Variation in children’s BMI by month of measurement

Analysis of the 2008/09 National Child Measurement Programme dataset

Technical briefing
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Key points

- In the 2008/09 National Child Measurement Programme (NCMP) dataset, the prevalence of obesity among children in Reception is lower for children measured later in the academic year. There is no significant trend for either boys or girls in Year 6.

- Each additional month of the academic year before NCMP measurement occurs is associated with a decrease in the reported prevalence of obesity of around 0.1% for children of Reception age.

- The reduction in the prevalence of obesity among children in Reception throughout the academic year does not appear to be caused by the confounding influence of other factors. When analysis was restricted to White British children of average socioeconomic status, obesity prevalence among children in Reception decreased by around 0.25% per month. Again there was no evidence of any relationship for children in Year 6.

- There is also a small, but statistically significant, decrease in the BMI of children in Reception by month of measurement. Each additional month is associated with a decrease in BMI z score (BMI adjusted for age and sex) of around 0.01 standard deviations, relative to the British 1990 growth reference.

- Looking at BMI of children rather than obesity prevalence figures, allows us to better adjust for the effects of age. For children in the first year of school, BMI does appear to decrease throughout the academic year, rather than change with the age of children measured. This suggests the observed pattern is not a result of changes in growth patterns among children.

- It is not possible to determine from this analysis what might cause the apparent reduction. Some studies from other countries have suggested that during school holidays children gain weight which is then lost during term time. One possible explanation for the observed trend might be that the school environment is in some way ‘healthier’ than the pre-school or home environment.

- These findings could also be a result of overall decreases in the prevalence of obesity and mean BMI in this age group over time, as has been suggested by some recent studies.

- It is possible that obesity prevalence figures at PCT level for the Reception year might be affected by the timing of NCMP measurements. However, preliminary analysis suggests any such impact is likely to be small, as timing of NCMP measurements explains only a small proportion of the observed variance in obesity prevalence between PCTs.

- To maintain a consistent trend, PCTs are advised to not make large changes to the timing of NCMP measurements – for example changing the majority of child measurements from the start to the end of the academic year. Small differences in the timing of measurements from one year to the next are unlikely to have any impact.
Introduction

Analysis of the 2007/08 NCMP dataset showed variation in the prevalence of obesity depending on the time of year at which measurements were taken. In 2007/08, obesity prevalence for children in Year 6 was significantly higher for children measured in September and October than for children measured in the subsequent months.

Such findings are not unique to the NCMP. A number of papers have been published which show seasonal variation in the prevalence of child obesity. Most commonly the body mass index (BMI) of children has been observed to be highest during the winter months, with such patterns reported in the US, Japan and Chile among others.

Other studies have suggested that children’s BMI may increase during the summer months or school holidays but decrease during the school term. One Japanese study has shown that the BMI of most children showed a seasonal pattern of increases in weight over the autumn, winter and early spring months, with a decrease over the summer. However, obese Japanese children also showed a pattern of weight gain over the summer months.

In this paper we have analysed the 2008/09 NCMP dataset to see whether any variation in both obesity prevalence and individual BMI can be detected between measurements taken in different months.

Methods

This analysis uses the 2008/09 NCMP dataset, distributed to PHOs by the NHS Information Centre for health and social care (NHS IC). Primary Care Trusts (PCTs) are not required to take NCMP measurements for children attending independent or special schools. Coverage of these schools is incomplete at national level and varies between different parts of the country, and so any records from such schools have not been included.

Children were compared with the British 1990 growth reference in order to account for the differences in BMI that occur with age and sex. The 95th centile was used to classify children as obese, and BMI z scores derived from this reference were used in the analysis of individual BMI.

Index of Multiple Deprivation (IMD) 2007 scores, to determine socioeconomic status were assigned to children based on the Lower Super Output Area of residence. The small number of children (approximately 1%) without valid geographic coding to assign IMD scores was not included in any analysis which included socioeconomic status.

Obesity prevalence by month of measurement has been examined using weighted linear regression. Changes in individual BMI were analysed using a multivariate linear regression model. Analysis has been conducted in Excel 2007 and PASW Statistics (SPSS) 18.

*Analysis of obesity prevalence and mean BMI z score (standard deviation scores) use the fields calculated and provided by the NHS IC.
†Weighted linear regression was used to take account of the variation in the number of child measurements between months. Monthly figures were weighted by the inverse of the standard error around prevalence estimates.
Monthly distribution of NCMP measurements

PCTs are able to take NCMP measurements at any time throughout the school year. This enables PCTs to achieve the highest possible participation rates as NCMP measurements can be fitted around the workload of both PCTs and schools. However, it also means that the measurements taken for the NCMP might be affected by any seasonal variation that occurs in children’s BMI.

