National Child Measurement Programme: Detailed Analysis of the 2006/07 National Dataset

A report for the Cross-Government Obesity Unit by the National Obesity Observatory, on behalf of the Association of Public Health Observatories

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Errata

In November 2009 the Information Centre for Health and Social Care identified an error in the HSE series relating to childhood obesity data for the years 1995 to 2007 inclusive. This report contains data affected by this error but the impact on the figures provided here is minimal, and does not affect the conclusions of the report.

For more information on the error and the revised child obesity figures visit http://www.ic.nhs.uk/statistics-and-data-collections/health-and-lifestyles-related-surveys/health-survey-for-england

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Key findings

The National Child Measurement Programme (NCMP) weighs and measures children in Reception (typically aged 4–5 years) and Year 6 (aged 10–11 years) annually. The report highlights the usefulness of the NCMP Dataset in furthering our understanding of underweight, overweight and obesity in children, as well as highlighting some areas where improvements can be made in the programme, or where further analysis and investigation is required. The purpose of this report is not to provide specific local results, but an understanding from national-level analysis that can be used to inform local uses and analysis of NCMP data.

Reported prevalence of obesity and overweight data appear to be influenced by:

Participation rates: Low participation rates and high opt out rates, particularly for Year 6, are associated with lower reported prevalence figures for overweight and obesity. This is likely to be caused by a selective opt out of larger children. This factor is likely affect the accuracy of prevalence figures.

In order to meet the 2007/08 participation goal of 85%, and also to ensure prevalence figures produced using NCMP data reflect the true prevalence in their populations, PCTs may need to improve participation rates, particularly for Year 6. Individual non-participation is a bigger issue than pupils not being measured on a whole school basis.

If PCTs are able to record non-participation rates in 2007/08 this could support analysis to inform improvements to the programme.

Rounding of measures: Accurate measurement and recording of measurements is important. Higher levels of rounding, especially of weight, appear to have a significant impact on PCT level prevalence figures.

Correct training and a good awareness of NCMP guidance will help staff to ensure correct recording of children's measurements. It is also important for PCTs to use the appropriate equipment, e.g. properly calibrated, digital scales.

Age of children measured: Although obesity prevalence is known to increase with age, there is no evidence from NCMP data of any increase in prevalence between younger and older children within the NCMP age bands.

There is however some evidence of an association between children measured at younger ages and higher reported prevalence figures at PCT level for both school years. This may be due to the time of year at which measures are taken. Further analysis is required to investigate if this is indeed an important factor that may need to be considered in future years.

Sex: The highest rates of non-participation appear to be among girls in Year 6, and this may result in an overestimation of the differences in prevalence of obesity between boys and girls at national level. There is however little evidence of this factor having an impact on headline PCT prevalence figures where the sexes are combined.

Prevalence of obesity in childhood is closely linked to the sociodemographics of the population. The most important factors appear to be:

> **Socioeconomic deprivation:** Measures of deprivation can explain up to 60% of the variation in prevalence of obesity between PCTs and are an important predictor of childhood obesity prevalence.
>
> The strength of this relationship is such that indices of deprivation could be used as a proxy for obesity prevalence in areas where data quality is poor, or for small populations (e.g. schools) where NCMP data are unable to provide robust data.
>
> **Ethnicity:** There are substantial differences in prevalence of childhood obesity by ethnic group, especially for Year 6. The highest rates of prevalence are found outside the 'White British' ethnic groups. Differences in the ethnic breakdown of PCT populations can explain a significant proportion of the variation in prevalence between PCTs.
>
> The association between ethnicity and prevalence of obesity requires further investigation. There is evidence that some ethnic groups with high prevalence have a substantially different height profile from the 'White British' population. The 1990 British Growth Reference, as used to classify children as overweight or obese, was based on a sample of 'White British' children and the suitability of this reference for today's multicultural population needs to be examined.

Analysis of these issues suggests that NCMP data may underestimate the true population prevalence of obesity and overweight at national, regional and local level.

List of Abbreviations

BMI	Body Mass Index
DCSF	Department for Children, Schools and Families
DH	Department of Health
FSM	Free School Meals
HSE	Health Survey for England
IC	NHS Information Centre
IMD	Index of Multiple Deprivation
IOTF	International Obesity Task Force
LA	Local Authority
NCMP	National Child Measurement Programme
NOO	National Obesity Observatory
PCT	Primary Care Trust
PHO	Public Health Observatory
PSA	Public Service Agreement
SEPHO	South East Public Health Observatory
SHA	Strategic Health Authority
SOA	Super Output Area
UK90	British 1990 Growth Reference
WHO	World Health Organization

List of figures and tables

1 Introduction

The National Child Measurement Programme (NCMP) weighs and measures children in Reception (typically aged 4–5 years) and Year 6 (aged 10–11 years). The findings are used to inform local planning and delivery of services for children and gather population-level surveillance data to allow analysis of trends in excess weight. The programme also seeks to raise awareness of the importance of healthy weight in children. The NCMP is an important part of the government's strategy to tackle the continuing rise in excess weight.

In September 2007, the government announced, as part of the Comprehensive Spending Review, a new ambition: *to reverse the rising tide of obesity and overweight in the population, by ensuring that all individuals are able to maintain a healthy weight.* The government's initial focus is on children, and by 2020 they aim: *to have reduced the proportion of overweight and obese children to 2000 levels*. The government set out its strategy on excess weight in *Healthy Weight, Healthy Lives: A Cross-Government Strategy for England*,[1] published in January 2008.

The Department of Health (DH) is responsible for overall policy on healthy weight and is jointly responsible with the Department for Children, Schools and Families (DCSF) for policy on healthy weight in children. Although the ambition covers a period of 12 years, progress over the period 2008-11 will be monitored through the inclusion of childhood obesity (as shown by NCMP data) as one of the indicators in the Child Health Public Service Agreement (PSA).

This report analyses the NCMP 2006/07 national dataset provided by the NHS Information Centre (IC). The IC collate and analyse NCMP data centrally after it has been collected at a local level and submitted to them by Primary Care Trusts (PCTs), with the support and cooperation of schools, children and parents.

This report follows on from the report *National Child Measurement Programme: 2006/07 school year, headline results,*[2] produced by the IC. It presents detailed secondary analysis to further our understanding of the epidemiology of child height, weight and Body Mass Index (BMI) across the country, and attempts to explain some of the findings presented in the IC 'headline results' report.

The Cross-Government Obesity Unit has made many key improvements since the first year of data collection in 2005/06. These include the collection of more detailed data nationally on actual child measurements and other information, such as pupil denominators. There has also been improved engagement with and guidance for PCTs and schools, as well as an enhanced data-capture tool.

2 Methods

The IC's report presents a summary of the method of central collection of NCMP data. The analysis presented here, unless specified otherwise, uses data from the national dataset provided to Public Health Observatories (PHOs) by the IC.

Further data cleaning has been undertaken in addition to that described in annex 4 of the IC's report. As a result of this additional cleaning, the total number of records analysed in this report (876,375) differs from that in the IC's report (876,416). A slightly different method has also been used to calculate the number of pupils deemed eligible for measurement, resulting in slightly different participation rates from those published by the IC.

To avoid conflict with the final 2006/07 NCMP figures, as published by the IC,[3] a complete set of PCT participation rates and prevalence figures has not been included in this report. The purpose of this report is not to provide specific local results, but an understanding from national-level analysis that can be used to inform local uses and analysis of NCMP data.

3 Participation rates

3.1 Headline figures and performance management

The IC's 'headline results' report showed that national participation rates were 83.2% for Reception and 77.9% for Year 6. Following additional data cleaning these have reduced slightly to 82.4% for Reception and 77.2% for Year 6. With this additional cleaning,112 PCTs (74%) exceeded the 80% target participation rate for Reception and 87 PCTs (57%) for Year 6, compared with 116 (76%) and 90 (59%) respectively using the IC's method.

The 80% goal set for participation in the 2006/07 academic year has been increased to an 85% participation rate for 2007/08. In 2006/07, 80 PCTs (53%) achieved 85% participation for Reception, and 40 PCTs (26%) achieved this for Year 6.

These findings show that some PCTs will have substantially to improve participation rates in the 2007/08 academic year to achieve the expected 85%. A particular focus will be needed on Year 6 pupils if PCTs are to meet these goals for both school years.

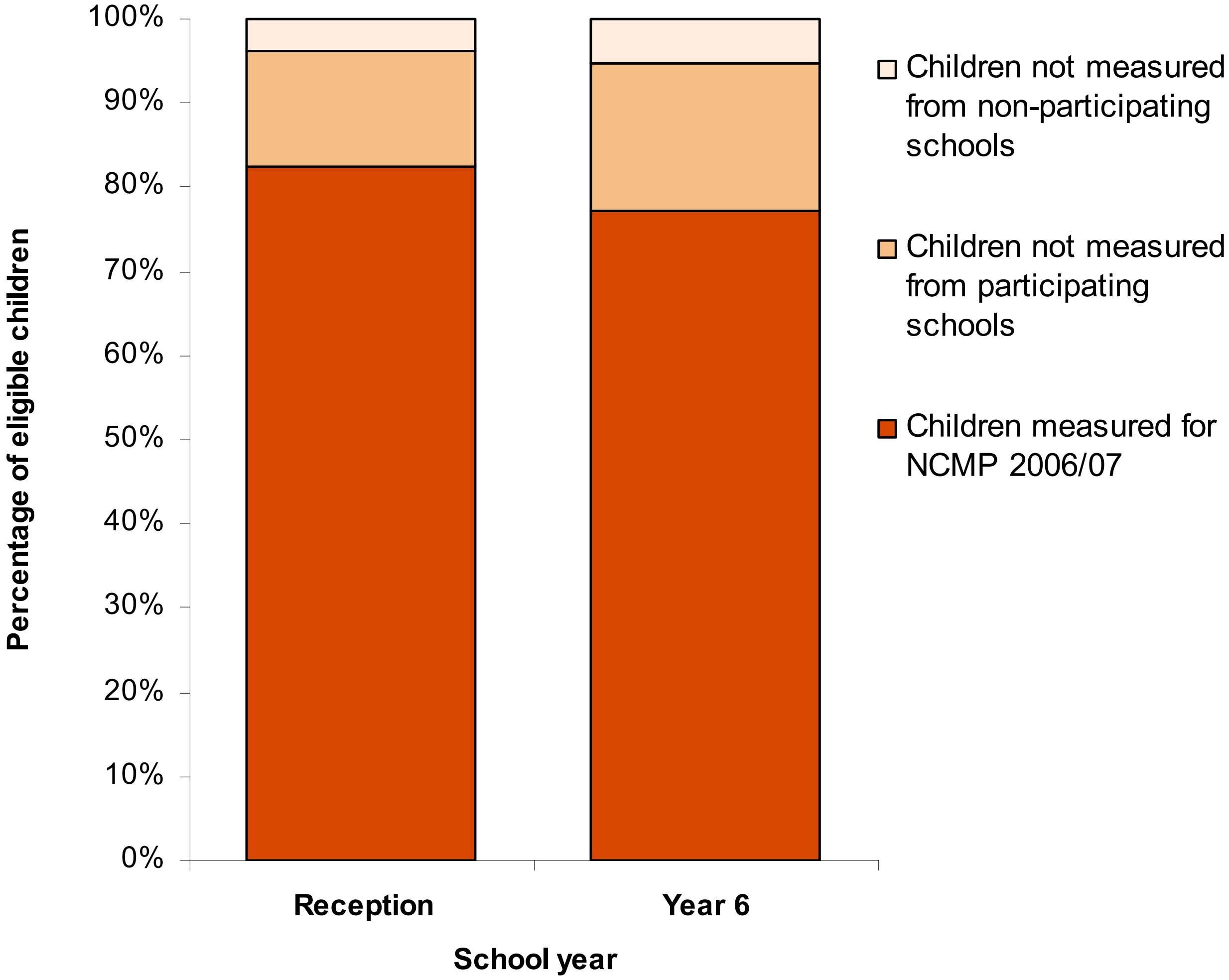
3.2 Breakdown of headline participation rate figures

PCTs are monitored on the total number of pupils measured, as compared with the number of pupils eligible to be measured within maintained primary schools within their PCT. Independent and special schools are not included in these figures and so are not included in this analysis.

When looking at participation rates, especially when considering the changes required to improve them, it is important to determine what proportion of children who were not measured did not participate because the school they attend did not take part in the NCMP and what proportion were not measured because of other reasons (such as parental opt out). This is an important consideration as the two types of non-participation require very different strategies to improve participation.

Figure 1 shows a breakdown of the headline participation rates based on these categories.

Figure 1: Participation rates by type of non-participation and school year



Nationally, 3.8% of all children in Reception, and 5.4% of those in Year 6 were not measured on a 'whole school' basis, i.e. as a result of their school year-group not being included in the NCMP. 13.9% of children in Reception and 17.4% of children in Year 6 were not measured on an 'individual' basis, i.e. children who were not measured even though other children of the same age in their school were measured for the NCMP.

Although it is mandatory for PCTs to collect NCMP data, it is currently not mandatory for schools to participate in the programme. Where no data are included for a school within the NCMP dataset this could therefore be for one of three reasons:

- The school refused to take part in the 2006/07 programme
- The PCT did not take measurements at that school
- Data were collected but were not entered into the data-capture tool.

It is hoped that, because PCTs have more time to make arrangements with schools for the 2007/08 data collection, and as the NCMP becomes more established in the third year of data collection more schools will participate. For the same reasons it is hoped the number of schools in which the PCT did not take measurements, often due to resource or time constraints or through uncertainty about which schools they were responsible for, will naturally reduce for the 2007/08 academic year. The issue of some of the data collected from schools not being entered into the national database should also reduce as PCTs become more aware of which schools they are responsible for submitting data for and of the systems used locally to store and extract child measurements.

Tackling non-participation where the school does not take part in the NCMP might prove to be the easier of the two types of non-participation to tackle. Such improvements could result in a 4-5% increase in participation rates at national level, but substantially bigger increases for some PCTs.

The main type of non-participation occurs where some children attending an eligible school have been measured but others are not included. Again this could occur for a number of reasons:

- Some children were absent on the day of measurement
- Children, or their parents, opted out of measurement
- The PCT did not attempt to measure all children
- Data were collected but were not entered into the data-capture tool or were excluded owing to invalid data fields.

Absence rates in primary schools are currently about 5.2%,[4] so this factor alone can probably explain about one third of the pupils not measured in this way. To what extent the remaining 10% of children are likely to have opted out of the programme, or not been measured by the PCT for other reasons, cannot be determined from the NCMP data alone.

In 2006/07 some information was collected from PCTs on the number of pupils opting out of the programme. This was an optional field and data were supplied by around a third of PCTs (see section 3.5). The figures returned show substantial variation between PCTs, from less than 1% to just under 17% of all eligible pupils for both Reception and Year 6, and so cannot be reliably used to draw conclusions about the overall rate of individual opt-out at national level.

This information supplied by PCTs does suggest though that the degree of opting out of NCMP measurements was greater for Year 6 than for Reception. The average proportion of eligible children reported to have opted out of the programme was 3.5% for Reception, but 6.4% for Year 6. This lends support to anecdotal claims that older children are more likely to have concerns about their weight or height and having this measured and recorded as part of the NCMP. Additionally, some PCTs routinely take a number of health measurements around a child's fifth birthday. As a result, many Reception NCMP measures are taken as part of a routine general health check and children may be less likely to opt out of such measurements than when data are being obtained solely for the purposes of the NCMP.

The Cross-Government Obesity Unit has made available an information flyer and short film clip for children to help explain and answer their queries about the measurement process.[5]

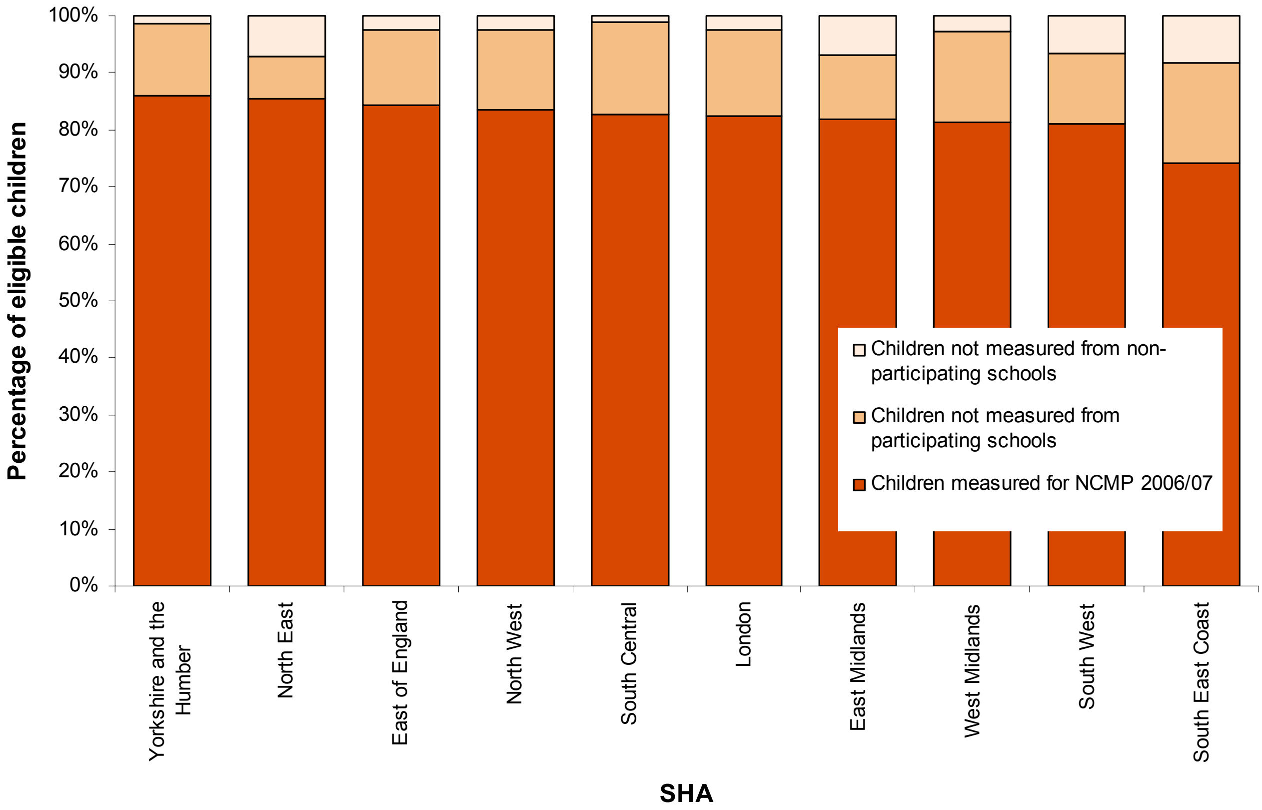
Because a greater proportion of the children who were not measured for the NCMP were omitted because of individual rather than school-level non-participation, the biggest improvements in national participation rates will be achieved through PCTs attempting to get full coverage of children when they attend schools to take measurements. Ensuring non-participating schools are included in the 2007/08

NCMP is important, but even if the participation of all schools was achieved, this could not boost participation rates to the same extent as eliminating individual opt-out or absenteeism.

3.3 Regional variation in participation rates

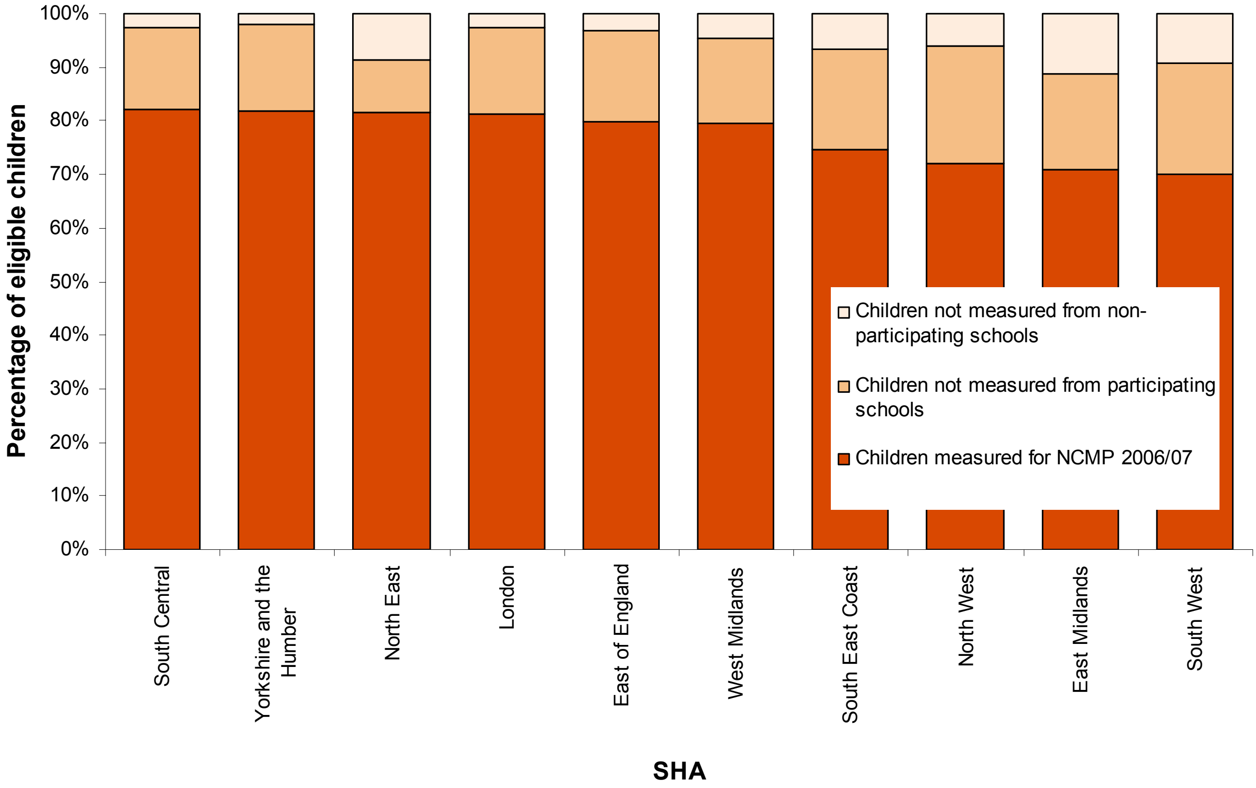
The IC's report shows that participation rates did vary substantially between PCTs*. Figures 2 and 3 below show variation in participation between Strategic Health Authorities (SHAs). Participation rates ranged from 74.1% in South East Coast to 86% in Yorkshire and the Humber for Reception, and 70.2% in the South West to 82.2% in South Central for Year 6.

Figure 2: Rates of participation and type of non-participation by SHA for Reception



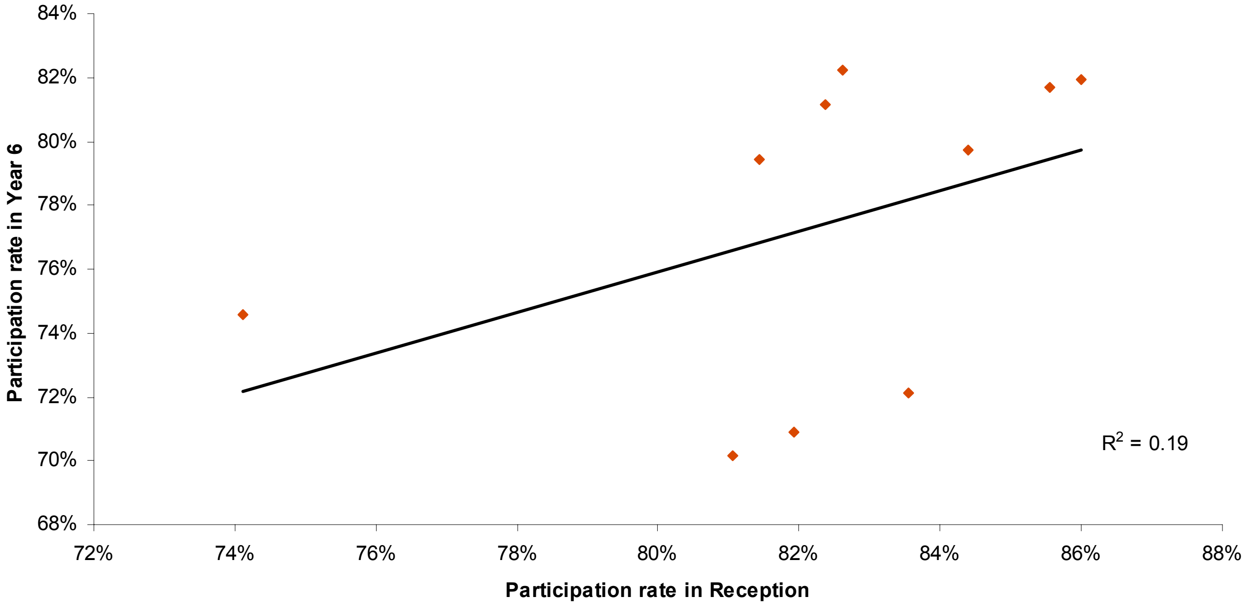
* See figures 1 and 2 in the IC report

Figure 3: Rates of participation and type of non-participation by SHA for Year 6



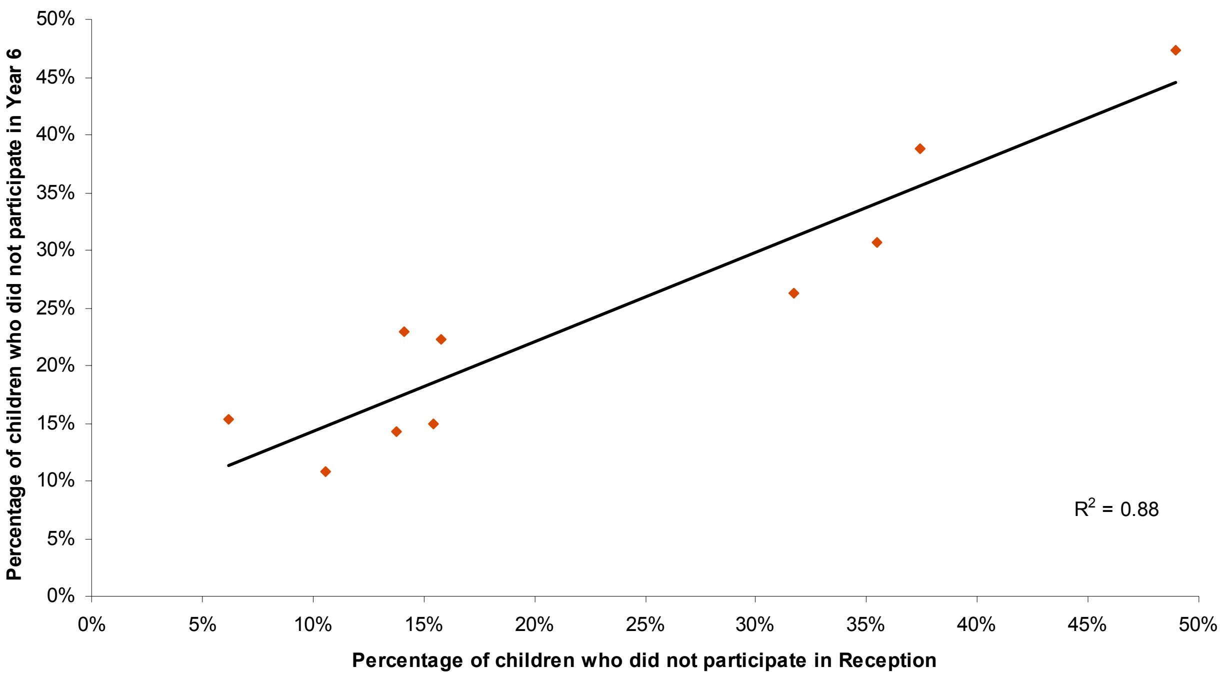
The correlation between Reception and Year 6 participation rates is not strong, (Figure 4) and is not statistically significant. Only 19% of the variation in Year 6 participation rates can be explained by the participation in Reception, and due to the small number of SHAs there is a high probability this relationship has arisen by chance (p=0.212). This lack of correlation is likely to indicate regional differences in the factors affecting participation in each school year, for example the extent to which regions already had routine surveillance of one age group.

