ORIGINAL ARTICLE

Overweight and obesity trends from 1974 to 2003 in English children: what is the role of socioeconomic factors?

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Aims: To examine the childhood overweight and obesity prevalence trends between 1974 and 2003 and to assess whether these trends relate to parental social class and household income.
Methods: A school based and a general population health survey: the National Study of Health and Growth in 1974, 1984, and 1994, and the Health Survey for England, yearly from 1996 to 2003. Participants were 14 587 white boys and 14 014 white girls aged 5–10 years. Overweight and obesity prevalence were calculated using UK specific as well as international body mass index (kg/m^2) cut-offs. Socioeconomic status was measured using the Registrar General's social class; household income (1997 onwards only) was adjusted for household size.
Results: The prevalence of obesity (UK specific definition) in boys increased from 1.2% in 1984 to 3.4% in 1996–97 and 6.0% in 2002–03. In girls, obesity increased from 1.8% in 1984 to 4.5% in 1996–97 and 6.6% in 2002–03. Obesity prevalence has been increasing at accelerating rates in the more recent years. Children from manual social classes had marginally higher odds (OR 1.14, 95% CI 0.98 to 1.33) and children from higher income households had lower odds (OR 0.74, 95% CI 0.61 to 0.89) to be obese than their peers from non-manual class, and lower income households, respectively.
Conclusion: Childhood obesity is increasing rapidly into the 2000s in England and these increases are more marked among children from lower socioeconomic strata. There is an urgent need for action to prevent further increase in obesity among children.

Data from the Health Survey for England[1 2] and the Dietary and Nutritional Survey[3] show that adult overweight and obesity have increased markedly over the last two decades. Despite the use of different methods to define childhood obesity, numerous studies have shown that increases occurred also among British children.[4–8] This is of great public health concern as excess adiposity at a young age is linked to numerous immediate and long term health risks, including increased risk for asthma[9] and type II diabetes,[10] persistence of the condition into adulthood,[11 12] and increased middle age mortality and morbidity regardless of adult weight status.[13–15]

Socioeconomic status (SES) has been found to relate to the risk of obesity in adults.[16–18] Individuals from lower socioeconomic strata may have diets rich in low cost energy dense foods,[19 20] participate less in sports[21] or physical activity in general,[22] and have lower weight control awareness.[23] Lower SES is linked to lower control over one's life and this does not encourages the adoption of healthy lifestyles for a given individual and their children.[24] However, it is unclear whether parental socioeconomic circumstances affect children's risk for obesity at a young age as highlighted in the review by Sobal and Stunkard[25] and by other results where SES was found to be inversely related[26 27] or not related[28 29] to childhood obesity in Britain. If a link between parental SES and childhood obesity exists, the new anti-obesity policy initiatives and public health interventions will need to target children from the most vulnerable SES groups.

The aim of this study is to provide an update on the most recent prevalence trends of overweight and obesity among British children and to investigate the role of parental SES in the risk for developing the condition. Anthropometric data from the 1970s provided the opportunity to examine whether obesity changed at different rates for children from different social class backgrounds. Our hypothesis was that overweight and obesity prevalence have been increasing at a faster rate among children from lower SES groups.

METHODOLOGY

Participants

Data for this study come from 28 601 children aged 5–10 years participating in two health surveys: the National Study of Health and Growth (NSHG) in 1974, 1984, and 1994, and the Health Survey for England (HSE) from 1996 to 2003 (yearly). The NSHG sample was selected via state primary schools in England and Scotland.[4] In this analysis we included only English children. NSHG areas were selected by stratified random sampling and schools were then selected within these areas. In most years around 95% of children[30] in included schools were measured for height and weight. The Health Survey for England draws every year a representative sample of the general population using multi-stage stratified probability sampling, with postcode sectors as primary sampling units and the Postcode Address File as the sampling frame for households. Interviewer response rates for children in HSE varied between 75% and 85%, depending on the survey year. Among cooperating households, height and weight measurements were obtained from around 90–95% of eligible children, depending on the survey year. Both surveys had relatively low numbers of non-white children, so only white children were included in this analysis.