The centrally collated NCMP dataset contains a field identifying the month of measurement of each child record. This enables any seasonal effect to be investigated.

Figure 1 shows how NCMP measurements are spread throughout the school year; the distribution of measurements is not even. March and June are the most common time for NCMP measurements to be taken, whilst September, December, and July are the least common.†‡

Figure 1: Number of NCMP measurements by month of measurement and school year, 2008/09

This pattern is similar to that seen in 2007/08, with the exception that in 2008/09 a greater proportion of measurements was taken in March. In 2007/08 approximately 12% of child measurements were taken in March, whilst in 2008/09 this proportion was just over 20%.

Although only a small proportion of NCMP measurements was taken in some months, this still equates to over 6,000 child measurements in each school year for the month with the fewest measurements taken (September). It is therefore possible to conduct robust analysis of the NCMP dataset by month of measurement.

†Measurements coded as being taken in August have not been included in this analysis. The majority of these have been found to result from data quality and processing issues rather than actual August measurements.
Prevalence of obesity by month of measurement

As seen with the 2007/08 data, the 2008/09 NCMP data show that reported obesity prevalence varies by month of measurement (Figure 2).

The pattern is different from that observed in 2007/08. In 2007/08 obesity prevalence in Year 6 appeared to be highest in September and October but otherwise varied little throughout the year. In 2008/09 obesity prevalence appears to have decreased with each successive month of the academic year for both boys and girls in both school years.

**Figure 2: Prevalence of obesity by month of measurement, school year and sex; NCMP 2008/09 (showing the linear trend and 95% confidence limits)**

The decrease in reported obesity prevalence by month of measurement is statistically significant for both boys (p<0.02) and girls in Reception (p<0.01). It appears that each additional month into the school year results in approximately a 0.1% decrease (in absolute terms) in reported obesity prevalence.

The apparent decrease in the prevalence of obesity with each month of measurement is not significant (p>0.05) for either boys or girls in Year 6.

**Possible confounding effects of sociodemographic variation**

Previous analysis of NCMP data has shown that obesity prevalence varies widely across socioeconomic and ethnic groups. Analysis of the 2008/09 NCMP data shows variation in mean socioeconomic status (based on the IMD score of place of residence) between different months of
measurement. The proportion of children measured of White British ethnicity also shows variation by month.

It is possible that some systematic variation in the demographic and socioeconomic status of the children measured throughout the academic year might cause the observed variation in obesity prevalence and mean BMI. However, there is no consistent pattern to the variation for either of these variables, and so it seems unlikely that these factors could cause the observed linear decrease in obesity prevalence and mean BMI.

To confirm that the apparent reduction in obesity prevalence is not caused just by changes in the sociodemographic mix of the children measured in each month, the analysis was repeated using a subset of the NCMP sample. To reduce the potential for confounding effects, only children of White British ethnicity living in areas with levels of socioeconomic deprivation close to the national average (the 4th, 5th and 6th IMD deciles) were selected.

Figure 3 shows the relationship between month of measurement and obesity prevalence among children in this subgroup. When assessed using weighted linear regression, the decrease in obesity prevalence by month is again significant for both boys (p<0.05) and girls (p<0.01) in Reception, but not for children in Year 6 (p>0.05).

**Figure 3: Prevalence of obesity by month of measurement, school year and sex for children of White British ethnicity and average socioeconomic status; NCMP 2008/09 (showing the linear trend and 95% confidence limits)**

For children in Reception, the association is stronger for this subgroup than for the population as a whole. Weighted linear regression of these data shows a decrease of approximately 0.25% (in absolute terms) in obesity prevalence with each successive month of the academic year.
Age of children and month of measurement

The average age of children measured in the NCMP sample increases with each consecutive month of measurement. In Year 6 the average age of children at the time of measurement rises by approximately one month for each consecutive month of the academic year. In Reception the increase in average age is 0.5 months for each month of the academic year. The smaller increase in Reception occurs because a number of PCTs measure children at or around their fifth birthday which acts to reduce the variation in average age by month of measurement.