Figure 4: Correlation between SHA participation rates for Reception and Year 6



Although the overall participation rate in Reception and Year 6 is not closely linked at SHA level, the proportion of children who did not participate due to whole schools not being measured is more similar between school years. 88% of the variation between SHAs in the proportion of Year 6 pupils who did not participate on a whole school basis can be predicted by the same measure for Reception, (Figure 5). This relationship is highly statistically significant, despite the low number of data points ($p<0.001$). It is possible that this close correlation is partly a result of the same schools not participating in both years' measurements.

Figure 5: Proportion of all non-participating pupils attending schools in which the whole school year was not measured, by SHA and school year



For North East SHA nearly half the pupils who did not participate attended schools in which the whole school year was not measured. By contrast, for South Central, London and Yorkshire and Humber SHAs, less than 15% of the non-participating pupils in either school year attended schools in which no measurements were taken.

These figures suggest that approaches to improve participation rates may differ across SHAs. For each SHA, the relative focus on school or individual non-participation should be similar for both Reception and Year 6.

3.4 PCT level variation in participation rates

Both overall participation rates at PCT level and the nature of non-participation also show substantial variation (Figures 6 and 7).

Figure 6: Participation rates and type of non-participation by PCT for Reception

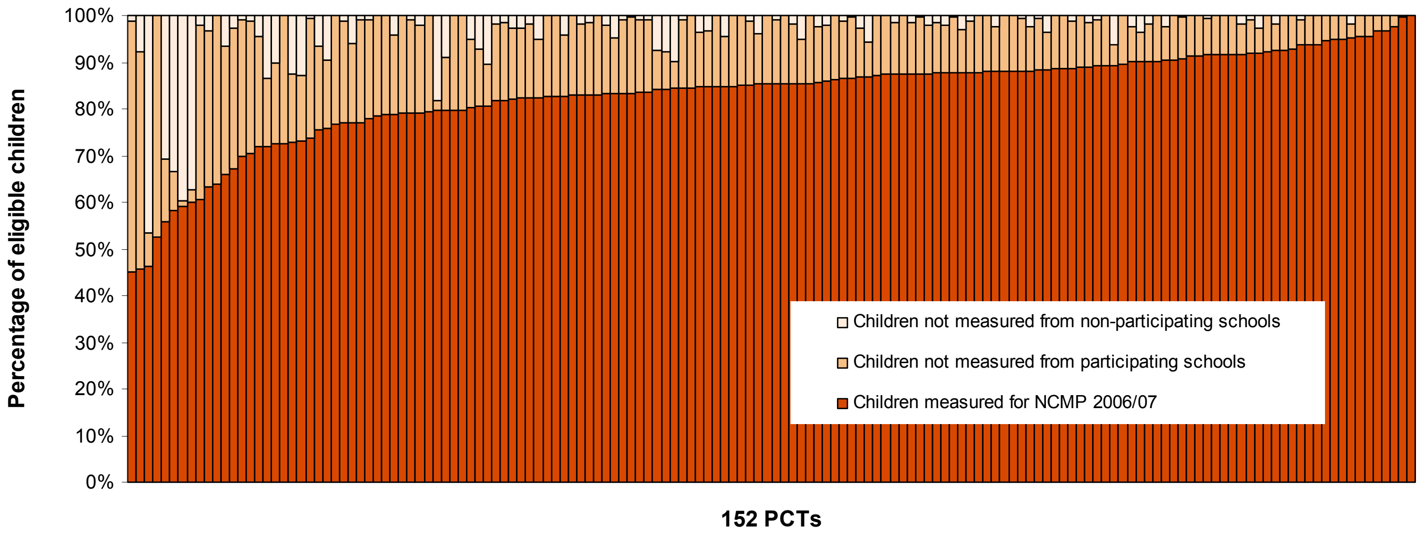
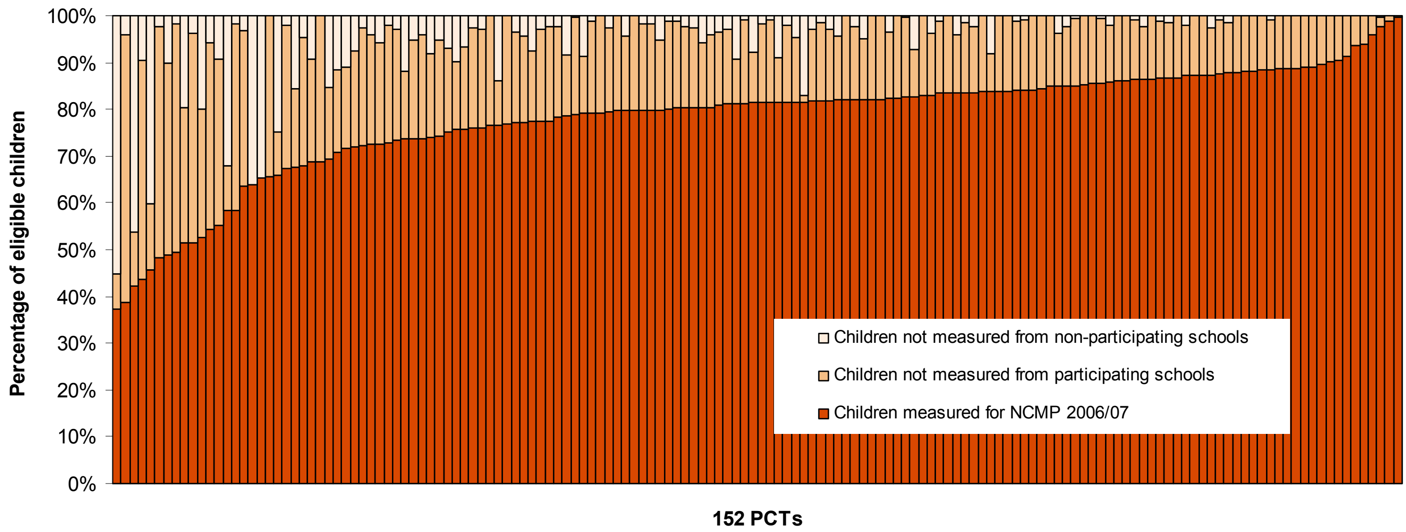


Figure 7: Participation rates and type of non-participation by PCT for Year 6



Figures 6 and 7 show that PCT participation rates vary substantially, from 45% to 100% in Reception and 37% to 100% in Year 6. In general, those PCTs which obtained good participation rates in Reception also managed the same in Year 6, though only 29% of the variance in Year 6 participation can be predicted by the participation rate for Reception.

Equally substantial differences exist between PCTs in terms of the reasons why some pupils were not measured. In both school years, a few PCTs obtained near to 100% participation of children in schools in which they took measurements, though such PCTs may still have not included up to 40% of eligible pupils because they did not measure in some schools. By contrast, some PCTs took measures in all schools eligible for inclusion, yet the low percentage of children being measured within these schools could result in around 50% of eligible children not participating in the NCMP.

As with SHAs, a relationship exists at PCT level between the reasons for non-participation in Reception and Year 6. 61% of the variation in the proportion of Year 6 children not included because PCTs did not measure any children in that school year can be explained by the same measure for Reception ($p<0.001$). Again this is likely to be because the same schools, with both Reception and Year 6 pupils, opted out of both years of measurements. In general, PCTs in which the biggest issue is coverage of schools (rather than coverage of individuals) will find the same issues relate to both Reception and Year 6, though a few PCTs do display very different patterns for Reception than for Year 6.

As with SHAs these findings suggest that the strategies PCTs use to improve their NCMP participation rates should depend upon the specific reasons for non-participation in 2006/07. It is recommended that PCTs routinely analyse their own participation rate data in detail to inform how best to improve participation rates.

3.5 Opt out of individual children at PCT level

In 2006/07, the data-capture tool provided PCTs with the opportunity to enter information on the number of pupils who opted out of the NCMP. 43 PCTs returned such information for Reception and 54 for Year 6 (i.e. about a third of all PCTs).

Two PCTs were excluded from the analysis. One of them returned a figure for the number of pupils opting out that was higher than the number of pupils who were not measured for both school years (according to the figures entered for their school-level pupil denominators). Although it is likely that the problem here lies with the pupil numbers entered rather than the opt-out figure, this PCT has been excluded from the analysis below as the overall proportion of children reported to have opted out was incorrect.

One additional PCT returned opt-out information for both year-groups combined. Data for this PCT has been excluded from the following analysis since it is not know how the number of children opting out would have been allocated between Reception and Year 6.

For PCTs that returned valid information, the reported proportion of all eligible children who had opted out of the programme ranged from less than 1% to nearly 17% of pupils for both Reception and Year 6. As a proportion of the number of children who did not participate in the 2006/07 NCMP, opt-out of individuals accounted for between 0% and 100% of non-participating pupils across these PCTs, again in both year groups. The distributions of these opt-out rates for both Reception and Year 6 are shown in Figures 8 and 9.

Figure 8: Reception children who opted out of NCMP as a proportion of all children eligible for measurement and as a proportion of all non-participating children

42 PCTs included in analysis

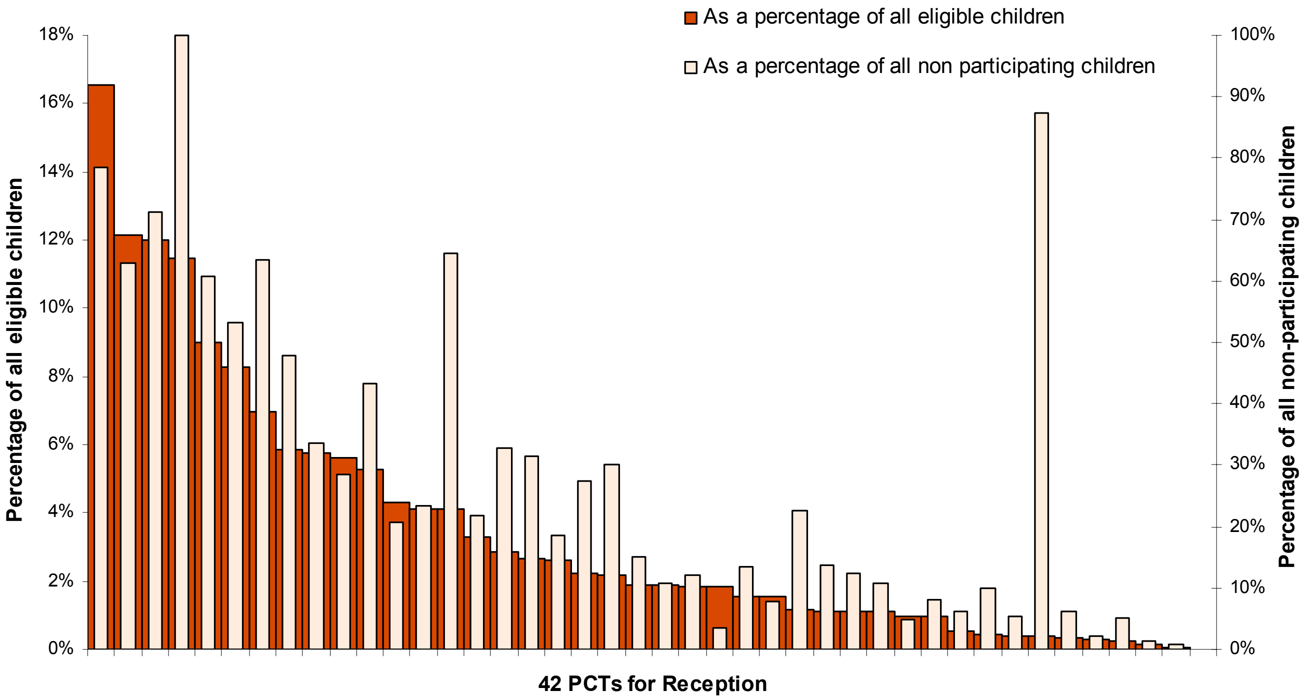
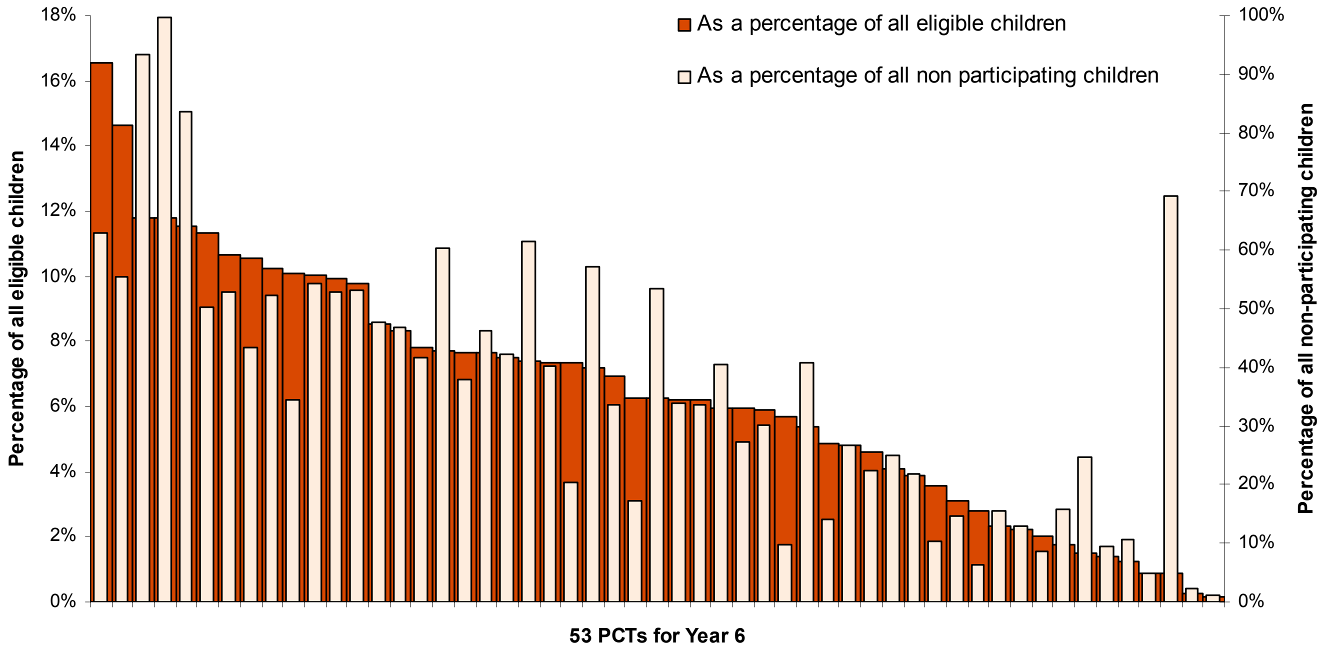


Figure 9: Year 6 children who opted out of NCMP as a proportion of all children eligible for measurement and as a proportion of all non-participating children

53 PCTs included in analysis



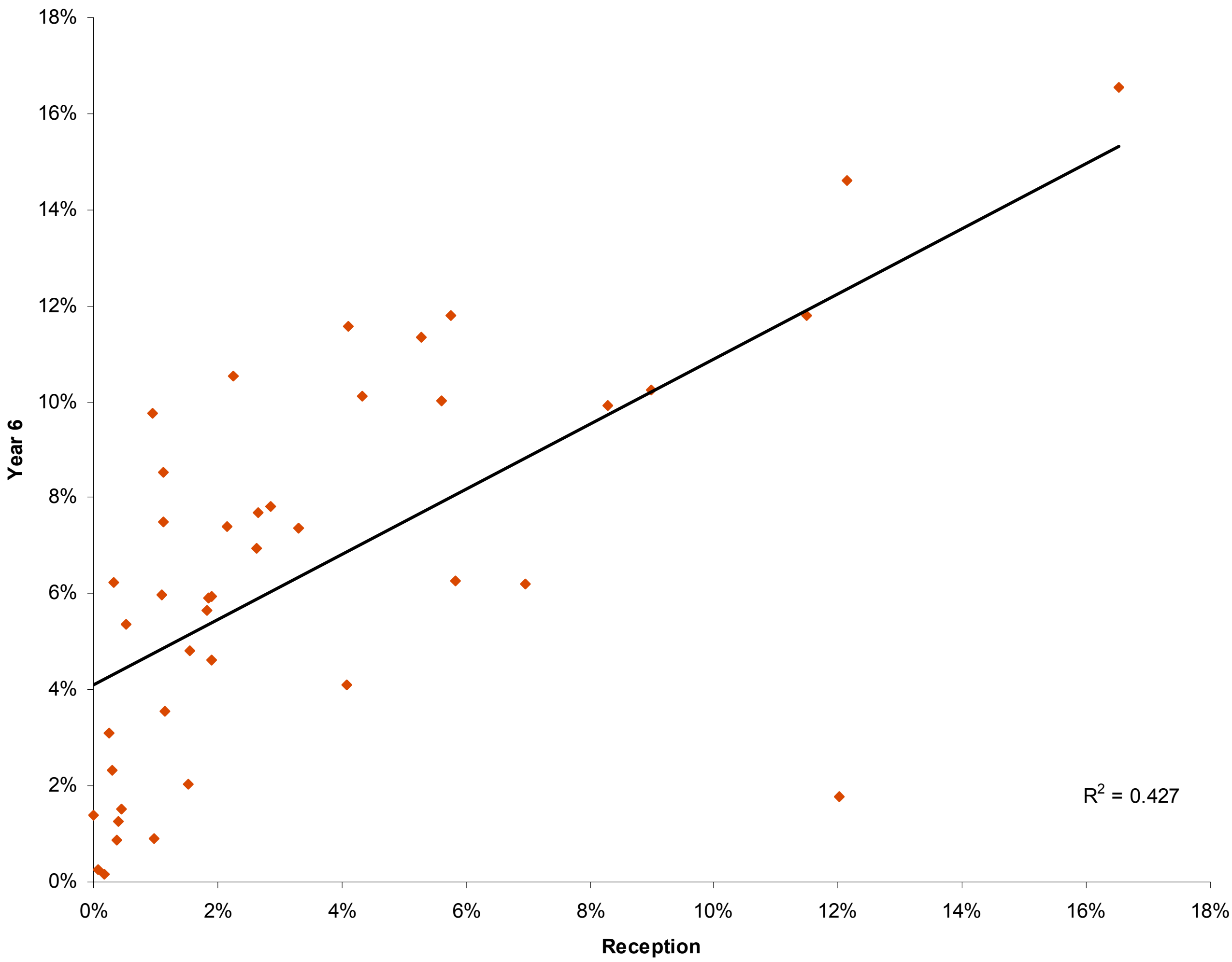
Figures 8 and 9 show that the degree of parent or child opt-out in both school years varies substantially between PCTs. As discussed in section 3.2 the average opt-out rate across all PCTs that returned information is higher for Year 6 than for Reception.

Furthermore, the proportion of non-participating children which can be accounted for by individual opt-out also shows substantial variation. For some PCTs this is the single barrier to achieving 100% participation rates, whereas for other PCTs individual opt-out accounts for only a small proportion of children who were not measured.

Figures 8 and 9 have been ordered independently by the proportion of all eligible children opting out of the NCMP measurements. PCTs are thus not presented in the same order in both figures so comparisons cannot be made between the figures to determine the relationship between opt-out rates in Reception and Year 6. There is a strong correlation between the degree of reported opt-out between the two age groups. Figure 10 shows the degree of similarity between the proportion of all eligible children opting out of the NCMP in Reception compared with that in Year 6.

Figure 10: The proportion of all eligible children reported to have opted out of the NCMP by school year

All 42 PCTs who returned valid information on opt-out for both school years are included



43% of the variation in Year 6 opt-out rates can be predicted by the opt-out rate in Reception, although in general the rates of opt-out are higher in Year 6 than in Reception: in general if it is high for one age group it is also high for the other.

It is important to note that the maximum reported opt-out rate exceeds 15% for both school years. PCTs have been asked to achieve a participation rate of over 85% in each school year for the 2007/08 programme. If individual opt-out by children or their parents exceeds 15% in some areas, PCTs will be unable to meet this target.

There is much that PCTs can do to ensure all eligible schools participate in the NCMP and that all children willing and available to be measured are included. There is also work that can be done to help ensure that children and parents understand the purpose of the programme and to try to minimise parental and child opt-out from the programme. The Cross-Government Obesity Unit has provided useful resources for parents and children.[6]

If a PCT's local data or anecdotal information identifies individual opt-out is a concern in their population, they might need to consider innovative approaches to attempt to encourage parents and children to participate in future years.

These analyses on individual opt-out should be treated with caution. Most PCTs did not have a method for routinely recording this information, and even if it has been recorded, some children might have stayed away from school on the day of measurement rather than opted out of the programme. It is recommended that, in future years, more PCTs attempt to record and supply this information to allow better understanding of the nature of participation rates, and what can be done to improve these, at both a national and a local level.

3.6 Conclusions

Although substantial improvements have been made since 2005/06, participation rates still need to improve if performance targets for 2007/08 are to be met. There is substantial variation in participation rates between both SHAs and PCTs, and areas that had high participation rates in one school year did not necessarily have high participation rates in the other.

At a national level, non-participation in the 2006/07 NCMP was due more to individuals not being measured than whole schools not being measured, but again there was substantial variation between areas. There is a significant correlation between the proportion of pupils not measured on a whole school basis in each school year, which may be a result of the some schools not being included in the NCMP for either school year.

Where individual pupils have not participated in the 2006/07 NCMP, it is clear that opt-out (by parents or children) is an important factor. Opt-out rates appear to vary substantially between areas, both in terms of the overall rates of opt out and the contribution of this factor to overall participation rates. Areas with high levels of reported opt out in Reception tend to report high levels of opt in Year 6.

Information on opt-out rates was incomplete in 2006/07 and PCTs are encouraged to try to collect this information on 2007/08 to enable more detailed analysis of this issue.

4 Prevalence figures of obesity, overweight and underweight

4.1 National prevalence of obesity and overweight

As shown in the IC's report, the reported prevalence of obesity was 9.9% in Reception and 17.5% in Year 6. The proportion of children classified as overweight was 13% for Reception and 14.2% in Year 6.

It is important to note that the NCMP 2006/07 uses the British 1990 growth reference (UK90) for BMI and the 85th and 95th percentiles to define children as obese or overweight according to age and sex.[7,8] This definition is commonly used in the UK for population monitoring. e.g. in recent Health Survey for England (HSE) reports. Some further discussion on the British 1990 growth reference is provided in the Ethnicity section of this report (section 9.3).

In the 1990 baseline population[†] 5% of children would have been classified as obese using this definition, with a further 10% classified as overweight. The 2006/07 NCMP prevalence figures show the substantial changes that have occurred in children's BMI over the past two decades – with the proportion of children classified as obese nearly doubling for children in Reception (i.e. aged 4-5 years) and increasing more than threefold for children in Year 6 (10-11 years) since the baseline. The rise in the proportion of children classified as overweight has been less marked, but has still shown a relative increase of 30% for Reception and 40% increase for Year 6.

The 85th and 95th percentiles are intended for use in population monitoring only, and do not provide the number or percentage of individual children clinically defined as overweight or obese. In the UK, the 91st and 98th percentiles are used in a clinical setting to classify individual children as overweight and obese respectively, though several other measures and indicators are usually taken into account before any clinical diagnosis is made. If the clinical thresholds were used to define rates of obesity and overweight, the reported prevalence of obesity would be substantially lower. NCMP prevalence rates defined with the 91st and 98th percentiles are: for obesity, 5.5% in Reception and 10.2% in Year 6; and for overweight (but not obese), 9.7% in Reception and 13.9% in Year 6.

As a result, when presenting prevalence rates based on the 85th and 95th cut offs in short reports where there is little room for additional clarification, it is preferable to avoid wording such as 'x percent of children are obese or overweight'. More appropriate wording may be 'x percent of children are classified as obese, as defined according to the UK90 95th percentile', or 'x percent of children are at risk of obesity'. The latter term is used in the NICE guidance on obesity[9] when discussing public health monitoring, though the guidance provides no formal recommendations on the definitions or terminology that should be used in such situations.

As announced in the government's *Healthy Weight, Healthy Lives* strategy, one of the first outputs of the recently established National Obesity Observatory (NOO) will be to examine the strengths and weaknesses of the various approaches currently available to classify children's BMI. This will examine both sets of UK90 cut offs, as well as other options such as the thresholds recommended by the International Obesity Task Force (IOTF) and the World Health Organization (WHO).

[†] Note the British 1990 growth reference is compiled out of data derived from a number of surveys conducted between 1972 and 1992.

4.2 National prevalence of underweight and healthy weight

Unlike the 2005/06 NCMP dataset, which only provided information on the number of overweight and obese children, the 2006/07 NCMP dataset now provides height and weight information on all children measured, including those who are underweight or a healthy weight. This allows for far more detailed analysis of the trends in BMI within the child population and fits with the government's new policy focus on a healthy weight across the population.

There is no agreed definition in the UK for classifying children as underweight for population monitoring purposes. A discussion of the issues around defining underweight was published recently in the BMJ (see the section 'choice of cut offs at age 18').[10] The 2nd percentile is most commonly regarded as the most appropriate threshold to use to define individual children as underweight but, in line with the use of the 85th and 95th percentiles to define obesity and overweight within the NCMP, a comparable classification of underweight for population monitoring purposes is most likely to be achieved by use of the 5th percentile.

The proportion of children within the 2006/07 NCMP dataset who are at or below the 5th percentile for BMI is 2.8% for Reception and 3.5% for Year 6. The equivalent figures using the 2nd percentile would be 1.3% and 1.5% for Reception and Year 6 respectively.

Again this does not mean that this proportion of children are clinically underweight but that, using the definition of the 5th percentile, 5% of children would have been classified as underweight in the 1990 baseline population. This proportion has now fallen by around 40% for Reception and 30% for Year 6.

