relationship of dietary contribution to weight outcomes. In spite of the care taken to eliminate under- and over-reporters, our data may also be subject to methodological bias, such as the ability to estimate diet[11], as previously discussed[18].

An unexpected finding was the association of higher protein intake with overweight. Greater protein intake was associated with overweight among men in the UK and Jamaican women and with obesity in men from the UK. This is inconsistent with other studies that associate healthy body weights with higher protein intakes[21] through suggested mechanisms of increasing satiety and facilitating weight loss[22]. It may be that overweight subjects in our study, in an attempt to lose adiposity, increased protein intakes, a regime widely promoted for weight loss[23,24]. The higher protein intakes associated with overweight/obesity may be a marker for attempted weight loss. Associations with protein intakes may also be confounded by social factors. Although we adjusted for education as a proxy for social class, confounding by other aspects of social class may remain.

The results for carbohydrate are similar to other cross-sectional studies. Greater carbohydrate intake predicted decreased likelihood of obesity among men in the UK, similar to negative associations of body weight and carbohydrate intakes in populations of industrialised countries[25,26], although an association of carbohydrate-rich diets with high glycaemic index and weight gain has also been suggested[27,28].

Table 5 OR (95% CI) for the likelihood of overweight (BMI = 25.00–29.99 kg m^{-2}) and obesity (BMI ≥ 30.00 kg m^{-2}) by dietary and sociodemographic factors – combined sites

Variable*	Overweight	Obesity
Males		
Age (years)		
25–40	1.00	1.00
41–59	1.57 (1.14–2.17)	4.33 (2.76–6.81)
60–74	1.07 (0.67–1.72)	2.10 (1.10–4.16)
Energy (kcal)		
Tertile 1	1.00	1.00
Tertile 2	1.11 (0.77–1.58)	1.09 (0.66–1.81)
Tertile 3	0.91 (0.61–1.32)	1.11 (0.63–1.93)
Site		
Rural Cameroon	1.00	
Urban Cameroon	6.68 (4.49–9.93)	1.00
Jamaica	2.02 (1.34–3.06)	0.09 (0.05–0.16)
UK	5.60 (3.13–10.01)	1.46 (0.83–2.64)
Females		
Age (years)		
25–40	1.00	1.00
41–59	2.52 (1.75–3.62)	3.14 (1.87–5.27)
60–74	1.48 (0.87–2.51)	1.65 (0.84–3.27)
Energy (kcal)		
Tertile 1	1.00	1.00
Tertile 2	0.82 (0.55–0.99)	0.52 (0.32–1.56)
Tertile 3	0.79 (0.51–1.10)	0.95 (0.54–1.68)
Protein (g)†		
Tertile 1	1.00	–‡
Tertile 2	1.70 (1.09–3.26)	
Tertile 3	2.67 (1.43–4.95)	
Education		
Primary	1.00	–
Secondary	1.91 (1.21–2.99)	
Tertiary	1.53 (0.90–2.60)	
Site		
Rural Cameroon	1.00	
Urban Cameroon	7.14 (3.96–13.01)	1.00
Jamaica	10.18 (5.82–17.76)	5.94 (3.00–11.77)
UK	17.51 (8.02–27.69)	3.06 (1.33–7.06)

OR – odds ratio; CI – confidence interval; BMI – body mass index.
* Age and energy were entered in the model; carbohydrate, protein, fat, fibre, education and marital status were offered.
† Energy-adjusted nutrients as suggested by Willett[11].
‡ Non-significant variable; not included in the model.

The importance of dietary fat in the regulation of body weight has received much attention but remains controversial[29,30]. Epidemiological studies in countries undergoing the nutrition transition have shown positive relationships between obesity and dietary fat intake but inverse associations with body weight in many Westernised populations[31,32]. The energy density of fat is higher than that of carbohydrate and satiety signals arising from its ingestion are weaker, thereby allowing passive overconsumption of fat-rich energy-dense diets[33–35]. In our study greater dietary fat intakes increased the risk of overweight and obesity in women in the UK only. Dietary fat was not associated with overweight in Cameroonians who consumed approximately 43–49% of energy as fat, and their low rate of overweight, despite the highest energy intakes and high percentage of energy from fat, is almost certainly explained by high physical activity. Energy intakes and percentage energy from fat were slightly lower in urban than rural Cameroon but overweight and obesity substantially higher, suggesting that lower physical activities due to more sedentary lifestyles may be a more critical influence on weight than intakes in this setting.

Our results differed by site. Overall mean intakes of nutrients differed appreciably within countries and increased the possibility that site-specific variability in intakes of macronutrients were large enough to detect significant associations. There were few associations between diet (energy and macronutrients) and weight in Cameroon and Jamaica but in the UK several associations were observed which were consistent with previous studies except for protein. We also analysed all sites together, potentially creating a more heterogeneous sample to provide insights into the factors affecting weight. The only association was between protein intake and overweight in females. The results suggest that energy expenditure may be a more important determinant of weight status than diet in developing counties and that diet becomes more important where the majority of the population has a sedentary lifestyle.

Non-dietary factors

Several studies provide evidence of the importance of socio-economic factors to weight gain in developing and developed countries and our results were consistent with previous associations. A positive association with age and overweight and/or obesity was noted among developing (urban Cameroon – males and females) and developed (UK – males) countries. Overweight in Jamaica and Cameroon was positively related with higher education, a proxy for social status, as has been reported in other transitional countries[1,36,37]. However, we did not find the inverse association with education in the UK. It is possible that this association may not be consistent across all ethnic groups. We are unaware of previous studies exploring this association among Afro-Caribbeans in the UK. The inverse relationship of not being married or in a stable union (Jamaican men) to weight gain was similar to our findings[38].

Body image has been identified as important in the aetiology of obesity and social norms are likely to influence reporting of habitual intakes[39]. Our earlier report[18] showed that the prevalence of underreporting was lowest in rural Cameroon, somewhat higher in urban Cameroon and Jamaica and highest in the UK, suggesting trends in cultural influences on obesity.

There are limitations to this study. Estimates of nutrient intakes from FFQs are not precise[9,40] and have potential for measurement error; however, the FFQs were calibrated for the nutrients examined in this report[7,8]. The cross-sectional nature of our study prohibits defining a temporal sequence between diet and weight gain. For example, the possibility exists that real changes to diet occur in response to weight gain, and hence the reported intakes could lead to misclassification of dietary intake and unexpected associations with weight status.

Our results show that associations between diet and overweight/obesity are not generalisable among populations. Given the high rates of overweight in populations of African origin in industrialised countries, longitudinal studies are needed to examine the relative influence of diet and lifestyle factors, including physical activity, on weight gain.

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