

ORIGINAL ARTICLE

Ethnic group differences in overweight and obese children and young people in England: cross sectional survey

S Saxena, G Ambler, T J Cole, A Majeed

Arch Dis Child 2004;**89**:30–36

See end of article for authors' affiliations

Correspondence to:
Dr S Saxena, Lecturer in
Primary Care, Research &
Development Directorate,
UCLH NHS Trust, 112
Hampstead Road, London
NW1 2LT, UK;
sonia.saxena@
pcps.ucl.ac.uk

Accepted 15 May 2003

Aims: To determine the percentage of children and young adults who are obese or overweight within different ethnic and socioeconomic groups.

Methods: Secondary analysis of data on 5689 children and young adults aged 2–20 years from the 1999 Health Survey for England.

Results: Twenty three per cent of children (n = 1311) were overweight, of whom 6% (n = 358) were obese. More girls than boys were overweight (24% v 22%). Afro-Caribbean girls were more likely to be overweight (odds ratio 1.73, 95% CI 1.29 to 2.33), and Afro-Caribbean and Pakistani girls were more likely to be obese than girls in the general population (odds ratios 2.74 (95% CI 1.74 to 4.31) and 1.71 (95% CI 1.06 to 2.76), respectively). Indian and Pakistani boys were more likely to be overweight (odds ratios 1.55 (95% CI 1.12 to 2.17) and 1.36 (95% CI 1.01 to 1.83), respectively). There were no significant differences in the prevalence of obese and overweight children from different social classes.

Conclusion: The percentage of children and young adults who are obese and overweight differs by ethnic group and sex, but not by social class. British Afro-Caribbean and Pakistani girls have an increased risk of being obese and Indian and Pakistani boys have an increased risk of being overweight than the general population. These individuals may be at greater combined cumulative risk of morbidity and mortality from cardiovascular disease and so may be a priority for initiatives to target groups of children at particular risk of obesity.

Obesity in children has become a public health problem worldwide and recent trends suggest obesity is also increasing among children in the UK.^{1–3} The UK parliament recommended that initiatives to tackle obesity should target schoolchildren, lower socioeconomic groups, and ethnic minorities.⁴ There are many immediate harmful physical and psychosocial effects of obesity in children. Long term consequences include increased risks for cardiovascular disease and death that are independent of adult body weight. In the United States, obesity is rising significantly faster among African-American and Hispanic children than any other group.^{5–6} Adult British South Asians and Afro-Caribbeans are at increased risk of coronary heart disease and stroke respectively compared with Europeans. A recent report suggested that South Asian children have more biochemical risk factors for cardiovascular disease and a higher insulin resistance than White British children do.⁷ Previous studies have reported trends in growth of weight in British children are outstripping that of growth in height in all but Afro-Caribbean ethnic groups.⁸ However, defining and measuring overweight and obesity is itself problematic in children. We examined ethnic differences in prevalence of obesity and overweight among children and young adults in the UK using body mass index cut off points as defined by the International Obesity Task Force.

METHODS

The Health Survey for England is an annual survey of people living in private households in England conducted by the National Centre for Social Surveys and Research and University College London on behalf of the Department of Health. The 1999 survey focused on the health of minority ethnic groups.⁹

Sampling and data collection

Three separate samples were obtained (fig 1). Firstly, a general population sample of 6552 households was obtained

using two-stage random sampling of postcode sectors and then addresses within each sector. Second, an "ethnic boost" sample of 26 528 addresses was obtained using stratified multistage probability sampling. Additional postcode sectors were selected as primary sampling units. The sampling of postcode sectors was systematic to include a greater proportion from areas with a high percentage of minority ethnic groups. Each household in the ethnic boost sample was screened initially and only included if respondents identified themselves as belonging to an ethnic minority group. A third sample was obtained for Chinese informants by following up 569 households who took part in a Health Education Authority survey in 1998. All participating households were interviewed in full. Individuals selected the most appropriate ethnic group from the categories: "White", "Black, Caribbean", "Black, African", "Black, other", "Indian", "Pakistani", "Bangladeshi", "Chinese", and "Other". Interviewers who could speak and read the respondent's language obtained household, socioeconomic, and personal information, and information on health and health service use. Social class categories, based on occupation of the head of household, were assigned using the Registrar General's classification: I, professional occupations; II, managerial occupations; III, skilled non-manual occupations; III, skilled manual occupations; IV, partly skilled occupations; V, unskilled occupations. Parents or guardians responded for children aged below 13. Children aged 13–15 were interviewed directly with a parent present in the household. A trained nurse took anthropometric measurements including height and weight at a follow up visit soon after the interview according to survey protocols. Quality control was performed on 10% of cooperating households and found to be within acceptable limits for the Health Survey for England.