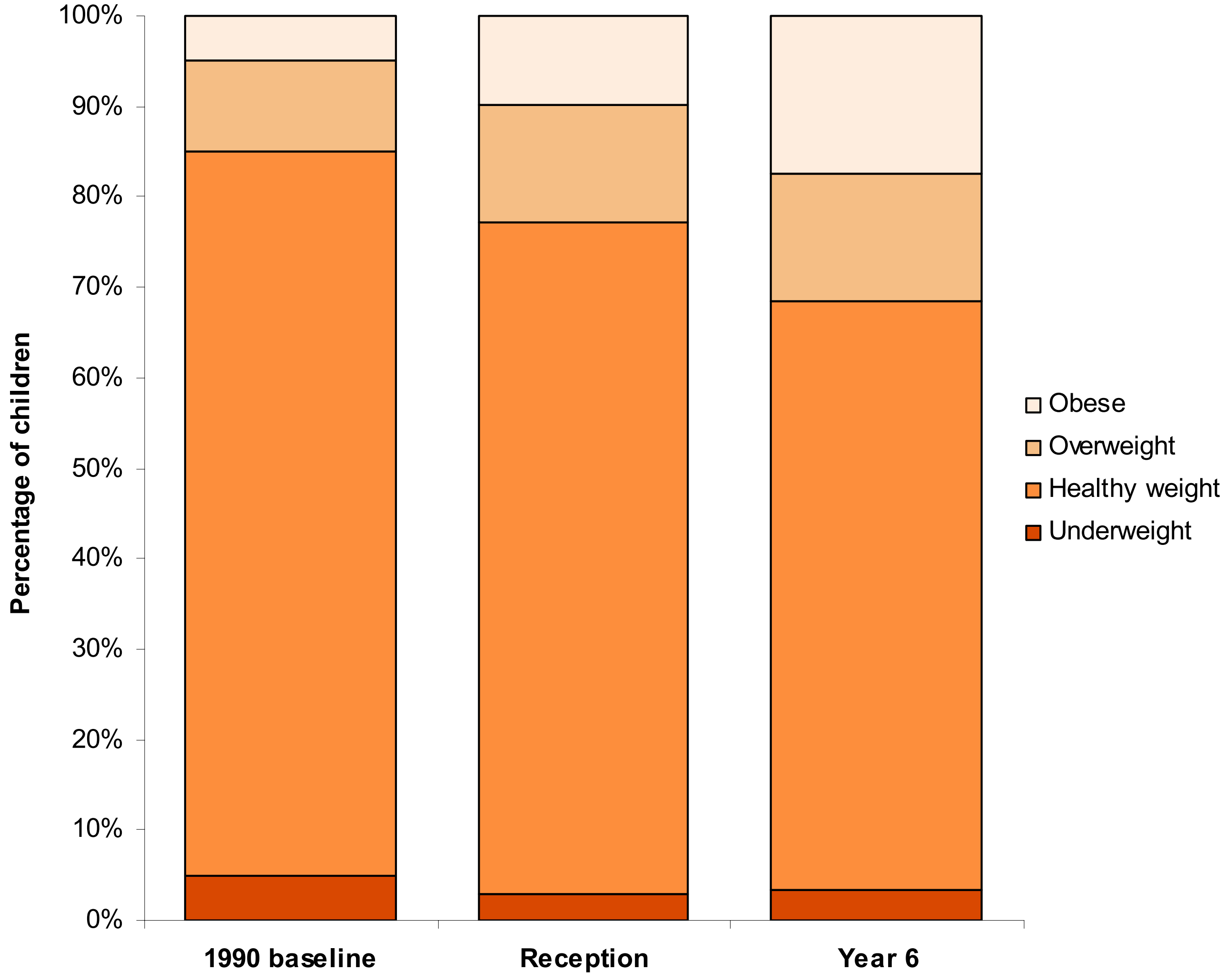
Although the largest increase in obese and overweight children has occurred for children aged 10-11 years, the biggest apparent reduction in underweight children has occurred for children aged 4-5 years.

The proportion of children classed as being at a healthy weight (according to the population monitoring definitions of the 5th-84.9th percentiles) would have been 80% in the 1990 baseline population for each school year. 2006/07 figures would be 74.3% for Reception and 64.9% for Year 6. Although the proportion of the population classified as having a healthy weight has fallen since 1990, mostly as a result of the increase in the percentages for obese and overweight, the decrease in the proportion of the child population at a healthy weight has been offset slightly by the small reductions in the proportion classed as underweight since the 1990 baseline.

Figure 11 shows the proportion of children classified as underweight, healthy weight, overweight and obese, according to the population monitoring cut offs for the 1990 baseline population, for Reception and Year 6 children from the NCMP 2006/07.

Figure 11: Comparison of children's BMI categorisation using 1990 baseline and NCMP 2006/07 populations

<5th percentile=underweight. 5th-84.9th=healthy weight. 85th-94.9th=overweight. ≥95th=obese.

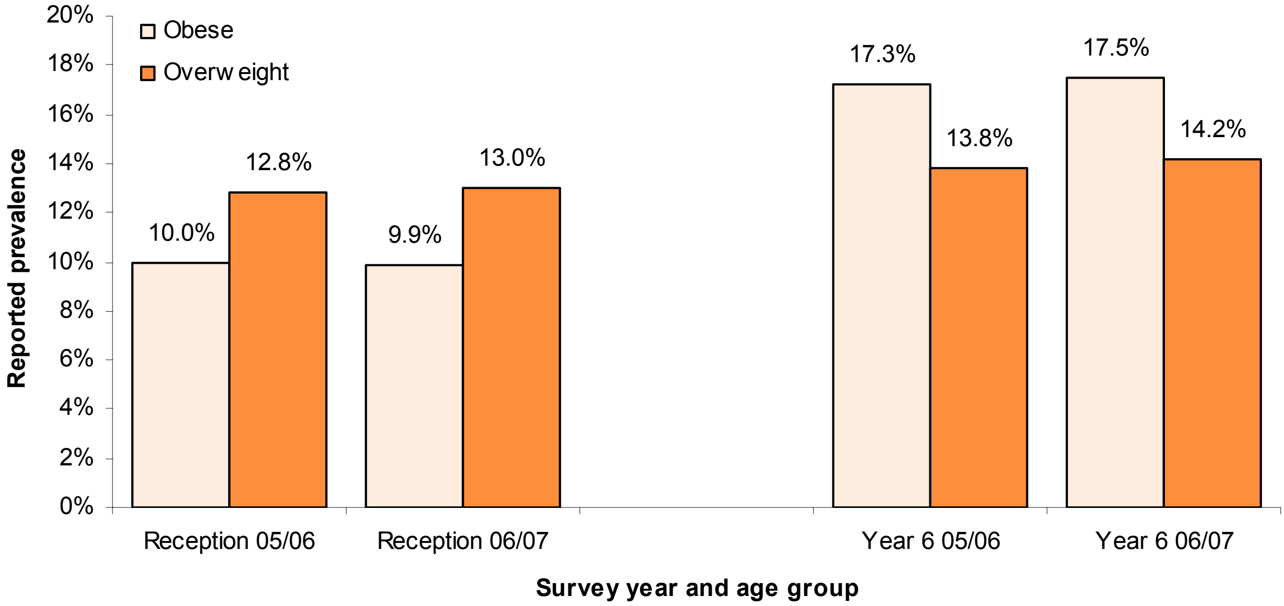


4.3 Comparison with 2005/06 NCMP data

As discussed in the IC's report, comparison with data from the 2005/06 NCMP is made difficult by several factors. It has been suggested that poor participation rates in the first year of child measurements might have reduced the reported prevalence of obesity due to a selective opt-out of overweight and obese children.[11] Additionally, poor coverage, which varies by region, means the resulting sample from 2005/06 may not have been nationally representative. Finally, some issues with data quality in the 2005/06 dataset could also have resulted in an under-recording of obese and overweight children.

Despite these difficulties, a comparison of prevalence figures at national level derived from the 2005/06 data with those from the 2006/07 NCMP can be used to inform our understanding of the NCMP data (Figure 12).

Figure 12: Comparison of national prevalence figures from NCMP 2005/06 and 2006/07

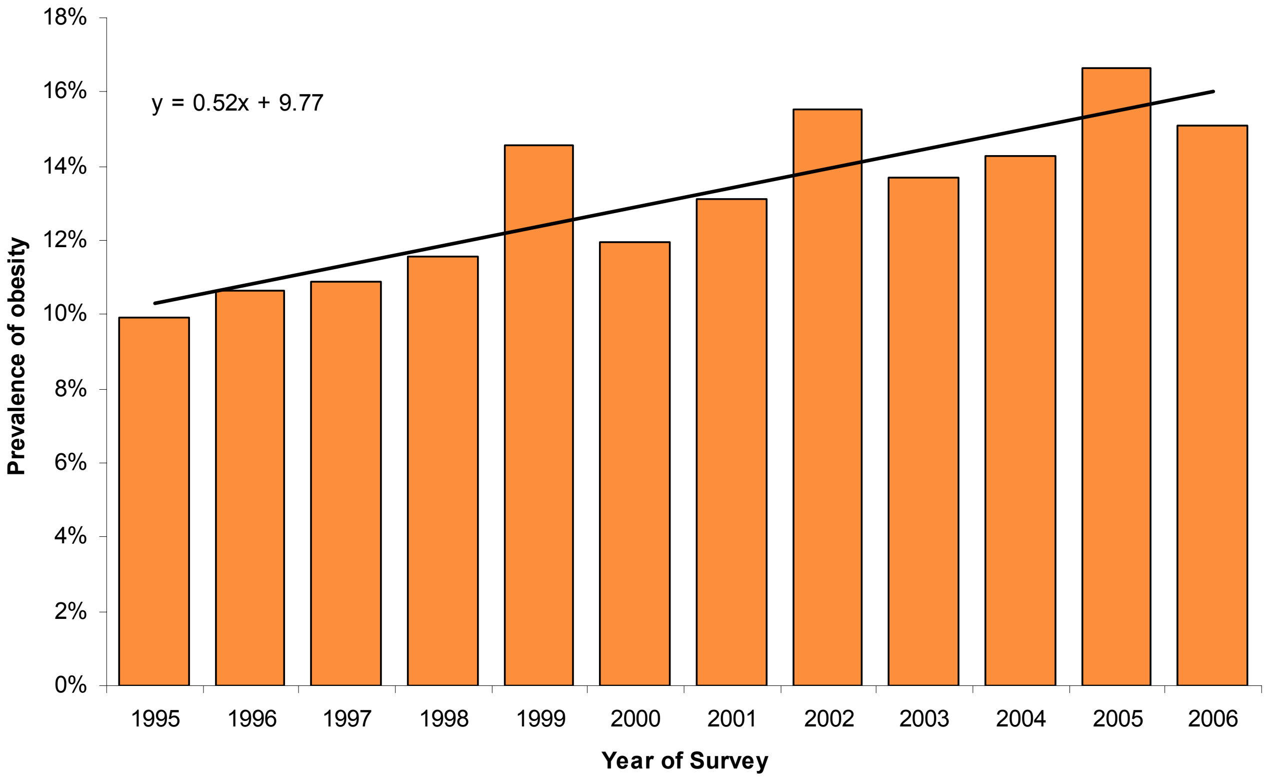


Due to the very large sample sizes, 95% confidence intervals around these prevalence figures of overweight and obesity are very small, and so are not shown in Figure 12. When comparing 2005/06 and 2006/07 results, prevalence of overweight and obesity show a small but significant increase at the 95% significance level in all groups except for rates of obesity in Reception, which do not differ significantly.

A substantial increase in reported prevalence of overweight and obesity from 2005/06 data was expected for several reasons. First, data quality issues with the 2005/06 dataset tended to be those which might artificially suppress the reported prevalence of obesity, and second, many improvements were made both in terms of participation rates and data quality for the 2006/07 NCMP.

Furthermore, evidence from the HSE shows that the prevailing trend of an increase in childhood obesity over the past 10 years has been in the region of 0.5–1% per year, as shown in Figure 13. In view of this trend, the changes in prevalence of obesity shown by the NCMP between 2005/06 and 2006/07 could be expected to be of this order, regardless of the data quality issues that have been tackled.

Figure 13: Trend in obesity prevalence for children aged 2-10, from Health Survey for England (1995 – 2006)



Because of the data quality issues and poor coverage in 2005/06, it is not possible to compare accurately NCMP results from present and previous years below national level, so more detailed analysis has not been conducted to examine the changes since the first year of the NCMP.

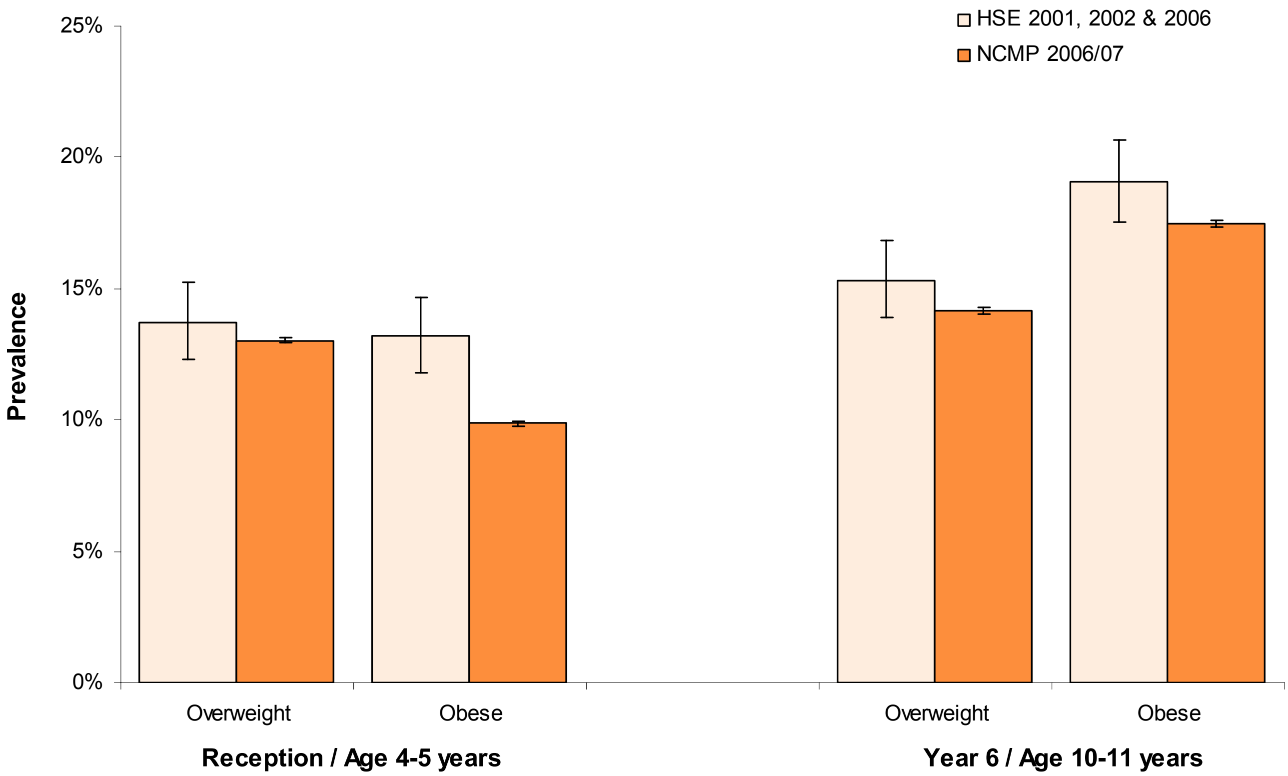
4.4 Comparison with HSE data

Comparison of the 2005/06 data with prevalence figures from the HSE for 2001/02 was presented in the 2005/06 NCMP report.[11] NCMP prevalence figures for obese and overweight, for boys and for girls, were lower than the equivalents from the HSE. Although most differences between the HSE and NCMP figures were not significant because of the size of the confidence intervals around the HSE data (with the exception of the figures for obese boys in Reception, which were significantly lower in the NCMP figures), the general pattern of lower prevalence for all age and sex groupings could be regarded as an indication that 2005/06 NCMP data might have under-reported prevalence of obesity and overweight.

The IC's report compares the 2006/07 NCMP data with the most recent HSE data (2006). Again the prevalence rates for obesity and overweight do not differ significantly, apart from obese boys in Reception, for which NCMP data again show significantly lower prevalence than the HSE equivalent, a finding which may be worthy of further investigation. In general, the NCMP data provide slightly lower prevalence figures than does the HSE for most age and sex groupings. For the 2006/07 NCMP data, this pattern is not across the board as it was in 2005/06, since overweight boys in both age groups show slightly higher (though not significantly different) prevalence in the NCMP data, but all prevalence figures for obese children are lower in the NCMP data than in the HSE.

A good comparison between HSE data and that from the NCMP can be made by combined HSE figures for 2001/02 and 2006 (Figure 14). 2002 and 2006 were 'boost years' for children in the HSE, which meant a greater number of children aged 2-15 were surveyed. Prevalence figures from these years are therefore more robust and can be produced for the specific age bands that relate to the NCMP sample. Obesity prevalence figures for 2001/02 combined have already been published,[12] and these figures have been combined with the 2006 data presented in the IC NCMP report to produce this figure.

Figure 14: prevalence of obesity and overweight from NCMP 2006/07 and HSE 2001, 2002 and 2006, with 95% confidence intervals



NCMP data show lower prevalence of obesity and overweight than the HSE equivalent in all cases, though the differences are only statistically significant at a 95% level for prevalence of obesity for children aged 4-5 years.

Although differences between NCMP and HSE prevalence data are non-significant, the repeated pattern of lower prevalence figures of obesity and overweight from the NCMP data is worthy of further investigation. Additionally, because the NCMP data for the 2006/07 academic year will have been mostly collected in 2007, it would be expected that these data would show a slight increase over prevalence figures from HSE 2001, 2002 and 2006 combined, in view of the historical rising trend in childhood obesity.

4.5 Conclusions

Comparison of 2006/07 NCMP with 2006 HSE data suggests possible under-reporting of the true obesity and overweight prevalence, though the wide confidence intervals around HSE data mean this is not conclusive. The minimal increase over the 2005/06 NCMP prevalence figures also supports this theory. As a result, it is worth considering the possible reasons why the 2006/07 NCMP data might still underestimate the prevalence of obesity and overweight.

One of, or more likely a combination of, a number of possible scenarios could have taken place:

I. The previous conclusion that 2005/06 NCMP data significantly underestimated prevalence was incorrect
II. The 2006/07 NCMP data still underestimates prevalence to some degree, despite the improvements in data quality and participation
III. The trend of a rise in childhood obesity of the order of 0.5-1% per year has slowed down
IV. Natural variation
V. HSE data routinely overestimates prevalence of obesity.

Scenario five is probably least likely, due to the rigorous sampling method used for the HSE, and the weighting applied to results to deal with some of the selection bias that does occur. In addition, the HSE covers a wide variety of health-related topics, so the likelihood of any selection bias affecting only overweight individuals is less than for the NCMP. The fourth scenario can also probably be discounted. Aggregate NCMP data should show very limited natural variation due to the very large sample size. Although HSE is subject to natural variation due to the limited sample size, the same suggestion of under-reporting has occurred with two years of HSE/NCMP comparisons, which suggests this may not be the reason. The third scenario is perhaps beyond the scope of this report, since it cannot be answered using NCMP data until robust measures have been collected from more than one point in time. Equally there is little more that can be done with 2005/06 NCMP data further to test for possible under-reporting of obesity prevalence. It is possible to use the 2006/07 NCMP data, though, to see if the second scenario might lead to the lower than expected estimates.

The 2005/06 NCMP dataset, in addition to the recognised data quality problems, was also highly aggregated, which prevented detailed analysis. The 2006/07 NCMP dataset, by contrast, provides a great deal more detailed information, which allows much more in-depth analysis to take place. Issues such as a selective opt-out of heavier children, which was identified as the most likely cause for the apparently low prevalence figures from 2005/06 NCMP data, or the effect of poor data quality can therefore be examined in more detail, and are discussed in the following sections of this report.

5 Participation and reported prevalence

In 2005/06 and 2006/07, anecdotal reports suggest that obese and overweight children within a school were more likely than healthy weight children to opt out of the programme, or to be absent on the day of measurement. If this occurs, such a selection bias could mean that ‘reported’ or ‘measured’ prevalence figures from NCMP data under-represent true prevalence.

As annex 7 of the IC’s report describes, analysis suggests that participation rate has a small but significant positive association with the measured prevalence of overweight and obese Year 6 children in the 2006/07 NCMP data. No significant association between participation rate and measured prevalence was identified for Reception. As a result, and as recognised in the IC report, the published reported prevalence figures from the NCMP dataset may underestimate the true prevalence of obesity and overweight in the child population.

Detailed analysis of this selection bias was not possible for the 2005/06 dataset since, in addition to the general data quality issues and poor coverage, accurate pupil denominators for PCTs were not available to calculate the accuracy of participation rates below SHA level. Some evidence of correlation between participation and prevalence of obesity could be detected at SHA level (unpublished analysis conducted by the South East Public Health Observatory (SEPHO) as part of the analysis of the 2005/06 NCMP dataset), but this was based on a small number of areas, and data quality problems mean these findings are not conclusive.

5.1 Calculating participation rates for examining the correlation with prevalence

The IC’s published analysis of the 2006/07 NCMP data, and the work done at SHA level with the 2005/06 NCMP dataset, compared the overall participation rate for the area with reported prevalence of obesity. It may be preferable to use a different method when testing for the effect of selective opt-out.

The overall participation rate for a PCT provides the total number of eligible children measured. The denominator used here includes children attending schools in which no measures were submitted. If no pupils within a school have been measured it is unlikely this is due to any selective opt-out of obese children, and so the potential effect on the reported prevalence of obesity or overweight is minimal.

To test for any correlation between individual opt-out rates and reported prevalence of obesity or overweight a new participation rate, based on the proportion of children measured in schools in which measurements were submitted, has been used. This ‘measured-school’ participation rate is calculated by dividing the number of children measured by a PCT in each school year by the sum of the pupil numbers in schools where measures were taken. This figure will be equal to, or higher than, the overall participation rate for that PCT.

Nationally, re-calculating participation rates in this way makes a small difference to the rates – an increase of 3.2% in Reception and 4.4% in Year 6. At PCT level though the differences can be substantial, with the participation rates for some PCTs more than doubling, and with absolute changes of over 40% in some cases.

Where a PCT has taken measurements in all eligible schools the ‘measured-school’ participation rate will not differ from the overall participation rate. By contrast, for those PCTs who did not measure a large proportion of children on a 'whole school' basis, their 'measured-school' participation rate can be very high, despite their overall participation rate being very low.

It is likely that the 'measured school' participation rate provides a better approximation of the rates of opt-out of individual children, though even this rate cannot provide an accurate indication of the rate of opt-out, as in some cases PCTs may not have measured all children in those schools where measures were taken due to other reasons, such as resource or time restrictions preventing measures being taken of all children who were willing to be measured for the NCMP.

5.2 The correlation between participation and reported prevalence

When testing for a correlation between two sets of variables, such as participation rates and prevalence of obesity or overweight, it is important to consider the precision of each data point being examined. For PCT prevalence figures using NCMP data this is particularly important, as typical 95% confidence limits around the prevalence figures produced can be in the region of +/- 1–2% for each PCT. This is primarily dependant on the size of the population measured.

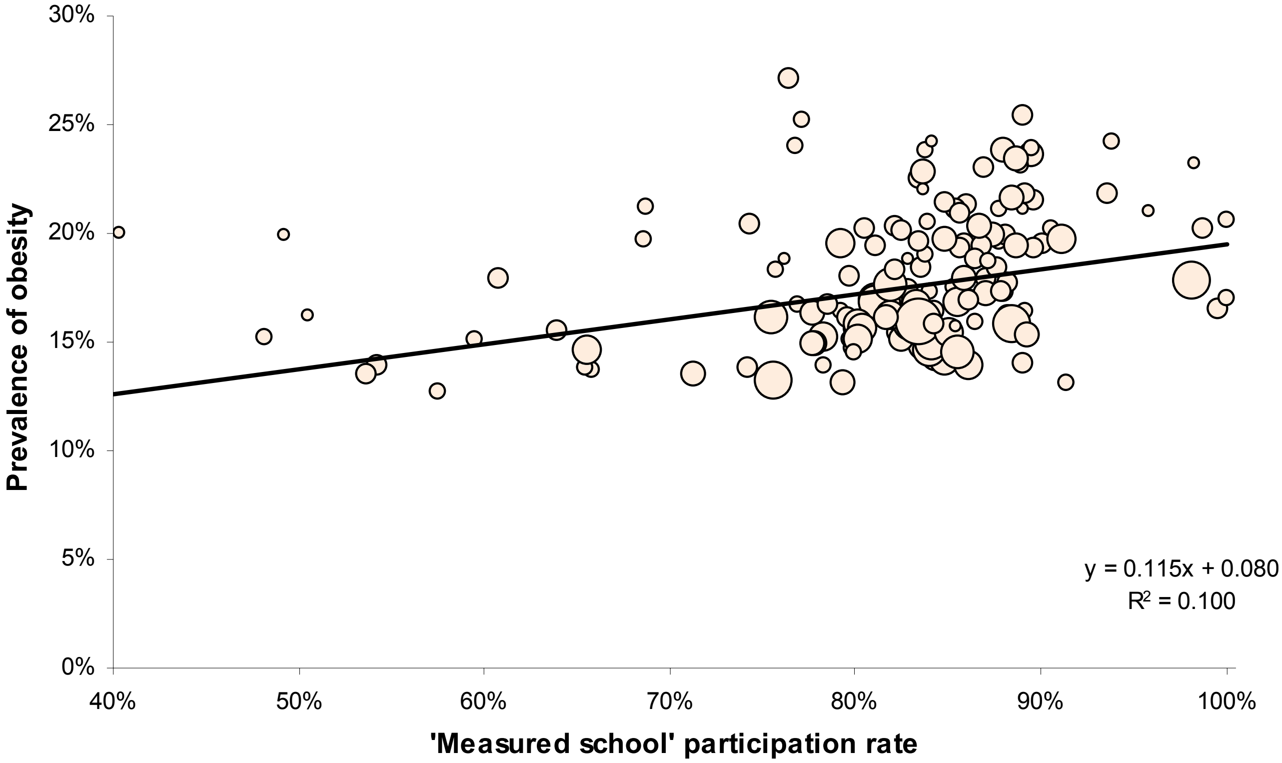
As a result, to test for a correlation between participation rates and prevalence of childhood obesity and overweight, weighted linear regression has been used, with the data points weighted by the number of children measured by each PCT in the relevant school year. This places more emphasis on those data points which are based on a larger number of children measured, as the prevalence figures for these PCTs will be more reliable.

Table 1 shows the results of weighted linear regression between participation rates and reported prevalence of obesity and overweight for Reception and Year 6, and the relationship between participation rates and obesity prevalence for Year 6 is shown in Figure 15.

Table 1: Results of weighted linear regression between PCT participation rate and reported prevalence of obesity and overweight for Reception and Year 6

Dependant variable	Coefficient of determination	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Reception obese	<0.001	0.004	0.020	0.820
Reception obese and overweight	<0.001	0.001	0.032	0.981
Year 6 obese	0.100	0.115	0.028	<0.001
Year 6 obese and overweight	0.110	0.141	0.033	<0.001

Figure 15: Reported prevalence of obesity and 'measured-school' participation rate by PCT for Year 6 measures, with trend from weighted linear regression



In figure 15, and in all subsequent figures that present the findings from weighted linear regression, the size of the circles represents the number of children measured per PCT. A larger circle means that datapoint is based on a greater number of children measured, and it receives a higher weighting in the regression analysis.

The results shown in Table 1 support the conclusion in the IC's report that participation rates have no effect on reported prevalence of obesity or overweight for Reception. Less than 0.1% of the variation in prevalence figures for Reception is explained by the variation in participation rate, even when the 'measured-school' participation rate and weighted data points (according to the number of children measured) are used.

By contrast, use of the 'measured-school' participation rate highlights the effect of participation rates on the reported prevalence of both obesity and overweight in Year 6. For Year 6, 10% of the variation in prevalence of obesity between PCTs can be explained by the participation rate, and 11% of the variation in prevalence of overweight and obese children.

The strength of this relationship is shown to be greater when using this method than when using the methods employed in previous studies. A 10% increase in participation rate will, on average, result in an increase of 1.15% (95% confidence intervals 0.6–1.7%) in the reported prevalence of obesity.

5.3 The effect of selection bias on Year 6 prevalence figures

The analysis above shows evidence of a significant selection bias in the Year 6 measurements. If those children who did not participate were equally likely to be obese or overweight as those who did participate, the participation rate would have no effect on reported prevalence of obesity or overweight. The observed effect on prevalence is therefore probably due to non-participating children being more likely to be overweight or obese than those who have been measured.

This finding has important implications both for the use of NCMP data to compare figures between PCTs and changes over time, but also as a source of robust prevalence figures for the child population as a whole.

'Measured-school' participation rates for Year 6, i.e. excluding those schools where no measures were taken from pupil denominators, range from 40% to 100%. This means that, within the 2006/07 dataset, figures for those PCTs with the lowest participation rates might underestimate Year 6 obesity prevalence by somewhere between 3.6% and 10.2%. As a result, comparison of Year 6 prevalence figures for two PCTs with very different participation rates, comparing prevalence for a PCT with a particularly high or low participation rate to the regional or national average, or comparing a PCT's Year 6 prevalence figure at baseline to a future year (should participation rates differ between the years of measurement), could all be affected by the impact of participation rates.

