Childhood overweight and obesity: is the gap closing the wrong way?

H. Brunt¹, N. Lester², G. Davies¹, R. Williams³

¹National Public Health Service for Wales, St. David’s Park, Job’s Well Road, Carmarthen SA31 3WY, UK
²National Public Health Service for Wales, Temple of Peace and Health, Cathays Park, Cardiff CF10 3NW, UK
³Centre for Health Information, Research and Evaluation (CHIRAL), The School of Medicine, Swansea University, Singleton Park, Swansea SA2 8PP, UK

Address correspondence to H. Brunt, E-mail: huw.brunt@nphs.wales.nhs.uk

ABSTRACT

Background Obesity is a significant public health issue. Obese children have an increased risk of developing chronic adult diseases. Knowledge of socio-economic distribution trends in childhood overweight/obesity is limited.

Methods Body mass indices for 3-year-old children resident in three South Wales localities from 1995 to 2005 were derived from the National Community Child Health Database (NCCHD) and examined in relation to residence lower super output area (LSOA) Townsend Material Deprivation Score.

Results Over 11 years, 53–69% of children had height/weight measurements recorded (with little difference observed across deprivation fifths). Amalgamating the data for all 11 years showed no significant association of prevalence with LSOA socio-economic status. Annual trends varied substantially: the most deprived fifth had the lowest proportion on five, and the highest on six, occasions. Linear regression analysis suggested a greater rate of increase of overweight/obesity in children from most-deprived LSOA areas compared with those from least deprived areas (not statistically significant).

Conclusions Socio-economic difference in overweight/obesity prevalence lessened between 1995 and 2005. Despite annual variation, this apparent closing of the gap has been the result of an increase in overweight/obesity prevalence in children from the most deprived areas who, initially, had a lower prevalence compared with children from least deprived areas, but by 2005, had overtaken them.

Keywords obesity, public health, socioeconomic status, childhood, overweight
The body of research investigating the relationship between socioeconomic status (SES) and obesity in adults is growing. However, evidence quantifying the influence of SES on childhood overweight/obesity is fairly limited.\textsuperscript{12–17} We know that eating habits develop early and a poor diet established in childhood and continued into adulthood can lead to later health problems.\textsuperscript{18} We also know that economically deprived families often replace fresh food with cheaper processed foods.\textsuperscript{19} Low-income households have restricted choices, especially in relation to healthier foods.\textsuperscript{19} Healthier food items may be difficult to access and more expensive. Generally, people in more deprived households have poorer nutrient intakes than people in less deprived households and evidence suggests the gap between them has widened over the last 20 years.\textsuperscript{19} There is also some evidence for decreased physical activity in economically disadvantaged households\textsuperscript{20} which only exacerbates the problem. Perhaps for these and other reasons, there is a developing evidence-base suggesting that overweight/obesity is associated with social deprivation.\textsuperscript{12–17}

This study analyses children’s height and weight data and investigates the association of family SES with overweight/obesity amongst 3 year-old children in three South Wales localities, between 1995 and 2005. The selection of these localities was based on National Community Child Health Database (NCCHD) data accuracy and completeness, but also because a doubling of the prevalence of obesity in boys and girls aged five (between 1986/87 and 2001/02) had been reported previously.\textsuperscript{11}

**Methods**

**Population measures**

Height and weight data of individual (but anonymised) children were obtained from the NCCHD, a database covering children resident in Wales which receives its information from trust-based child health systems.\textsuperscript{21} A data extract was obtained containing information which had been collected as part of the schedule of pre-school health examinations by NHS Trust-employed health visitors between 1995 and 2005 in the Swansea, Neath and Port Talbot areas of South Wales, UK. The final two examinations in the schedule (exams 06 and 07) are undertaken on children aged 152–160 and 182–208 weeks, respectively. Exam 06 includes a height and weight measure as standard and exam 07 includes it as an option. Data from these tests are captured by the NCCHD and mapped to the CHIRP08 examination code, enabling area comparison.

Those performing the school-entry examinations had been appropriately trained. Child height and weight measurements were taken using standardised methodology and regularly calibrated equipment. For both, averages of three readings were taken.

