Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies

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Abstract

Objective To determine trends in weight, height, and body mass index in children between 1989 and 1998.
Design Retrospective series of cross sectional studies of routinely collected data.
Setting Primary care in the Wirral Health Authority.
Participants 35 662 infants aged 1-3 months (representing 88% of live births) and 28 768 children aged 2.9-4.0 years. 21 582 infants and children (25.1%) were excluded because of missing or inaccurate data.
Main outcome measures Weight, height, sex, and age routinely recorded by health visitors. Height, weight, and body mass index standardised for age and sex. SD score >1.04 for body mass index (>85th centile) was defined as overweight and >1.64 (>95th centile) as obese. Body mass index was not calculated in infants as it is difficult to interpret.
Results From 1989 to 1998 there was a highly significant increasing trend in the proportion of overweight children (14.7% to 23.6%; P<0.001) and obese children (5.4% to 9.2%; P<0.001). There was also a highly significant increasing trend in the mean SD score for weight (0.05 to 0.29; P<0.001) and body mass index (−0.15 to 0.31; P<0.001) but not height. Infants showed a small but significantly increasing trend in mean SD score for weight (−0.17 to −0.05; P=0.005).
Conclusions From 1989 to 1998 there was a highly significant increase in weight and body mass index in children under 4 years of age. Routinely collected data are valuable in identifying anthropometric trends in populations.

Introduction

The increased number of overweight and obese children has been highlighted in a cohort study of British children examined at 24, 49, and 61 months of age.[1] We describe similar findings in a large population based study, in which data were obtained from measurements routinely performed by health visitors as part of the 6 week and preschool assessment. We examined trends in weight, height, and body mass index in a defined population between 1989 and 1998.

Participants and methods

Health visitors in the Wirral Health Authority of the North West region review children regularly, and routinely collected data are stored on computer. These data include weight (in grams), height (in centimetres), date of birth, and date of the examination. Data from the 6 week and preschool assessments for the years 1989 to 1998 were transferred to spreadsheet and statistical software for analysis. For the 6 week assessment we included only infants aged between 28 and 90 days. For the preschool assessment we included children between 2 years 11 months and 4 years of age.

The study population consisted of 35 662 infants and 28 768 children. Records of 21 582 infants and children (25%) were removed because of missing or inaccurate data: in 13 240 (15%) full data were not recorded; in 930 (1%) the weight or height was more than 5 SD from the mean and was therefore considered inaccurate; and in 7412 (9%) the age recorded did not match the age calculated from the date of examination and the date of birth. As the date of birth was available for all infants, it was possible to calculate the number of infants studied in relation to the live birth rate for the area. The year 1998 was excluded as some infants born late in this year will have been measured in 1999. For the years 1989 to 1997 there were 37 292 live births in the Wirral Health Authority area; of these we included 32 655 (88%) in our study.

We calculated the body mass index for preschool children using the formula (weight (kg)/height (m)^2). This was not done for infants aged 1 to 3 months as it is difficult to interpret body mass index at this age. The height, weight, and body mass index were standardised for age and sex with the British growth reference charts[2 3] and the conversion programme obtained from the Child Growth Foundation.[4] The resulting standard deviation (SD) scores were used in all calculations. An SD score of 0 represents the 50th centile, 1.04 represents the 85th centile, and 1.64 the 95th centile. An SD score >1.04 for body mass index (>85th centile)[1 5] was defined as overweight and >1.64 (>95th centile) as obese.

Statistical analysis

StatsDirect software was used for all statistical calculations.[6] We considered calculated probabilities of <0.05 to be significant and <0.001 to be highly

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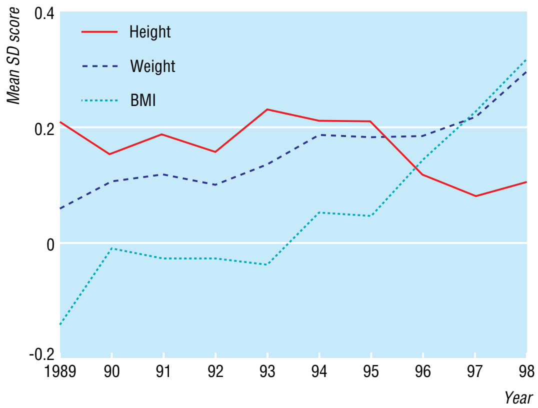