Perhaps more importantly, the average Year 6 PCT participation rate for schools where measures were taken was 82.1% in 2006/07, so 17.9% of pupils in these schools did not participate for some reason – potentially owing to selective opt-out of overweight and obese children. This means that on average Year 6 PCT obesity prevalence figures might underestimate the true prevalence of obesity in their area by somewhere between 1.1% and 3%, though the confounding effects of other variables (such as socioeconomic deprivation) need to be considered before making such predictions (see sections 9 and 10).

5.4 Adjustment of NCMP prevalence figures for selection bias

It is possible to use these findings to adjust the published national Year 6 prevalence figures to take account of the possible effect of this selective opt-out of obese and overweight children. If the regression coefficients described in Table 1 are applied to individual PCT's figures, assuming that all Year 6 children attending schools where some measurements were taken had been measured, the resulting adjusted number of obese children per PCT can be summed to produce estimates of the true national prevalence of obesity and overweight.

This approach suggests the true prevalence of obesity for the Year 6 population is actually between 18.5% and 20.5%, rather than the 17.5% previously published. Likewise the prevalence of obesity and overweight is higher than the published figure if adjustment is applied (32.9–35.5% *vs* 31.6%).

Although the 2006 HSE figures are available split by sex, it is not possible to perform the adjustment for participation outlined above by sex, as participation rates cannot be accurately determined for males and females separately. To make such a comparison the HSE figures for males and females must be combined.

2006 HSE data shows the average prevalence of obesity for boys and girls combined in Year 6 is 18.9% (95% limits 16.4%-21.4%) and for overweight and obesity combined is 34.0% (30.9%-37.2%). The published NCMP prevalence figures are 17.5% for obesity and 31.6% for obesity and overweight combined, lower than the HSE figures. In contrast, Year 6 figures adjusted for participation are 19.5% for obese and 34.1% for overweight and obesity (using the midpoints of the predicted range) - considerably closer to the HSE figures.

These adjusted prevalence figures are marginally higher than those from the HSE, in line with what might be expected. Unfortunately, the large confidence limits and large annual year-on-year variation around HSE figures (as a result of the small numbers sampled), as well as the lack of certainty about this methodological approach, mean caution should be taken and these figures cannot simply be used in place of the published national NCMP prevalence figures.

5.5 Prevalence and opt-out rates

This analysis provides some evidence of a selection bias in Year 6 NCMP data and shows that selection bias has the potential to affect significantly reported prevalence of obesity and overweight. However, the findings are not conclusive and still warrant further investigation.

For instance, this analysis assumes that all PCTs with a participation rate of less than 100% are affected by the same rate of selection bias, yet this is unlikely to be the case. The ‘measured-school’ participation rate used is the best available approximation of the amount of selective opt-out that occurred in each PCT, but does not provide an exact measure of this variable. Some PCTs did not measure 100% of pupils in all schools in which they took measurements as a result of resource issues – perhaps only having adequate time or staff to measure one of two Year 6 classes in a school. In such cases, the opportunity for selection bias to arise is limited, and the effect on reported prevalence is far less than in a PCT in which the pupils did not participate mainly owing to individual, and possibly selective, opt-out.

As described in section 3.5 some information is available on the proportion of all eligible children who opted out of the 2006/07 programme. Although not available for all PCTs and only an approximate measure of actual opt-out, this information can be used to verify the analysis performed with participation rates.

Repeating the weighted linear regression analysis described in section 5.1 for just those PCTs who provided information on opt-out rates, indeed lends support to the earlier findings using the ‘measured-school’ participation rate (see Table 2). These make interesting comparison with Table 1.

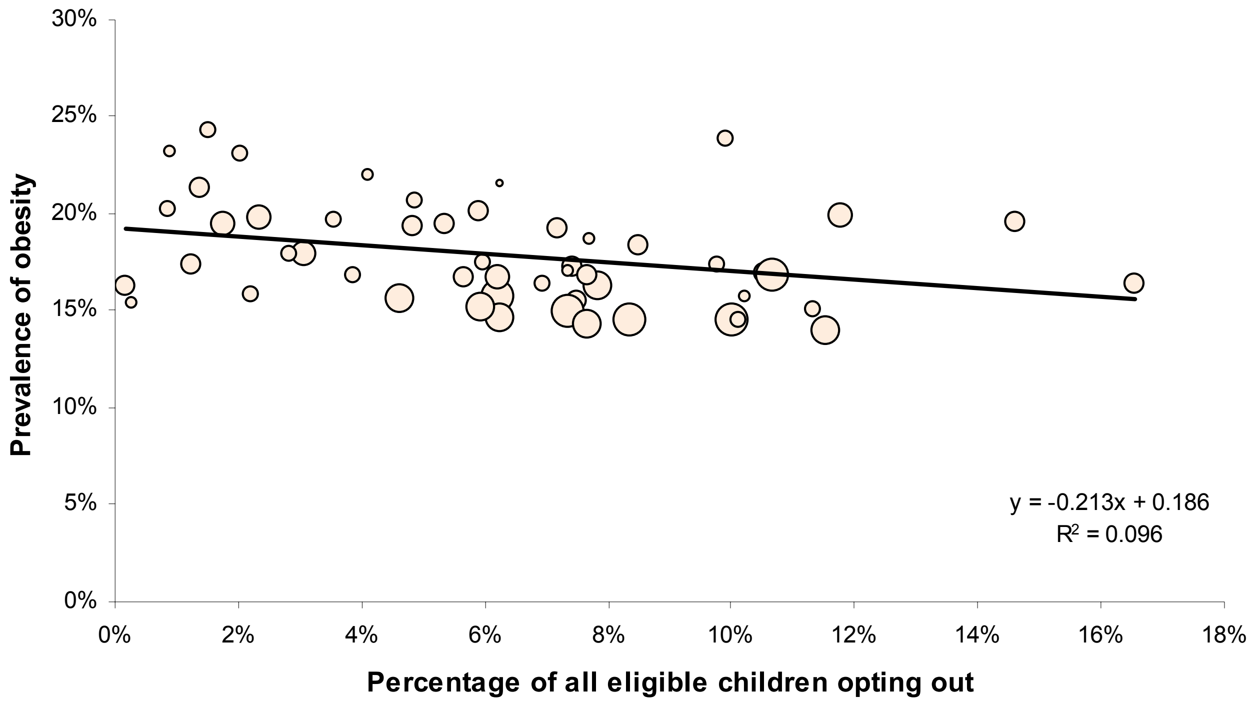
Table 2: Results of weighted linear regression between PCT opt-out rates and prevalence figures for Year 6

Dependant variable	Coefficient of determination	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Year 6 obese	0.096	-0.213	0.091	0.024
Year 6 obese and overweight	0.100	-0.256	0.107	0.021

9.6% of the variance in obesity prevalence figures between the 53 PCTs who provided opt-out information can be explained by the proportion of all children who opted out of the NCMP measurements (Figure 16). 10% of the variance in prevalence of obesity and overweight can be explained by the PCT’s Year 6 opt-out rate. No significant correlation exists between prevalence rates and opt-out rates for Reception.

Figure 16: Prevalence of obesity and the proportion of all eligible children reported to have opted out of measurements for Year 6, and the trend from weighted linear regression

All 53 PCTs who returned valid opt-out information



The slope of this line shows that for every 5% of children in a PCT who withdraw from NCMP measurements, the reported prevalence of obesity falls by an average of 1.1% (95% confidence intervals 0.1–2%). Confidence intervals are wide since this analysis is based on only 53 PCTs, but does suggest that, for those PCTs with the highest reported opt-out rates of around 17%, the reported prevalence of obesity from NCMP data might underestimate the true prevalence by around 3.6% (95% confidence intervals 0.5–6.7%).

5.6 Conclusions

Further analysis into this issue would benefit from more detailed feedback on the number of children opting out of the NCMP being obtained from all PCTs, as well as information on the number of children absent from school on the day of measurement. If more PCTs supply information on individual opt-out of pupils in the 2007/08 data collection this will enable more detailed analysis with the next NCMP dataset.

Although the NCMP data has undergone substantial cleaning and quality controls, some aspects, in particular pupil numbers, are likely in places to contain some inaccuracy which might affect our analysis of participation and reported prevalence of obesity or overweight. Pupil numbers at school level are still noticeably inaccurate in many places – for example where the number of pupils measured for a school year-group exceeds the number of children recorded at that school by the PCT. This has prevented detailed analysis of the effect of participation on reported prevalence being performed at school or school cluster level. If this were possible it might provide a better understanding of the links between reported prevalence and participation than when the relatively large and heterogeneous PCTs are used as the unit of analysis.

PCTs should be encouraged to ensure they achieve the highest possible rates of participation. They should carefully check and correct the pupil numbers they enter into the data-capture tool, to ensure more detailed and accurate analysis can be done on the resulting dataset.

Finally, it is important to remember that variation in reported prevalence of obesity or overweight is not only affected by participation rates. Other factors, such as data quality, sex, age, deprivation, urban/rural environment and ethnicity all have the potential to affect both the reported and underlying prevalence and potentially confound the observed relationship between participation and prevalence. If the relationship between these factors and prevalence is better understood, this might enable us better to assess the association between prevalence figures and participation rates within the NCMP. These issues are explored in further detail in the following sections of this report.

6 Accuracy of weight measures

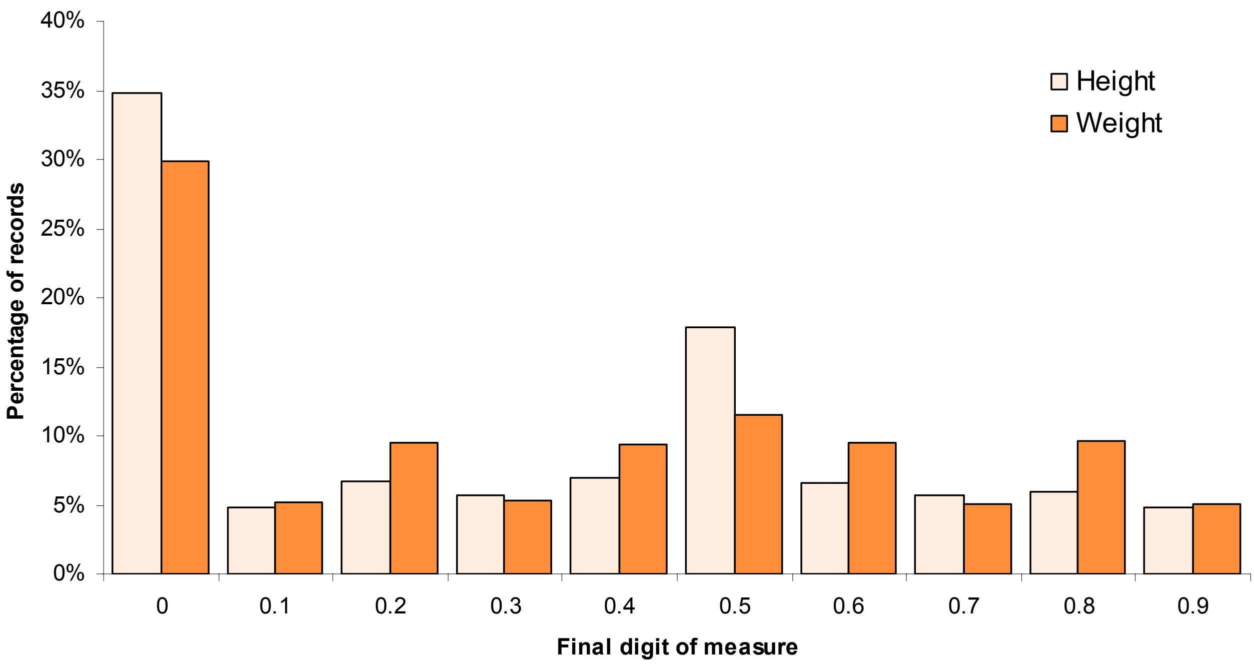
6.1 Rounding of child measurements

Since the 2005/06 NCMP, many improvements in data quality have been made, but the 2006/07 dataset still has some issues which may potentially affect the accuracy of the reported prevalence of obesity or overweight. One notable issue is evidence of 'digit preference' within the height and weight measures entered by PCTs.

PCTs were requested in the NCMP guidance to collect height in centimetres and weight in kilograms to the first decimal place (i.e. the nearest millimetre for heights and 100 grams for weights). Despite this guidance, many PCTs appear to be routinely rounding a large proportion of their measurements to the nearest whole or half number (i.e. 23kg or 23.5kg rather than 23.1kg, 23.2kg etc).

For a random distribution of heights and weights, it would be expected that PCTs would record about 10% of height and weight measures to the nearest whole number, and 10% to the nearest half number. A further 10% of measures would be recorded for each of the other decimal places, i.e. 10% to x.1, 10% to x.2 etc. The actual distribution of height and weight measures in the 2006/07 NCMP show very strong 'digit preference' (Figure 17).

Figure 17: 'Digit preference' for recorded height and weight measures, all children measured



Over 30% of recorded heights and weights in the NCMP dataset were provided to the nearest whole number, more than three times the expected value. In some instances, it is known that technical issues during the upload process caused some measurements to become rounded despite them being correctly recorded by staff taking the measurements, but in many cases this 'digit preference' arises from the data entered by PCTs into the data-capture tool.

6.2 The importance of accurate measurements

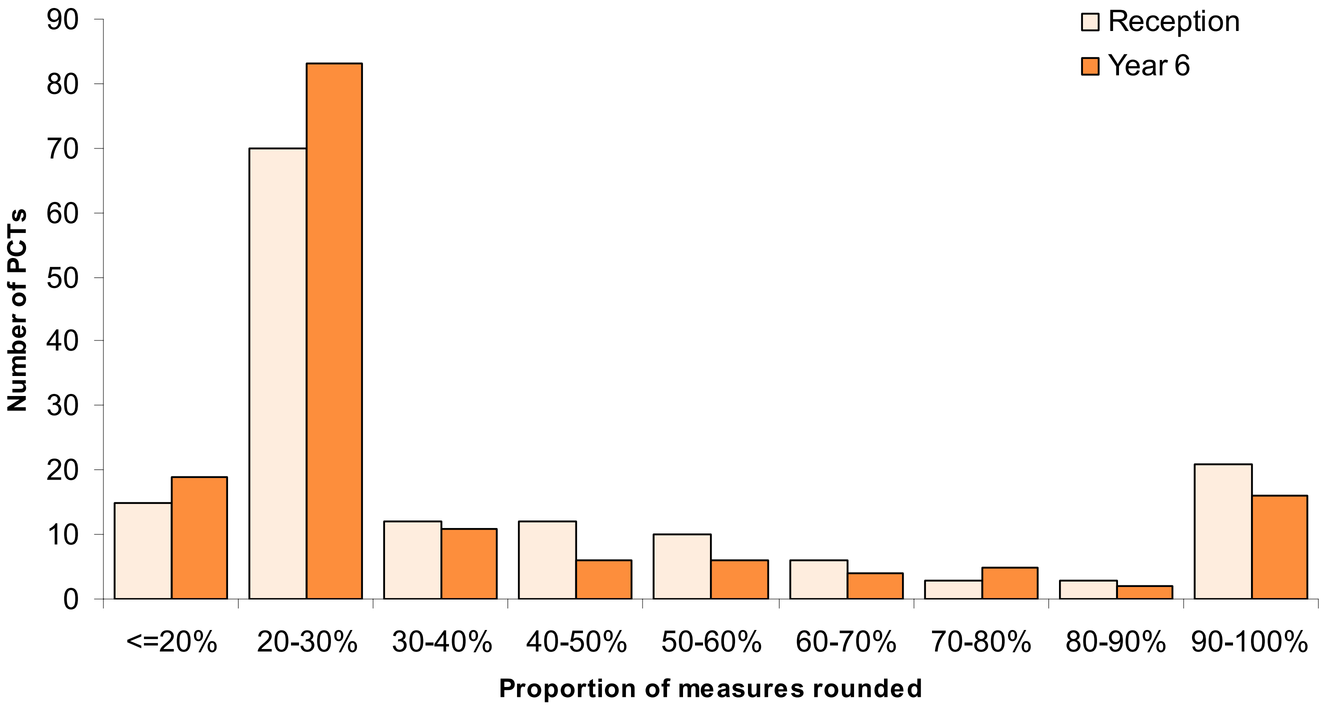
Such rounding is especially important for weight measures, and particularly so for Reception. The average height of children in the 2006/07 dataset was 110cm in reception and 146cm for Year 6. As a result, rounding to the nearest centimetre will, on average, result in an error of less then 1% to the height measurement. Even though height is squared for the BMI calculation, this will still only result in a maximum error of less than 2% on the resulting BMI calculation.

By contrast, the average weight within the 2006/07 dataset was 20kg for Reception and 41kg for Year 6. A difference of 1kg on a weight measure will therefore equate to an error of 5% for the average child in Reception (and resulting BMI and percentile), or 2.5% for the average child in Year 6.

In theory, a systematic rounding of measurements (i.e. correctly rounded to the nearest whole or half number) spread evenly across all PCTs should make little difference to the reported prevalence of obese or overweight children. Two things need to occur to lead to such rounding becoming problematic. Firstly, if the amount of ‘digit preference’ differs greatly between PCTs, which allows the possibility that this will result in differences between PCTs’ prevalence figures. Secondly, if a systematic rounding down or up of measures takes place (i.e. rounding 23.7kg down to 23kg, not up to 24kg), the potential effect on prevalence is far greater. Analysis of the 2006/07 NCMP data suggests that both these issues have arisen.

The frequency of rounded measures is far greater in some PCTs than in others. In both Reception and Year 6, some PCTs have 100% of measures rounded to the nearest whole or half kilogram, whereas others have the expected frequency of rounded measures. Figure 18 shows the number of PCTs which have rounded weight measures to the whole or half kilogram.

Figure 18: Number of PCTs and proportion of measures rounded to a whole or half kilogram



21 PCTs (13%) have rounded more than 90% of their weight measurements for Reception to the nearest whole or half kilogram, with 16 (11%) doing the same for Year 6. By contrast, 85 PCTs for Reception (56%) and 102 in Year 6 (67%) show little or no 'digit preference', with less than 30% of records appearing to have been rounded in this way.

6.3 Effect on local prevalence figures

Regression analysis shows significant correlations between the proportion of rounded weight measures and prevalence, as shown in Table 3. The slope of this correlation suggests some PCTs' data may have been truncated or systematically rounded down, rather than correctly rounded to the nearest whole or half kilogram.

Table 3: Results of weighted linear regression between the proportion of measures rounded and prevalence

Variables	Coefficient of determination	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Reception, whole number rounding, obese only	0.111	-0.025	0.006	<0.001
Reception, whole and half number rounding, obese only	0.118	-0.021	0.005	<0.001
Reception, whole number rounding, obese and overweight	0.199	-0.055	0.009	<0.001
Reception, whole and half number rounding, obese and overweight	0.226	-0.047	0.007	<0.001
Year 6, whole number rounding, obese only	0.028	-0.022	0.010	0.038
Year 6, whole and half number rounding, obese only	0.022	-0.016	0.009	0.067
Year 6, whole number rounding, obese and overweight	0.033	-0.027	0.012	0.025
Year 6, whole and half number rounding, obese and overweight	0.029	-0.022	0.010	0.036

As Table 3 shows, the proportion of weight measures rounded to whole or half numbers explains 12% of the variation in obesity prevalence in Reception. The same measure can explain nearly 23% of the variation in combined prevalence of obesity and overweight for this age group. Both the correlations are significant ($p<0.001$) and, for obesity, this variable can explain a similar proportion of the variation in prevalence as participation rates for Year 6 prevalence, as discussed in section 5.

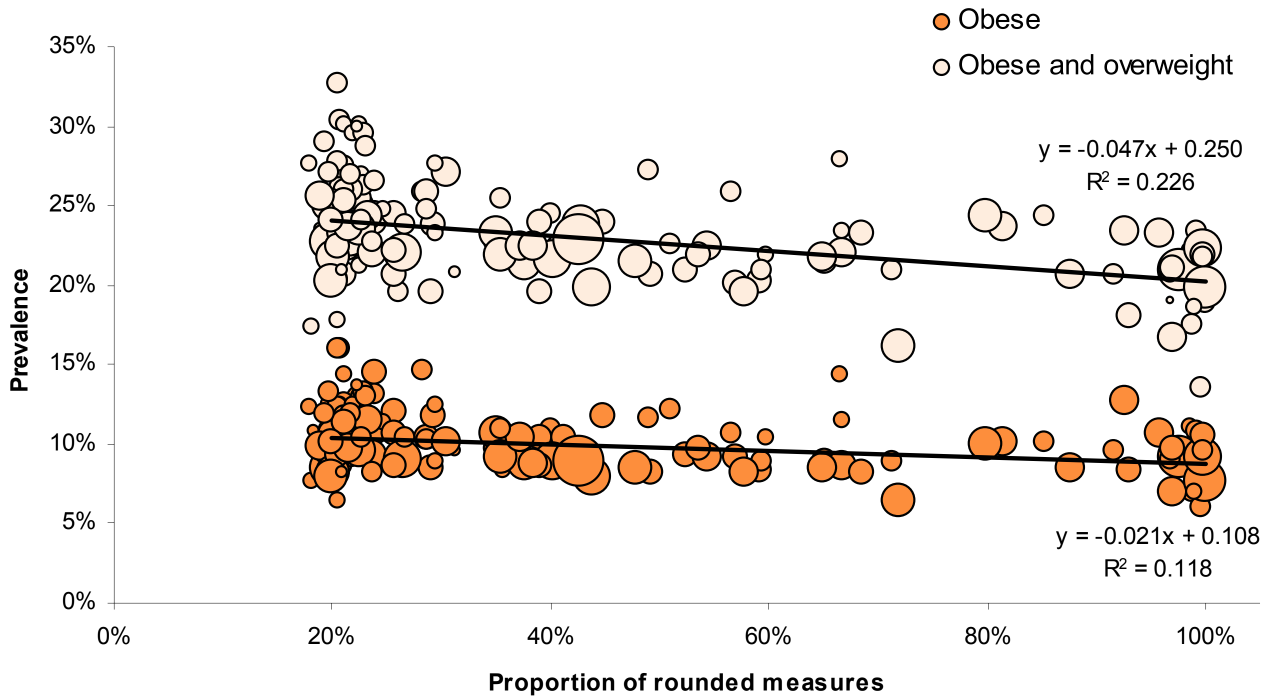
Although significant correlation exists between the proportion of Year 6 records rounded to the whole number and prevalence of obesity and overweight ($p<0.04$), these correlations are weaker and explain only 3% of the variation between PCT prevalence figures for that age group. For Year 6, the proportion of measures rounded to the whole number is more closely correlated with prevalence than the proportion rounded to either the whole or half number.

For Reception, the slope of the line of best fit suggests that the reported prevalence of obesity for PCTs in which all weight measures were rounded to the nearest whole or half number will be, on average, 1.7% (95% confidence intervals 0.9–2.4%) less than the prevalence in PCTs that correctly entered their weight measures to the first decimal place.

For obese and overweight prevalence, PCTs that rounded all their records to the nearest whole or half number will tend to have prevalence figures 3.7% (95% confidence intervals 2.6-4.9%) below those PCTs who correctly rounded their data.

Figure 19 shows the correlation between the proportion of measures rounded to the whole or half number and the reported prevalence of obesity and obesity and overweight children.

Figure 19: PCT prevalence of obesity and obesity and overweight and the proportion of weight measures rounded to the full or half kilogram for Reception, with the trend from weighted linear regression



Although the slope of the line of best fit for obesity is not as steep as the relationship between Year 6 obesity prevalence and participation rates, relative to the underlying prevalence of obesity for children in Reception, (9.9% for Reception *vs* 17.5% for Year 6), these differences are of similar magnitude. When considering prevalence of obese and overweight children at PCT level the impact of rounding is undoubtedly an important consideration.

6.4 Effect on national prevalence figures

As with the effect of participation on prevalence, it is possible to model the possible effect of rounded measures on the reported national prevalence of obesity and overweight in Reception.

If it is assumed that all PCTs supplied all measures to the first decimal place, the prevalence figures for those PCTs with rounded measurements can be adjusted using the coefficients supplied in Table 3 to produce the predicted number of obese children in the underlying population, once the effect of rounded measures is excluded.

This analysis suggests that the prevalence of obesity for Reception children is between 10.1% and 10.6% (95% Confidence intervals), rather than 9.9% as stated in the ICs report. Prevalence of obese and overweight in Reception is likely to be between 23.7% and 24.4%, rather than 23% reported by the IC.

Unlike Year 6 prevalence rates after adjustment for participation, even after adjustment for rounding of measures, NCMP prevalence figures for Reception are still lower than the equivalent HSE figures. HSE 2006 shows that for boys and girls combined, the average prevalence of obesity is 14.4%,(95% limits 11.9% - 17.0%) and for obese and overweight is 26.9% (23.7% - 30.1%). These figures are high because of a high prevalence of obesity for boys aged 4 and 5 years (17.4%), which might be the result of natural variation given the small numbers in the HSE sample. It does though seem that rounding of measures does not account for as much under-recording of obesity nationally in Reception as does participation rate for Year 6.

6.5 Conclusions

Although, at national level, rounding of measures and ‘digit preference’ for Reception is perhaps not as important an effect as participation rate is for Year 6, the effect for those PCTs who rounded a large proportion of their weight measures is still substantial. This is especially the case in view of the small changes in prevalence on which PCTs are being performance managed.

Although it is possible accurately to determine what proportion of PCTs provided rounded measures (unlike for participation rates, which are always approximate), these data do not provide all information required for a thorough analysis of this issue. It is likely that some PCTs that show ‘digit preference’ on their weight measures have correctly rounded these to the nearest half or whole kilogram. Others may have truncated or rounded down their measures, which has greater potential to affect recorded prevalence. As a result, the analysis presented here, which assumes all PCTs rounded in the same way, is likely to overstate the effect for some PCTs, but underestimate it for others. As a result, some PCTs in which measures have been rounded down may underestimate the local prevalence of obesity and overweight by a greater degree than suggested above, whilst for other PCTs this factor may have a limited impact on local NCMP prevalence figures.

This issue should be considered when looking at year-to-year changes in obesity prevalence. PCTs should consider the extent to which their data were rounded in each year before assuming any observed changes reflect real differences in the underlying prevalence of obesity and overweight in their child population.

‘Digit preference’ is a simple issue to tackle, since the correct recording of weight measurements can easily be addressed by PCTs. Staff need to be correctly trained and aware of the guidance for PCTs[13] which states that measurements should be supplied to the first decimal place; this is achievable by all PCTs with little expense or time commitment.

Equally it is vital that staff use appropriate equipment to take height and weight measurements. It is known that one of the PCTs with a very high proportion of rounded weight measures for the Reception year used analogue scales to collect these data. These did not meet the specifications in the NCMP guidance, but this made it more difficult for school nursing staff to take accurate measurements and probably resulted in the high proportion of measures recorded to the whole or half number. This PCT also reported one of the lowest obesity prevalence figures in the country for Reception, although prevalence in Year 6 is far closer to the national figure. It is possible that these factors are related and that had measures been correctly supplied to the first decimal place, Reception prevalence would be substantially increased.

The 2007/08 data collection will include additional checks within the data-capture tool to alert PCTs to a high proportion of rounded measures to ensure they are aware of this issue and can seek to address it.

7 Age at time of measurement

The prevalence of obesity increases with age, as shown by both the HSE and NCMP data, where prevalence in Year 6 is significantly higher than that in Reception.