**Estimates of adiposity**

Body mass index (BMI—weight (kg) divided by the square of height (m)) was used as a surrogate for adiposity, and overweight and obesity classifications were based on International Obesity Task Force (IOTF) cut-offs.\textsuperscript{21} This method of assessing childhood overweight and obesity was chosen since it was used in a previous study of childhood obesity trends in the same South Wales localities.\textsuperscript{11} BMI values were scrutinised to eliminate spurious results arising from data recording errors. As in the previous study, analysis was restricted to a BMI range of 10–27 units, regarded as biologically feasible. No outliers were identified.

**SES measures**

Townsend material deprivation scores\textsuperscript{22} (which comprises assessments of unemployment, overcrowding, home and car-ownership) were used to determine childhood SES and was assigned according to NCCHD-recorded postcode of residence. Townsend scores, standardised to Wales, were calculated from 2001 census data at lower layer super output area (LSOA) level. LSOAs are a small area statistical geography produced by the Office for National Statistics (ONS) whose minimum and mean populations are 1000 and 1500, respectively. All-Wales LSOA Townsend scores were ranked and deprivation fifths (from one, least deprived, to five, most deprived) were derived.

**Statistical analysis**

Data were analysed using Microsoft Access and Excel software. The NCCHD extract received for analysis contained a number of duplicates, including individuals with more than one height and weight measure. Data were ‘cleaned’ to identify unique individuals.

Analysis of the data identified the proportion of three-year old children who had received a CHIRP08 examination and those with a height and weight measure recorded, allowing BMI scores to be calculated. In order to minimise bias, data were analysed to show the proportion of children with a BMI score stratified by fifth of deprivation.

The proportion of children within the ‘overweight’ and ‘obese’ categories (determined by IOTF cut-offs\textsuperscript{23}) was calculated for each deprivation fifth. This was done for the eleven-year period (1995–2005) as a whole. The proportions of overweight/obese children in the least and most deprived fifths were then calculated for each individual year.
to determine any time trends. This was supported by the addition of a linear regression analysis.

**Results**

**Data coverage**

A total of 53,716 records of CHIRP08 health examinations were obtained for the period 1995–2005. Child age, as recorded on the database, ranged from 0–11 years. However, the majority of the records (92.76%) applied to three-year olds. Our analysis focuses solely on these 49,826 three-year old children.

The CHIRP08 examination includes items other than the measurement of height and weight, e.g. vision and hearing tests. 14,266 of the 49,826 records identified were duplicate entries. This included a small number (n = 293) where height and weight had been measured on more than one occasion and these were excluded for the purposes of the analysis. Where there were duplicates, the most recent examination was selected.

Comparison of the number of individual children examined with office for national ONS mid-year population estimates for this age group resident in Swansea, Neath and Port Talbot (Table 1) showed that the estimated proportion of three-year olds having a CHIRP08 exam was between 63 and 87%. Of those children who were examined, between 53 and 69% had a height and weight measurement recorded (Table 1) with a clear rise in the proportion demonstrated over the study period. This population was distributed across the deprivation fifths as shown in Table 2.

**Trends in overweight and obesity**

Amalgamating the data over the 11-year study period showed that 1115 or 5.2% (95% CI: 4.9–5.5%) of the 21,301 children for whom a BMI could be calculated were obese (according to the IOTF definition\(^2\)). A further 3202 or 15.0% (95% CI: 14.6–15.5%) of children were overweight. The proportions of boys and girls in these categories were: overweight—boys: 14.3% (95% CI: 13.6–14.9%) and girls: 15.8% (95% CI: 15.1–16.5%); obese - boys: 4.9% (95% CI: 4.5–5.3%) and girls: 5.6% (95% CI: 5.1–6.0%).