Method of analysis

We merged individual data from the ethnic boost and Chinese samples with that of the general population sample.

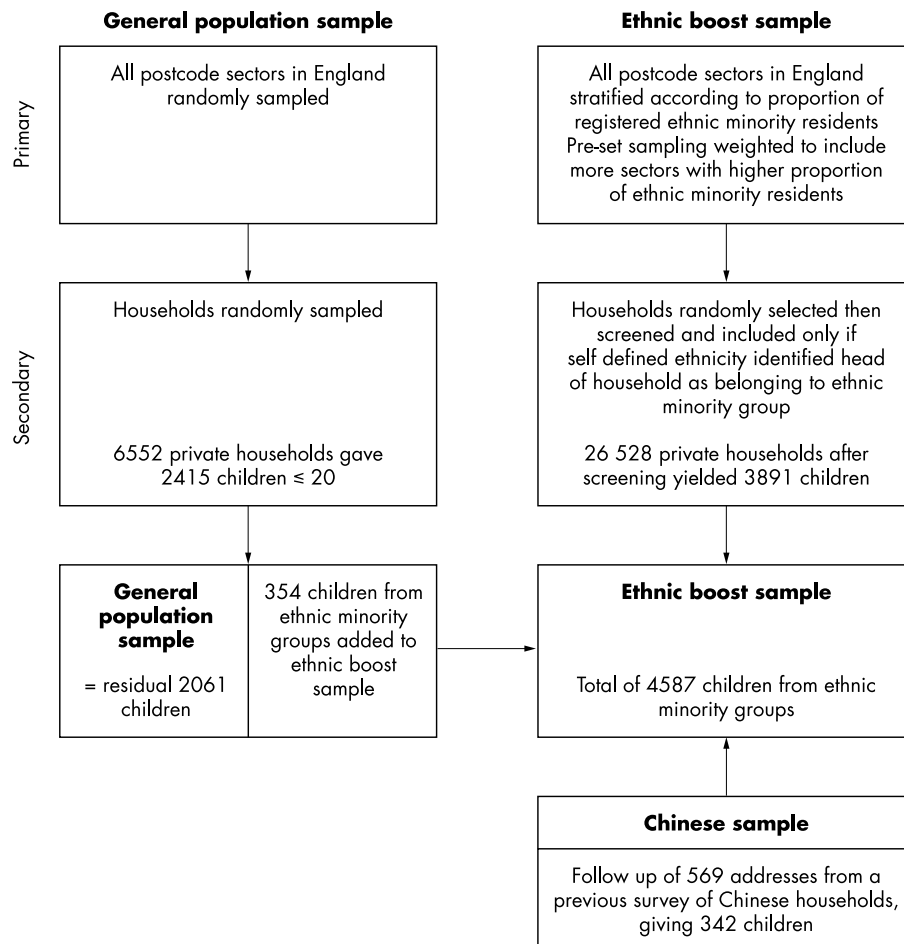


Figure 1 Sampling method for 1999 Health Survey for England focus on ethnic minorities.

We redefined ethnic group categories as: “Afro-Caribbean”, “Indian”, “Pakistani”, “Bangladeshi”, “Chinese”, and “Irish”, and all other ethnic groups together in a baseline group called “general population”. We grouped social class into four groups: I & II, III_n, III_m, IV & V.

Defining overweight and obesity in children

Adults are defined as overweight if their body mass index (BMI) exceeds 25 kg/m² and obese if their BMI exceeds 30 kg/m². These values correspond to increased morbidity and mortality from cardiovascular disease. However, no such data linked to adverse health outcomes exist for children. We used an international standard giving BMI cut off points for age and sex published by the International Obesity Task Force (IOTF; see Appendix, table A1). The IOTF charts were developed for young people by back extrapolating from the centile of body mass index corresponding to values over 25 kg/m² (overweight) and over 30 kg/m² (obese) at age 18.¹⁰ Hence, our definition of overweight includes obesity. Our data included the age of each child as an integer, so we used the mid year points from the IOTF chart to read cut off points for the outcomes. Using mid year cut off points rather than decimalising age has recently been shown not to bias prevalence rates.⁶

We examined prevalence of overweight and obesity in the sample overall and in strata according to age, sex, social class, and ethnic group. We used χ^2 tests to examine the statistical significance of such differences. We used STATA version 7 and weighted all analyses according to sampling probability. We fitted multiple logistic regression models for overweight

and obesity with age, socioeconomic status, and ethnic group as explanatory variables.