Analysis of the NCMP data show that substantial variation exists in the age at which children are measured for the NCMP. This arises for several reasons:

- Firstly, PCTs may take measurements as part of the programme at any time within the school year – this can result in a variation of nearly 11 months in the average age of children measured, depending on whether a PCT takes measurements at the start or end of the academic year.
- Secondly, although PCTs are required to measure children in Reception and Year 6, some PCTs have routinely taken some child measurements in Year 1 of primary school in programmes that precede the NCMP. As a result, these measurements taken slightly outside the specified year-groups are accepted into the NCMP dataset.
- Finally, some children are outside the expected age range for the school year in which they are educated (e.g. if they are held back a year because of long term illness or slow academic progress). Such pupils might be more common in some areas than in others, owing to local education policies or the sociodemographic characteristics of the local population. As a result, this factor might also result in differences in the average age of children measured for the NCMP by each PCT.

In the 2006/07 dataset, PCTs were able to submit children within the age ranges of 48-83 months and 120-143 months inclusive (i.e. pupils aged 4-6 years and 10-11 years inclusive). This variation has potential to affect local prevalence figures for obesity and overweight - if a PCT measures older children than a neighbouring PCT, this might explain a reported higher prevalence than their neighbour's.

Due to the data quality and participation problems with the 2005/06 NCMP dataset it was not possible to test for the effect of age. The more detailed 2006/07 NCMP dataset allows for detailed checks to be done, based both on the average age of children measured and with individual child ages, to reduce the potential for confounding effects that might vary at PCT or regional level.

7.1 Mean age of children measured at national and SHA level

The mean age of children measured for the NCMP 2006/07 was 61.7 months (5.1 years) for Reception and 134.2 months (11.2 years) for Year 6. As children enter Reception in the academic year in which they turn 5 years, and Year 6 in the academic year in which they turn 11 years, these ages suggest that most PCTs measure children in the appropriate academic year.

At SHA level there are variations in the age of children measured (Figure 20), but these differences are small – a range of 2.6 months in Reception and 3.9 months in Year 6. Although confidence limits are not shown, the standard deviation around the average pupil's age within each SHA are large though (at least 3.6 months for Reception and 3.9 months for Year 6), so the small differences by SHA are unlikely to represent significant differences in the age distribution of the children being measured by region.

Figure 20: Average age of children measured, by SHA

As shown in Figure 20, there is very little correlation between the mean age of children measured in Reception and Year 6. This suggests that the reasons affecting the age of children when measured, principally the model used to collect child measurements locally, differ between Reception and Year 6 within each SHA.

The average age of Year 6 children is only worthy of comment for South East Coast SHA, being on average more than 2 months younger than the SHA with the next youngest sample. These differences are likely to occur from PCTs in this area taking their Year 6 measurements earlier in the year than PCTs in the other SHAs.

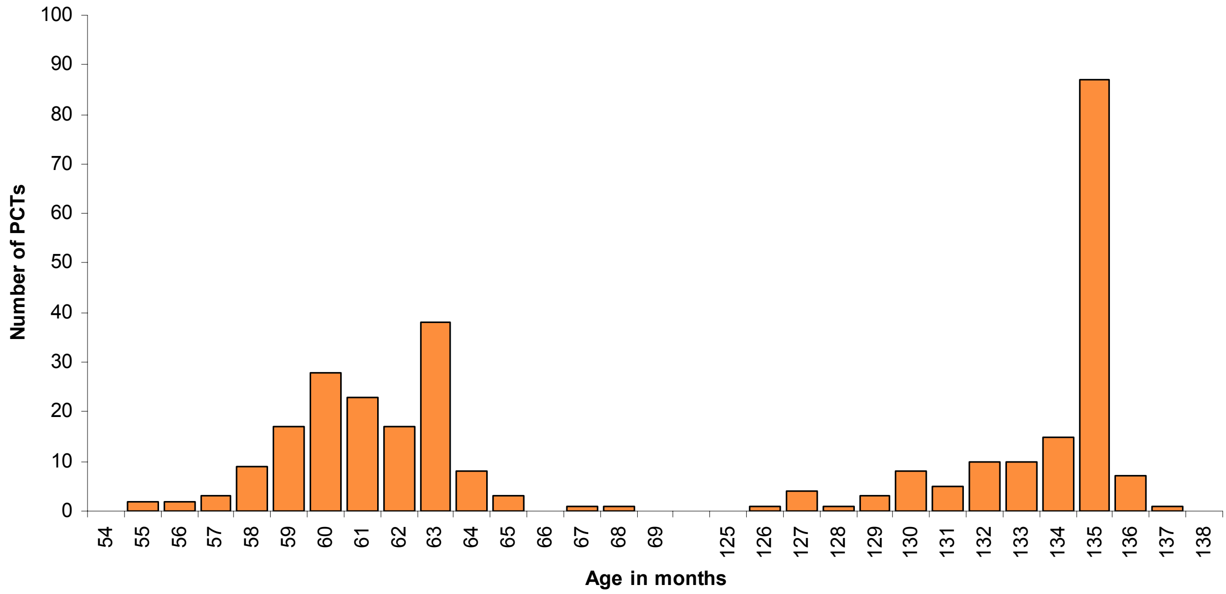
7.2 Mean age of children measured, by PCT

In contrast, at PCT level, the mean age of children measured shows substantial variation, with differences of more than 12 months in Reception (55.4–68.3 months) and more than 10 months for Year 6 (126.9–137.1 months).

The age differences in Year 6 probably result from PCTs taking measurements either at the start or the end of the academic year. The differences in Reception are slightly greater than might be anticipated from this kind of variation and may result from PCTs with the highest age ranges taking some measurements towards the start of Year 1, rather than all for children in Reception. This can occur if PCTs operate a rolling ‘five-year health check’, sampling batches of children shortly after their fifth birthday. As a result, the youngest in an academic year might not be measured until the first term of Year 1, even where most children are measured during Reception.

Figure 21 shows the distribution of the mean age of children measured by PCT for Reception and Year 6, rounded down to the age in completed months.

Figure 21: Average age of measured children by PCT for both Reception and Year 6 children



The mean age of children measured in Reception has elements of a normal distribution, but with a prominent peak at age 63-63.9 months. If PCTs took measurements throughout the year, a normal distribution would be expected, centred around 60. The peak at age 63 months is probably due to PCTs recording measurements in a batch in the final term of Reception (i.e. May, June and July). Children will then average approximately 63 months in age if measured at this time.

The distribution of ages for Year 6 shows a very different pattern. 87 PCTs (57%) have measured Year 6 children with an average age of 135 months. This suggests that most Year 6 measurements were taken in the last term of the academic year. This is probably because many PCTs had pre-existing measurement programmes for Reception, whereas Year 6 measurement programmes have mostly been started to fulfil the requirements of the NCMP. The publication schedule of guidance for both 2005/06 and 2006/07 (during the last term of each academic year) provides a possible explanation of why most PCTs have measured at this time.

In 2007/08, data will be collected centrally on the month of measurement of individual children, to allow more detailed analysis of the time of year measurements are taken. As well as the relationship with age of children measured, as discussed here, there are possible impacts on obesity prevalence as a result of summer/winter clothing, or seasonal changes in child weight throughout the year. Unfortunately such analysis cannot be conducted with the 2006/07 dataset.

7.3 Effect of age of children at measurement on prevalence

Differences in the mean age of children measured at PCT level might have the potential to skew recorded prevalence of obesity and overweight. The expected pattern would be that PCTs that measured older children would report higher prevalence than those that measured younger children.

Again, weighted linear regression can be used to explore the relationship between these variables (Table 4).

Table 4: Results of weighted linear regression between the mean age of children when measured and prevalence

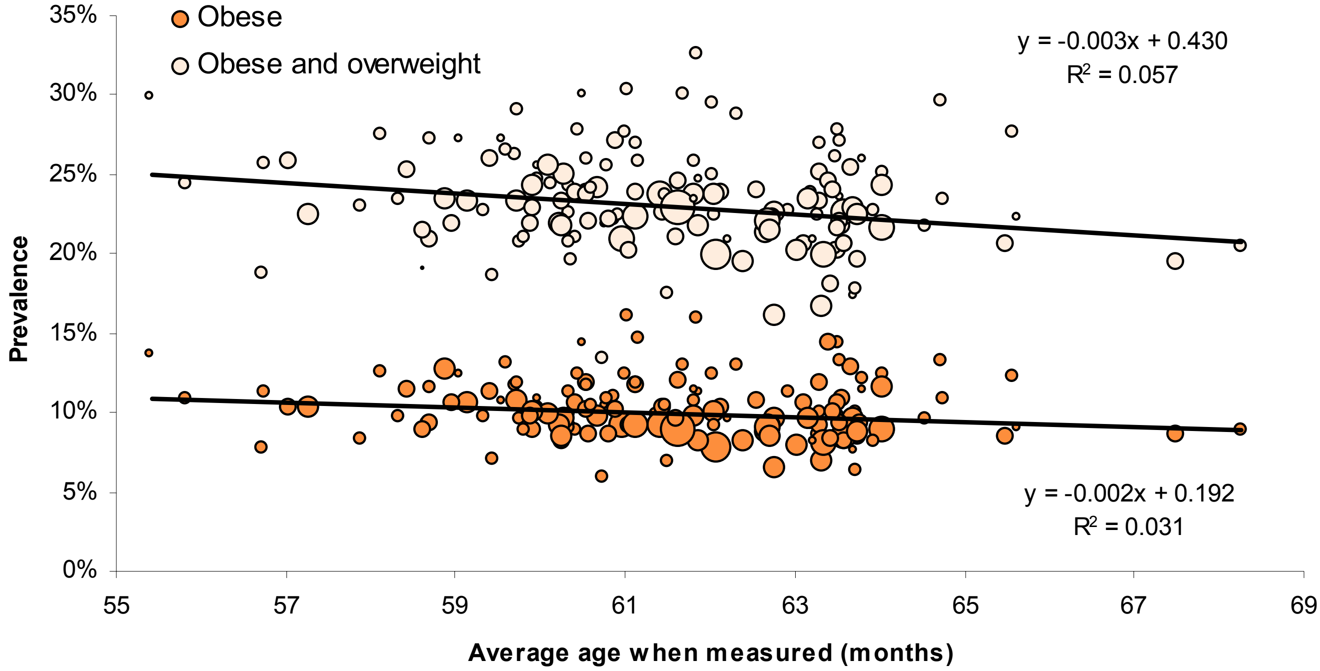
Dependant variable	Coefficient of determination	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Reception obese	0.031	-0.002	0.001	0.029
Reception obese and overweight	0.057	-0.003	0.001	0.003
Year 6 obese	0.002	0.001	0.001	0.628
Year 6 obese and overweight	0.001	0.000	0.001	0.779

As Table 4 shows, the mean age of children when measured for the NCMP 2006/07 has no significant effect on the reported prevalence of obesity or obese and overweight for Year 6 children. This is perhaps unsurprising, in view of the limited variation in age of measurement between most PCTs, as shown in Figure 21.

For Reception, significant correlations exist between prevalence and mean age at time of measurement, but these only explain a small proportion of the variance between PCTs in prevalence of obesity and obese and overweight. 3.1% of the variation in obesity prevalence can be explained by the age of children, whereas 5.7% of the variation in obese and overweight prevalence can be accounted for by this variable.

Surprisingly these correlations show a gradient that is in the opposite direction to what would be expected. Regression analysis shows that the older the children measured in Reception, the lower the reported prevalence. The slope of the line of best fit suggests that PCTs who measured the oldest Reception children (68 months) might expect to see prevalence of obesity around 2% (95% confidence intervals 0.2–3.7%) less than for PCTs that measured the youngest children (55 months). Figure 22 shows the correlations between obesity and obese and overweight prevalence and average age at time of measurement.

Figure 22: Prevalence of obesity and obese and overweight and average age of measurement by PCT for Reception, with the trend from weighted linear regression



Although these correlations are weak and the slope is slight, they are unlikely to have arisen by chance ($p<0.03$), so it is worth considering the possible reasons for their direction being counter-intuitive.

Since the age at which PCTs measure children is mainly due to the time during the academic year when measurements take place, PCTs in which older children are measured are likely to have taken most measurements during the summer term. It is possible that the correlation described above results from seasonal variations in BMI or the type of clothing worn by children.

Although the 2006/07 NCMP guidance stated that children should be asked to remove shoes and any heavy outdoor clothing,[14] it is still possible that children measured in the summer term would be measured in lighter clothing than those measured in the winter term. Due to the light weight of Reception children this could potentially affect the resulting weight and BMI measurements taken, and result in a slight decrease in the reported prevalence of obesity or overweight. Equally there may be slight seasonal variation in children's BMI which could produce the same effect if children happened to be slightly lighter during the summer rather than the winter months.

This analysis is far from conclusive and further investigation is required. The 2007/08 NCMP data collection will collect the date of measurement of all individual children to allow more detailed investigation into any seasonal variations in obesity prevalence. If this analysis shows that the time of year when measurements are taken significantly affects obesity prevalence, there may be a case for requesting that PCTs undertake child measurements at the same point of the year or for giving more detailed guidance on what clothing children should be wearing when measures are taken.

7.4 Prevalence of obesity and the age of individual children

The analysis above examines the possible effect of age on PCT prevalence figures. Because of the large number of potential confounding factors that could affect PCT prevalence - participation rates, rounding of measures, socioeconomic factors such as deprivation and ethnicity, but particularly the time of year of measurement which will impact on the average age of a PCT's sample - PCT level analysis is not the best way to investigate any correlation between prevalence of obesity and age.

As discussed earlier, the 2006/07 NCMP dataset allows detailed individual-level analysis with each child's age and BMI classification, rather than aggregated data by area as was the case with the 2005/06 dataset.

Figures 23 and 24 show prevalence of obesity and overweight by age, obtained by grouping individual children by age in months, and calculating the prevalence for these sub-groups of the dataset.

Figure 23: Prevalence of obesity and overweight in Reception, by age in months, with 95% Confidence intervals

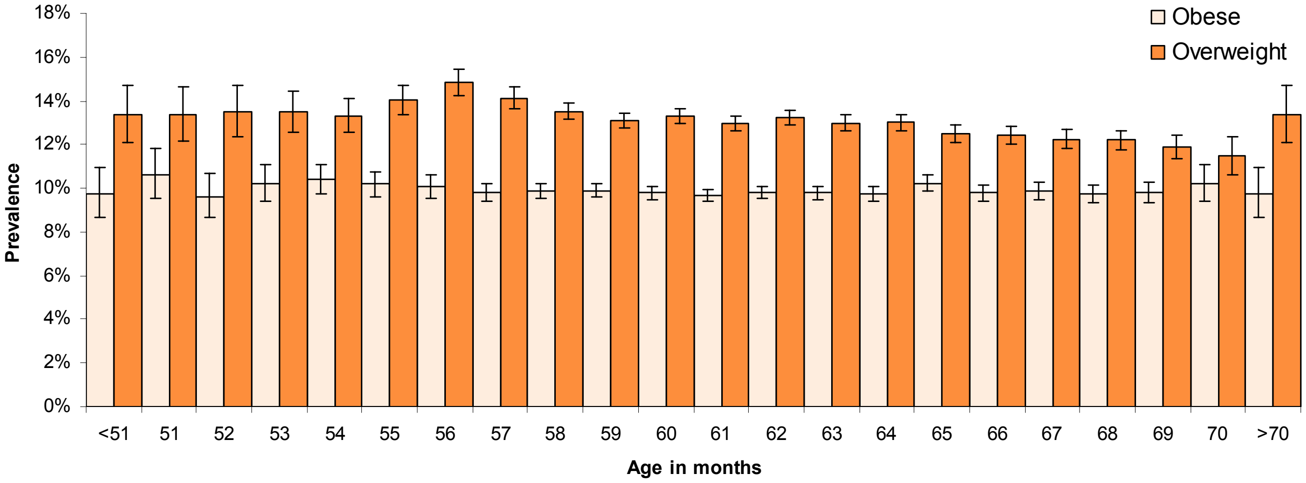
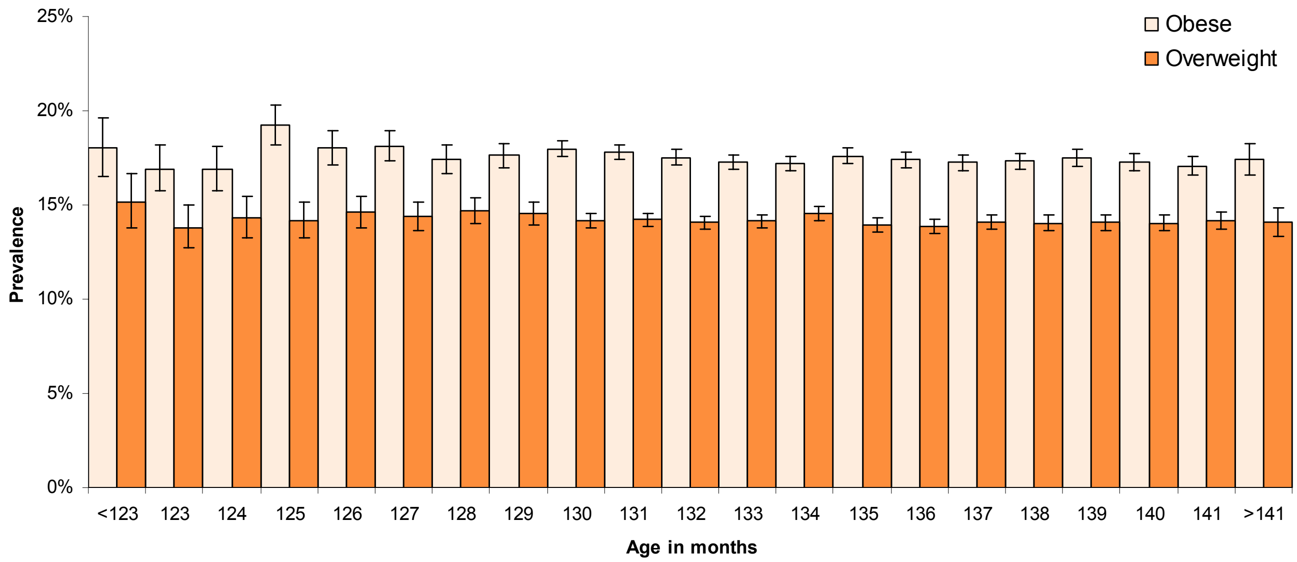


Figure 24: Prevalence of obesity and overweight in Year 6, by age in months, with 95% Confidence intervals



As these figures show, analysis of individual children by age in months shows little sign of any differences in obesity or overweight prevalence with increasing age of children.

Prevalence of obesity appears to be constant with age for both Reception and Year 6 children though there is some evidence of a decrease in prevalence of overweight in Reception between ages 56 and 70 months. Children aged 56 months show a significantly higher prevalence of overweight than those aged 70 months (at the 95% significance level).

These findings show that obesity prevalence varies little by age within year-groups. This suggests that restrictions on the age at time of measurement are not required for the NCMP.

7.5 Conclusions

The mean age of children measured by SHA or PCT for the 2006/07 NCMP, shows variation between SHAs and PCTs. This variation is far greater at PCT level. This variation seems to have little effect on reported prevalence of obesity and overweight for Year 6, but there is a significant correlation between prevalence and mean age of children measured in Reception.

Although it would be expected that areas that measured older children would report higher prevalence of obesity and overweight, this correlation suggests that areas that measured younger children in the Reception year report higher prevalence. One possible explanation for this may be linked to the time of measurement - children measured in winter months may record heavier weights, possibly due to the clothing worn or seasonal differences in BMI. In future years the month of measurement will be collected nationally to allow for more detailed analysis of the links between age and prevalence of obesity and overweight.

When analysis is conducted on individual children, rather than at PCT level, there is no apparent increase in prevalence of obesity or overweight with age within the NCMP age groups. This suggests no further restrictions on the age at which PCTs take measurements need to be considered in order to provide robust prevalence figures.

8 Sex ratios

The analysis of the 2005/06 NCMP data reported a slightly higher participation rate for girls than for boys (section 2 in the 2005/06 report).[11] The IC's report also reported small differences in participation between the sexes in the NCMP 2006/07 – of children measured, boys made up 51% in Reception and 52% in Year 6 (section 3.1.3 in the IC report).

As mentioned in the IC's report, detailed analysis of participation rates by sex is not possible because the pupil denominators collected from PCTs are not broken down by sex. Despite this some further analysis is still possible since some information on the expected sex ratio of pupils is known and can be compared to the sex ratios of children measured for the NCMP 2006/07 both nationally and by SHA or PCT.

8.1 Sex ratios at national level

Pupil number data from DCSF show that the ratio of boys to girls for pupils aged 4–5 years attending schools measured in NCMP 2006/07 was 1.046:1. For pupils aged 10–11 years, this ratio falls slightly to 1.041:1. These data are from January 2006 - slightly before NCMP measurements were taken - but sex ratios nationally are unlikely to have changed significantly since this time. Additionally, 107 of the 17,107 schools where measures were taken are not included in this DCSF dataset (these are probably schools that opened after January 2006), but again this is unlikely to make a significant difference to the overall sex ratios.

In the NCMP 2006/07, the sex ratio of measured pupils was 1.051:1 in Reception and 1.073 in Year 6. This suggests that nationally a greater proportion of boys took part than did females, particularly in Year 6.

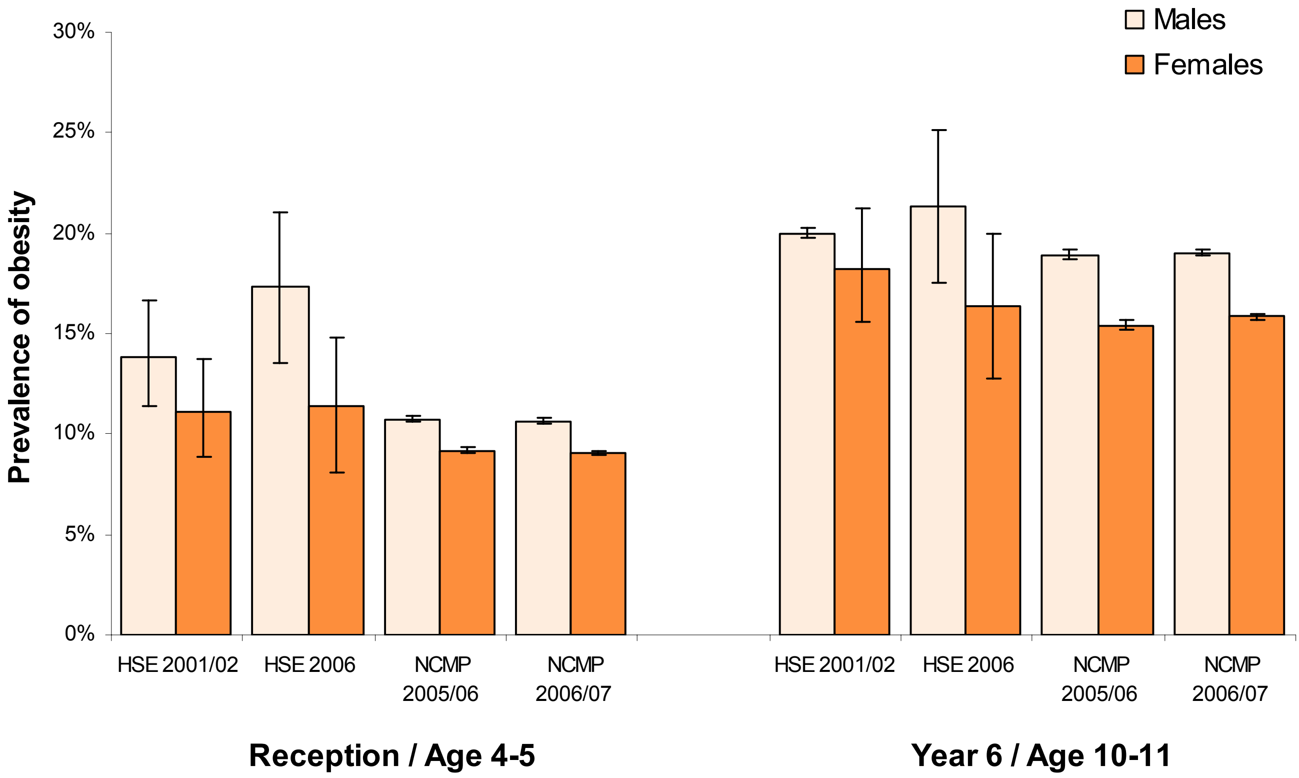
In NCMP 2005/06, these ratios were 1.050:1 for Reception and 1.087:1 for Year 6. This suggests that the participation rate for Year 6 girls may have increased slightly since the first year of measurement, but that the rate of participation for girls is still lower than that for boys.

As it is highly unlikely that PCTs preferentially include boys rather than girls in their measurements, the most likely explanation for this difference can be that girls are more likely to withdraw from the NCMP measurements. This could be due to an increased concern about weight or stigmatisation, or concern around the actual measurement process. Whatever the reason, this finding raises the possibility that a greater proportion of selective opt-out, as discussed in section 5, involves girls. If this is the case, when prevalence of obesity or overweight is produced separately for girls and boys, it is possible that figures for girls underestimate the true prevalence to a greater extent than those for boys.

This hypothesis is difficult to test as the only comparison data for obesity prevalence are from the HSE. Due to the small numbers sampled, the wide confidence limits around HSE prevalence figures are even wider when broken down by sex. Even the differences in prevalence between boys and girls are not significant for narrow age bands.

All available datasets, i.e. HSE data and NCMP from 2005/06 and 2006/07, consistently show higher prevalence of obesity in boys than in girls in both age groups (Figure 25). The large confidence limits around HSE data mean that the difference between obesity prevalence for boys and girls are not statistically significant. In addition the substantial year on year changes with HSE data mean that this dataset can tell us little about the possible scale of any differences. Whilst NCMP data do show significant differences in obesity prevalence between the sexes, it is still possible that prevalence figures from this dataset may overestimate the size of the differences.

Figure 25: Obesity prevalence by sex based on NCMP and HSE data with 95% confidence limits



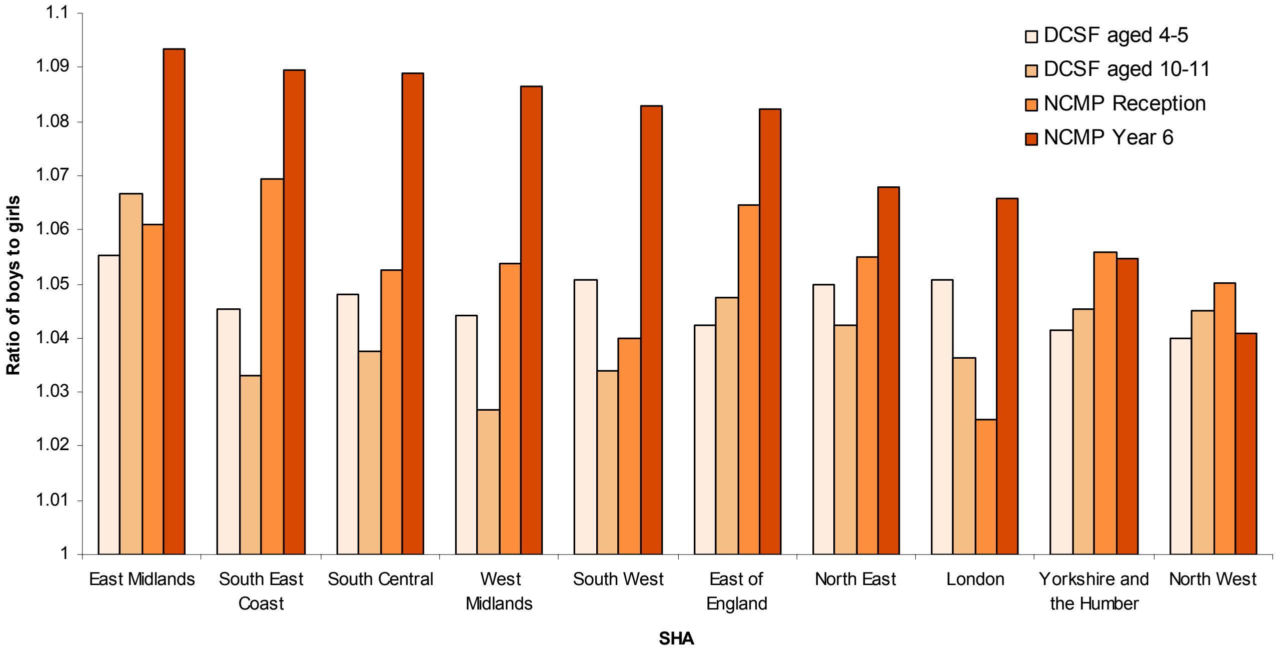
Although no firm conclusions can be drawn by comparing NCMP prevalence figures by sex with existing data sources, there is certainly potential for the sex ratio in the NCMP sample to affect national prevalence figures. The overall NCMP sex ratio in Year 6 of 1.073:1 suggests around 6,500 additional girls opted out of NCMP measurements compared to boys. If the additional girls who opted out were twice as likely as the general population to be obese, then the reported prevalence of obesity for Year 6 girls from NCMP data would underestimate the true prevalence by 0.4%. If 50% the additional girls who opted out were actually obese (i.e. around 3 times more likely to be obese than the population average), the true prevalence of obesity for year 6 girls would be 16.9% rather than 15.8% as reported.