Ethical approval

Ethical approval had been granted by the London Medical Research Ethics Council and/or local research ethics councils prior to each annual data collection cycle of the HSE. When the NSHG began in 1972 a system of ethical committees for community based studies had not been established, but the

Table 1 Overweight and obesity prevalence (95% CI), for boys and girls aged 5–10 between 1974 and 2002–03 (UK specific definition)

	1974	1984	1994	1996–97	1998–99	2000–01	2002–03
Boys aged 5–7 years							
n	1582	1238	1278	1053	538	449	839
% overweight	12.4 (10.8 to 14.0)	9.4 (7.7 to 11.0)	9.9 (8.3 to 11.6)	14.1 (12.0 to 16.2)	17.3 (14.1 to 20.5)	16.5 (13.0 to 19.9)	18.5 (15.8 to 21.1)
% obese	1.9 (1.2 to 2.6)	1.2 (0.6 to 1.8)	1.7 (1.0 to 2.4)	2.5 (1.5 to 3.4)	3.7 (2.1 to 5.3)	3.1 (1.5 to 4.7)	5.2 (3.7 to 6.8)
Boys aged 8–10 years							
n	1909	1436	1287	1036	535	456	951
% overweight	10.4 (9.1 to 11.8)	10.1 (8.5 to 11.7)	15.5 (13.6 to 17.5)	18.4 (16.1 to 20.8)	22.1 (18.5 to 25.6)	26.8 (22.7 to 30.8)	26.3 (23.5 to 29.1)
% obese	1.8 (1.2 to 2.4)	1.1 (0.6 to 1.7)	3.1 (2.2 to 4.1)	4.3 (3.1 to 5.6)	5.6 (3.7 to 7.6)	8.1 (5.6 to 10.6)	6.7 (5.1 to 8.3)
Boys total (5–10 years)							
n	3491	2674	2565	2089	1073	905	1790
% overweight	11.3 (10.3 to 12.4)	9.8 (8.6 to 10.9)	12.7 (11.5 to 14.0)	16.2 (4.6 to 7.8)	19.7 (17.3 to 22.0)	21.7 (19.0 to 24.3)	22.6 (20.7 to 24.6)
% obese	1.8 (1.4 to 2.3)	1.2 (0.8 to 1.6)	2.4 (1.8 to 3.0)	3.4 (2.6 to 4.2)	4.7 (3.4 to 5.9)	5.6 (4.1 to 7.1)	6.0 (4.9 to 7.1)
Girls aged 5–7 years							
n	1460	1137	1212	1060	527	461	809
% overweight	9.0 (7.6 to 10.5)	8.2 (6.6 to 9.8)	11.4 (9.6 to 13.2)	14.9 (12.8 to 17.0)	15.9 (12.8 to 19.1)	16.9 (13.5 to 20.3)	20.0 (17.3 to 22.8)
% obese	1.0 (0.5 to 1.5)	1.1 (0.5 to 1.6)	2.3 (1.5 to 3.2)	3.8 (2.6 to 4.9)	4.4 (2.6 to 6.1)	3.9 (2.1 to 5.7)	5.6 (4.0 to 7.1)
Girls aged 8–10 years							
n	1842	1377	1213	1051	476	496	893
% overweight	10.1 (8.7 to 11.5)	11.5 (9.8 to 13.2)	17.3 (15.2 to 19.4)	20.1 (17.7 to 22.5)	22.7 (18.9 to 26.5)	27.8 (23.9 to 31.8)	27.1 (24.2 to 30.0)
% obese	1.6 (1.0 to 2.1)	2.4 (1.6 to 3.2)	3.1 (2.2 to 4.1)	5.3 (4.0 to 6.7)	6.3 (4.1 to 8.5)	6.5 (4.3 to 8.6)	7.6 (5.9 to 9.4)
Girls total (5–10 years)							
n	3302	2514	2425	2111	1003	957	1702
% overweight	9.6 (8.6 to 10.6)	10.0 (8.8 to 11.2)	14.4 (13.0 to 15.7)	17.5 (15.9 to 19.1)	19.1 (16.7 to 21.6)	22.6 (19.9 to 25.2)	23.7 (21.7 to 25.8)
% obese	1.3 (0.9 to 1.7)	1.8 (1.3 to 2.3)	2.7 (2.1 to 3.4)	4.5 (3.7 to 5.4)	5.3 (3.9 to 6.7)	5.2 (3.8 to 6.6)	6.6 (5.5 to 7.8)

coordinators at the time obtained ethical approval from St Thomas' Hospital Medical Ethics Committee. Participation of schools was agreed with the health and education authorities in each selected area, and with the head teacher. Parents were notified of the study in advance and were able to withdraw their child from measurement.