As month of measurement and the average age of the children measured in that month are closely linked, it is possible that the variation observed in obesity prevalence with month of measurement might be down to changes related to age of children rather than month of measurement. This may occur if current patterns of child growth differed from those described by the British 1990 growth reference. The analysis described above, based on analysis of the NCMP in monthly age bands, cannot distinguish between these two closely linked variables, and so a different approach must be taken.

Analysis based on the BMI of individual children

To distinguish between the effects of month of measurement and age at time of measurement, a multivariate linear regression model was applied to individual child records in the NCMP dataset. This was used to determine the relative impact of age at time of measurement, month of measurement for each child, and the IMD score of place of residence on the BMI z score of each child.

To ensure differences in the ethnic breakdown of the sample by month of measurement did not impact on the results, this analysis was conducted for all children measured for the NCMP, as well as using only children identified as being of White British ethnicity.

For both boys and girls in both school years, a higher IMD score and therefore increased socioeconomic deprivation, was associated with a higher BMI z score. This finding was significant for both the NCMP dataset as a whole and for only children of White British ethnicity (p<0.001).

For children in Reception, later months of measurement were significantly associated with a lower BMI z score (p<0.001). Again this was the case for both the whole sample and the White British subset. Each additional month into the academic year is associated with a decrease in BMI z score of around 0.01 standard deviations.

For children in Year 6 there was no significant association between month of measurement and BMI z score (p>0.05) for both the whole sample and the White British subset.

The picture is less clear cut with regard to the impact of age at time of measurement. There is a significant decrease in BMI z score with age for all boys in Reception (p<0.001) and White British boys and girls in Year 6 (p<0.01). No significant association was identified between age and BMI z score for girls in Reception (p>0.05).
Discussion

The analysis presented in this paper shows a consistent pattern. For boys and girls in Reception, both the prevalence of obesity and BMI at individual level appear to have decreased throughout the 2008/09 academic year. This does not seem to be explained by changes in the socioeconomic status or ethnic mix of children measured at different times of the year, as the pattern is observed among white British children of average socioeconomic status as well as across the population as a whole.

As the average age of children at the point of measurement is known to increase through the academic year, it is possible that the variation observed may be due to changes in patterns of child growth compared to the British 1990 growth reference. However, although there is a decrease in BMI z score with age for some population groups, the impact of month of measurement appears to act independently.

There was no significant association with month of measurement for either boys or girls in Year 6 regardless of whether obesity prevalence or individual BMI is used, or what other factors are controlled for.

This pattern is slightly different from that observed in 2007/08 and described in a previous publication. The previously identified rise in obesity prevalence among Year 6 children measured in September and October is not evident in the 2008/09 dataset. It is possible that the pattern of obesity prevalence previously observed for Year 6 children was due to factors such as a high proportion of children from deprived socioeconomic groups being measured in September and October than other months in 2007/08, as this was not checked in the earlier analysis.

If the methods used in this paper are applied to the 2007/08 data, a significant linear decrease in the prevalence of obesity by month of measurement is evident for children in Reception year.

Possible reasons for the variation in children’s BMI by month

Although this analysis confirms an association between month of measurement and children’s BMI, it does not provide evidence as to what might cause this pattern. Weight gain of children over summer months or over school holidays has been noted in previous studies, albeit not with the English population and not just confined to the Reception year age group.

However, it seems unlikely that such seasonal increases could explain the pattern observed with NCMP data. The BMI of Reception age children appears to decrease across the whole period from September to July, meaning that any summer weight gain would have to take place in August alone. In addition, a lack of a significant change through the academic year in the BMI of children in Year 6 suggests that weight gain during summer holidays does not occur for children of this age group.

One possible explanation for the pattern observed with NCMP data is that the school environment, as currently experienced by children in the Reception year, might, in some way, be ‘healthier’ than the pre-school environment. This might, for example, be due to increased physical activity or improved diet as a result of attending school. This could also explain why no significant decrease in children’s BMI is observed for Year 6, as these children have been in school for several years prior to measurement.
Another possible explanation is that the observed pattern represents a decrease over time in the BMI of children of Reception age year – in a way which is unrelated to the school environment. Recent Health Survey for England data suggests that the trend in child obesity prevalence is ‘flattening out’; and analysis of the 2008/09 NCMP showed that obesity prevalence for boys in Reception was lower than that for previous years. If obesity prevalence or BMI of children of Reception age has indeed begun to decrease, this may be detectable over the period of an academic year, as a result of the large numbers of children measured for the NCMP.