Fig 1 Mean SD scores for weight, height, and body mass index plotted against year of measurement for children aged 2.9 to 4 years. Increasing trend in scores significant for weight and body mass index but not for height (Pearson's correlation (95% CI) and P for *r*=0 (weighted): 0.94 (0.77 to 0.99), P<0.001; 0.93 (0.71 to 0.98), P<0.001; and 0.61 (–0.03 to 0.90), P=0.059)

significant. Summary statistics and confidence intervals are quoted here to two decimal places (original measurements included two significant digits) and calculated probabilities to three decimal places. Mean SD scores for height, weight, and body mass index were calculated for each year for the 3 to 4 year age group. Mean SD scores for weight were calculated for each year for the 1 to 3 month age group. We examined trends in weight, height, and body mass index with Pearson's product moment correlation for mean SD scores (weighted by the inverse of the observed variance) and year. The robustness of inferences made with these parametric and linear methods was explored by reanalysis with non-linear and non-parametric alternative methods; an alternative assumption that data exclusion constituted censorship was considered in the reanalysis.[7–9]

We analysed categorical data derived from definitions of obese (body mass index SD score >1.04) and overweight (>1.64) using a χ^2 trend with evenly spaced scores representing the order in years from 1989 to 1998.[10]

Results

Preschool children

Figure 1 shows the mean SD scores for weight, body mass index, and height for children over the 10 year period. If the distribution of weights in the study and reference populations is similar, the mean SD score from a large sample should be close to zero. We observed a significantly increasing trend in mean SD score for weight and body mass index between 1989 and 1998. Over the same period there was no increasing trend in the mean SD score for height.

Table 1 shows the percentage of overweight and obese children as measured by body mass index in each year. In a population with normally distributed weights, we would expect 15% of children to be overweight (>85th centile; SD score >1.04) and 5% obese (>95th centile; SD score >1.64). This was the case for our study population in 1989, but since then the proportion of overweight and obese boys and girls increased significantly (fig 2).

Table 1 Annual trend in proportion of overweight (SD score for body mass index (BMI) >1.04; >85th centile) and obese (>1.64; >95th centile) preschool children

Year	No of children	No (%) overweight	No (%) obese
1989	2728	402 (14.7)	146 (5.4)
1990	3033	495 (16.3)	188 (6.2)
1991	3185	525 (16.5)	224 (7.0)
1992	3028	491 (16.2)	167 (5.5)
1993	3051	490 (16.1)	198 (6.5)
1994	3104	553 (17.8)	209 (6.7)
1995	2803	483 (17.2)	205 (7.3)
1996	2687	511 (19.0)	210 (7.8)
1997	2516	549 (21.8)	221 (8.8)
1998	2633	621 (23.6)	242 (9.2)
No linear trend		P<0.001	P<0.001

Infants

Figure 3 shows a slight increase in the mean SD scores for weight of infants during the 10 year period. However, it was close to zero (the 50th centile) and below zero for the whole period. Table 2 shows the proportion of infants with a weight above the 85th and 95th reference centiles. Throughout the study period fewer than 15% of infants weighed above the 85th centile and fewer than 5% above the 95th centile. During the same period there was an increase in the number of preschool children with a weight above the 85th and 95th reference centiles.