Physical measurements

Exact age was used to calculate prevalence rates but age was rounded to the nearest integer and grouped for the presentation of the results. Height and weight in the NSHG and the HSE were measured by a school nurse and an interviewer, respectively, using the same standard protocols. The NSHG used Holtain (Holtain, Crymych, Dyfed, UK), and the HSE used Chasmors (Chasmors Ltd, London, UK) stadiometers to measure height. In all HSE years and 1994 NSHG weight was measured by electronic digital scales (beam balances were used by the NSHG in 1974 and 1984). Children were weighed wearing only underpants in the NSHG, while in the HSE informants were asked to remove only shoes, accessories, and heavy clothing items. Children's weights in HSE have been adjusted for clothing,[31] giving estimated unclothed weights comparable with those of NSHG.

Socioeconomic status measures

The occupation of the head of the household determined children's social class. In HSE this information was collected during the interviews with the head of the household. In the NSHG this information was collected by parental self-competed questionnaires that were taken home by the child or posted, and returned in a closed envelope by the child or posted. We used the Registrar-General's classification in this report. Household income (adjusted for household size) was available for HSE years from 1997 onwards. Income information was also collected during the interviews with the children's parents. Income information was available for NSHG 1974 but it was not possible to categorise it in the same way as in the HSE as it was reported in broad categories.

Overweight and obesity measures

Body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2). Overweight and obesity rates were computed using a set of age and sex specific BMI cut-off points[32] based on the UK 1990 BMI reference data.[33] These BMI cut-off points were developed using the same method as the international BMI cut-offs[34] but used UK specific data and correspond to the adult BMI cut-offs of 25 and 30 kg/m^2 at age 19.5 (as opposed to the international standards which are based on the averaged and smoothed BMI curves of six countries and correspond to the adult BMI cut-offs at age 18). Confirmatory analyses of the overweight and obesity prevalence trends were performed using international standards.

Statistical analysis

HSE years were merged in pairs (1996–97; 1998–99; 2000–01; 2002–03) to increase statistical power at each time point. We computed the sex and age specific (5–7 years and 8–10 years) prevalence of overweight (including obesity) and obesity at each time point between 1974 and 2002–03 for the entire population, and by social class. Social classes based on occupations are unstable over time in relation to each social class but

Table 2 Overweight and obesity prevalence (95% CI), for boys and girls aged 5–10 between 1974 and 2002–03 (international definition)

	1974	1984	1994	1996–97	1998–99	2000–01	2002–03
Boys aged 5–7 years							
n	1582	1238	1278	1053	538	449	839
% overweight	7.6 (6.3 to 9.0)	5.5 (4.2 to 6.8)	6.4 (5.1 to 7.8)	9.6 (7.8 to 11.4)	11.2 (8.5 to 13.8)	11.6 (8.6 to 14.5)	13.7 (11.4 to 16.0)
% obese	1.3 (0.7 to 1.8)	0.6 (0.2 to 1.1)	1.4 (0.8 to 2.1)	1.9 (1.1 to 2.7)	2.4 (1.1 to 3.7)	2.7 (1.2 to 4.2)	4.1 (2.7 to 5.4)
Boys aged 8–10 years							
n	1909	1436	1287	1036	535	456	951
% overweight	6.2 (5.1 to 7.3)	5.9 (4.7 to 7.1)	10.8 (9.1 to 12.5)	13.0 (11.0 to 15.1)	15.9 (12.8 to 19.0)	18.6 (15.1 to22.2)	18.8 (16.3 to 21.3))
% obese	0.9 (0.5 to 1.4)	0.5 (0.1 to 0.8)	1.9 (1.1 to 2.6)	3.3 (2.2 to 4.4)	3.4 (1.8 to 4.9)	5.9 (3.8 to 8.1)	5.2 (3.7 to 6.6)
Boys total (5–10 years)							
n	3491	2674	2565	2089	1073	905	1790
% overweight	6.9 (6.0 to 7.7)	5.7 (4.8 to 6.6)	8.6 (7.5 to 9.7)	11.3 (9.9 to 12.7)	13.5 (11.5 to 15.6)	15.1 (12.8 to 17.5)	16.4 (14.7 to 18.1)
% obese	1.1 (0.7 to 1.4)	0.6 (0.3 to 0.8)	1.6 (1.1 to 2.1)	2.6 (1.9 to 3.3)	2.9 (1.9 to 3.9)	4.3 (3.0 to 5.6)	4.6 (3.7 to 5.6)
Girls aged 5–7 years							
n	1460	1137	1212	1060	527	461	809
% overweight	9.4 (7.9 to 10.9)	8.4 (6.8 to 10.1)	11.8 (10.0 to 13.6)	15.5 (13.3 to 17.6)	16.7 (13.5 to 19.9)	17.6 (14.1 to 21.0)	20.5 (17.7 to 23.3)
% obese	1.4 (0.8 to 2.0)	1.1 (0.5 to 1.8)	2.6 (1.7 to 3.4)	4.6 (3.4 to 5.9)	4.7 (2.9 to 6.6)	5.0 (3.0 to 7.0)	6.6 (4.8 to 8.3)
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% overweight	9.4 (8.1 to 10.7)	11.1 (9.5 to 12.8)	15.7 (13.7 to 17.8)	19.3 (16.9 to 21.7)	21.4 (17.7 to 25.1)	26.0 (22.1 to 29.9)	25.8 (22.9 to 28.6)
% obese	1.4 (0.8 to 1.9)	2.0 (1.3 to 2.8)	3.2 (2.2 to 4.2)	5.3 (4.0 to 6.7)	6.1 (3.9 to 8.2)	6.5 (4.3 to 8.6)	7.1 (5.4 to 8.7)
Girls total (5–10 years)							
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% overweight	9.4 (8.4 to 10.4)	9.9 (8.7 to 11.1)	13.8 (12.4 to 15.1)	17.4 (15.8 to 19.0)	18.9 (16.5 to 21.4)	21.9 (19.3 to 24.6)	23.3 (21.3 to 25.3)
% obese	1.4 (1.0 to 1.8)	1.6 (1.1 to 2.1)	2.9 (2.2 to 3.6)	5.0 (4.0 to 5.9)	5.4 (4.0 to 6.8)	5.7 (4.3 to 7.2)	6.8 (5.6 to 8.0)