There is some suggestion of further variation within the dataset, in addition to the trend across the whole academic year. It is possible this might indicate variation due to factors such as weight gain during Christmas and Easter school holidays. Further analysis, using more than one year of NCMP measurements, will be needed to confirm whether such variation does occur or whether this is a result of natural variation.

**Limitations of this study**

This study is limited by the cross sectional design of the NCMP and by the surveillance approach taken by the programme. As a different sample of children is measured in each month, there is no way to ensure the children measured in each month show similar characteristics. This increases the potential for confounding factors to affect any findings based on NCMP analysis.

Although this analysis has controlled for the main possible confounding effects, it is still possible that the observed decrease in children’s BMI through the academic year could be caused by other factors that were not covered in this analysis. For example, it is possible that PCT and school level effects (such as data quality or NCMP participation/opt out) might have some impact, although it is unlikely that such variables would show systematic variation.

Other possible confounding factors cannot be easily examined using NCMP data alone. It is possible that factors such as the weight of clothing worn by children at the time of measurement (which is not recorded in the NCMP) might decrease through the school year. Such changes might have a greater impact on children in Reception, as their average body weight is lower than for children in Year 6. However, this might be expected to increase prevalence during the period from autumn to winter, rather than lead to the observed linear decrease in BMI across the school year.

A decrease in the accuracy of the scales used for NCMP measurement through the academic year could result in the decrease observed. However, PCTs are required to calibrate scales regularly and errors of this sort would be expected to balance out, with some children’s weight being recorded as too light and others as too heavy. In addition this effect would also affect children in Year 6 as well as Reception.

To understand the causes of this observed pattern it might be necessary either to collect additional data from PCTs, or to conduct new research to collect this information. To monitor changes in BMI over the academic year and over time, a sample of children who were repeatedly measured at different points in the year would ideally be needed (i.e. a longitudinal design). However, multilevel analysis of the NCMP data, including factors such as data quality indicators at PCT level, should be able to provide some useful information.
Impact on PCT figures

As PCTs take NCMP measurements at different times of the year, a decrease of 0.25% in obesity prevalence with each month of the academic year could potentially lead to differences in obesity prevalence figures between PCTs where the timing of measurement differs substantially.

Analysis suggests this effect is likely to be small. Regression analysis of obesity prevalence at PCT level shows no relationship between average month of measurement at PCT level and reported obesity prevalence, even when ethnicity, deprivation, and PCT level participation are included in the analysis.

In addition, in 2008/09 only 9 (6%) PCTs had a mean month of measurement more than 3 months different from the national average (6.9 months). So in the vast majority of cases the difference made to PCTs’ reported obesity prevalence by the timing of NCMP measurements should be less than +/- 1% at most.

In order to maintain consistent data PCTs should continue the established pattern of taking measurements throughout the academic year. PCTs are advised to not make large changes to the timing of NCMP measurements. However, small differences in the timing of measurements from one year to the next are unlikely to have any impact.

Impact on evaluation of obesity related interventions

The observed decrease in obesity prevalence among children in Reception throughout the academic year should also be considered when evaluating obesity related interventions that are aimed at Reception year.

If an intervention were to be evaluated by monitoring the BMI of individual children in Reception over time, it is possible that any observed decrease in BMI of children may not be a result of the intervention but a result of the background decrease occurring across the population as a whole.

Ideally this would be tackled by use of a control group used as a comparison for the evaluation data, however this is rarely possible. Evaluation of changes in individual level BMI for this age group may need to consider the possibility that a decrease over time might be expected.

Conclusions

This analysis shows a significant pattern of decreasing obesity prevalence through the academic year for children in Reception. This effect seems to be independent of other factors, such as sociodemographic variables or child age. However further research into this pattern may be needed to determine what causes the observed decrease over time.

It is possible that the observed decrease is a result of differences between the pre-school and school environment, which means the lifestyle of young children improves after they start school, leading to lower BMI and obesity prevalence. It could also be that a background trend of reducing BMI over time for this age group is occurring.
It seems unlikely that systematic variation in factors such as data quality could result in the pattern observed, however the nature of the NCMP dataset means this is not impossible. Further analysis, using more advanced techniques and NCMP data from future years will be needed to confirm whether this pattern represents real change and to further investigate the causes.

It is unlikely that timing of measurement would have any detectable impact on child obesity prevalence figures at PCT level and PCTs should not make large changes to the timing of NCMP measures to preserve a consistent trend. However, these findings should be considered when evaluating child obesity interventions aimed at younger children.

References

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