Due the apparent increased opt-out of girls nationally, and the evidence of selective opt-out of children who are more likely to be obese or overweight, the possibility that reported prevalence of obesity or overweight for girls may be artificially low should always be considered when using NCMP prevalence rates by sex.

8.2 Sex ratios by SHA

Examination of the sex ratios of children measured for the 2006/07 NCMP by SHA does show substantial differences between SHAs (Figure 23). The ratio of boys to girls ranges from 1.025:1 to 1.069:1 in Reception, and from 1.041:1 to 1.093:1 in Year 6. Figure 26 is ordered by ratio of boys to girls measured in Year 6 and shows the measured sex ratio as well as the expected ratio, based on the January 2006 pupil numbers in those schools in which measurements were taken.

Figure 26: Ratio of boys to girls in DCSF pupil numbers and NCMP 2006/07 for Reception and Year 6, by SHA



The ratio of boys to girls at SHA level NCMP exceeds that expected from the DCSF figures, except for South West and London in Reception, and North West in Year 6.

Figure 26 shows that sex ratios in Year 6 exceed the usual range of sex ratios for six of the ten SHAs. Sex ratios based on DCSF figures are all in the range of 1.027:1 to 1.067:1, and NCMP sex ratios for Reception barely exceed this range. By contrast, in Year 6, six SHAs have a sex ratio greater than 1.08:1.

Little correlation exists between NCMP and DCSF sex ratios by school year, but additionally, even the DCSF ratio between boys and girls shows substantial variation between Reception and Year 6 within SHAs. This suggests that the sex ratio, even at SHA level, can change substantially from year-to-year, and so the January 2006 figures might not be a good predictor of the children eligible for measurement in the 2006/07 NCMP

Although sex ratios within SHAs may change from year-to-year, they are unlikely to deviate much from the expected range. As the measured sex ratios in Year 6 are often outside this expected range, it seems unlikely that this variation could have arisen by chance.

As a result, it is probably not possible to determine from this information precisely which SHAs have a greater opt-out of girls than others. The 2006/07 NCMP data can only confirm the national trend- i.e. many SHAs there appears to be higher participation amongst boys than girls. Further analysis with more recent DCSF data would be needed to determine if this is a bigger issue for some SHAs than for others.

8.3 Sex ratios by PCT

Sex ratios at PCT level show greater variation than that seen for SHAs. Sex ratios vary from 0.92:1 to 1.20:1 in Reception and 0.83:1 to 1.27:1 in Year 6. Perhaps surprisingly, given the relatively large number of pupils at PCT level, DCSF figures show a similar, though slightly reduced, degree of variation.

The distribution of sex ratios for Reception and Year 6, from both NCMP and DCSF data, are shown in Figures 27 and 28 respectively.

Figure 27: Distribution of sex ratios in DCSF pupil numbers and NCMP 2006/07 for Reception, by PCT

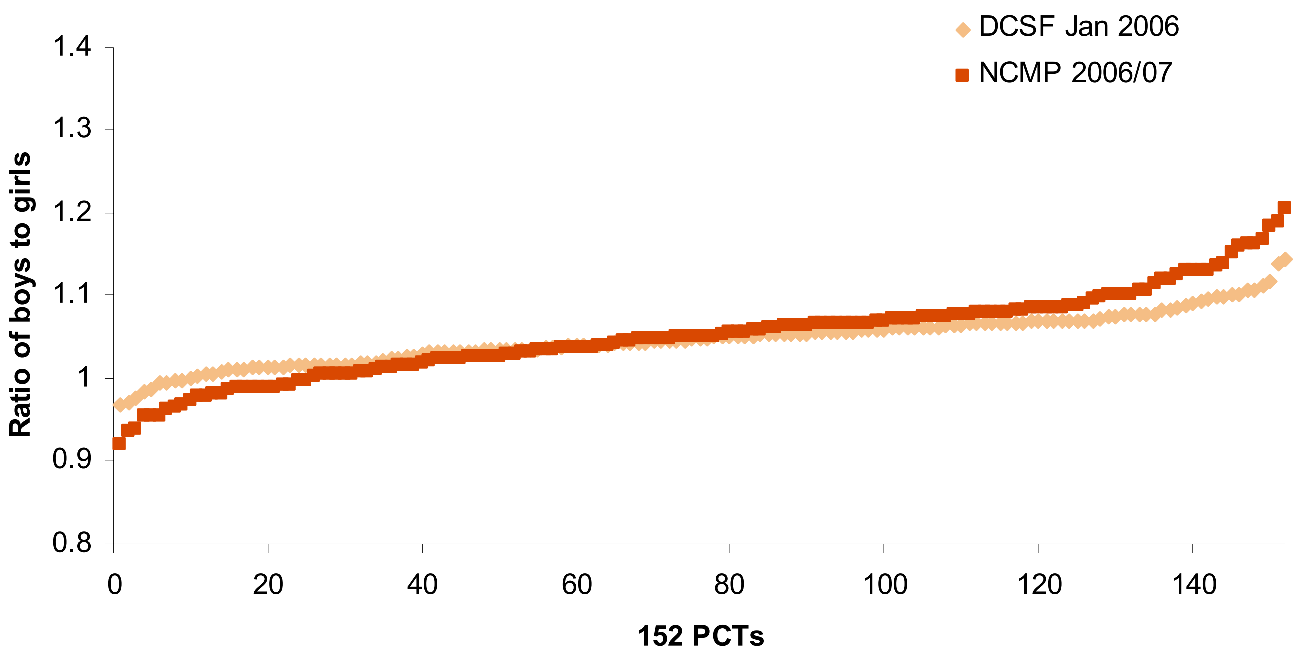
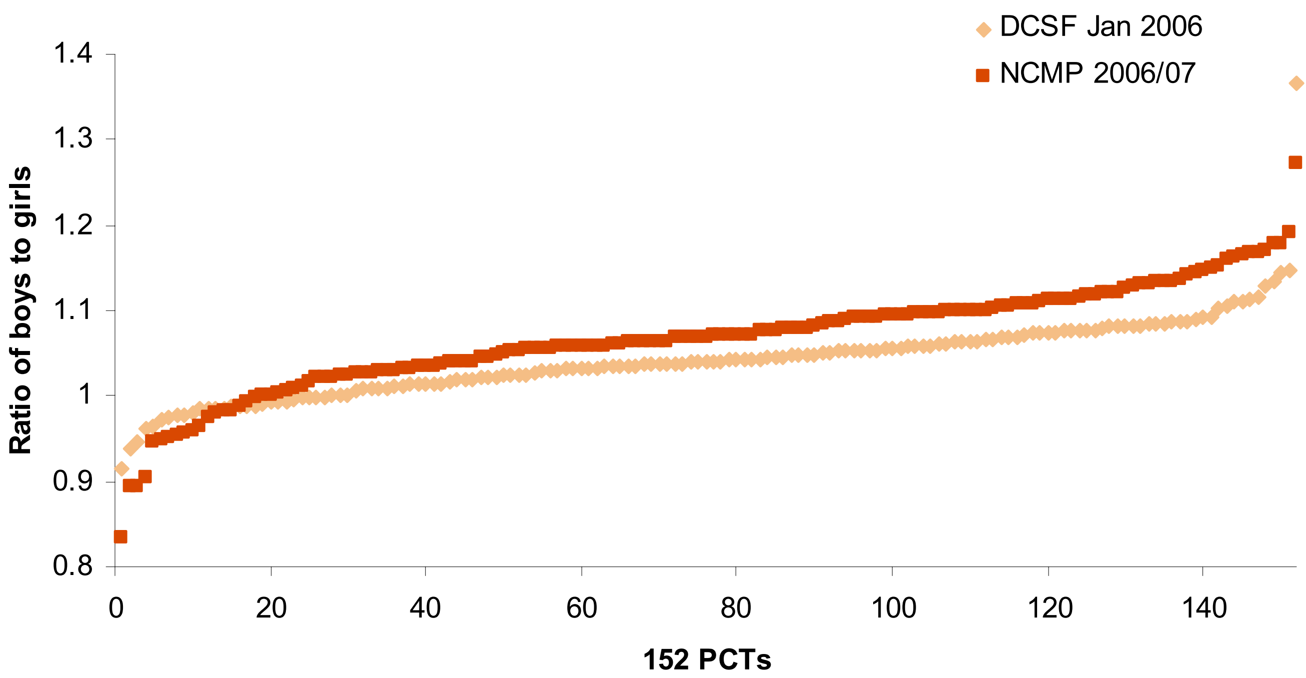


Figure 28: Distribution of sex ratios in DCSF pupil numbers and NCMP 2006/07 for Year 6, by PCT



Figures 27 and 28 show that sex ratios for both Reception and Year 6 are slightly more spread than those based on DCSF pupil numbers.

For Reception, the average sex ratio is much the same, but NCMP figures show slightly lower and higher sex ratios at the extremes. This pattern is perhaps to be expected, since although the DCSF figures are based on the same schools that were measured for the NCMP, the NCMP data are based on a smaller sample of the children attending these schools due to participation rates being less than 100%. These smaller samples are likely to lead to more natural variation, and thus a slightly wider spread in the sex ratios.

Quantification of the extent to which the smaller sample sizes explain the wider variation in NCMP sex ratios is difficult, and so the possibility that the extreme sex ratios at both ends of the distribution are a result of some participation rates being lower for girls in some areas and for boys in others cannot be ruled out.

For Year 6, the shape of the distribution compared with that of the DCSF figures suggests that the increased participation for boys than for girls at national level affects most PCTs. It is not the case that the higher ratio of boys at national level is the result of a few PCTs having skewed sex ratios, with most PCTs having the expected ratio.

Figures 27 and 27 show sex ratios ordered by the ratio of boys to girls, so do not show direct comparisons between individual PCTs. No significant correlations exist between the expected and measured sex ratios by PCT. Whether this is a result of random year-on-year variation in the sex ratio for individual PCTs, meaning the January 2006 DCSF dataset is not a good comparator, or due to different rates of selective opt-out of girls or boys in different areas confounding the expected pattern, cannot be determined from this analysis.

As with SHAs, NCMP cannot be used accurately to determine which PCTs have the biggest deviations from the expected sex ratio. The data do though suggest that an increased opt out of girls in Year 6 is a problem across the country, so in the absence of better information it is advised that this issue is addressed by all PCTs in future years of measurement.

8.4 Effect on PCT prevalence figures

Since sex ratios by PCT show the variation described in Figures 27 and 28, and in view of the difference in obesity prevalence between girls and boys in NCMP and HSE data shown in figure 25, this raises the question of whether prevalence figures need to be adjusted for sex.

Since reported obesity prevalence is higher for boys than for girls, it might be expected that PCTs that measured a higher proportion of boys than girls would report higher prevalence of obesity than those that measured fewer boys than girls.

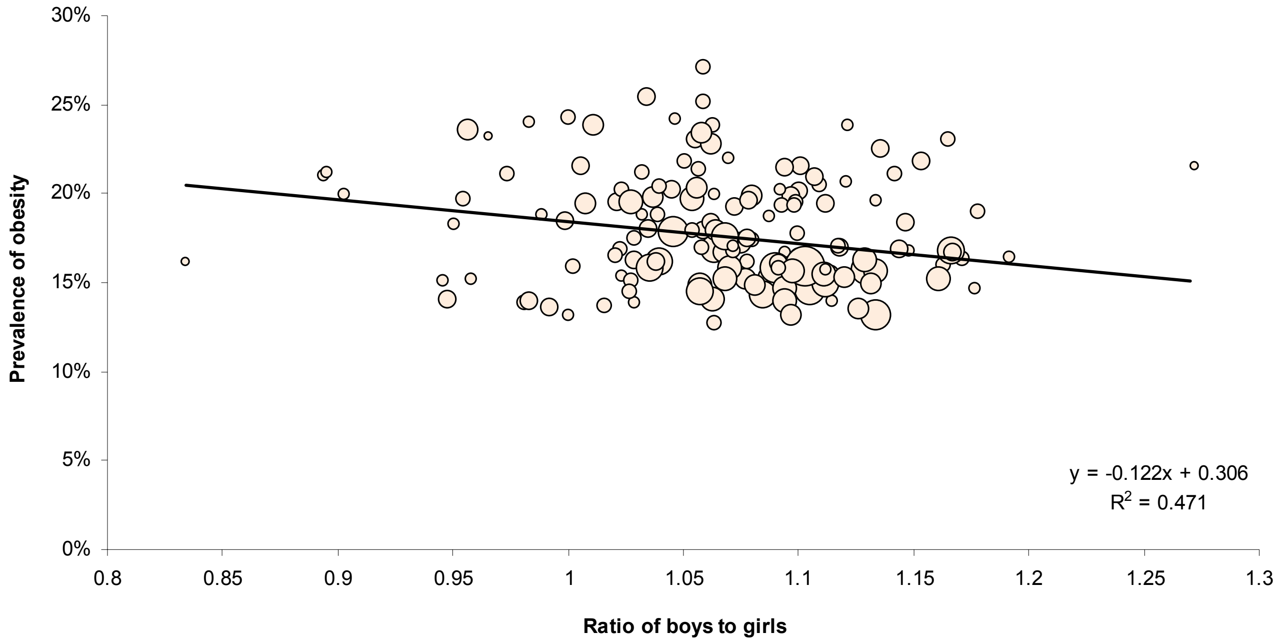
In theory, this potential effect should though be very small. For example, prevalence of obesity in Year 6 is 17.5% for girls and boys combined, but this varies from 19% for boys to 15.8% for girls. If two PCTs had the same Year 6 obesity prevalence as the national average for boys and girls but vastly different sex ratios, the overall prevalence would change very little. A PCT with a sex ratio of 0.8:1 would have a combined prevalence of 17.2%, whereas a PCT with a sex ratio of 1.3:1 would have a prevalence of 17.6%.

This relationship may though be more complex. If a PCT's skewed Year 6 sex ration actually reflects a substantial selective opt out of obese and overweight girls, then there is a possibility that the reduced reported prevalence of obesity for girls might lower the PCTs overall Year 6 obesity prevalence.

Regression analysis of prevalence of obesity and sex ratio, though, does show a correlation between these variables for Year 6, but not for Reception. Weighted linear regression of the sex ratio by PCT and Year 6 prevalence of obesity and overweight combined and obesity alone shows significant correlations (p=0.007 for obesity, p=0.029 for overweight and obese combined).

Figure 29 shows the correlation between Year 6 obesity prevalence and the ratio of boys to girls.

Figure 29: Prevalence of obesity and ratio of boys to girls measured, by PCT, for Year 6, with trend from weighted linear regression



As this figure shows, PCTs that measured more boys than girls show a lower reported prevalence of obesity than those that measured more girls than boys. A 0.1 change in the sex ratio of boys to girls is associated with a -1.2% reduction in obesity prevalence (standard error=0.045, 95% confidence intervals -0.3% to -2.1%). Although the gradient of the line is slight, this correlation means that for the expected range of sex ratios (0.9–1.2, excluding extreme values), the sex ratio of children measured could result in differences in PCT level obesity prevalence of 1.0–6.3% (using 95% Confidence intervals).

It is therefore possible that the lower prevalence PCTs which appear to have had many girls opting out (i.e. a high ratio of boys:girls) do show a lower reported obesity prevalence due to the selective opt out of obese girls. It is though also possible that the skew in the sex ratio relates to another variable which also affects prevalence.

A small but significant correlation exists between participation rate and sex ratio of children measured. However, this shows that the proportion of boys measured increases with participation rates. Because higher participation is associated with a higher reported prevalence of obesity, this cannot explain the observed association between prevalence and the sex ratio.

Significant correlation does though exist between the ratio of boys to girls and deprivation at PCT level. This suggests that more deprived PCTs, which tend to have higher prevalence of obesity (see section 9), also have a lower ratio of boys to girls measured. This finding could explain the observed association between prevalence and sex ratio. Multiple population-weighted regression of both sex ratio and Index of Multiple Deprivation (IMD) score at PCT level results in the sex variable becoming non-significant, which appears to confirm this as the likely explanation.

The apparent link between opt out of girls and deprivation also suggests that opt out by girls is slightly more frequent in affluent areas. This may provide useful information to help tackle the problem of non participation by girls, but given the inadequacies of the sex ratio of measured children as a definitive measure of opt-out of girls, further analysis would be required before this finding is used to direct interventions.

8.5 Conclusions

Evidence exists of higher rates of non-participation amongst girls than boys in Year 6 at national level, but this does not seem to be an important issue for children in Reception. A lack of robust comparison data below national level prevents identification of regions or PCTs where this is a particular problem, but the available data confirms that this is an issue for Year 6.

An absence of robust information about the numbers of pupils eligible for measurement by sex hampers this analysis. Considerable benefits could be gained by collecting from PCTs the number of eligible pupils by sex, though the extra administrative burden this would place on PCTs needs to be considered.

If the apparent non-participation amongst girls reflects selection bias (as appears to be the case for opt-out in general), this could lead to an underestimation of obesity prevalence for girls at national level which might artificially widen the differences in reported prevalence of obesity between girls and boys using NCMP figures.

The sex ratio of pupils measured for the NCMP has no apparent effect on the reported prevalence of obesity for individual PCTs for the Reception year. In Year 6 PCTs who measured more boys than girls tend to report a slightly lower prevalence of obesity than those that measured more girls than boys.

This though appears to be explained by links with socioeconomic deprivation – more affluent PCTs appear to have higher opt-out rates amongst girls. Further investigation is required to test whether this is indeed the case and, if so, whether this information can be used to target interventions to encourage girls to participate in the NCMP.

The available analysis suggests standardisation for sex is not needed when producing prevalence figures, even if the sex ratio is substantially skewed.

Attempts to improve participation rates in future years would benefit from further investigation into the reasons why children, especially girls in Year 6, opt out of the NCMP. If these reasons can be addressed, PCTs might be able to reduce opt-out rates and improve overall participation and reliability of prevalence figures when produced by sex.

9 Sociodemographic effects on prevalence of obesity and overweight

The IC's report showed that obesity prevalence is affected by sociodemographic factors: mainly socioeconomic deprivation, urban/rural classification and ethnicity.

These findings are important, because up to now only limited detailed evidence has been available showing the links between childhood obesity and socioeconomic factors, or whether certain ethnic groups have a higher reported prevalence of obesity. The 2006/07 NCMP dataset provides the first opportunity for analysis to be undertaken using a large sample size available at national level.

These sociodemographic factors are inter-related; deprived areas are most often urban areas, and areas with the largest minority ethnic populations tend to be deprived urban areas. This section of the report will examine the inter-relation of these factors and their effect on PCT obesity prevalence rates.

9.1 Obesity and overweight prevalence and socioeconomic deprivation

The IC's report showed a strong correlation between prevalence of obesity and deprivation, as measured by the IMD 2007,[15] and the proportion of children eligible for free school meals (FSM),[16] for both age groups.

Analysis of deprivation (using both FSM and IMD) by Local Authority (LA), showed that correlation with prevalence of obesity was stronger in Year 6 than in Reception. The IC's analysis showed that eligibility for FSM was the best predictor of child obesity prevalence at LA level.

This analysis can be replicated by PCT. IMD 2007 scores were derived for PCTs by taking a population-weighted average of the super output area (SOA) IMD scores for the SOAs assigned to each PCT.[‡] The proportion of pupils eligible for FSM by PCT was calculated using the sum of the number of pupils eligible for FSM and dividing this by the total number of pupils for all the schools within each PCT using DCSF data from January 2006. To make the FSM index as relevant to the NCMP prevalence figures as possible, FSM and pupil data were only used for schools in which PCTs had taken measurements.

Weighted linear regression analysis lends support to the strong relationship between socioeconomic deprivation and obesity prevalence reported by the IC (Table 5).

[‡] 2001 SOA population estimates have been used to weight SOA IMD scores and the Feb 07 'Gridlink' file (postcode to higher geography lookups) was used to allocate SOAs to PCTs.

Table 5: Results of weighted linear regression between the prevalence of obesity, IMD 2007 and proportion of children eligible for FSM, by PCT

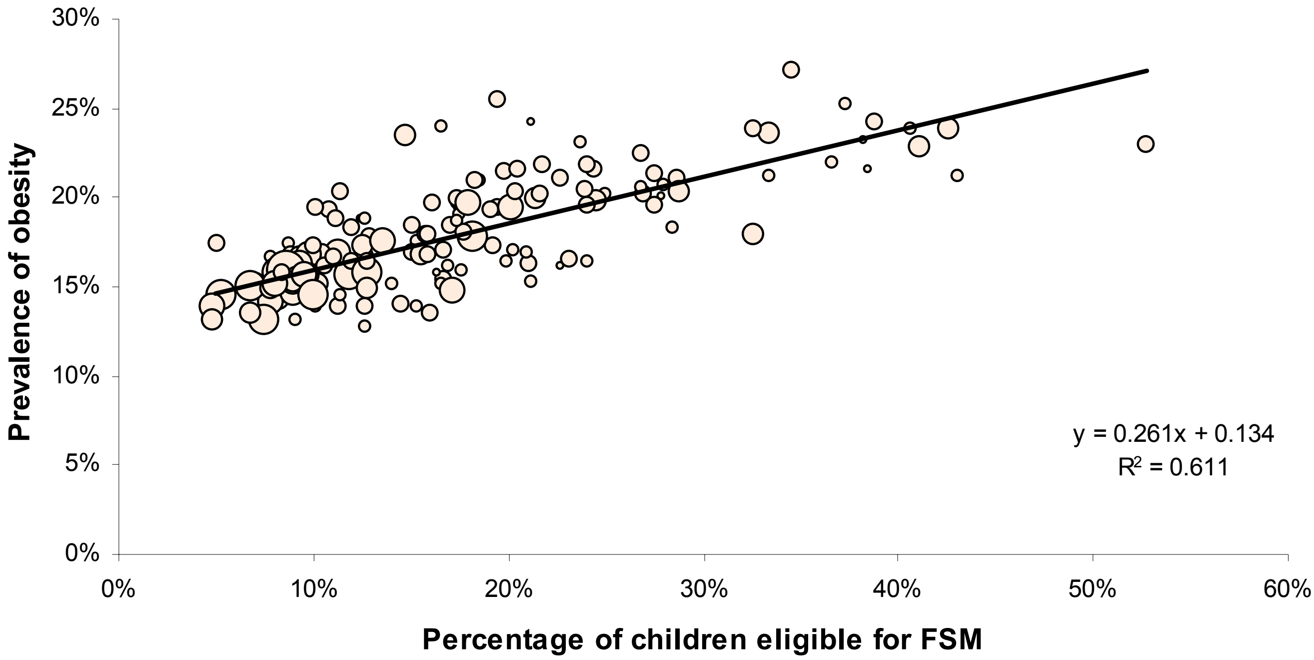
Variables	Coefficient of determination	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Reception obese and IMD	0.414	0.001	0.000	<0.001
Reception obese and FSM	0.406	0.121	0.012	<0.001
Year 6 obese and IMD	0.516	0.002	0.000	<0.001
Year 6 obese and FSM	0.611	0.261	0.017	<0.001

Table 5 shows strong and highly significant ($p<0.001$) correlations between obesity and both indicators of socioeconomic deprivation in both year-groups. All correlations are stronger at PCT level than those reported by the IC for LAs using unweighted regression.

The IC's analysis by LA showed the IMD explained 45% of variation in Year 6 obesity prevalence and 36% in Reception using unweighted analysis. Weighted regression by PCT shows that IMD can explain 52% of variation in Year 6 obesity prevalence and 41% for Reception. Equally, FSM by PCT can explain 61% of obesity prevalence for Year 6 and 41% for Reception, whereas by LA, these figures were 57% and 33%. The differences result from the use of weighted regression; correlations by PCT using unweighted analysis are similar to those reported by the IC.

The gradient of these correlations has a substantial effect on obesity prevalence. Between the PCTs with the lowest and highest IMD scores, the expected difference in obesity prevalence would be around 4.6% (95% confidence intervals 3.7–5.5%) in Reception and 8.9% (7.5–10.3%) in Year 6, partly on the basis of the relative levels of socioeconomic deprivation. Use of FSM as the independent variable gives slightly higher predictions, suggesting differences in obesity prevalence of 5.7% (95% confidence intervals 4.6-6.8%) in Reception and 12.3% (95% confidence intervals 10.7-13.9%) in Year 6 could be explained by variation in socioeconomic conditions between PCTs. The correlation between FSM and prevalence of obesity in Year 6 is shown in Figure 30.

Figure 30: Prevalence of obesity and proportion of pupils eligible for FSM by PCT for Year 6, with trend from weighted linear regression



These findings show that socioeconomic deprivation is a strong predictor of obesity prevalence, and lend support to the finding in the IC report that deprivation has a greater effect on obesity in Year 6 than in Reception. For Year 6, either of the indicators of deprivation used can explain more than half the variation in obesity prevalence between PCTs.

The issues identified with 2006/07 NCMP data (e.g. low participation rates or rounding of weight measures) might mean that published obesity prevalence figures are unreliable for some PCTs. Since one of the intended uses of NCMP data is to identify areas with high obesity prevalence, the strength of the association between socioeconomic deprivation and prevalence suggests that deprivation indices might provide a useful proxy indicator of obesity prevalence where NCMP data are unable to provide this

Use of deprivation as a proxy for obesity prevalence could be particularly advantageous for estimating obesity prevalence for areas smaller than PCTs. Many PCTs want to identify areas of high prevalence within their boundaries, perhaps to target resources or interventions. Obesity prevalence figures for sub-PCT populations (particularly school-level prevalence figures) are likely to have very wide confidence intervals and, therefore, few will display significant differences from the comparator population, whether that is the PCT, regional or national prevalence. Prevalence figures for small populations are also particularly vulnerable to the impact of data quality issues such as low participation rates or rounded data. In such situations PCTs could use socioeconomic deprivation to identify small areas that are likely to have a high prevalence of obesity with a reasonable degree of confidence.

9.2 Urban and rural classification

As well as the effect of deprivation on prevalence of obesity, the IC's report drew attention to large differences in obesity prevalence between in children living in urban areas and those living in areas classified as 'village, hamlet and isolated dwellings' or 'town and fringe'.

