ORIGINAL ARTICLE

The TRENDS Project: development of a methodology to reliably monitor the obesity epidemic in childhood

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Aims: The government has set a target to halt the rise in childhood obesity in those aged under 11 by 2010, but no system is in place to ascertain if this has been achieved. We aimed to develop a simple and reproducible methodology to monitor trends in childhood obesity.

Methods: A purposive sample of 10 primary schools and three secondary schools was selected. Children were measured with parental "opt out" consent in reception class, year 4, and year 8 (ages 5, 9, and 13 years, respectively). Measurements were compared with those obtained locally in 1996–2001. Calculations were then performed to ascertain the sample size required to confidently identify a halt in the rise in obesity using three growth measures.

Results: A total of 999 children were measured with ascertainment of 95% in primary and 85% in secondary schools. The proportion of overweight and obese children aged 9 and 13 years had increased since 1996–2001, although only 9 year olds showed a significant rise. A general trend of an increase in obesity was observed with increasing age. Calculations showed that 1900–2400 children per age group are needed to detect a halt in the rise in obesity based on mean body mass index (BMI) standard deviation scores (SDS) by 2010 with 90% power, whereas 4200–10 500 children are needed for other measures.

Conclusion: We have developed a simple, cost effective methodology for accurately measuring the epidemic and recommend the use of mean BMI SDS for demonstrating if a halt has been achieved.

Obesity in children has reached unprecedented levels, and a plethora of initiatives (largely without any evidence base) are being launched to tackle the problem. In its recent white paper,¹ the government set a target to halt the rise in obesity by 2010, but little thought has gone into ascertaining the progression of the epidemic or what data are needed to determine if the target has been reached.

Relying solely on school entry measurement would be inappropriate as the rise in obesity occurs later in childhood.² The Department of Health is now debating whether to monitor progress by annual ascertainment of the body mass index (BMI) of all children,³ which would require measurement of height and weight. This would be an expensive undertaking and there is an immediate need to determine whether the aims of the government could be achieved by developing a high quality public health monitoring system that does not depend on the annual measurement of all children.

The TRENDS Project was funded in order to see if it was possible to devise a simple, generalisable, cost effective methodology. We aimed to do this by ascertaining current levels of childhood obesity in marker schools, identified to reflect local sociodemographic characteristics. We then calculated how many children and schools would be required to track obesity and determine if the government target was being met.

METHODS

Leeds, in West Yorkshire in the United Kingdom, is ideally suited to health services research studies as it comprises areas with diverse socioeconomic profiles and contains a relatively high proportion of ethnic minority groups. A purposive sample of three secondary schools and ten primary schools was selected for the project, with the aim of attaining a sample that would approximate the sociodemographic make up of the city. In order to maximise numbers, primary schools

with two class entry were selected, taking one inner-city and one suburban school for each of the city's five sectors. The inner-city schools with the highest free school meal index and largest proportion of minority ethnic pupils were chosen in order to ensure that disadvantaged populations were well represented. The secondary schools were selected from three of the five sectors.

Ethics approval was obtained to measure the children with parental "opt out" consent at school entry, year 4, and year 8. All measurements were carried out by one school nurse (AC) who received auxological training. The children wore light clothing only and were measured in privacy. The following were recorded: height to 0.1 cm with a freestanding stadiometer (Raven, Dunmow, UK); weight to 0.1 kg; body composition by body impedance (Tanita, West Drayton, UK); and waist circumference 4 cm above the umbilicus.

Ethnicity was determined from school records and self report. The Townsend score was used to assign a measure of socioeconomic status (SES) to each child based on postcode of residence. Figures were compared with those for Leeds in the 2001 census.

BMI was calculated, and data were converted to standard deviation scores (SDS).^{4,5} Percentages of obese and overweight children were calculated using current clinical criteria⁶ based on the UK 1990 growth references (>91st centile for overweight; >98th centile for obese). The percentage of obese children was also calculated using the International Obesity Task Force (IOTF) criteria.⁷ Data were analysed by age, SES, and ethnicity. The latter was categorised as Caucasian, Asian, or other, as numbers were too small to allow for meaningful analysis of other ethnic minority groups.