stable over time in relation to the non-manual and manual contrast: the classification of occupations is modified every 10 years before the census. Some occupations disappear over time, others are newly created, and others decrease or increase status according to new technology. Thus each social class includes a different but overlapping set of units of occupations. In contrast, it is less likely that an occupation will be reclassified from manual to non-manual or vice versa. For this reason, social class was dichotomised into non-manual (I, II, IIINM) and manual (IIIM, IV, V). Since household income data were not available for all years, prevalence trends by income were examined between 1997, 1998–99, 2000–2001, and 2002–03. For this analysis we compared the bottom 50% (lower income group) with the top 50% (higher income group) of the income distribution, using the internal 50th centile as a cut-off for each HSE year. The relation of overweight and obesity with time point, sex, age group, and social class were tested by multiple logistic regression where obesity or overweight were the binary dependent variables. The effect of social class on the prevalence trend was tested by examining both the linear and quadratic interactions between social class and time point. We also examined the linear and quadratic interactions between time point and sex, and time point and age group. As income data were only available from 1997 onwards, we ran a separate logistic regression model to examine the relation between overweight and obesity with income and time point, and the linear and quadratic interactions of income with time point.

RESULTS

A total of 14 587 boys and 14 014 girls had a valid BMI. Of those, 87% of both boys (n = 12692) and girls (n = 12178) had valid parental occupation information and were included in the analysis by social class. Analyses by income included 4729 boys and 4698 girls measured in 1997 or later with a valid BMI and valid household income information. There were no significant differences in sex distribution, mean age, or mean BMI between those with valid BMI and the sub-samples with valid SES indicators that were included in the analyses.

Table 1 presents the overweight and obesity prevalence rates by sex, age group, and survey year(s). While no or little change in the prevalence of overweight and obesity was seen over the period 1974–84 in either sex, the increase since 1984 has been more marked, especially from 1994 onwards. Overall, the prevalence of obesity in boys increased from 1.2% in 1984 to 3.4% in 1996–97 and 6.0% in 2002–03. In girls, obesity increased from 1.8% in 1984 to 4.5% in 1996–97 and 6.6% in 2002–03. Repeating the same analysis using the international classification standards did not change the upward trend but, as previously reported,[4 35] increased the differences between boys and girls which were statistically significant at all time points. Table 2 presents the overweight and obesity prevalence trends over the same time period using the international classification standards.