RESULTS

Household response rates were 76% in the general population and 71% in the ethnic boost sample. Interview response rates were 97% in children from the general population and 92–96% in children from ethnic minority groups, giving a total of 6648 interviews. Within this sample there were 5689 children agreeing to a follow up nurse visit. Height and weight response rates were 86% overall (5689/6648), ranging from 73% in the Bangladeshi subgroup to 89% among children in the general population. Response rates among children from the other ethnic minority groups in the survey were comparable to the overall rate. The baseline characteristics of the sample are shown in the Appendix (tables A2 and A3). Age and sex distribution was similar across the different ethnic groups except for Irish children who had a lower mean age than all other ethnic groups. However, there were differences in social class distribution between the ethnic groups with up to 33% of Bangladeshi children coming from social classes IV & V compared with a fifth of children from the general population (21%).

In the Afro-Caribbean sub group, only 13/6648 children were “Black, African”, the majority assigning themselves to “Black, Caribbean” (n = 495) or “Black, other black groups” (n = 176).

Overall, 23% (n = 1311) of children were overweight, and 6% (n = 358) of these were obese. More girls than boys were overweight (24% compared with 22%, χ^2 p = 0.03) (table 1).

Table 1 Prevalence of obesity and overweight in children and young adults in England*

Factors	n	Overweight		Obesity	
		n	%	n	%
Age group (y)					
2-4	965	208	20.8	55	5.8
5-9	1660	395	24.0	117	7.0
10-15	1841	421	23.0	95	5.6
16-20	1223	287	22.6	91	6.8
Sex					
Male	2853	612	21.5	164	5.7
Female	2836	699	24.2	194	6.8
Overall	5689	1311	22.9	358	6.3

*All survey percentages are calculated using sample weights.

We found an interaction between sex and ethnicity for overweight and obesity. Hence, we have presented results separately for girls and boys. We did not identify significant differences or gradients in the distribution of overweight or obesity by age or between social class groups. No social class gradients in overweight and obesity were seen overall or in individual strata according to age, sex, or ethnic group. We found marked differences in outcomes between the ethnic groups (tables 2 and 3). Adjusting for differences in mean height between ethnic groups in our logistic regression model made no difference to our results. Hence we have presented ethnic differences adjusted for age, sex, and social class.

Boys

Indian and Pakistani boys had the highest prevalence of overweight (30% and 26% respectively) compared with boys in the general population (22%). Indian and Pakistani boys were more likely to be overweight (odds ratios 1.55 (95% CI 1.12 to 2.17) and 1.36 (95% CI 1.01 to 1.83), respectively). In contrast, Bangladeshi and Chinese males had the lowest prevalence of overweight (14%) and were least likely to be

overweight compared with the general population (0.58 (95% CI 0.40 to 0.86) and 0.58 (95% CI 0.35 to 0.96)).

Similarly, Indian and Pakistani boys had highest prevalence (8% and 9%) of obesity. Bangladeshi boys had the lowest prevalence of obesity (3%) and were less likely to be obese (0.49, 95% CI 0.25 to 0.94).

Girls

Afro-Caribbean girls had the highest prevalence of overweight (33%), and Afro-Caribbean girls were more likely to be overweight (1.73, 95% CI 1.29 to 2.33) than girls in the general population. In contrast Chinese girls had the lowest prevalence of overweight (13%) and were less likely to be overweight than the general population (0.52, 95% CI 0.29 to 0.91).