The main purpose of the study was to establish a methodology for monitoring by sample rather than by whole

Abbreviations: BMI, body mass index; IOTF, International Obesity Task Force; SDS, standard deviation scores; SES, socioeconomic status

Table 1 Measures of obesity in Leeds school children measured in 2004 and in those measured in 1996–2001

	Reception class		Year 4		Year 8	
	APPLES	TRENDS (2004)	APPLES (1996–98)	TRENDS (2004)	APPLES (2001)	TRENDS (2004)
Number of children	–	380	609	417	315	225
Age range (years)	–	4.5–5.8	7.0–9.0	8.5–9.8	12.6–14.9	12.8–14.1
Intraclass correlation†	–	0.078		0.016		0.001
% Overweight children with BMI >91st centile (95% CI)	–	14.7 (11.3 to 18.7)	14.8 (12.0 to 17.9)*	21.8 (18.0 to 26.1)*	20.3 (16.0 to 25.2)	24.0 (18.6 to 30.1)
% Obese children with BMI >98th centile (95% CI)	–	7.1 (4.7 to 10.2)	6.0 (4.2 to 8.2)	10.3 (7.6 to 13.6)	9.8 (6.8 to 13.7)	12.9 (8.8 to 18.0)
% Obese using IOTF criteria ⁷ (95% CI)	–	4.7 (2.8 to 7.4)	3.3 (2.0 to 5.0)	6.7 (4.5 to 9.6)	5.1 (2.9 to 8.1)	8.0 (4.8 to 12.3)
Mean BMI SDS (95% CI)	–	0.16 (0.05 to 0.28)	0.21 (0.12 to 0.30)	0.38 (0.26 to 0.50)	0.35 (0.22 to 0.48)	0.53 (0.37 to 0.69)
SD of mean BMI SDS	–	1.11	1.10	1.24	1.17	1.25
Mean waist circumference SDS (95% CI)	–	–	0.35 (0.27 to 0.43)*	0.6 (0.5 to 0.71)*	0.63 (0.49 to 0.76)	0.55 (0.35 to 0.75)
Mean % body fat by BIA (95% CI)	–	–	–	18.9 (18.0 to 19.7)	23.0 (22.0 to 24.1)*	20.7 (19.5 to 21.9)*

†Intraclass correlation coefficients for BMI SDS calculated across schools.

*Significant differences ($p < 0.05$) between 1996–2001 and 2004.

BIA, bioelectrical impedance analysis.

population. The most important requirement was to determine the size of the sample required to demonstrate a halt in the rise in obesity. No guidance has been delivered to determine either what constitutes a rise or what indicates it has been curbed. We used the data that we had obtained to perform sample size calculations in order to determine the number of individuals and schools that would be required to confirm that no change in obesity had occurred between 2004 and 2010. Calculations were analogous to those used for a non-inferiority (equivalence) clinical trial, where measures of obesity are “equivalent” over time if they are within some pre-defined threshold or “margin of equivalence”. We chose the more stringent criteria of 90% power to minimise the risk of a type II error, alongside a 5% level of significance.

We therefore considered three conservative scenarios, bearing in mind that we had previously shown that mean BMI SDS increased by 0.00–0.17/year (depending on age and sex) between 1996 and 1998⁴:

- a difference in mean BMI SDS of no more than 0.15 between 2004 and 2010,
- a difference in the proportion of obese children (BMI >98th centile) of no more than 2% between 2004 and 2010, and
- a difference in the proportion of obese children (using IOTF cut offs) of no more than 2% between 2004 and 2010.

We also compared our growth data with data from a previous local cohort of children in order to see if there had been an increase in obesity over time. These measurements had been carried out during the APPLES project, a randomised controlled trial of a health promotion programme to prevent obesity in primary schools.^{8,9} Children in the intervention and control arms in this study were followed as a cohort between the years 1996 and 2001.^{2,5}

RESULTS

A total of 999 children were measured with ascertainment of 95% in primary and 85% in secondary schools. Only eight parents opted to exclude their children from the study (two in reception class and six in secondary school). Three primary school children could not be measured due to plaster casts or wheelchairs, six were abroad, and 30 children were absent. The secondary schools had problems in organisation on the

days visits were arranged and 62 pupils were not measured. Analysis confirmed the sample was representative of the city's sociodemographic and ethnic profile.

The results are shown in table 1. Mean BMI SDS ($p = 0.001$) and the percentage of obese ($p = 0.017$) and overweight children ($p = 0.003$) all increased significantly with age. Figures had also increased compared with our equivalent data from 1996–2001, with a statistically significant rise observed in the percentage of overweight children (BMI >91st centile) in year 4. There was also a small increase in the SD of mean BMI SDS between 1996–2001 and 2004 for both year 4 and year 8 children, raising the possibility that a concurrent increase in underweight children may be occurring. Subgroup analysis showed no differences by ethnicity or SES.