The proportion of children in the overweight and obese categories combined increased over the study period from 18.0% (95% CI: 16.1–19.9%) in 1995 to 22.0% (95% CI: 20.2–23.8%) in 2005. The proportion of overweight children rose from 13.9% (95% CI: 12.2–15.6%) in 1995 to 16.8% (95% CI: 15.2–18.5%) in 2005, whereas the proportion of obese children rose from 4.1% (95% CI: 3.1–5.1%) in 1995 to 5.1% (95% CI: 4.2–6.1%) in 2005. The proportion of overweight and obese girls was generally greater than for boys during the study period. Both boys and girls showed a similar rate of increase. Amongst boys, the proportion of overweight and obese individuals rose from 17.5% (95% CI: 14.9–20.1%) in 1995 to 21.2% (95% CI: 18.7–23.7%) in 2005 and, in girls, from 18.7% (95% CI: 15.9–21.4%) to 22.7% (95% CI: 20.2–25.3%). Over the 11-year period,
the proportion of overweight boys increased from 14.2% (95% CI: 11.8–16.6%) to 16.8% (95% CI: 14.5–19.1%) and in girls from 13.6% (95% CI: 11.2–16.1%) to 16.8% (95% CI: 11.2–16.1%). During this time, the proportion of obese boys rose from 3.3% (95% CI: 2.1–4.5%) to 4.4% (95% CI: 3.1–5.7%), and girls, from 5.0% (95% CI: 3.5–6.6%) to 5.9% (95% CI: 4.4–7.3%).

Association with socio-economic status

As shown in Table 3, when the data for all 11 years were amalgamated, there were no significant associations between SES and the proportions of either boys or girls considered obese or the proportions considered overweight. This was also true when overweight and obese categories were combined (not shown).

When these data were analysed by year, there was a small decrease in the proportion of children who were obese from the least deprived areas (from 5.6% (95% CI: 2.9–8.2%) in 1995 to 4.3% (95% CI: 2.3–6.3%) in 2005), whilst there was a more substantial increase (from 3.3% (95% CI: 2.1–4.5%) to 4.4% (95% CI: 3.1–5.7%), and girls, from 5.0% (95% CI: 3.5–6.6%) to 5.9% (95% CI: 4.4–7.3%).

<table>
<thead>
<tr>
<th>Townsend deprivation fifth</th>
<th>Proportion (n)</th>
<th>Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Obese</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Least deprived</td>
<td>4.4% (92)</td>
<td>1.03</td>
<td>0.77–1.38</td>
</tr>
<tr>
<td>2</td>
<td>4.5% (78)</td>
<td>1.08</td>
<td>0.82–1.43</td>
</tr>
<tr>
<td>3</td>
<td>4.8% (96)</td>
<td>1.15</td>
<td>0.88–1.51</td>
</tr>
<tr>
<td>4</td>
<td>5.1% (115)</td>
<td>1.23</td>
<td>0.95–1.58</td>
</tr>
<tr>
<td>Most deprived</td>
<td>5.4% (149)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Least deprived</td>
<td>5.9% (118)</td>
<td>0.96</td>
<td>0.73–1.25</td>
</tr>
<tr>
<td>2</td>
<td>5.7% (92)</td>
<td>0.96</td>
<td>0.73–1.25</td>
</tr>
<tr>
<td>3</td>
<td>5.3% (105)</td>
<td>0.89</td>
<td>0.69–1.15</td>
</tr>
<tr>
<td>4</td>
<td>4.9% (107)</td>
<td>0.93</td>
<td>0.82–1.10</td>
</tr>
<tr>
<td>Most deprived</td>
<td>6.1% (163)</td>
<td>1.03</td>
<td>0.82–1.29</td>
</tr>
<tr>
<td><strong>Overweight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Boys</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Least deprived</td>
<td>14.3% (298)</td>
<td>1.08</td>
<td>0.92–1.25</td>
</tr>
<tr>
<td>2</td>
<td>15.4% (264)</td>
<td>1.06</td>
<td>0.92–1.23</td>
</tr>
<tr>
<td>3</td>
<td>15.2% (307)</td>
<td>0.95</td>
<td>0.82–1.10</td>
</tr>
<tr>
<td>4</td>
<td>13.6% (308)</td>
<td>0.93</td>
<td>0.81–1.08</td>
</tr>
<tr>
<td>Most deprived</td>
<td>13.3% (367)</td>
<td>1.00</td>
<td>0.86–1.16</td>
</tr>
<tr>
<td><strong>Girls</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Least deprived</td>
<td>15.8% (315)</td>
<td>1.00</td>
<td>0.93–1.24</td>
</tr>
<tr>
<td>2</td>
<td>15.8% (256)</td>
<td>1.07</td>
<td>0.93–1.24</td>
</tr>
<tr>
<td>3</td>
<td>17.0% (337)</td>
<td>0.90</td>
<td>0.78–1.04</td>
</tr>
<tr>
<td>4</td>
<td>14.2% (311)</td>
<td>0.90</td>
<td>0.91–1.18</td>
</tr>
<tr>
<td>Most deprived</td>
<td>16.4% (439)</td>
<td>1.04</td>
<td>0.92–1.25</td>
</tr>
</tbody>
</table>

Association with socio-economic status

As shown in Table 3, when the data for all 11 years were amalgamated, there were no significant associations between SES and the proportions of either boys or girls considered obese or the proportions considered overweight. This was also true when overweight and obese categories were combined (not shown).

