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Central overweight and obesity in British youth aged 11-16 years: cross sectional surveys of waist circumference

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Abstract

Objective To compare changes over time in waist circumference (a measure of central fatness) and body mass index (a measure of overall obesity) in British youth.

Design Representative cross sectional surveys in 1977, 1987, and 1997.

Setting Great Britain.

Participants Young people aged 11-16 years surveyed in 1977 (boys) and 1987 (girls) for the British Standards Institute (n=3784) and in 1997 (both sexes) for the national diet and nutrition survey (n=776).

Main outcome measures Waist circumference, expressed as a standard deviation score using the first survey as reference, and body mass index (weight(kg)/height(m)^2), expressed as a standard deviation score against the British 1990 revised reference. Overweight and obesity were defined as the measurement exceeding the 91st and 98th centile, respectively.

Results Waist circumference increased sharply over the period between surveys (mean increases for boys and girls, 6.9 and 6.2 cm, or 0.84 and 1.02 SD score units, $P<0.0001$). In centile terms, waist circumference increased more in girls than in boys. Increases in body mass index were smaller and similar by sex (means 1.5 and 1.6, or 0.47 and 0.53 SD score units, $P<0.0001$). Waist circumference in 1997 exceeded the 91st centile in 28% (n=110) of boys and 38% (n=147) of girls (against 9% for both sexes in 1977-87, $P<0.0001$), whereas 14% (n=54) and 17% (n=68), respectively, exceeded the 98th centile (3% in 1977-87, $P<0.0001$). The corresponding rates for body mass index in 1997 were 21% (n=80) of boys and 17% (n=67) of girls exceeding the 91st centile (8% and 6% in 1977-87) and 10% (n=39) and 8% (n=32) exceeding the 98th centile (3% and 2% in 1977-87).

Conclusions Trends in waist circumference during the past 10-20 years have greatly exceeded those in body mass index, particularly in girls, showing that body mass index is a poor proxy for central fatness. Body mass index has therefore systematically underestimated the prevalence of obesity in young people.

Introduction

Recent studies based on body mass index have shown an increase in the prevalence of overweight and obesity in British children over the past 10-15 years.[1 2] Body mass index, however, gives no indication of the distribution of body fat. In children, as in adults, centralised or upper body fat carries an increased risk for metabolic complications. Waist circumference is a highly sensitive and specific measure of upper body fat in young people and should be valuable for identifying overweight and obese children at risk of developing metabolic complications.[3 4] To this end the first waist circumference centile curves for British children and adolescents have recently been published.[5]

We compared data on waist circumference, together with body mass index, in the same young people, collected in surveys over the past 10-20 years in Great Britain.

Methods

Participants

We obtained data for height, weight, and waist circumference, previously collected from British youth in two large cross sectional surveys. The British Standards Institute survey was conducted in males aged 6-16 years in 1977 and females aged 6-17 years in 1987 and was representative of socioeconomic, ethnic, and urban and rural groups in Britain.[6] The second survey was the national diet and nutrition survey of young people aged 4-18 years carried out in 1997, where waist circumference was measured in those aged 11 years and over.[7] We selected for analysis data on 4560 young people aged 11-16.99 years.

Anthropometric measurements

In both surveys height was measured without shoes. In the British Standards Institute survey weight was measured with participants wearing minimal clothing, whereas in the national diet and nutrition survey heavy clothing, jewellery, and small change were removed before weighing (weight was recorded to the nearest 0.1 kg and corrected for clothing effects). In both surveys, waist circumference (cm) was measured midway between the 10th rib and the top of the iliac crest.[8] In the British Standards Institute survey clothing did not significantly influence the measurement. In the national diet and nutrition survey we corrected for the effect of clothing on waist circumference by subtracting 0.5 cm (see bmj.com). Five participants had data missing for either body mass index or waist circumference.

