SHORT REPORT

Rising obesity and expanding waistlines in schoolchildren: a cohort study

M C J Rudolf, D C Greenwood, T J Cole, R Levine, P Sahota, J Walker, P Holland, J Cade, J Truscott

A cohort of schoolchildren was followed up over 6 years from 1996 to 2001. In the final year, 315 of 500 targeted children were measured. Body mass index (BMI) increased substantially over time (p<0.001), indicating a further rise in obesity into the secondary school years. Two new indicators of obesity were also measured. Waist circumference scores rose as substantially as BMI (p<0.001), and may be of particular significance given the association between abdominal girth in adults and cardiovascular morbidity. International Obesity Task Force measures were found to be more stringent than previous criteria, with no significant change noted over the time period.

In 2001 we reported an alarming increase in the prevalence of obesity in primary school children in Leeds. Our data were collected during a trial of APPLES, a primary school health promotion programme designed to improve children's diets and lifestyle. Over the course of 3 years we found a steady increase in the numbers of overweight and obese children so that by the age of 11 years, 30% of children were overweight (>85th centile) and 17% were obese (>95th centile).

In 2001, 6 years after the start of APPLES, we obtained funding to follow up the children to secondary school in order to determine whether this trend had persisted, and how this might relate to the new international criteria for obesity defined by the International Obesity Task Force. In addition, as childhood waist circumference standards had been published for the first time, we were interested to see if waist measurements were a useful measure during this current “epidemic” of obesity.

METHODS

In the original longitudinal study, 694 children (378 boys and 316 girls) had participated, with measurements taken in 1996, 1997, and 1998. Of these children, 608 were tracked from school leaving lists and the local education authority database to 32 secondary schools. We excluded 14 schools on the basis that they had fewer than five pupils from the original study and were distantly located. The remaining 18 schools had 500 pupils who were targeted for follow up. Written consent to participate was obtained from both the pupils and their parents.

Data were collected in March–June 2001. Height was measured to 0.1 cm with a freestanding stadiometer (Raven Dunmow). Weight was recorded to 0.1 kg without shoes or sweaters. The mean of three triceps measurements was taken. Waist circumference was measured 4 cm above the umbilicus. Body mass index (BMI) was calculated from the formula (weight in kg/height in m²). Data were converted to SD scores using the UK 1990 growth references for height, weight, and BMI, the 1975 Tanner references for triceps measurements, and the 2001 McCarthy references for waist circumference. Puberty was staged by self report. The International Obesity Task Force criteria were used to calculate the numbers of obese and overweight children (table 1).

SD scores of participants and nonparticipants were compared by unpaired Student’s t test. The percentages of overweight and obese children in each year were compared using McNemar’s test. Random effects regression was used to test for trends over the 6 years of the study.

RESULTS

Of the 500 possible children, 348, now aged 12–14 years, agreed to participate in the study. Complete growth measures were obtained from 315 (63% of 500) of whom 174 were boys and 141 were girls. As there was concern that children who did not consent might be more obese, participants’ and nonparticipants’ growth data from 1998 were compared (see table 2). There was no significant difference for any measurement, suggesting that this was not the case.

The demographics of the children used to generate data for figs 1 and 2 are shown in table 3. Fig 1 shows the mean (SD) scores for growth. There was a substantial increase in weight throughout the period 1996–2001. Mean (SD) height scores also increased in the final year. As expected, all subjects were in puberty. Only 39 of the girls were premenarchal. The mean age for menarche was 12.6 (0.7) years.

Obesity measures are shown in fig 2. Mean (SD) BMI and waist circumference scores increased substantially, indicating a rise in obesity. The triceps measurements did not change significantly. Results did not change for any measurement when boys and girls were analysed separately.

Overweight and obesity rates using the International Obesity Task Force criteria (table 1) are shown in table 4. Numbers of overweight and obese children were higher than expected from the 1990 growth references. There was no significant trend over time, but there appeared to be a tendency towards girls being more overweight and obese than boys, with an increase over the years.

DISCUSSION

Over six years the population showed a substantial increase in height and weight, although the former was restricted to the final year. The most likely explanation for this rise in height is an earlier onset of puberty. However, we were unable to demonstrate this as the subjects were already in puberty. The mean age for menarche was 3.5 months younger than that found in a survey of British girls from the early 1980s, which provides little support for this suggestion. Pubertal status was ascertained by self report.