When these data were analysed by year, there was a small decrease in the proportion of children who were obese from the least deprived areas (from 5.6% (95% CI: 2.9–8.2%) in 1995 to 4.3% (95% CI: 2.3–6.3%) in 2005), whilst there was a more substantial increase (from 3.3% (95% CI: 2.1–4.5%) to 4.4% (95% CI: 3.1–5.7%), and girls, from 5.0% (95% CI: 3.5–6.6%) to 5.9% (95% CI: 4.4–7.3%).

The proportion of overweight boys increased from 14.2% (95% CI: 11.8–16.6%) to 16.8% (95% CI: 14.5–19.1%) and in girls from 13.6% (95% CI: 11.2–16.1%) to 16.8% (95% CI: 11.2–16.1%). During this time, the proportion of obese boys rose from 3.3% (95% CI: 2.1–4.5%) to 4.4% (95% CI: 3.1–5.7%), and girls, from 5.0% (95% CI: 3.5–6.6%) to 5.9% (95% CI: 4.4–7.3%).

Table 3 Ratios (compared to least deprived fifth) of the proportion of overweight and obese 3 year-old boys and girls by Townsend deprivation fifth

Table 4 Proportion of children overweight or obese, least and most deprived fifth
least deprived fifths indicates that at no time during the study period was the difference in the rates statistically significant (Fig. 1). The 95% confidence limits are reasonably wide due to the fairly small numbers involved.

Linear regression lines were plotted to show trends in the proportion of overweight or obese children in the most deprived and the least deprived fifths between 1995 and 2005 (Fig. 2). The regression line for the least deprived fifth appears almost flat across the study period, whilst the regression line for the most deprived fifth shows some degree of a positive trend. An F test was conducted on each line to evaluate the likelihood that any observed association between time and proportion overweight and obese occurred by chance. Neither regression line produced a statistically significant result at the 5% level (Least deprived $F = 0.188$, d.f. = 9, $P = 0.68$/Most deprived $F = 3.335$, d.f. = 9, $P = 0.10$).

These results suggest that it is not possible to reject the null hypothesis (that there is no relationship between time and proportions of overweight or obese children within either the most or least deprived fifths).

The difference in the slopes of the two regression lines was $-0.53$ (95% CI: $-1.22$ to $0.17$) and not statistically significant.

In summary, the analysis suggests that the percentages overweight and obese within both the most deprived and least deprived fifths have not changed to any statistically significant extent.

![Fig. 1](image1.png) 
Fig. 1 Rate ratio (most deprived to least deprived) of overweight and obese (combined) three year-old children in Swansea, Neath and Port Talbot, 1996 to 2005.

![Fig. 2](image2.png) 
Fig. 2 Proportion of overweight and obese (combined) three year-old children in Swansea, Neath and Port Talbot from the ‘least’ and ‘most’ deprived areas, linear regression, 1995–2005.
significant degree over the study period. Furthermore, the rates of any (non-statistically significant) changes that have taken place are not statistically significantly different between the most and least deprived fifths.

Discussion

Main findings of this study

This study investigated the relationship between SES of three-year old children in three Welsh localities and the prevalence of overweight and obesity in these children. When data from 1995 to 2005 were combined, there was no association. Analysis of the annual trend in overweight and obesity among children resident in the most and least deprived fifth of LSOAs showed substantial annual variation. Linear regression analysis showed that the regression line for the least deprived fifth appears almost flat across the study period, whilst the regression line for the most deprived fifth appears to show some degree of a positive trend (but not statistically significant).

What is already known on this topic

A growing body of research has investigated the relationship between SES and obesity, but with an adult focus. There is limited research specifically looking at the relationship between deprivation and obesity in children (particularly young children) over time.