The prevalence of obesity in Afro-Caribbean girls was twice that in the general population (13% v 6%). Afro-Caribbean and Pakistani girls were more likely to be obese than girls in the general population (2.74 (95% CI 1.74 to 4.31) and 1.71 (95% CI 1.06 to 2.76), respectively). Indian and Chinese girls were less likely to be obese than girls in the general

Table 2 Prevalence of obesity and overweight in male and female children and young adults in England by ethnic group and social class

Factors	Males					Females				
	n	Overweight		Obesity		n	Overweight		Obesity	
		n	%	n	%		n	%	n	%
Age (y)										
2-4	489	91	19.2	30	6.9	476	117	22.4	25	4.7
5-9	849	177	21.0	48	5.5	811	218	27.0	69	8.4
10-15	954	218	23.0	46	4.7	887	203	22.9	49	6.5
16-20	561	126	21.5	40	6.7	662	161	23.7	51	6.8
			p=0.46		p=0.31			p=0.21		p=0.12
Social class										
I & II	794	172	21.6	41	5.1	769	171	23.8	53	8.6
III _n	309	67	22.7	12	4.1	355	92	23.5	33	8.2
III _m	871	192	22.1	55	6.3	842	218	24.3	58	6.0
IV&V	683	141	20.5	44	6.3	659	175	26.1	44	6.2
			p=0.88		p=0.48			p=0.79		p=0.19
Ethnic group										
General population	950	206	21.7	54	5.8	916	204	22.3	54	5.8
Afro-Caribbean	322	68	22.6	16	5.1	373	119	33.3	47	13.0
Indian	304	84	29.6	23	7.9	267	64	24.0	8	2.1
Pakistani	436	110	26.2	36	9.0	458	119	25.7	38	8.0
Bangladeshi	377	66	14.2	15	2.8	335	77	20.7	23	5.8
Chinese	160	23	14.4	8	4.7	150	18	13.0	2	1.2
Irish	304	55	17.3	12	3.3	337	98	25.6	22	8.3
			p<0.0001		p<0.0001			p<0.0001		p<0.0001
Total	2853	612	21.5	164	5.7	2836	699	24.2	194	6.8

*All survey percentages are calculated using sample weights.

p values refer to χ^2 significance tests for a difference across groups.

Table 3 Odds ratios (OR) for multiple logistic regression analysis model of factors affecting prevalence of overweight and obesity in children and young adults in England

Factors	Males				Females			
	Overweight		Obesity		Overweight		Obesity	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age (continuous)	1.012	(0.997 to 1.037)	0.997	(0.961 to 1.034)	0.997	(0.979 to 1.016)	1.006	(0.977 to 1.036)
Social class								
I & II*	1		1		1		1	
III _n	1.09	(0.77 to 1.54)	0.81	(0.40 to 1.66)	0.91	(0.66 to 1.26)	0.80	(0.48 to 1.35)
III _m	1.03	(0.80 to 1.34)	1.23	(0.78 to 1.94)	1.01	(0.77 to 1.31)	0.62	(0.40 to 0.96)
IV&V	0.93	(0.70 to 1.22)	1.24	(0.77 to 2.01)	1.07	(0.81 to 1.42)	0.62	(0.39 to 1.00)
Ethnic group								
General population*	1		1		1		1	
Afro-Caribbean	1.11	(0.80 to 1.56)	0.87	(0.46 to 1.64)	1.73	(1.29 to 2.33)	2.74	(1.74 to 4.31)
Indian	1.55	(1.12 to 2.17)	1.38	(0.79 to 2.42)	1.07	(0.74 to 1.53)	0.39	(0.17 to 0.86)
Pakistani	1.36	(1.01 to 1.83)	1.53	(0.94 to 2.51)	1.22	(0.91 to 1.64)	1.71	(1.06 to 2.76)
Bangladeshi	0.58	(0.40 to 0.86)	0.49	(0.25 to 0.94)	0.99	(0.67 to 1.46)	1.25	(0.66 to 2.37)
Chinese	0.58	(0.35 to 0.96)	0.74	(0.31 to 1.77)	0.52	(0.29 to 0.91)	0.08	(0.01 to 0.56)
Irish	0.81	(0.54 to 1.20)	0.57	(0.28 to 1.17)	1.17	(0.84 to 1.63)	1.49	(0.83 to 2.68)

Odds ratios from multiple logistic regression model. All odds ratios calculated using sample weights.

*Baseline group for adjusted odds ratios for categorical variables.

population (0.39 (95% CI 0.17 to 0.86) and 0.08 (95% CI 0.01 to 0.56), respectively).

DISCUSSION

The percentage of children and young adults who are obese and overweight differs by ethnic group and sex. Within ethnic groups there are large sex differences in prevalence of overweight and obesity. Afro-Caribbean and Pakistani girls had significantly higher risks of obesity, and Indian and Pakistani boys were more likely to be overweight than children and young adults in the general population. In contrast, Indian girls and Bangladeshi boys were significantly less likely to be overweight or obese than the general population. There were no significant differences in the prevalence of obesity or overweight children in different social class groups.