Increases in both overweight and obesity prevalence rates were significantly different from 1974 to 1984 onwards, as shown by the odds ratios and 95% confidence intervals presented in table 3. Children's odds to be overweight in 2002–03 were over two and a half times higher than in 1974 and the odds to be obese in 2002–03 were over four times higher than in 1974. Children aged 8–10 had significantly higher odds to be

Table 3 Mutually adjusted odds ratios and 95% confidence intervals for overweight and obesity for time point, social class, sex, and income group

		Overweight			Obesity		
			95% CI			95% CI	
	n	OR	Lower	Upper	OR	Lower	Upper
Year		**(p<0.001)**			**(p<0.001)**		
1974*	5595	1	–	–	1	–	–
1984	4171	1.02	0.89	1.17	1.02	0.73	1.42
1994	3919	1.44	1.27	1.64	1.77	1.31	2.39
1996–97	4018	1.80	1.59	2.04	2.62	1.99	3.46
1998–99	2013	2.13	1.85	2.46	3.37	2.49	4.56
2000–01	1782	2.54	2.20	2.93	3.65	2.68	4.95
2002–03	3372	2.67	2.36	3.01	4.25	3.25	5.55
Social class		(p=0.133)			(p=0.080)		
Non-manual*	11299	1	–	–	1	–	–
Manual	13571	1.05	0.98	1.13	1.14	0.98	1.33
Sex		(p=0.310)			**(p=0.047)**		
Boys*	12692	1	–	–	1	–	–
Girls	12178	1.04	0.97	1.11	1.15	1.00	1.32
Age group		**(p<0.001)**			**(p<0.001)**		
5–7 years*	11829	1	–	–	1	–	–
8–10 years	13041	1.39	1.30	1.49	1.49	1.29	1.72
Household income†‡		(p=0.466)			**(p=0.002)**		
Lower*	4729	1	–	–	1	–	–
Higher	4698	0.96	0.87	1.07	0.74	0.61	0.89

*Reference category.
†Lower: up to the 50th centile; higher: over the 50th centile.
‡Income category odds were calculated in a separate logistic regression model using data from 1997, 1998–99, 2000–01, and 2002–03 only.

overweight and obese than children aged 5–7. Both sex and social class showed associations with obesity prevalence that were of borderline statistical significance: girls' odds to be obese were higher than boys' (OR 1.15, 95% CI 1.00 to 1.32, p = 0.05), and children from manual classes had higher odds than children from non-manual classes (OR 1.14, 95% CI 0.98 to 1.33, p = 0.08). The interactions between time point and social class, and time point and sex were not significant. The interaction between age group and time point was significant for the prevalence of overweight (but not obesity), with children aged 8–10 showing significantly faster rates of increase than children aged 5–7 (p < 0.001). Although the interaction of income group and time was not significant, the odds for obesity were significantly higher among children from lower income households than among children from higher income households (table 3 and fig 1).

All logistic regression analyses were repeated using the international BMI classification standards[34] to calculate overweight and obesity prevalence. As expected, sex was significantly associated with both overweight and obesity prevalence, with the odds being higher among girls (p < 0.0001). However, all other results were similar to those obtained using the National BMI cut-offs (data not shown).

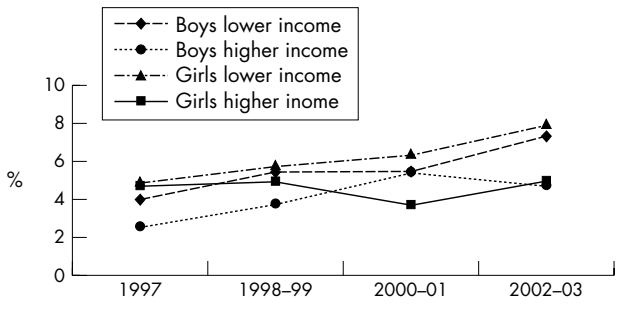

Figure 1 Obesity prevalence trends from 1997 to 2002–03 by income category and sex. Lower income: bottom 50% of income distribution of each individual year; higher income: top 50% of income distribution of each individual year.

DISCUSSION

These results showed that the upward trends in overweight and obesity in children noted by other authors[4–7] over the 1990s are continuing into the 2000s and, more alarmingly, that the rate of increase has accelerated over the last decade. Evidence for an accelerated trend for children of a similar age (7–11 years) was first reported by Lobstein and colleagues[5] using HSE 1998 data and comparing them with already published NSHG figures from 1974, 1984, and 1994. In our study, the obesity prevalence change for boys was an average increase of 0.03 percentage points per annum (pppa) for the period 1974–94 and of 0.44 pppa for the period 1996–97 to 2002–03. For girls, the average annual rate increased from 0.07 pppa for the period 1974–94 to 0.35 pppa for the period 1996–97 to 2002–03. These figures represent a 15-fold and 5-fold increase in the average annual rates of change for boys and girls, respectively. Our results show that a recently publicised report,[36] that was based on mean BMI and mean weight trends, was misleading in claiming that there is no increase in childhood obesity in England. Our data show that the sharp upward trend is independent of the obesity definition used as both the UK specific and the international definitions confirmed this.