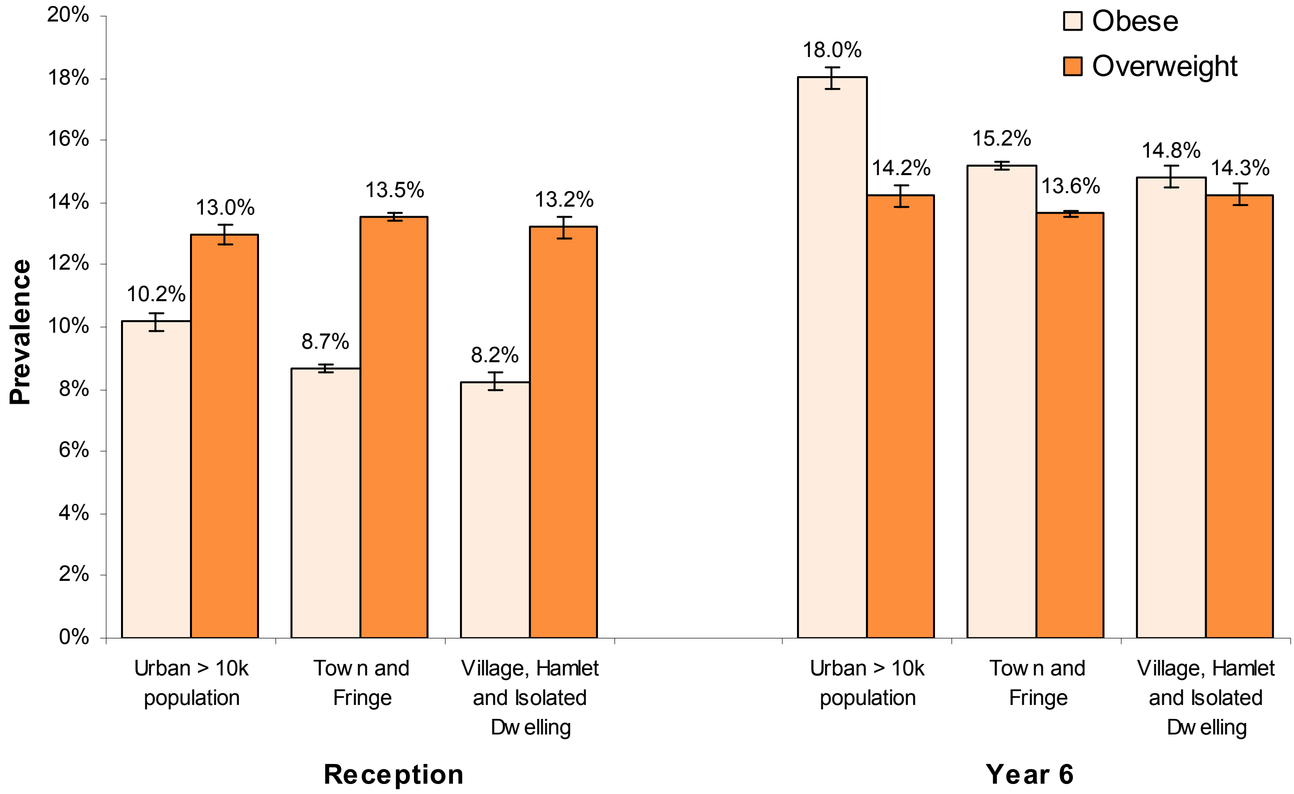
Obesity prevalence in both Reception and Year 6 was considerably higher in urban areas than in those classified as 'town' or 'village'. Obesity prevalence in children living in 'towns' and 'villages' was broadly the same and no significant differences existed between any of the urban/rural classifications for overweight prevalence.

The IC's analysis was based on the child's postcode of residence, a data item that was provided for about 58% of pupil records and converted to SOA of residence at the point of upload to the NCMP dataset. Since this variable is not available for all children in the NCMP dataset, and because 44 PCTs (29%) did not supply any child postcodes, PCT level analysis is not possible using the child's postcode of residence. As a result the SOA of the child's school was used to provide the urban/rural classification in the following analysis.

Additional data cleaning and analyses conducted for this report suggests that some PCTs incorrectly entered the postcode of the school instead of the child's postcode. This occurred with around 10% of the records with postcodes submitted to the NCMP. As a result analysis of the urban/rural indicator by SOA of school will actually differ less than might be expected from any analysis where this variable is based on the child's SOA of residence.

Figure 31 shows prevalence of obesity and overweight for both year-groups by urban and rural classification, with individual pupils classified according to the SOA of their school. The prevalence figures here differ little from the analysis produced by the IC, suggesting that urban/rural classification by school SOA rather than by SOA of residence is accurate enough for the purposes of this analysis. Additionally, this finding suggests that the analysis produced by the IC, which did not include data from the 44 PCTs which did not supply child postcodes, nevertheless provides an accurate representation of the relationship between urban/rural classification and prevalence of obesity and overweight at national level.

Figure 31: Prevalence of obesity and overweight by urban/rural classification of child's school for all children, with 95% confidence limtis



As Figure 31 shows, the biggest differences observed in prevalence of obesity and overweight are between urban areas and all other classifications. At the 95% significance level there are no significant differences between prevalence figures for schools located in 'town and fringe' or 'village, hamlet and isolated dwellings', with the exception of figures for Year 6 overweight, where prevalence is marginally higher in villages. As a result, for the purposes of further analysis, the 'town' and 'village' groupings can be combined.

Because PCTs differ in their degree of urbanisation, these differences in obesity prevalence suggest that some of the variation in prevalence of obesity between PCTs could be explained by the urban/rural classification.

To test this, the proportion of children measured by each PCT who attend schools in urban areas was calculated for each school year. This variable ranged from less than 40% in the least urbanised PCT, to 100% in nearly 60 (40%) PCTs. The correlation between the proportion of measured pupils attending schools in urban areas in Reception and Year 6 was strong (R^2=0.97, $p<0.001$), though a small number of PCTs displayed large changes (up to 20%) between the school years.

Population-weighted linear regression by PCT shows the expected associations between the proportion of children measured who attend urban schools and the local prevalence of obesity. In Year 6, this variable explains 28.5% of the variation in prevalence figures, and 20.1% for Reception. Both correlations are significant ($p<0.001$). The gradient of the line of best fit suggests that a 10% increase in the proportion of children measured who attend schools in urban areas is associated with a 0.85% rise in obesity prevalence for Year 6 and a 0.41% rise for Reception.

Though this association is strong, the links between urbanisation and deprivation need to be considered There is also a significant correlation between the proportion of children measured by each PCT who attend schools in urban areas and the IMD score (R^2= 0.29 for Reception and 0.26 for Year 6, p<0.001 for both years) or FSM index for that PCT (R^2= 0.35 for Reception and 0.33 for Year 6, p<0.001 for both years). This means that some of the variation in obesity prevalence that is explained by the degree of urbanisation within a PCT might also be explained by the degree of social deprivation. These variables cannot be seen as independent predictors of obesity prevalence, so any correlations between these variables and prevalence of obesity and overweight should be treated with caution.

9.3 Ethnicity

In 2006/07, PCTs were able to enter ethnicity information on their child population alongside NCMP child measurements. Many PCTs were able to extract this information from child health systems or obtain it from schools. Ethnicity was not defined by staff taking measurements or obtained by asking children. Although this was an optional field, valid ethnic coding was returned for over 30% of the NCMP sample, i.e. nearly 300,000 records.

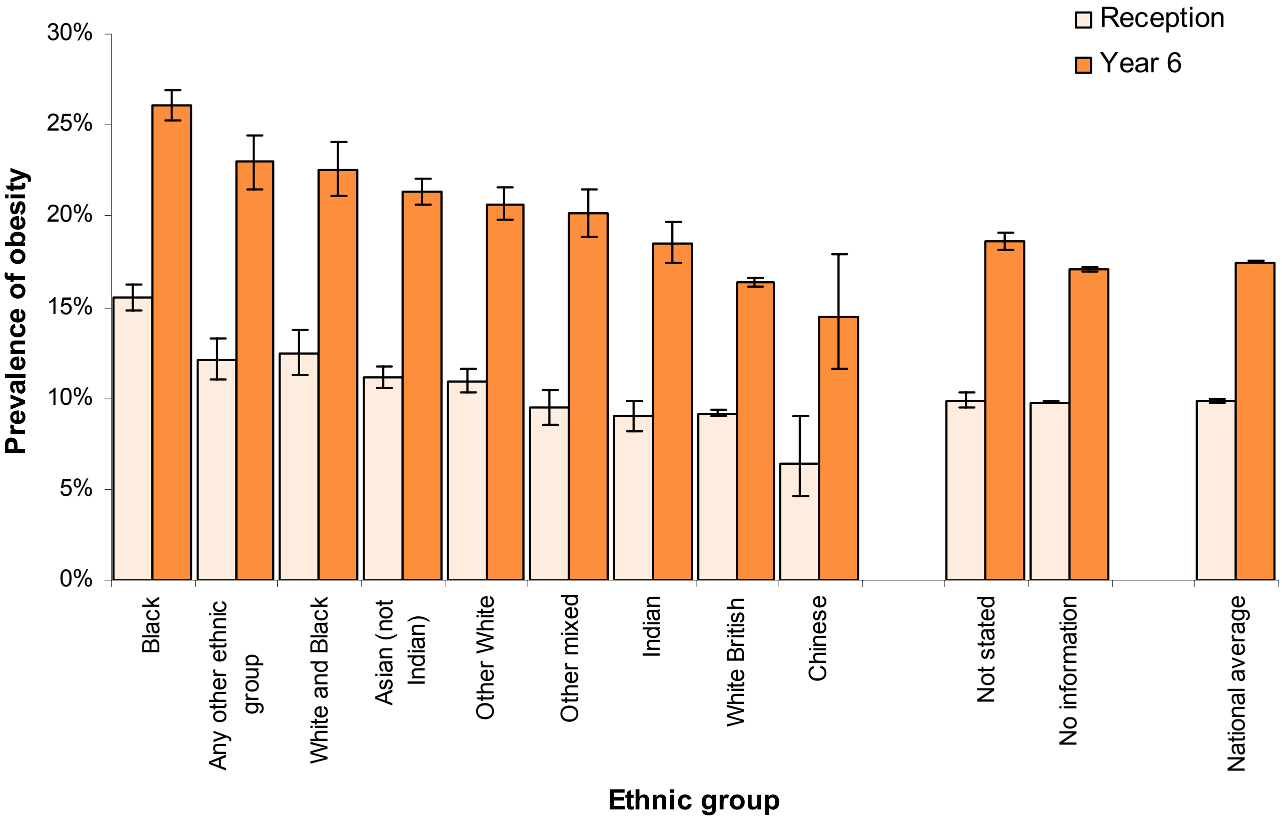
Although not all PCTs returned ethnicity information, and so the sample cannot be said to be truly nationally representative, there was a good coverage of PCTs from across the country. It is therefore likely that any patterns observed in this large sample reflect the underlying links between ethcity and obesity prevalence for the population as a whole.

The IC's report showed for the first time the significant differences in child obesity prevalence between different ethnic groups. At both Reception and Year 6 there was evidence of a substantially higher prevalence of obesity in the 'Black African', 'Black Caribbean', 'Any other Black background', 'White and Black Caribbean', as well as the 'Any other' ethnic groups. At Year 6, prevalence of obesity in most ethnic groups was substantially greater than the national average, except for 'White and Asian', 'White British', 'Indian' and 'Chinese'.

Figure 32 shows the prevalence of obesity in Reception and Year 6 by ethnic group. In order to make this chart easier to interpret, ethnic groups with similar obesity prevalence have been combined. There were no significant differences in prevalence between any of the groups that have been combined (at the 95% significance level).

Children classed as 'Black African', 'Black Caribbean' and 'Any other Black background' have been combined, 'White and Black Caribbean' and 'White and Black African' have been grouped, as have those in the 'Bangladeshi', 'Pakistani' and 'Any other Asian' categories. 'White Irish' children have been included with the 'Other White' ethnic group, and those classed as 'White and Asian' have been added to the 'Other mixed' group.

Figure 32: Prevalence of obesity in Reception and Year 6 by broad ethnic group, with 95% confidence limits



As this figure shows, children of all ethnic groups, with the exception of Chinese children, have significantly higher obesity prevalence than the 'White British' population in Year 6. Fewer significant differences exist in Reception, but the overall pattern is similar. A close correlation exists between prevalence in Reception and Year 6, with 81% of the variance in Year 6 obesity prevalence explained by the figure for Reception.

The 'Black' ethnic group, comprising children defined as 'Black African', 'Black Caribbean' and 'Any other Black background', has the highest prevalence of obesity in both school years. Year 6 children in these three ethnic groups combined have a prevalence of obesity of 26.1% (95% confidence intervals 25.3–27%) for Year 6 and 15.5% (95% confidence intervals 14.9-16.3%) for Reception, which is significantly higher than prevalence in any other ethnic group. In Year 6, prevalence of obesity is nearly 10% higher in children in 'Black' ethnic groups than in 'White British' children (26.6% *vs* 16.4% (95% confidence intervals 16.1-16.6%)).

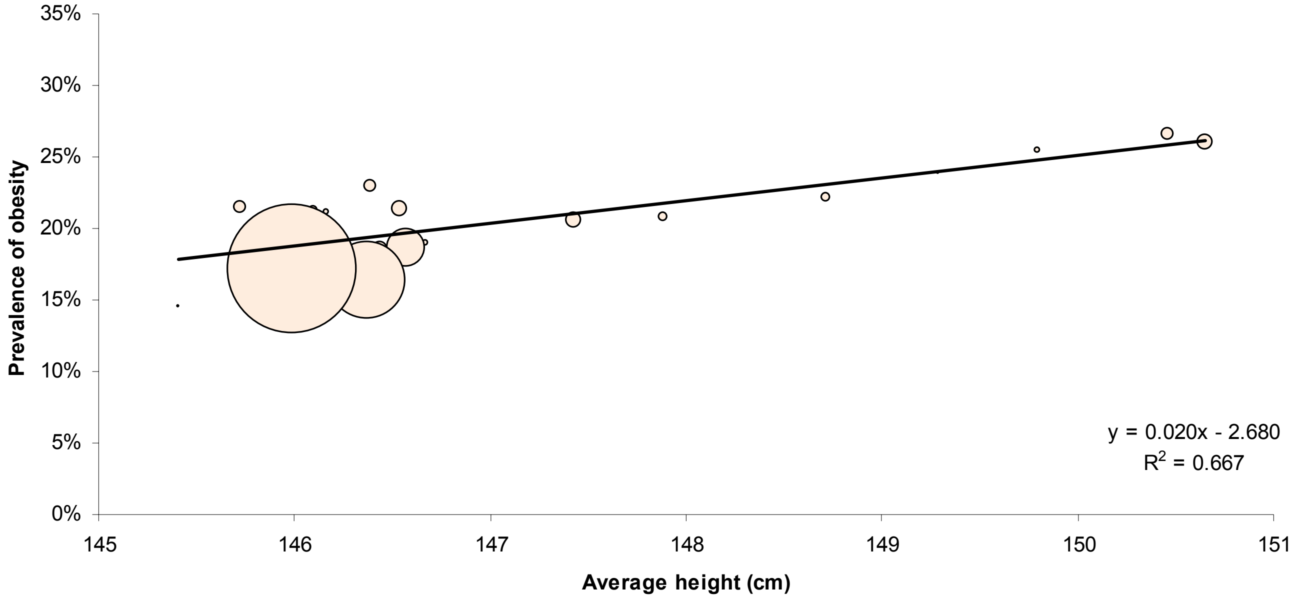
For both age groups, prevalence of obesity in children classified as 'Indian' is significantly lower than that for 'Asian' children (children classified as 'Bangladeshi', 'Pakistani' or 'Any other Asian').

As figure 32 shows, Year 6 obesity prevalence in the group of children for whom an ethnicity code was provided but ethnicity was 'not stated' was significantly higher than prevalence for those children where no information on ethnicity was provided by the PCT. In addition the combined obesity prevalence for all individuals with stated ethnicity (not shown on figure 32) is also significantly higher than the prevalence for the 'no information' group, but not significantly different from the 'not stated' group.

This suggests that obesity prevalence is slightly higher in those PCTs who provided ethnicity information. This may merit further investigation.

The issues raised by these findings warrant more detailed investigation than is possible to include in this report. For example, it can be shown that ethnic groups with higher prevalence of obesity also have significantly higher average height than the 'White British' children. Figure 33 shows the correlation between height and prevalence of obesity at Year 6 for all ethnic groups (i.e. not grouped as previously described).

Figure 33: Prevalence of obesity and average height for Year 6 children by ethnic group, with trend from weighted linear regression



This figure shows that nearly 67% of the variance in prevalence of obesity between ethnic groups can be predicted by the average height of children in that population. This raises questions about whether the differences in prevalence across ethnic groups truly reflect a higher proportion of obese individuals, or whether this is a result of differences in build and growth patterns in these sub-populations. Some research evidence suggests this may the case and that BMI, at least when using existing BMI thresholds, is not a good predictor of obesity in some ethnic groups.[17]

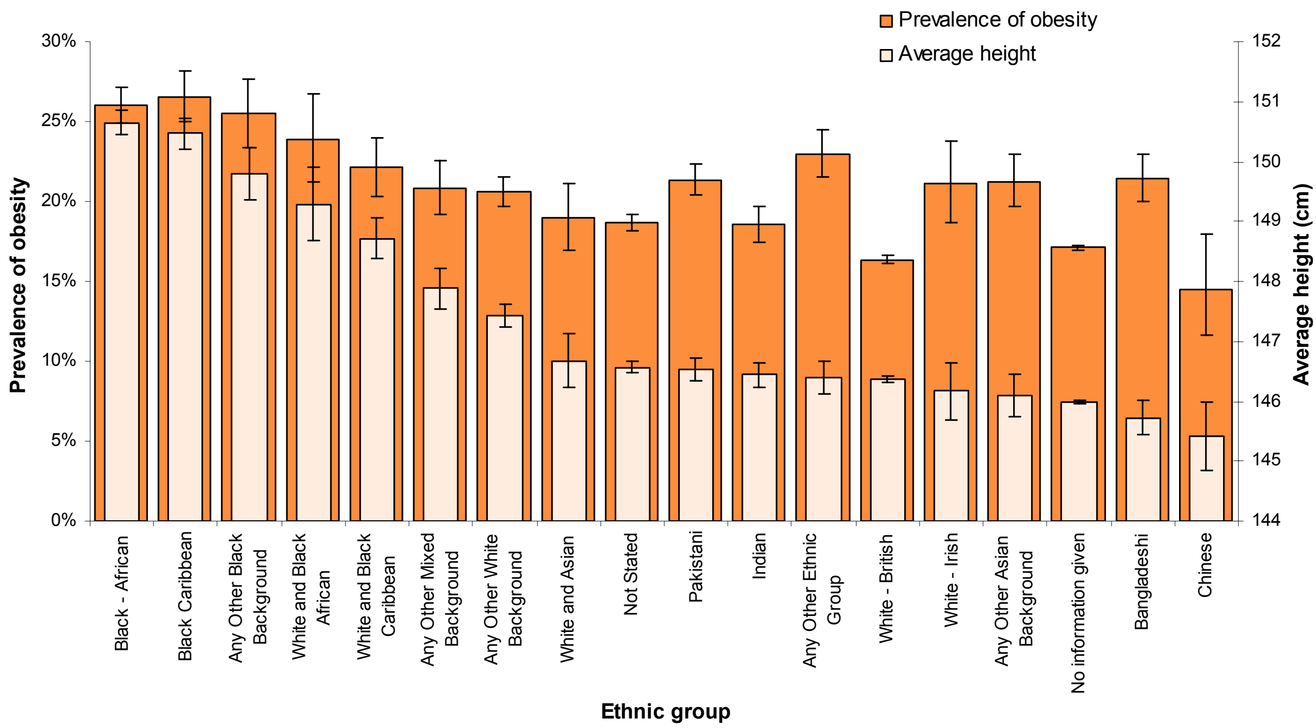
Although BMI adjusts for height to some extent, this is not fully accounted for, and if a small individual were scaled up in all dimensions (while maintaining the same body density), their BMI would also increase. As a result, taller children will tend to have slightly higher BMIs than shorter children, even if all their body dimensions were in the same proportions. Additionally, BMI cut offs for children change with age, unlike cut offs for adults. As a result, if children in some ethnic groups have earlier growth spurts than others, their height, weight and BMI would all be at a high percentile for their age, resulting in a higher prevalence of obesity.

These findings mean that the suitability of both BMI as a measure and the British 1990 growth reference (UK90) for all sections of the current English child population needs to be reviewed. The UK90 reference was based on a sample of 'White British' children.[18] Other countries have produced different growth curves from the UK, so the UK reference is not universal to all child populations. To what extent differences in growth curves result from differences in the socioeconomic or nutritional situations between these countries and the UK and to what extent these show genetic differences between populations, for example in terms of average height, build or time of growth spurts, is not known. It is, however, important to note that for the time being BMI is the only practical measure available for the NCMP.

The differences in height between ethnic groups in the NCMP suggest that there are some genetic differences between populations that could explain some of the variation in obesity prevalence recorded by the NCMP. Further analysis is required to determine how applicable the UK90 BMI thresholds are for children of different ethnic groups.

Only some of the ethnic groups with higher prevalence of obesity (i.e. ‘Black African’, ‘Black Caribbean’, ‘Any other Black’, ‘White and Black African’, ‘White and Black Caribbean’, ‘Any Other Mixed’ and ‘Other White’) have higher average height than the ‘White British’ population. ‘Pakistani’, ‘Bangladeshi’, ‘Any other Asian’, ‘White Irish’ and ‘All other ethnic groups’ all have higher prevalence of obesity than the ‘White British’ population, though height does not show the same degree of increase, as shown in Figure 34.

Figure 34: Prevalence of obesity and average height for Year 6 children by ethnic group, with 95% confidence limits



This suggests that even if some of the variation in obesity prevalence can be explained by the differences in height between ethnic groups, this probably would not explain the differences for some ethnic groups. Even though reported obesity prevalence is highest in the ‘Black’ ethnic groups, it is possible that the true prevalence of obesity in some other communities, such as the ‘Pakistani’, ‘Bangladeshi’, ‘Any Other Asian’, White Irish’ and ‘Any Other Ethnic Groups’ might in fact be a more significant issue. Again further analysis, which is possible given the richness of the NCMP dataset, is warranted to investigate these issues further.

9.4 Effect of ethnicity on PCT obesity prevalence figures

The magnitude of the differences in obesity prevalence by ethnic group could potentially explain some of the variance in obesity prevalence between PCTs. It was optional for PCTs to provide ethnicity for the NCMP 2006/07, and valid information was only received for 31% of Reception and 33% of Year 6 records. 83 (55%) of PCTs returned no ethnicity information at all, so the potential to use this information to compare with PCT level obesity prevalence figures is limited using this dataset.

The size of the NCMP sample does, though, mean that robust analysis can be produced for ethnic groups as a whole. In addition, DCSF data are available that provide pupil ethnicities by school. It is therefore possible to combine this information to produce a PCT level ethnicity indicator that can be used in such analysis.

Firstly, DCSF school data were aggregated for pupil ethnicities from January 2006 to PCT level, based on the schools in which measures were taken for NCMP 2006/07. This ensures that the ethnicity variable being created for PCTs relates directly to the population sampled in the NCMP dataset and reduces the potential for bias.

Secondly, the national prevalence of obesity by ethnic group and school year from the NCMP 2006/07, as described in the IC's report, has been applied to these data to produce an 'expected prevalence' of obesity based on the ethnicity of that PCT's child population. This provides the prevalence of obesity that PCTs would report should they have the same ethnic group-specific obesity rates as the national population.

This approach relies on the ethnic mix of the 2006/07 population having the same ethnic profile as that captured in the January 2006 DCSF data. For some areas where rapid changes are taking place in the ethnic mix this will not be the case. Additionally, the DCSF figures are based on whole school data, and are not broken down by age group. As a result, the same ethnic breakdown of population has been applied to both Reception and Year 6 prevalence figures. This will not be accurate in areas where the ethnic mix has changed in recent years and resulted in a different ethnic mix between the Reception and Year 6 populations. Despite these issues, it is reasonable to assume that, across all 152 PCTs, the January 2006 snapshot is a fair representation of the ethnic mix of the current child population as sampled for the NCMP 2006/07.

Comparison of the 'expected prevalence' of obesity, based solely on the ethnicity profile of the population, to reported prevalence figures from the NCMP data (using population-weighted linear regression) shows strong correlation between the two sets of prevalence figures (Figure 35).

Figure 35: Reported prevalence of obesity and expected prevalence based on PCT ethnicity profile in measured schools, with the trend from weighted linear regression

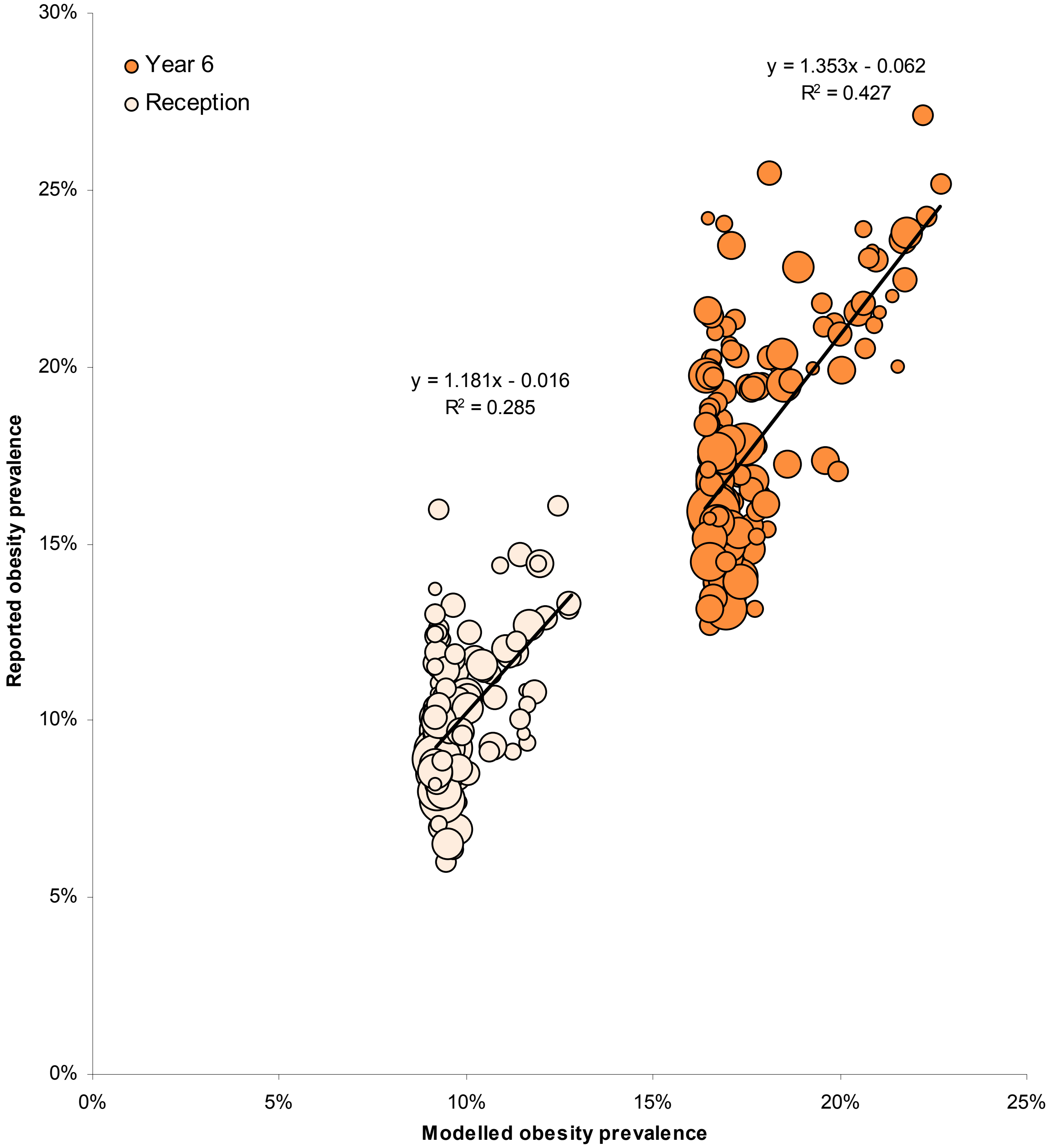
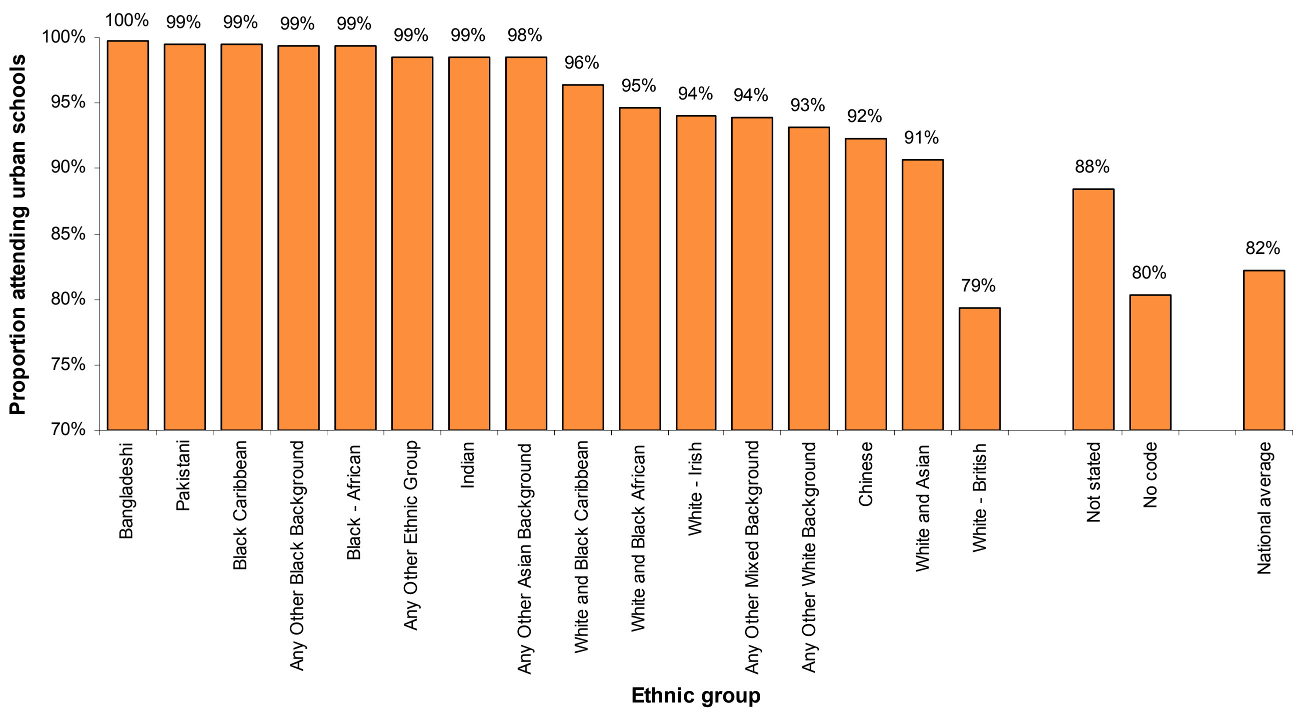


Figure 35 shows that the model does not explain differences in obesity prevalence between PCTs that have an ethnicity profile similar to that of the national population (illustrated by the clusters of PCTs with predicted prevalence around 10% and 17.5%). However, for PCTs with more varied ethnicity profiles, this variable is a good predictor of obesity prevalence, especially for Year 6. Overall, ethnicity can explain over 40% of the variation in obesity prevalence between PCTs for Year 6, and nearly 30% for Reception.