Previous research

Ethnic group differences in height and weight are present within the Health Survey for England. Measures other than BMI showed that Afro-Caribbean boys were taller, and Indian, Chinese, Pakistani, and Bangladeshi boys shorter, than boys in the general population. Similarly Afro-Caribbean girls were taller, and Indian, Bangladeshi, and Chinese girls shorter, than girls in the general population. Bangladeshi boys were lighter on average, and Afro-Caribbean boys heavier on average, than boys in the general population. Afro-Caribbean girls were heavier, and Indian, Bangladeshi, and Chinese girls lighter, than girls in the general population. Mean BMI was higher for Black Caribbean boys and girls, and for Indian boys, than for children in the general population. It was lower for Bangladeshi boys.⁹

Previous studies, based on height and weight, have reported South Asian school children to be less heavy and shorter than Afro-Caribbean and White schoolchildren.⁷ Afro-Caribbean primary school age children were taller than other ethnic groups at all the ages studied and maintained their growth in height with increases in mean weight. All other ethnic groups displayed a trend towards greater obesity over the decade 1983 to 1994.⁸ Neither of these studies examined the association between obesity and socioeconomic status.

The prevalence of overweight among British children reported previously ranged from 14% to 19% in 1999 and 6% to 25% in 2001 (see Appendix, table A4). Obesity in

British children has been reported as being between 6% and 8% in 1999 and between 1% and 12% in 2001.^{1-3 11} The reason for this increase in reporting range can be accounted for by researchers using different standard cut off points in defining overweight and obesity in children. The international reference curves we used are more recent, provide prevalence rates that are comparable to the corresponding prevalence rates in adults, which the other child definitions do not, and have been used in over 30 published studies.^{10 12} Hence, this method is more useful for international comparisons to monitor the worldwide epidemic of childhood obesity and to follow up time trends in future waves of the Health Survey for England. One limitation of this method is that the six countries on which the reference curves are based do not directly reflect the ethnic mix of the UK population. However, this should not bias our estimates of obesity overall since it is the gradient of the growth curve that is taken into account rather than the absolute obesity level of the countries they represent.¹⁰

Previous research examining the relation between socioeconomic status and obesity across countries has found higher socioeconomic status subjects to be more likely to be obese in China and Russia, but in the United States, groups from lower socioeconomic status were at higher risk.¹³ Our finding of a lack of socioeconomic gradient is therefore an important one and is consistent with one study that found that poor physical fitness rather than social class and lifestyle factors is strongly related to obesity in English "white" children, though other reports have implicated dietary and lifestyle factors.^{4 14}

South Asian adults are known to have higher risks of cardiovascular disease and diabetes, and a lack of aerobic exercise. Afro-Caribbean and South Asian adults are at higher risk of stroke from hypertensive disease. We found little previous research about whether our finding of increased obesity in Afro-Caribbean girls and South Asian boys was reflected in adults of the same ethnic group. Recently, South Asian children were reported to have worse biological risk factors than European children and lower weight for height and ponderal index (kg/m^3).⁷ Indian adults have more body fat for a given BMI than other ethnic groups and the WHO has recently agreed to use a cut off of 23 and 25 rather than 25 and 30 in defining overweight and obesity among adults originating from the Indian subcontinent on the basis that they correspond to the fat mass% of ethnic Caucasians on the 25/30 cut offs.¹⁵ Hence, our findings that

Indian and Pakistani boys and Pakistani girls are more likely to be overweight are of greater concern for South Asian children in this study than for other ethnic groups such as Afro-Caribbeans.

In other areas of child and adolescent health there are socioeconomic gradients in mortality, overall health status, and for specific conditions including risks for cardiovascular diseases.^{16, 17} Other socioeconomic factors including poverty and social exclusion of families as a result of migration may act cumulatively to increase these risks.^{4, 18} In addition, we found certain ethnic groups have a sex specific risk of overweight and obesity. This may reflect culture specific ideals of body morphology around critical stages in child development and peri-pubertal development. Our findings that Indian boys are more likely to be overweight or obese but that Indian girls were markedly less likely to be overweight or obese raises questions about nutritional status in Indian girls. Although this outcome was not specifically examined, it may bear scrutiny in further study. More information about levels of physical exercise and diet is needed to assess whether children from Afro-Caribbean and some South Asian ethnic groups are at risk from environmental factors or greater genetic susceptibility. Future work could focus on familial patterns of overweight and obesity by ethnic group and provide longitudinal data about adverse outcomes.