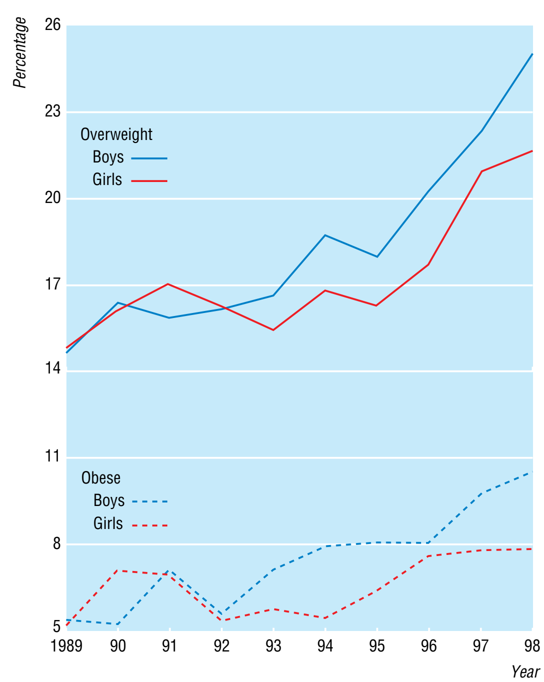

Fig 2 Annual increase in proportion of overweight and obese children; χ^2 for trend in overweight 71.1 (P<0.001) for boys and 33.1 (P<0.001) for girls, for trend in obesity 48.3 (P<0.001) for boys and 7.3 (P=0.007) for girls. Proportion of overweight and obese boys becomes greater than girls in early 1990s and remains so

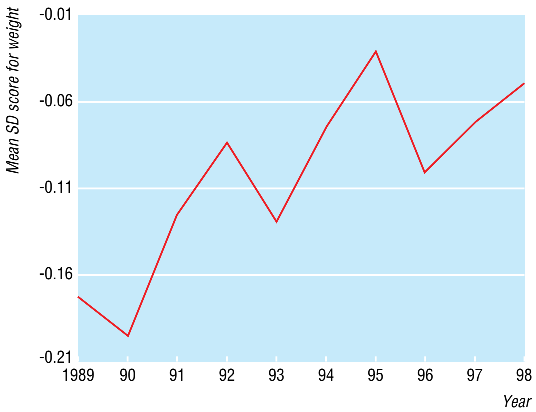

Fig 3 Median SD scores for weight at 6 weeks bounded by interquartile range plotted against year of measurement for infants aged 1 to 3 months (Pearson's correlation (95% CI) 0.80 (0.35 to 0.95), P=0.005 for *r*=0)

Alternative analyses

Reanalysis of the data with non-linear and non-parametric methods and assumptions did not change any of the inferences drawn.

Discussion

We have found a highly significant increase in the number of overweight and obese children in the Wirral Health Authority area over the decade to 1998. In 1989 the weight and height of children in this area were similar to those of the reference population underlying the British growth reference charts, compiled in 1990.[2] The increase in weight and body mass index over time has not been accompanied by an increase in height. As this was a population based study without patient identifiers we made no attempt to link the infant group to the same children measured three to four years later. However, the increase in the proportion of children above the 85th and 95th centiles for weight was not present in infants. The excessive weight gain therefore occurred between infancy and preschool age.

In adults body mass index is useful in the assessment of fatness. Concerns have been expressed regarding its use in children because it covaries with height and does not take into account the differences in the timing of growth in height and weight among various ethnic groups.[11] Nevertheless, it is easy to measure and has been validated against calculations of body density.[12 13] For these reasons it has been recommended by the American Society of Clinical Nutrition and others as a reliable measurement of overweight and obese children.[12] Pietrobelli et al also concluded that body mass index could be used as a measure of fatness in groups of children, although caution should be exercised in the comparison of body mass index across different age groups.[13] We consider measurement of body mass index to be valid in this study because of the similar ages of the children. In addition, more than 97% of the Wirral population is of white European origin.

Table 2 Annual trend in proportion of infants above 85th (SD score >1.04) and 95th (>1.64) centiles for weight

Year	No of infants	No (%) >1.04	No (%) >1.64
1989	4263	453 (10.6)	134 (3.1)
1990	4519	479 (10.1)	124 (2.7)
1991	4161	499 (12.0)	146 (3.5)
1992	3816	486 (12.7)	139 (3.6)
1993	3682	444 (12.1)	144 (3.9)
1994	3301	413 (12.5)	113 (3.4)
1995	3165	442 (14.0)	133 (4.2)
1996	2960	368 (12.4)	104 (3.5)
1997	2914	389 (13.4)	123 (4.2)
1998	2881	354 (12.3)	113 (3.9)
No linear trend		P<0.001	P=0.006