These results show that the obesity prevalence in some PCTs may be largely explained by the local ethnicity profile. Whether this means these are truly areas of high prevalence, or whether this is a result of the limitations of UK90 when applied to a variety of ethnic groups needs to be considered.

Another factor that needs to be taken into account when looking at the effect of ethnicity on obesity prevalence is the co-variance between ethnicity, urbanisation and deprivation. Children from all the ethnic groups analysed were more likely to live in urban areas than the 'White British' population (Figure 36).

Figure 36: Proportion of children attending schools in urban areas by ethnic group (Reception and Year 6 combined)



79% (slightly less than the national average of 82%) of children classified as 'White British' attend schools in urban areas. By contrast, more than 90% of children in all other ethnic groups attend urban schools. This means that PCTs with a high proportion of the population from non-'White British' ethnic groups are more likely to be found in urban areas, which also tend to be more deprived areas. As deprived urban areas are also known to have higher obesity prevalence, to some extent the urban environment in which ethnic communities tend to live, or the deprived socioeconomic conditions that usually affect these populations, might explain some of the observed differences in obesity prevalence between ethnic groups.

In order to establish whether the urban/rural environment is a confounding factor, it is possible to analyse prevalence of obesity by ethnic group for just those children attending urban schools. This analysis shows that the significant differences in prevalence between most of the ethnic groups remain, even compared with other children who also live in urban areas. Similar analysis with deprivation is more difficult, because once the population is examined by, for example, quintiles of deprivation, the number in the most deprived quintile is too small to allow meaningful analysis.

The relationship between deprivation, ethnicity and the prevalence of obesity can be examined with multiple linear regression. Such analysis supports strong and significant correlation between ethnicity and prevalence, even when deprivation is also included. This is examined in more detail in section 10 of this report.

9.5 Conclusions

The sociodemographic variables examined in this report – deprivation, urban/rural environment, and ethnicity – all show a strong correlation with reported prevalence of obesity from the NCMP.

Deprivation appears to be a very strong predictor of obesity prevalence, explaining over 50% of the variation in prevalence between PCTs. The strength of this relationship suggests deprivation indicators, such as the IMD and FSM, could potentially be used to identify areas likely to have high prevalence of obesity where NCMP data quality are lacking, or for small populations such as schools where prevalence figures are unlikely to be robust.

Urban areas report a significantly higher prevalence of obesity than non-urban areas, but due to the possible confounding effect of deprivation this finding should be treated with caution.

There are also significant differences in prevalence of obesity by ethnic group, with most ethnic groups showing a higher prevalence of obesity than the 'White British' population. The ethnic mix of a PCT's population is also a good predictor of their reported obesity prevalence and can explain a substantial proportion of the variation in prevalence between PCTs.

NCMP data though also shows substantial variation in mean height between ethnic groups, and those groups with a taller mean height tend to have higher reported obesity prevalence. Further investigation is required to determine whether BMI, particularly when using the current classification for obese and overweight, can be used to accurately determine whether a child is obese and overweight across all ethnic groups.

Although all the socioeconomic variables examined showed strong correlations with obesity prevalence at PCT level, these factors are inextricably linked. The most deprived communities are often found in urban areas, and frequently have a high proportion of the population from non-'White British' ethnic groups. As a result the potential confounding affects of all these socioeconomic variables needs to be considered when they are analysed in isolation.

10 Combined effects of all variables

This report has shown that several factors influence the obesity prevalence reported by PCTs through the NCMP. Some of these factors relate to NCMP data quality issues or characteristics of the dataset (e.g. participation rates, rounding of measures, age at time of measurement and the sex ratio of children measured). Other factors relate to the environment or population in which measurements were taken, for example, deprivation, the urban/rural environment and ethnicity.

These factors are often inter-related, which makes it difficult fully to appreciate their relative effects on prevalence when analysed separately. The technique of multiple linear regression allows several independent variables such as these to be analysed simultaneously to estimate their combined and relative effects on obesity prevalence.

The following analysis uses multiple linear regression to investigate the relative influences of the main factors affecting the reported obesity prevalence within the NCMP. The analysis has used the number of children measured by each PCT in each school year to weight each data point. As described in section 5.1, this gives greater weight to PCTs that measured more children, since prevalence figures for these PCTs are likely to be more robust than those for PCTs that measured fewer children.

10.1 Results of multiple regression

When all the factors examined in this report were compared with PCT prevalence figures, weighted multiple linear regression shows that 59% of the variation in prevalence for Reception, and 71% of the variation for Year 6, can be explained by these factors (Tables 6 and 7). The proportion of weight measures rounded to whole or half kilograms has been used for Reception, whereas the proportion of records rounded to whole kilograms has been used for Year 6.

Table 6: Results of weighted multiple linear regression between the reported prevalence of obesity at PCT level in Reception and all independent variables

Independent variable	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Participation rate in measured schools	-0.027	0.014	0.047
Average age of measured children	-0.001	0.000	0.005
% of weight measures rounded to the whole or half kg	-0.019	0.003	<0.001
Sex ratio (Males to females)	-0.001	0.021	0.951
IMD	0.001	0.000	<0.001
Proportion eligible for Free School Meals	-0.046	0.032	0.154
% of children at urban schools	0.004	0.006	0.547
Predicted prevalence based on ethnicity	0.818	0.210	<0.001

Table 7: Results of weighted multiple linear regression between the reported prevalence of obesity at PCT level in Year 6 and all independent variables

Independent variable	Slope (Beta coefficient)	Standard error of Beta	Significance (P value)
Participation rate in measured schools	0.064	0.017	<0.001
Average age of measured children	-0.001	0.001	0.034
% of weight measures rounded to the whole kg	-0.019	0.006	0.002
Sex ratio (Males to females)	0.025	0.029	0.394
IMD	0.001	0.000	0.001
Proportion eligible for Free School Meals	0.056	0.047	0.237
% of children at urban schools	0.008	0.009	0.401
Predicted prevalence based on ethnicity	0.595	0.160	<0.001

Tables 6 and 7 show that three variables (sex ratio, FSM and urban/rural environment) do not have a significant effect on obesity prevalence when combined in this way, for either age group.

The sex ratio only has a very small impact on obesity prevalence, and this seems to be related to deprivation (as discussed in section 8.4). Similarly, urban/rural classification is known to be closely correlated to the indicators of deprivation (see section 9.2), which perhaps explains why this variable proves non-significant when combined with FSM and IMD. By contrast, FSM proved a better predictor of obesity prevalence than IMD for both age groups, and the finding that FSM was non-significant is unexpected. FSM and IMD are closely correlated and show much the same pattern between PCTs. Whilst FSM alone explains more of the variation in obesity prevalence between PCTs than does IMD, when combined with the other factors IMD is a better predictor than is FSM.

In view of these findings the analysis was repeated without the factors that had no significant effect on the reported obesity prevalence. The remaining variables explained 58% of the variance in reported obesity prevalence for Reception, and 70% for Year 6, with all variables remaining significant (Tables 8 and 9).

These tables have been sorted by the absolute value of the ‘standardised Beta’ coefficients. As the independent variables are all measured in different units, the Beta coefficients (which provide the gradient of the lines of best fit for each variable) cannot be directly compared. The standardised Beta coefficients allow a direct comparison to be made, and provide an indication of the relative importance of each of the independent variables towards explaining the variance in obesity prevalence.

Table 8: Results of weighted multiple linear regression between the prevalence of obesity at PCT level in Reception and all significant independent variables

Independent variable	Slope (Beta coefficient)	Standard error of Beta	Standardised Beta	Significance (P value)
IMD	0.001	0.000	0.460	<0.001
% of weight measures rounded to the whole or half kg	-0.019	0.003	-0.307	<0.001
Predicted prevalence based on ethnicity	0.630	0.139	0.285	<0.001
Average age of measured children	-0.001	0.000	-0.155	0.006
Participation rate in measured schools	-0.028	0.013	-0.117	0.039

Table 9: Results of weighted multiple linear regression between the prevalence of obesity at PCT level in Year 6 and all significant independent variables

Independent variable	Slope (Beta coefficient)	Standard error of Beta)	Standardised Beta	Significance (P value)
IMD	0.002	0.000	0.526	<0.001
Predicted prevalence based on ethnicity	0.766	0.108	0.370	<0.001
Participation rate in measured schools	0.071	0.017	0.194	<0.001
% of weight measures rounded to the whole kg	-0.018	0.006	-0.142	0.002
Average age of measured children	-0.001	0.001	-0.104	0.026

Tables 8 and 9 show that IMD is the most important predictor of obesity prevalence by PCT for both age groups. IMD contributes 35% of the predictive power of the model for Reception and 39% for Year 6. For Reception, the second most important variable is the proportion of rounded measures (23% of the model's predictive power), followed by ethnicity (22%), average age of children when measured (12%) and participation rates (9%). For Year 6, ethnicity is the second most important variable (28%), followed by participation rates (15%), rounding of measures (11%) and average age of children when measured (8%).

This analysis shows that, although the same variables prove significant in age groups, their relative importance differs between Reception and Year 6. Participation rates in Reception which, when analysed alone, had no significant effect on obesity prevalence, have a small but significant effect when the effects of deprivation, rounded measures, ethnicity and age have been adjusted for. A 10% change in participation rates is likely to affect prevalence by around 0.3% in Reception.

Tables 10 and 11 show the possible effect on prevalence that can be explained by each variable within this model. The column labelled 'maximum difference in prevalence' shows the size of the differences in prevalence that may be explained by each variable given the range of values of each across the country.

Table 10: Potential maximum effect on Reception prevalence of obesity for all significant variables

Independent variable	National maximum	National minimum	Maximum difference in prevalence	95% upper limit	95% lower limit
IMD	48.2	8.1	3.3%	4.2%	2.4%
% of weight measures rounded to the whole or half kg	100%	18%	-1.5%	-1.0%	-2.1%
Predicted prevalence based on ethnicity	13%	9%	2.3%	3.3%	1.3%
Average age of measured children	68.3	55.4	-1.7%	-0.5%	-2.9%
Participation rate in measured schools	100%	45%	-1.5%	-0.1%	-3.0%

Table 11: Potential maximum effect on Year 6 prevalence of obesity for all significant variables

Independent variable	National maximum	National minimum	Maximum difference in prevalence	95% upper limit	95% lower limit
IMD	48.2	8.1	6.6%	7.9%	5.3%
Predicted prevalence based on ethnicity	23%	16%	4.8%	6.1%	3.5%
Participation rate in measured schools	100%	40%	4.2%	6.2%	2.2%
% of weight measures rounded to the whole kg	100%	9%	-1.7%	-0.6%	-2.7%
Average age of measured children	137.1	126.9	-1.5%	-0.2%	-2.8%

As Tables 10 and 11 show, although IMD has the greatest potential to affect obesity prevalence figures, all factors have the potential to result in differences of at least 1% between reported prevalence figures for PCTs in both age groups.

10.2 Comparison of expected and reported prevalence figures

The analysis presented above can be used to calculate a 'modelled' prevalence of obesity in all PCTs, using the five variables described. These 'modelled' prevalence figures give the expected level of obesity prevalence in each PCT, given the local socio-demographic profile (IMD and ethnicity), the participation rate, the proportion of rounded measures and the average age at which children were measured.

These figures can be compared with the reported prevalence of obesity for each PCT, as calculated from the height and weight information collected through the NCMP. In most cases PCTs reported figure will be close to the modelled figure, showing that their prevalence figure is in line with what would be expected given the characteristics of their population and NCMP dataset.

If a PCT's 'modelled' prevalence is substantially different from the reported figure then this might suggest that that these PCTs have an unusual obesity profile - i.e. higher or lower than would be expected given the local socioeconomic conditions and the ethnicity profile of the PCT, but could equally be due to inadequacies of the model These PCTs are advised to check their local data carefully and use local knowledge to determine whether other data quality issues not analysed here could have led to the large deviation from the modelled prevalence.

Tables 12 and 13 list PCTs in which the reported prevalence of obesity differs by more than +/- 2% from the 'modelled' value.

Table 12: PCTs where the reported obesity prevalence deviates by more than +/- 2% from the 'modelled' prevalence in Reception

PCT	Modelled prevalence of obesity	Reported prevalence of obesity	Difference
Wakefield District PCT	10.7%	16.0%	5.3%
Isle of Wight Nhs PCT	10.5%	13.7%	3.2%
Derby City PCT	10.0%	13.2%	3.2%
Barking and Dagenham PCT	11.5%	14.4%	2.9%
North Lincolnshire PCT	8.4%	11.1%	2.7%
North Staffordshire PCT	9.8%	12.4%	2.6%
Portsmouth City Teaching PCT	9.8%	12.3%	2.4%
Telford and Wrekin PCT	10.0%	12.5%	2.4%
City and Hackney Teaching PCT	13.8%	16.0%	2.3%
North Tees PCT	10.4%	12.6%	2.2%
Sutton and Merton PCT	9.6%	11.7%	2.1%
Redcar and Cleveland PCT	9.4%	11.5%	2.0%
Hastings and Rother PCT	9.1%	7.0%	-2.0%
Camden PCT	11.5%	9.3%	-2.2%
Islington PCT	12.3%	10.1%	-2.3%
Greenwich Teaching PCT	11.4%	9.1%	-2.3%
Sheffield PCT	9.2%	6.9%	-2.3%
Richmond and Twickenham PCT	8.9%	6.4%	-2.5%
Brighton and Hove City PCT	9.0%	6.0%	-3.1%

Table 13: PCTs where reported obesity prevalence deviates by more than +/- 2% from the 'modelled' prevalence in Year 6

PCT	Modelled prevalence of obesity	Reported prevalence of obesity	Difference
Portsmouth City Teaching PCT	17.2%	24.0%	6.8%
Wolverhampton City PCT	19.5%	25.4%	5.9%
Hartlepool PCT	19.0%	24.2%	5.2%
Dudley PCT	18.7%	23.4%	4.7%
Southwark PCT	22.6%	27.1%	4.4%
Western Cheshire PCT	14.4%	18.8%	4.4%
Bexley Care Trust	15.9%	19.4%	3.5%
Havering PCT	17.1%	20.3%	3.2%
Halton And St Helens PCT	18.6%	21.6%	2.9%
Sunderland Teaching PCT	18.6%	21.4%	2.8%
North Staffordshire PCT	16.2%	18.8%	2.6%
Greenwich Teaching PCT	19.0%	21.2%	2.2%
Barking and Dagenham PCT	17.7%	19.9%	2.2%
Newcastle PCT	19.2%	21.3%	2.1%
North Tees PCT	17.6%	19.6%	2.0%
Darlington PCT	19.0%	21.0%	2.0%
Plymouth Teaching PCT	17.4%	15.4%	-2.0%
Dorset PCT	15.2%	13.1%	-2.0%
Barnet PCT	19.4%	17.3%	-2.1%
City and Hackney Teaching PCT	26.4%	24.2%	-2.1%
Torbay Care Trust	17.8%	15.7%	-2.2%
Bury PCT	17.3%	15.1%	-2.2%
Liverpool PCT	20.2%	17.9%	-2.3%
Hastings and Rother PCT	16.3%	13.9%	-2.3%
Redcar and Cleveland PCT	19.4%	17.0%	-2.3%
Peterborough PCT	18.6%	15.9%	-2.7%
Sheffield PCT	17.7%	14.8%	-2.9%
Oldham PCT	19.2%	16.2%	-3.0%
East Lancashire PCT	16.7%	13.5%	-3.1%
Richmond and Twickenham PCT	16.4%	13.1%	-3.3%
Calderdale PCT	17.7%	14.0%	-3.7%
Heywood, Middleton and Rochdale PCT	20.8%	16.5%	-4.3%
Blackburn with Darwen PCT	20.9%	16.4%	-4.5%

10.3 Conclusions

This analysis shows that five independent factors - deprivation, ethnicity, participation rate, rounding of weight measures, and the age at which children are measured - significantly affect obesity prevalence for both age groups.

Deprivation and ethnicity have an important influence on the underlying prevalence of obesity in the population. By contrast, the other three factors relate to NCMP data quality issues which need to be minimised as far as possible if NCMP prevalence figures are to provide a robust indication of the underlying prevalence within the population. Factors that did not have a significant effect on prevalence in this model (i.e. sex ratio and the urban/rural classification) are not necessarily unimportant.

In the case of the sex ratio, it appears that higher rates of non-participation occurred in girls. This is important to tackle, even if it does not have a significant effect on PCT level prevalence figures. Additionally, it might be the case that the sex ratio used in this analysis, in view of the limitations of this measure discussed in section 8 (i.e. a lack of accurate pupil denominators by sex), is simply not accurate enough to show a significant correlation with prevalence at PCT level.

The urban/rural classification used in this report is also an approximation – based on the location of schools rather than the individual child. Although this factor is non-significant in PCT level analysis if the IMD is included, this does not necessarily mean that the urban/rural classification is not an important factor for obesity prevalence. More detailed analysis, ideally using pupil-level data to assign the urban/rural classification, may show a separate effect of the urban environment from that of deprivation.

The relationship between the five factors in this model and prevalence is likely to vary in strength within regions or PCTs. For example, for some PCTs deprivation might not be as powerful a predictor of obesity as it is for other PCTs. The NCMP dataset provides potential for more detailed analysis, and there may be potential to use multi-level modelling techniques to consider the nature of the variation in obesity prevalence within a region or PCT (e.g. using school as a unit) to do more powerful analysis than has been presented in this report.

Finally, the model presented here can only account for 60-70% of the variation in prevalence between PCTs. Much of this remaining variation will be due to genuine underlying differences in obesity prevalence between PCTs, but some might be explained by other data quality issues that have not been examined here. Where the published reported prevalence figure differs substantially from the figures obtained using this model (as shown in Tables 12 and 13), PCTs are advised to check whether such data quality issues or other local peculiarities of the dataset could not have caused these differences, before implementing policy or interventions based on the prevalence of obesity reported by their NCMP data.

11 Conclusions

This report shows the importance of the NCMP dataset for improving our understanding of trends in childhood obesity and overweight in England at a national and local level. The analysis also raises issues that need to be addressed if we are fully to understand this detailed and complex dataset.

Some issues can be examined with further analysis of the NCMP dataset, for example with school-level or grouped individual analysis or examination of the correlation between height, weight and BMI measures in relation to ethnic group. Other issues might need to be addressed through evaluation of the available evidence, for example studies from other countries that could inform our understanding of correlations between ethnicity and obesity prevalence. Others might need to be addressed by gathering information in addition to that obtained through the NCMP – for example a detailed, small scale study could be undertaken to record information on children who do not participate in the NCMP better to understand and tackle this issue.

The most important findings of this report are the potential effects of data quality issues, mainly participation rates and rounding of weight measures, on NCMP prevalence figures. Both these factors have a significant effect on obesity prevalence even when the effects of deprivation and ethnicity are accounted for.

Unless participation is improved to near 100%, or detailed information is recorded on opt-out rates to allow for accurate adjustments to prevalence figures, it is likely that national prevalence figures produced from NCMP data underestimate the true prevalence of childhood obesity.

Although rounding of measurements is likely to have only a small, yet significant, effect on national prevalence, this issue may influence individual PCT's prevalence figures and can be easily tackled. PCTs should ensure all measures are recorded as specified in the guidance in future years. Until this is achieved comparison of prevalence figures between PCTs or to guide local policy should be done with caution and with consideration to this issue.

Other issues, including variation in age at time of measurement and sex ratio of children measured, may or may not influence PCT level prevalence figures, but still need to be considered. Efforts should be made to record more detailed information on the time measurements are taken and on the expected sex ratios in local child populations so these issues can be assessed in more detail.

These data quality issues are important, but should not detract from the importance and value of the NCMP. These data are from the first year of the programme in this form, and hopefully many of these issues will rectify themselves as the programme becomes fully bedded in.

This increased understanding of child obesity prevalence and its influencing factors is one of the most valuable benefits of the programme, yet also poses some challenging questions. As with many other health conditions, childhood obesity is most prevalent in the most disadvantaged sections of our communities. If a change in obesity prevalence occurs in an area, this may have resulted from changes in the level of deprivation or the demographics of the underlying population, rather than any interventions (or lack of them) to tackle obesity.

Additionally, the finding that the variance in prevalence of obesity between ethnic groups may be linked to height means that the issue of the suitability of BMI and the UK90 growth standards for all ethnic groups should be reviewed. Further analysis is needed better to understand these issues.

Notwithstanding the above it is important to note that for a number of reasons BMI is currently the only practical measurement taken in a large programme such as the NCMP.

NCMP data are already yielding findings that add to our understanding of childhood obesity in a way that would not be possible if the programme did not exist. NCMP data can be used at national, regional and local level to further our understanding, inform policy, target resources and monitor progress.

Analysis of the NCMP dataset shows that much of the variation in obesity prevalence can be explained by sociodemographic factors. Targeting resources at specific ethnic groups or deprived communities is likely to be a helpful approach to tackling obesity.

References

[1] Department of Health. Healthy Weight, Healthy Lives, A Cross Government Strategy for England. London: DH, 2008
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_082378
Accessed 01/06/08

[2] The Information Centre for Health and Social Care. National Child Measurement Programme: 2006/07 school year, headline results. Leeds: IC, 2008
http://www.ic.nhs.uk/webfiles/publications/ncmp/ncmp0607/NCMP%202006%2007.%20Bulletin%20Final.pdf
Accessed 01/06/08

[3] The Information Centre for Health and Social Care. National Child Measurement Programme, Online results. Leeds: IC, 2008
http://www.ncmp.ic.nhs.uk
Accessed 01/06/08

[4] Department for Children, Schools and Families. Pupil absence in schools in England, including pupil characteristics: 2006/07. London: DCSF, 2008
http://www.dfes.gov.uk/rsgateway/DB/SFR/s000775/SFR05-2008-rev.pdf
Accessed 01/06/08

[5] Department of Health. NCMP film clips, Being measured: For children. London: DH, 2008
http://www.dh.gov.uk/en/Publichealth/Healthimprovement/Healthyliving/DH_073787
Accessed 01/06/08

[6] Department of Health. Parents' leaflet: Why your child's weight matters and Children's flyer. London: DH, 2008
http://www.dh.gov.uk/en/Publichealth/Healthimprovement/Healthyliving/DH_073787
Accessed 01/06/08

[7] Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK. Arch Dis Child 1995; 73: 25-9

[8] Cole TJ, Freeman JV, Preece MA. British 1990 growth reference centiles for weight, height, body mass index and head circumference fitted by maximum penalized likelihood. Stat Med 1998; 17: 407-29

[9] National Institute of Clinical Excellence. CG43 Obesity: Full guideline, section 2 - Identification and classification: evidence statements and reviews (Section 5.2 B Public Health). London: NICE, 2007
http://www.nice.org.uk/nicemedia/pdf/CG43FullGuideline2v.pdf
Accessed 01/06/08

[10] Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007; 335: 194-7

[11] Crowther R, Dinsdale H, Rutter H, Kyffin R. Analysis of the National Childhood Obesity Database 2005–06. London: DH, 2006
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_063565
Accessed 01/06/08

[12] National Centre for Social Research, The health of children and young people, HSE 2002. London: NatCen, 2003
http://www.archive2.official-documents.co.uk/document/deps/doh/survey02/hcyp/tables/hcypt159.htm
Accessed 01/06/08

[13] Department of Health. The National Child Measurement Programme - Guidance for PCTs: 2007–08 school year. London: DH, 2007
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_078689
Accessed 01/06/08

[14] Department of Health. The National Child Measurement Programme - Guidance for 2006–07 school year. London: DH, 2007
http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyAndGuidance/DH_073786
Accessed 01/06/08

[15] Department for Communities and Local Government. Indices of Deprivation 2007. London: DCLG, 2008
http://www.communities.gov.uk/communities/neighbourhoodrenewal/deprivation/deprivation07/
Accessed 01/06/08

[16] Governornet. School Meals and Nutritional Standards – Overview. London: DCSF, 2008
http://www.governornet.co.uk/publishArticle.cfm?contentId=724
Accessed 01/06/08

[17] Shaw NJ, Crabtree NJ, Kibirige MS, Fordham JN. Ethnic and gender differences in body fat in British schoolchildren as measured by DXA. Arch Dis Child 2007;92:872-5

[18] Freeman JV, Cole TJ, Chinn S, Jones PRM, White EM, Preece MA. Cross sectional stature and weight reference curves for the UK, 1990. Arch Dis Child 1995; 73: 17-24