Abbreviation: BMI, body mass index

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rather than examination, with somewhat inconsistent findings, so this relationship could not be explored further.

Despite the increase in height, BMI scores continued to increase substantially, indicating a further rise in obesity for the population as a whole. This was probably caused by children becoming more overweight as they got older, although we could not disentangle the secular trend from the age trend because of their co-linearity. The triceps measurements were not consistent with other measurements, as previously noted.

In addition to providing further epidemiological data on the rise in children’s weight, this report provides information on waist circumference measurements. Waist circumferences were significantly larger in 1996–8 than in the late 1970s and 1980s when the references were obtained, and were also larger than BMI. They continued to rise through the course of the study, so that by 2001 children’s waists were on average 4 cm (two clothing sizes) larger than they had been 20 years ago. This figure is all the more disturbing when one reflects on how many notches on a belt this represents, and is consistent with the cross sectional survey of waist measurements recently reported in the BMJ. Waist circumference as a measure of obesity may be of particular significance, given the association between abdominal girth in adults and cardiovascular morbidity.

It has been recommended that we should now be utilising new criteria for identification of obesity. These have been developed by the International Obesity Task Force in order to allow for international comparison and consistency. As our numbers show, these criteria are more stringent than the previous cutoff points and the numbers of obese children now appear to be relatively small. It is to be hoped that this will not lull us into a false sense of security about the problem.

Our data are of concern. The previous rise in BMI levels reported through primary school has continued into secondary school and emphasises the need for more rigorous efforts to stem the tide of child obesity. Waist circumference measures provide an extra level of concern. Larger cohort studies specifically designed for the purpose are required to

Table 1  International Obesity Task Force definitions of obesity, giving the approximate relationship of BMI SD score to placement on the UK 1990 growth charts

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centile</td>
<td>BMI SD score</td>
</tr>
<tr>
<td>Normal</td>
<td>&lt;90.4</td>
</tr>
<tr>
<td>Overweight</td>
<td>90.4–99.1</td>
</tr>
<tr>
<td>Obese</td>
<td>&gt;99.1</td>
</tr>
</tbody>
</table>

* Nineteen additional participating children and two non-participating children had not been measured in 1998 (but were in 1997 and 1996). They therefore could not be included in this analysis.

Numbers are mean (SD) unless stated otherwise.
monitor obesity trends, and effective interventions are urgently needed to address this major public health issue.

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Long-term survivors of acute lymphoblastic leukaemia

Current treatment of children with acute lymphoblastic leukaemia (ALL) gives an overall 5-year survival rate of 80–86% and a 5-year event-free survival rate of 78–83%. Some of these survivors will suffer relapse, second cancers, or other complications between 5 and 10 years after first treatment but many will be cured. Now a report from St Jude Children’s Research Hospital in Memphis, Tennessee (Ching-Hon Pui and colleagues. New England Journal of Medicine 2003;349:680–9; see also perspective article, ibid: 627–8) has illustrated the excellent prognosis for those who survive free of disease for 10 years, especially for those who did not receive central nervous system irradiation.

Between 1962 and 1992 a total of 2069 patients under the age of 21 years with ALL were included in 13 consecutive clinical trials and 1112 survived for at least 10 years. Eight hundred and fifty-six of these (41% of the total) survived free of leukaemia and were followed up for an average of a further 19 years after achieving 10-year survival. Fifty-six of the 856 (6.5%) had major adverse events in the period 10–30 years after first treatment. These were: eight deaths during remission (four from car accidents, two from suicide, one obstetric death, and one of unknown cause), four relapses of leukaemia, and 44 second neoplasms (10 basal cell carcinomas, 10 meningiomas, five malignant brain tumours, two myeloid neoplasms, two soft tissue sarcomas, one Hodgkin’s lymphoma, and 14 other carcinomas). Forty-one of the second neoplasms were related to radiotherapy. The estimated cumulative risk of a second neoplasm in the 20 years after 10-year survival was 21% among patients who had received radiotherapy and 1% among those who had not. Overall mortality in the irradiated group was significantly greater than in the US general population (standardised mortality ratio 1.9) but mortality was not increased significantly in the non-irradiated group. Survivors who did not receive radiotherapy had rates of health insurance coverage, marriage, and employment similar to their US population peers. Among those who had had radiotherapy both men and women had higher than population average rates of unemployment and fewer women were married.

Children with ALL who survive for 10 years free of leukaemia and are not treated with radiotherapy have a normal long-term survival.
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