One study that examined childhood overweight/obesity prevalence trends in 28,601 children (aged 5–10 years) in relation to trends in parental social class and household income, concluded that childhood obesity rates are increasing rapidly and that these increases are more marked amongst children from lower socio-economic strata. The authors’ reasons for this include the economics of healthier eating, the availability of, and access to, a choice of good quality healthy foods and also the likelihood that children from poorer families have reduced levels of physical activity. A similar association between deprivation and childhood obesity was found in another cross-sectional study. Another study to determine whether SES is associated with overweight and obesity in pre-pubertal children (1420 10/11 year olds) in Italy found that the lower the cultural resources of the mother and economical resources of the family, the greater the rate of childhood weight gain. Furthermore, a cross-sectional analysis of routinely collected data on Scottish preschool children suggested that obesity is associated with social deprivation. The observed trends highlight the influence socioeconomic factors may have on childhood overweight/obesity and suggest that directing lifestyle-changing messages and interventions towards those in more deprived population groups could have a greater impact on addressing this issue.

What this study adds

This analysis shows that the relationship, between overweight and obesity on the one hand, and social deprivation on the other, is dynamic. It showed signs of change in these South Wales localities over the study period, from one in which the prevalence of overweight and obesity appeared to be greater in the least socially deprived fifth of children to one where the prevalence of overweight and obesity appeared to be greater in the most deprived fifth. It should be noted, however, that substantial variation in overweight and obesity prevalence was observed over time and results obtained were not statistically significant.

There are important wider public health implications associated with this analysis. The fact that only 59.9% of examined children had corresponding height and weight measurements reinforces the need for improved data quality and surveillance of overweight and obesity amongst children. The observed trends highlight the influence socioeconomic factors may have on childhood overweight/obesity and suggest that directing lifestyle-changing messages and interventions towards those in more deprived population groups could have a greater impact on addressing this issue.

Limitations of this study

This is an ecological analysis with all the limitations of such analyses—difficulties of dealing with confounding and identifying cause and effect relationships. There is limited coverage for height and weight measurements. We have estimated that, over the study period, around 80% of children appear on the NCCHD with at least one CHIRP08 entry. Of these, an average of 60% have a valid height and weight measurement recorded, although improvements were observed over the study period. This
raises the probability of selection bias if either BMI or deprivation, or both, are associated with the probability of heights and weights being recorded, or indeed appearing on the database with a CHIRP08 exam in the first instance. The fact that there were no differences related to deprivation in the probability of data being recorded provides some assurance that, if such bias exists, it does not have a major influence over the conclusions of the study.

The problems with NCCHD coverage exemplify the need for investment in a proper surveillance system for this important public health area. As mentioned above, height and weight measurements were only recorded in around two thirds of the records on the NCCHD, despite the study focusing on three localities where coverage is believed to be better. Had national coverage been higher, this would have enabled the analysis to take place across Wales, yielding larger numbers and more statistically robust findings.

A further limitation of this study is that data coverage constraints determined that the focus of the study had to be on three-year-olds. It is likely that the effect of socioeconomic disadvantage in increasing the risk of overweight and obesity in children will manifest itself more strongly as they become older. In order to make comparisons with other studies, it would have been interesting to have undertaken a similar analysis looking at the relationship between overweight/obesity and deprivation in older children, but poor data coverage issues for older children prevented this.

BMI is a widely used, but increasingly questioned, proxy for adiposity. Other measures, particularly waist circumference and more sophisticated estimates of body fat may be more relevant in relation to the prediction of future cardiovascular morbidity. However, as a proxy measure of changes in the prevalence of overweight and obesity, BMI is a practical measure on a population basis and should be retained at least until a better and equally practical measure is available.

As with the previous study using similar data, the range of acceptable BMI values was restricted to the range 10–27 kg/m². The upper limit of this range may well be inappropriate given current trends in childhood obesity. However, unless the accuracy and recording of measurements improve, such a restriction on the range of valid BMI values is probably required.

Acknowledgements

We would like to acknowledge Gareth John and Louise James of Health Solutions Wales for facilitating the extraction of data from the NCCHD and providing information in respect of the CHIRP08 pre-school examinations.

References