Strengths and weaknesses of the study

Ours is among the first community based studies examining ethnic group differences in overweight and obesity. The study strengths are its large nationally representative sample, use of an objective measure (body mass index) not subject to reporting or misclassification bias as with other measures, quality and consistency of data collection, and use of multivariate analysis to adjust for potential confounding factors.

Body mass index ($\text{weight}/(\text{height})^2$) provides a more robust measure on which to base definitions of overweight and obesity than using weight or weight for height measurements alone and is useful for large epidemiological comparisons.¹⁹ Although body mass index acts as a proxy for both lean and fat mass it does not reflect body composition. A range of physiological indices can be used to measure and define obesity and overweight in children, including waist and hip circumference and subcutaneous fat measurement such as triceps skinfold thickness. However, these methods are subject to potential sources of bias due to measurement error and do not provide absolute measures of fat mass.

The WHO now recommends using lower BMI cut off points to define overweight and obesity for South Asian adults on the basis of higher percentage body fat composition for the same BMI among Caucasians. Some studies suggest that there may be ethnic group differences in body fat among infants with the same body mass index. While body mass index is a much more readily measurable index of obesity than more sophisticated methods interethnic differences in body composition could be a confounding factor in comparing obesity levels between ethnic groups. In our study higher levels of overweight and obesity in Pakistani and Indian boys are likely to underestimate their health risks on the basis of body fat alone. The mean heights of ethnic groups varied, with Afro-Caribbeans being taller and South Asians shorter than the general population. In the case of Afro-Caribbean children this may result in a higher proportion who are defined as overweight and obese. In South Asian groups who tended to be shorter than the general population, this may further underestimate levels of obesity and overweight.

Our sample only included private addresses and may underestimate refugees and the homeless. Given the scale of the study it is likely that there was some variation in the

consistency of data collection between interviewers and trained nurses responsible for recording physiological measurements. Inevitably, surveys of some ethnic groups will be subject to language and communication difficulties, which in turn may compromise the accuracy of self reported data, but not outcomes based on height and weight. The definitions of ethnicity in this study rely on self assigned categories from the pragmatic classification system devised in the 1991 Census. These categories are subject to misclassification and are constantly changing. Given that our study population is children and teenagers, the ethnic categories themselves may be relatively crude in identifying risk in subpopulations of children that may be second or even third generation ethnic minority groups. The response rate for interview was high in Bangladeshis but low for the nurse's visit (73% compared with 86% in the general population). Finally, our data are cross sectional and we therefore cannot track the consequences of overweight and obesity on individuals over time.

Policy and public health implications

Our finding that ethnic group is more important than social class as a determinant of obesity and overweight in children has enormous chronic health disease burden and cost implications. The medical treatment of obesity is difficult and has only limited success. Hence, prevention in childhood is essential to limiting the potential ill effects of the epidemic of obesity.²⁰ Policies to tackle obesity through population based measures such as promoting healthier diets and more exercise require resolve from government and other agencies across the spheres of health, transport, education, media, and culture.²¹ Large epidemiological studies of mixed ethnic groups examining prevalence of overweight and obesity should consider that the definitions of overweight and obesity might differ with ethnicity.

Conclusions

Ethnicity and sex are stronger determinants than social class of whether children are obese or overweight. British Afro-Caribbean and Pakistani girls have a significantly increased risk of being obese and Indian and Pakistani boys are more likely to be overweight than the general population. These individuals may be at greater combined cumulative risk of morbidity and mortality from cardiovascular disease, and so may be a priority for initiatives to target groups of children at particular risk of obesity.

ACKNOWLEDGEMENTS

We are grateful to the survey teams responsible for devising and carrying out the Health Survey for England and to the Essex Data Archive for providing us with these data. We thank Dr Rumana Omar for statistical advice and comments on the drafts of this paper. AM and SS conceived the original idea for the study, and planned the study with help from GA and TC. GA and SS carried out the data analysis with advice from TC. SS wrote the paper and all authors contributed their comments to drafts of the paper.