Definitions of overweight and obesity

There is no consensus as to the definition of overweight and obese children. The International Obesity Task Force suggests that children over the 80th centile are overweight, as this corresponds to a body mass index of 25 at the age of 18 years in men and women, which is the adult definition of overweight.[12] Our definition of overweight as being above the 85th centile has been used by others[5] but is arbitrary, and data based on the 80th centile could be calculated easily. We agree with other authors that a consensus figure is required.[12 14]

It is important that centiles should be based on a reference population that does not change with time.[12] If, when growth curves are updated to account for changes in nutritional state, they are based on the increased weight and body mass index as found in this and other studies,[1 15] they will mask an important increase in obesity. This problem can be overcome by combining data from populations with a low prevalence of undernutrition and data that were collected before the increases in obesity now being reported. Prentice also emphasises the importance of monitoring and interpreting these changes over time.[11] Data routinely collected by health authorities fulfil most of the criteria described by Bellizzi and Dietz for the development of a reference population[12] and are ideal for examining change over time, as we have shown. It is also important to take into account changes in height over time. In our study, height had not increased in the preschool population. The increase in the number of children with an SD score for weight and body mass index above 1.04 must be recognised for what it is—an increase in the number of overweight and obese children and not a "normal" trend in the population. Kotani et al found that the proportion of obese children in their population had increased from 5% to more than 10% over two decades.[15] In our study, a similar increase occurred in 10 years.

Effects on later health

There is evidence that obesity is likely to persist into adult life[12 15 16] and to increase the likelihood of morbidity and mortality.[17] Calle et al prospectively examined the risk of death related to body mass index in over a million adults and concluded that heavier men and women in all age groups had an increased risk of death.[18] Cardiovascular disease remains one of the principal causes for this excess mortality. Increased body mass index is also one of the important risk factors associated with the extent of atherosclerotic lesions in the aorta and coronary arteries in people between 2 and 39 years of age.[19] Must and Strauss reviewed the risks and consequences of obesity in childhood and adolescence and concluded that an aggressive approach to prevention and treatment was required.[20] Early intervention, including increased activity and reduction in high fat, high calorie foods, is important,[5] and some success has been shown in such a programme.[21–23] Power et al have emphasised the importance of population based intervention to achieve this.[24] In our study, the increase in the incidence of obesity occurred before the age of 4 years, and interventions should be targeted at this age group if they are to have an impact.

The National Service Framework for Coronary Heart Disease identifies the need to develop, implement, and monitor policies that reduce the prevalence of coronary risk factors in the population.[25] Data that are routinely collected are important in monitoring the health of communities and should be used in the planning of community based interventions. Such data may be less accurate than those collected prospectively in carefully executed studies, but this must be balanced against the large amount of information that is readily available. In our study, valid data were collected on over 64 000 infants and children, which represented 88% of live births in the health authority and thus provided a large sample of the relevant population. The accuracy of routinely collected data must be ensured as they are a valuable source of information on population trends. Similar information obtained from other districts could be used to determine standard anthropometric measurements and trends in large numbers of infants and children. This information could be the impetus for a national programme to prevent and treat childhood obesity and its long term complications.

What is already known on this topic

The incidence of childhood obesity is increasing and obesity is likely to persist into adult life

Obesity results in considerable morbidity and mortality, of which cardiovascular disease remains one of the principal causes

Interventions aimed at weight reduction must include increased physical activity as well as a reduction in consumption of high fat, high calorie foods

What this study adds

Height and weight measurements taken by health visitors showed a significant increase in overweight and obese children over the decade to 1998

This increase occurred before the age of 4 years and interventions must be targeted at this age group if they are to have an impact

Routinely collected data are valuable in identifying anthropometric trends in populations

Contributors: PB had the original idea for the study and carried out the initial data analysis and is guarantor. DK carried out further analysis and drafted the manuscript. IB was responsible for all the statistical analysis as well as writing the statistical methodology.

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