Sample size calculations to determine the number of individuals and schools required to confirm no increase in obesity since 2004 for each scenario are shown in table 2. The results show that between 1900 and 2400 children per age group/year would be needed to detect a halt in the rise in obesity by examining the change in mean BMI SDS by 2010 with 90% power, whereas 4200–10 500 children are needed if other measures are to be considered.

Table 2 Numbers of children in each school year required to detect a halt* in the rise in obesity with 90% power (α 5%) using three measures of obesity

	A difference between mean BMI SDS of ≤ 0.15	A difference between the proportion of obese (BMI >98th centile) children of 2%	A difference between the proportion of obese (IOTF criteria) children of 2%
Reception (5 year olds)	1880	6150	4180
Year 4 (9 year olds)	2340	9110	6400
Year 8 (13 year olds)	2380	10450	7180

*Data shown in table 1 from 2004 were used as the baseline figures.

What is already known on this topic

- Obesity in childhood has reached unprecedented levels in recent years
- The government has set a target to halt the rise in childhood obesity by 2010, but no system is in place to ascertain if this has been achieved

DISCUSSION

Since this study was devised, a heated debate has developed regarding the value or harm of routinely identifying children as obese. The government has now suggested a policy of measuring all school children annually with feedback to parents in the hope that this will encourage families to action. This proposal has been met with opposition by paediatricians, the National Screening Committee, and school nurses. The objections relate to the cost of universal screening, the lack of any evidence that informing parents is effective as an intervention, and the potential harm that may accrue to obese children, for example in terms of their self esteem or bullying.

Our results suggest an alternative to universal monitoring by demonstrating a cost effective methodology for accurately measuring the epidemic of obesity, using a minimal number of schools. It also indicates that the use of routinely collected data is quite inadequate for monitoring. Apart from their inaccuracy,^{10 11} measurements are only taken at school entry, when levels are low compared with later on in childhood. Reliance on this data could be falsely reassuring.

We found that the conduct of the study was straightforward in primary schools, with an excellent ascertainment of 95%, providing confidence in the quality of our results. Data collection was more problematic in secondary schools as they tended to be more disorganised in their cooperation and the lower ascertainment rate reduces confidence in the results. However, despite the difficulties, we would argue that it is important to capture this age group as it is at this age that obesity gets a grip and tracks most strongly into adult life. We need to refine the process rather than take the option of dropping secondary schools from a monitoring programme.

Our sample size calculations were based on a number of hypothetical scenarios such that a halt in the increase in obesity, however defined, would be considered to have occurred if the margin of equivalence was no more than 0.15 SDS for mean BMI or a 2% increase in the proportion of obese children. These are clearly arbitrary figures; the sample size estimates depend not only on the length of time over which the levels of obesity are being monitored but are also highly sensitive to changes in the tolerance limits. However, our data from 2004 can be used as a baseline for future studies, and ultimately provide an indication of the numbers of children who need to be sampled and measured in order to determine whether the rise in childhood obesity has begun to level off.

We would recommend that change in mean BMI SDS is used as the principal measure to determine if the epidemic has been halted, as it utilises data from a cross-section of the whole population rather than taking a minority who reach a somewhat arbitrary cut off. It not only requires a substantially smaller sample size compared to other measures but also is probably more effective at monitoring the effects of preventive strategies that are likely to have more of an impact on the mildly overweight than those at the extreme. The standard deviation of this measure provides some information regarding the distribution within the population, and could alert to the possibility of increasing numbers of underweight children.

What this study adds

- We have developed a simple, cost effective methodology for accurately measuring the obesity epidemic
- We recommend the use of mean BMI SDS for demonstrating if a halt in the rise in obesity is achieved

Discerning the percentage of obese children provides additional information, although these figures need not be used to ascertain if the government target has been met as this requires much larger numbers. The IOTF criterion for obesity is the more stringent measure and is useful for international comparison, although clinicians tend to prefer the clinical cut off of the 98th centile. Waist circumference and body composition measurements are also of interest but require more study before they can be considered useful; waists are difficult to measure accurately and showed no increase over time despite the increase in BMI SDS. Body composition was problematic as it cannot be measured in young children, although paediatric standards have recently been devised for a portable device.¹²

We conclude that the TRENDS experience has enabled us to initiate a public health monitoring system using a representative sample of less than 10% of schools. It is important to emphasise that a primary school is too small a unit to assess change in obesity levels even if universal monitoring was introduced, but accurate information using our methodology will be available for each Primary Care Trust in Leeds as well as by SES and ethnicity. Our approach can be easily implemented, is cost effective, and could be extended across the country to determine if government targets are met over the next 5 years.

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