Authors' affiliations

S Saxena, A Majeed, Department of Primary Care and Population Sciences, Royal Free and University College London, Rowland Hill Street, London NW3 2PF, UK

G Ambler, Medical Statistics Unit, Research & Development Directorate, UCLH NHS Trust, London NW1 2LT, UK

T J Cole, Centre for Paediatric Epidemiology and Biostatistics, Institute of Child Health, London WC1N 1EH, UK

The Health Survey for England is funded by the Department of Health and carried out jointly with the National Centre for Social Surveys and Research and University College London. Dr Sonia Saxena holds a National Primary Care Researcher Development Award and Professor Azeem Majeed holds a National Primary Care Career Scientist Award from the NHS R&D Capacity Development Programme

APPENDIX

Table A1 presents the international cut off points for body mass index for overweight and obesity by sex between 2 and 18 years. Table A2 lists the baseline characteristics of sample

from 1999 Health Survey for England. Table A3 details the age, sex, and socioeconomic factors in children and teenagers by ethnic group. Table A4 lists published studies of prevalence rates for obesity and overweight in British children.

Table A1 International cut off points for body mass index for overweight and obesity by sex between 2 and 18 years*†

Age	Overweight		Obese	
	Body mass index 25 kg/m ²		Body mass index 30 kg/m ²	
	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
2.5	18.13	17.76	19.80	19.55
3	17.89	17.56	19.57	19.36
3.5	17.69	17.40	19.39	19.23
4	17.55	17.28	19.29	19.15
4.5	17.47	17.19	19.26	19.12
5	17.42	17.15	19.30	19.17
5.5	17.45	17.20	19.47	19.34
6	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46
10	19.84	19.86	24.00	24.11
10.5	20.20	20.29	24.57	24.77
11	20.55	20.74	25.10	25.42
11.5	20.89	21.20	25.58	26.05
12	21.22	21.68	26.02	26.67
12.5	21.56	22.14	26.43	27.24
13	21.91	22.58	26.84	27.76
13.5	22.27	22.98	27.25	28.20
14	22.62	23.34	27.63	28.57
14.5	22.96	23.66	27.98	28.87
15	23.29	23.94	28.30	29.11
15.5	23.60	24.17	28.60	29.29
16	23.90	24.37	28.88	29.43
16.5	24.19	24.54	29.14	29.56
17	24.46	24.70	29.41	29.69
17.5	24.73	24.85	29.70	29.84
18	25	25	30	30

*Adapted from Cole *et al.*¹²

†Defined to pass through body mass index of 25 and 30 kg/m² at age 18, obtained by averaging data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and the United States.

Table A2 Baseline characteristics of sample from 1999 Health Survey for England

Characteristic	n (%)
Age group (y)	
2-4	1253 (18.9)
5-9	1901 (28.6)
10-15	2103 (31.6)
16-20	1391 (20.9)
Sex	
Male	3358 (50.5)
Female	3290 (49.5)
Social class	
I	356 (5.4)
II	1406 (21.2)
III _n	783 (11.8)
III _m	2008 (30.2)
IV	1373 (20.7)
V	214 (3.2)
Unemployed	402 (6.1)
Other	98 (1.5)
Ethnic group	
General population	2061 (31.0)
Afro-Caribbean	807 (12.1)
Indian	668 (10.1)
Pakistani	1060 (15.9)
Bangladeshi	974 (14.7)
Chinese	342 (5.1)
Irish	736 (11.1)

Table A3 Age, sex, and socioeconomic factors in children and teenagers by ethnic group; data from 1999 Health Survey for England

Ethnic group	General population	Afro-Caribbean	Indian	Pakistani	Bangladeshi	Chinese	Irish	p value
% Boys	51	47	56	49	51	51	47	0.100*
Mean age (SE)	10.5 (0.12)	10.0 (0.19)	10.6 (0.22)	9.9 (0.18)	10.0 (0.21)	10.7 (0.28)	9.4 (0.21)	0.03†
Social class, n (%)								
I	148 (7.4)	21 (2.7)	64 (8.0)	47 (4.8)	11 (2.1)	29 (9.0)	36 (6.8)	0.001*
II	558 (26.3)	156 (18.9)	159 (20.0)	134 (13.0)	57 (7.1)	99 (27.5)	243 (31.7)	
III _n	264 (12.9)	183 (21.9)	62 (10.2)	72 (6.4)	59 (6.5)	49 (15.6)	94 (14.6)	
III _m	626 (30.5)	176 (22.4)	184 (30.1)	405 (40.0)	305 (35.2)	102 (30.9)	210 (29.1)	
IV	316 (15.6)	182 (23.6)	157 (25.8)	237 (20.8)	339 (30.4)	26 (7.2)	116 (13.8)	
V	79 (4.0)	30 (4.1)	14 (2.3)	24 (2.3)	38 (3.2)	10 (2.9)	19 (1.7)	

* χ^2 for significance testing of differences across groups.