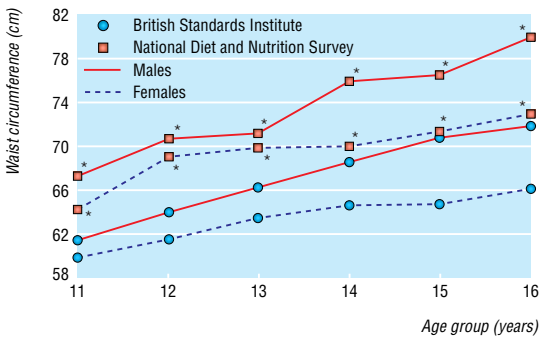

Fig 1 Waist circumference in British youth aged 11-16 years. *P<0.0001

Statistical methods

Body mass index and waist circumference were expressed as standard deviation scores using national references.[5 9] For each survey we calculated means and standard deviations by sex and compared means. The secular change in waist circumference was adjusted for corresponding changes in body mass index and height with multiple regression. We used cut-off points corresponding to the 91st and 98th centiles (SD scores 1.33 and 2, respectively) to define overweight and obesity based on body mass index and waist circumference separately.

Results

The mean waist circumference and body mass index for females and males by age were appreciably greater in the national diet and nutrition survey than in the British Standards Institute survey ($P<0.001$ for all groups except body mass index in males aged 13, $P<0.05$), the differences being similar at all ages (figs 1 and 2). The mean increase in body mass index was 1.5 (SE 0.16) for males and 1.6 (SE 0.16) for females. The mean increase in waist circumference was 6.9 (SE 0.46) cm for males and 6.2 (SE 0.34) cm for females (all $P<0.0001$). The standard deviations were also larger in the national diet and nutrition survey than in the British Standards Institute survey.

Standard deviation scores for waist circumference increased much more than for body mass index. The mean increase in waist circumference in males was 0.84 units versus 0.47 units for body mass index, whereas in females the contrast was even greater: 1.02 units versus 0.53. Waist circumference increased by 0.18 (SE 0.08) units more in the females than in the males, and the variability in the females in 1997 was also significantly greater than that in the males. The changes in the females correspond to a shift from the 50th to the 85th centile for waist circumference and the 44th to the 70th centile for body mass index.

The standard deviation scores for waist circumference were strongly correlated with body mass index (r=0.82 in males, 0.79 in females) and less with height (r=0.48 and 0.30). Adjusting for body mass index and height changes between surveys reduced the increase in mean waist circumference from 0.84 to 0.45 (SE 0.029) units in males and from 1.02 to 0.57 (SE 0.033) units in females. So less than half the increase in waist circumference was explained by increases in body mass index or height.

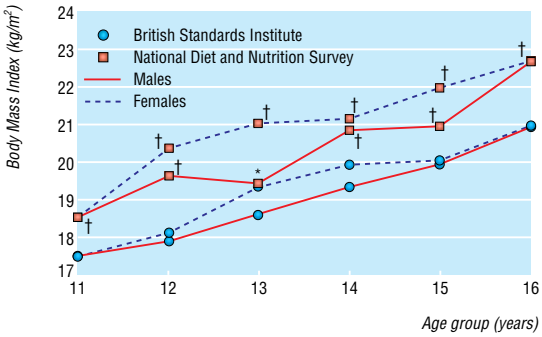

Fig 2 Body mass index in British youth aged 11-16 years. *P<0.05, †P<0.001

What is already known on this topic

The prevalence of overweight and obesity in youth based on body mass index has increased over the past 10-20 years

Body mass index gives no indication of body fat distribution

Waist circumference is a marker for central body fat accumulation; a large waist circumference is linked to an increased risk of metabolic complications

What this study adds

Waist circumference in British youth has increased over the past 10-20 years at a greater rate than body mass index, the increase being greatest in females

The accumulation of central body fat has risen more steeply than whole body fatness based on height and weight

Current and future morbidity in British youth may be seriously affected due to accumulation of excess central fat

In all cases the prevalence by sex of overweight and obesity based on body mass index and waist circumference increased over time. The increases were appreciably larger for waist circumference (20-29% overweight and 11-14% obese) than for body mass index (11-13% overweight and 7% obese) ($P<0.001$). Based on waist circumference, more than one third of females in 1997 were overweight and over one sixth were obese.