Other studies have shown that while family social class at birth[37] and in infancy[38] have a long term effect on BMI, the relation seems to be less clear during childhood and adolescence.[39] We showed an association of borderline significance between parental social class and obesity among this population of 5–10 year olds, but a rapid upward overall trend in recent years, especially among children from lower income households, as shown in fig 1. Regardless of the differences in the magnitude of the correlations, the overall results for social class parallel those for income as shown in

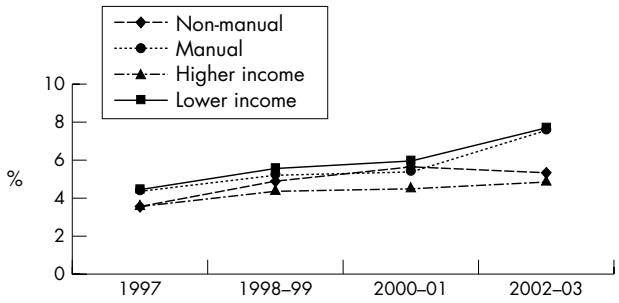

Figure 2 Obesity prevalence trends from 1997 to 2002–03 by income group and social class for boys and girls combined. Lower income: bottom 50% of income distribution of each individual year; higher income: top 50% of income distribution of each individual year.

fig 2. Obesity among children from manual classes and children from lower income households seems to be increasing more rapidly than among children from non-manual classes and higher income households, respectively. This similarity in trends is not explained by the inter-correlation between income and social class variables as the correlation coefficient was of moderate to low magnitude only (Spearman's rho = 0.37) and their interaction was non-significant. These results suggest that both material deprivation and other early social influences such as parental occupation are closely related to the development of obesity in childhood. In the case of income, it may be that the availability of healthy food is a mediator, since financial constraints may be the main obstacle with regard to access to a healthy diet.[20 40] The different magnitude of the relations between obesity prevalence and the two SES indicators suggests that income may be a more sensitive indicator of socioeconomic status than social class. Income based indices have been previously found to outperform occupation based ones in predicting health related outcomes.[41]

One of the limitations of this study is that the slightly different methodologies and sampling procedures between HSE and NSHG may partly account for the differences observed over time, and especially the sharp increase in prevalence between 1994 (last NSHG point) and 1996–97 (first HSE point). However, these increases continued the upward trend already found between the mid-1980s and the mid-1990s in the NSHG. Another limitation of this study lies in the reliance on BMI to calculate overweight and obesity: although BMI's components are highly repeatable in survey conditions, BMI is a poor proxy measure of obesity in childhood[42 43] as it does not measure fat directly. This may provide an explanation for the constant overweight and obesity prevalence from 1974 to 1984 and the relatively small increases between 1984 and 1994, when visually children were clearly getting fatter. This can been attributed to the failure of BMI to detect a shift from muscle to fat over the period, as children may have became both fatter and probably less active since weight was relatively unaffected.[44 45]

These data suggested that social class and especially income inequalities should be tackled, and interventions aimed at relieving economic hardship may reduce the risk of behaviours damaging health from childhood. The World Health Organisation's[40] general recommendations to combat childhood obesity include the promotion of active lifestyles, the restriction of television viewing, the promotion of fruit and vegetable consumption, and the restriction of energy dense and sugary foods and drinks. Future research should provide more information on the effectiveness of specific public health interventions to combat childhood obesity in Britain and on the mechanisms of how lower income and social class may influence obesity among children.

What is already known on this topic

- Childhood obesity in England increased through the 1980s and 1990s
- The role of parental socioeconomic status in childhood obesity is unclear

What this study adds

- Childhood obesity prevalence is increasing at accelerating rates through the 2000s
- Obesity increases are more pronounced among boys and girls from lower income and manual occupation households

In conclusion, this is the first study to our knowledge to report on the long term and most recent overweight and obesity prevalence trends using both UK specific and international obesity classification standards, as well as multiple SES indicators. Obesity rates among both boys and girls increased at accelerating rates into the early 2000s and these upward trends were more marked among children from lower income families and to a lesser extent among children from manual social classes. Considering the calamitous consequences of obesity, there is an urgent need for action to halt and reverse this rapid upward trend among English children, especially among those from lower socioeconomic strata.

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