†Wald test.

Table A4 Previously published studies of prevalence rates for obesity and overweight in British children

Author, publication date	Study population	Sample size	Prevalence of overweight, %		Prevalence of obesity, %		Standard used (reference no.)
			Males	Females	Males	Females	
Reilly, 1999	Avon 1991–92 birth cohort, aged 2 years	1031	13.9	18.1	5.9	6.2	12
Reilly, 1999	Aged 5.5 years	972	18.2	19.3	8.1	6.1	12
Bundred, 2001	Wirral 1998, under 4 years	2633	25	24	8	11	12
Chinn, 2001	White primary schoolchildren, aged 4–11 years						
	England 1974	8010	6.4	9.1	1.4	1.5	10
Chinn, 2001	England 1984	6267	5.4	9.3	0.6	1.3	10
Chinn, 2001	England 1994	5874	9.0	13.5	1.7	2.6	10
Rudolf, 2001	England 1994	975	22	22	12	11	12

REFERENCES

- Chinn S, Rona RJ. Prevalence and trends in overweight and obesity in three cross sectional studies of British children, 1974–94. *BMJ* 2001;**322**:24–6.
- Bundred P, Kitchiner D, Buchan I. Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *BMJ* 2001;**322**:326.
- Reilly JJ, Dorosty AR, Emmett PM. Prevalence of overweight and obesity in British children: cohort study. *BMJ* 1999;**319**:1039.
- The Committee of Public Accounts. *The Ninth Report of the Committee of Public Accounts: Tackling obesity in England*. London: HMSO, 2001.
- Strauss RS, Pollack HA. Epidemic increase in childhood overweight, 1986–1998. *JAMA* 2001;**286**:2845–8.
- Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA* 2002;**288**:1723–7.
- Whincup PH, Gilg JA, Papacosta O, et al. Early evidence of ethnic differences in cardiovascular risk: cross sectional comparison of British South Asian and white children. *BMJ* 2002;**324**:635.
- Chinn S, Hughes JM, Rona RJ. Trends in growth and obesity in ethnic groups in Britain. *Arch Dis Child* 1998;**78**:513–17.
- Office for National Statistics. *Health Survey for England: the health of minority ethnic groups '99*. London: HMSO, 1999.
- Cole TJ, Bellizzi MC, Flegal KM, et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;**320**:1240.
- Rudolf MCJ, Sahota P, Barth JH, et al. Increasing prevalence of obesity in primary school children: cohort study. *BMJ* 2001;**322**:1094–5.
- Cole TJ, Freeman JV, Preece MA. British 1990 growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood. *Stat Med* 1998;**17**:407–29.
- Wang Y. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *Int J Epidemiol* 2001;**30**:1129–36.
- Kikuchi S, Rona RJ, Chinn S. Physical fitness of 9 year olds in England: related factors. *J Epidemiol Community Health* 1995;**49**:180–5.
- Mehta S, Mahajan D, Steinbeck KS, et al. Relationship between measures of fatness, lipids and ethnicity in a cohort of adolescent boys. *Ann Nutr Metab* 2002;**46**:192–9.
- Starfield B, Robertson J, Riley AW. Social class gradients and health in childhood. *Ambul Pediatr* 2002;**2**:238–46.
- Starfield B, Riley AW, Witt WP, et al. Social class gradients in health during adolescence. *J Epidemiol Community Health* 2002;**56**:354–61.
- Bhopal R. Epidemic of cardiovascular disease in South Asians. *BMJ* 2002;**324**:625–6.
- Freeman JV, Power C, Rodgers B. Weight-for-height indices of adiposity: relationships with height in childhood and early adult life. *Int J Epidemiol* 1995;**24**:970–6.
- Campbell K, Waters E, O'Meara S, et al. Interventions for preventing obesity in children (Cochrane Review). *Cochrane Database Syst Rev* 2001;**3**:CD001871.
- Crawford D. Population strategies to prevent obesity. *BMJ* 2002;**325**:728–9.