Discussion

We found substantially larger increases in waist circumference than body mass index in British youth aged 11-16 years surveyed 10 years apart (1987 and 1997 for females) and 20 years apart (1977 and 1997 for males), suggesting a steeper rise in abdominal obesity than whole body obesity based on weight and height.

The increased waist circumference probably reflects both visceral and subcutaneous fat and hence total fatness. In contrast the body mass index measures the sum of fat mass and fat free mass. It is impossible to know the relative contributions of each,[10] and monitoring trends in body mass index alone will fail to identify shift from muscle to fat. The accumulation of excess fat predominantly in the upper body rather than in the peripheral region[11 12] has also been observed in Spanish youth.[13]

Methodological differences may have accounted in part for these observations. However, in both surveys the site of the waist measurement was defined identically. Furthermore, with a low reported technical error of measurement, low intraobserver and interobserver error (unpublished data), and adjustment for

clothing, it is likely that the increases in waist circumference are genuine.

Increases in waist circumference on current and future morbidity should be a cause for concern. One US study found that young people above the 90th centile for waist circumference had higher concentrations of low density lipoprotein cholesterol, triglycerides, and insulin and lower concentrations of high density lipoprotein cholesterol than young people below the 10th centile.[14] It is not known how early in life the increases in waist circumference over the reference values from 1977 and 1987 are detectable in a contemporary population, although we have observed similar increases in children as young as 3 years (unpublished observations).

The increase in waist circumference was appreciably larger in females than in males, for reasons that are unclear. Energy intake has decreased to a similar extent in the sexes.[7] It may be that levels of physical activity have decreased faster in females than in males, and central fatness may be related more to physical activity than to energy intake.

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Views of doctors and managers on the doctor-manager relationship in the NHS

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A well functioning relationship between doctors and managers is crucial if government plans for "modernising" the NHS are to deliver real service improvements.[1 2] We aimed to shed some light on current perceptions of the doctor-manager relationship by examining areas of convergence or divergence of views among a large sample of doctors and managers in the NHS.

Participants, methods, and results

We conducted a postal questionnaire survey in NHS acute trusts across Great Britain during the summer of 2002. The survey included a census of chief executives and medical directors (from 197 trusts), together with a stratified cluster sample of both medical and non-medical managers at directorate level (clinical directors or their equivalent and non-medical directorate managers or their equivalent) randomly selected from 75 trusts. Comparisons between these different role groups form the central part of the analysis; we assessed variations across all four groups using χ^2 tests.

We received replies from 103 chief executives, 168 medical directors, 445 clinical directors (or equivalent), and 376 non-medical directorate managers (or equivalent). The response rate was 66% at board level and 73% at directorate level, giving a total of 1092 respondents.

Overall, chief executives were the most optimistic about the state of doctor-manager relationships, and clinical directors the least. About three quarters (78/103, 76%) of chief executives rated the quality of current doctor-manager relationships as 4 or more on a scale of 1 (poor) to 5 (excellent), compared with just 37% (164/443) of clinical directors. Further, 78% (80/102) of chief executives thought that doctor-manager relationships would improve over the next year, compared with just 28% (123/439) of clinical directors (indeed, 26% (113/439) of clinical directors thought that the relationships would deteriorate). Differences across all four groups were significant at $P < 0.01$.

Questions about specific aspects of the doctor-manager relationship showed some areas of good agreement but also highlighted issues where views diverged significantly between the four groups (table). Only rarely was the most obvious divide between those medically qualified and those not. More often, the dif-