



Public Health
England

Protecting and improving the nation's health

National Child Measurement Programme

Changes in children's body mass index
between 2006/07 and 2015/16

Detailed Report

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health, and are a distinct delivery organisation with operational autonomy to advise and support government, local authorities and the NHS in a professionally independent manner.

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1. Summary of key findings 2006/07 to 2015/16^a

	Reception		Year 6	
	Boys	Girls	Boys	Girls
Changes in prevalence of obesity Page 7	Downward trend, decreasing at a slower rate compared with last year ↓	No upward or downward trend ▬	Upward trend, rate of increase speeding up compared with last year ↑	
Changes in prevalence of excess weight Page 7	Downward trend, decreasing at a faster rate compared with last year ↓	No upward or downward trend ▬	Upward trend, rate of increase speeding up compared to last year ↑	Upward trend, rate of increase slowing down compared to last year ↑
Changes in prevalence of overweight Page 7	Downward trend, decreasing at a faster rate compared with last year ↓	No upward or downward trend ▬	No upward or downward trend ▬	
Changes in prevalence of underweight Page 7	Downward trend ↓		No upward or downward trend ▬	Downward trend ↓
Changes by deprivation quintile Page 9	Widening inequality in excess weight, obesity and overweight prevalence ↔		Widening inequality in excess weight, obesity and overweight prevalence ↔	
Changes in weight category prevalence by ethnic group^b Page 15	Downward trends in excess weight and obesity prevalence in Black Caribbean, Indian and White British boys; and in excess weight prevalence in Pakistani boys ↓	Downward trends in underweight prevalence in Black African, Pakistani and White British girls ↓	Upward trends in obesity prevalence in Bangladeshi, Black African, Indian, Pakistani and White British boys ↑	Upward trends in excess weight and obesity prevalence in Bangladeshi, Black African, Indian, Pakistani and White British girls; and in excess weight in Black Caribbean girls ↑
Change in BMI for age^c Page 21	Downward trend ↓	No upward or downward trend ▬	No upward or downward trend ▬	Upward trend ↑

^a All trends reported in this table are statistically significant.

^b The proportion of records with valid ethnicity coding has increased substantially over the ten years of the NCMP. This variation in coding means that trends over time by ethnic group must be interpreted with caution.

^c Mean body mass index (BMI) for age is measured using BMI z-scores. These are measured in standard deviations from the mean and show how a child's BMI compares to the British 1990 reference population, taking the child's age and sex into account.

2. Key messages

- Obesity prevalence shows a significant downward trend in Reception boys overall in the 2006/07 to 2015/16 period covered by the NCMP. The rate of decrease is lower than that estimated with data to 2014/15
- The trends in obesity in Year 6 boys and girls continue to show year on year increases. The rates of increase are slightly higher than those estimated with data to 2014/15
- Underweight prevalence in Year 6 girls shows a significant downward trend and there is a continuing significant small annual reduction in underweight prevalence among Reception boys and girls
- Analysis by Index of Multiple Deprivation (IMD) quintile continues to show a widening inequality gap in the overweight, obese and excess weight categories for all groups – Reception boys and girls and Year 6 boys and girls. Where obesity and excess weight prevalence is declining overall it is either increasing in the most deprived quintiles compared to the least or is generally declining at a slower rate; and where prevalence is increasing overall it is increasing at a faster rate in the most deprived quintiles
- In some cases the inequality gap is widening at a faster rate than estimated last year, for example the gap in obesity prevalence between the most and least deprived quintiles in Reception boys and Reception girls
- There are newly significant declining trends in excess weight prevalence in Indian and Pakistani Reception boys and in obesity prevalence in Indian boys
- There are newly significant upward trends in obesity prevalence in White British Year 6 boys and Black African Year 6 girls; in excess weight prevalence in Black Caribbean Year 6 girls; and in overweight prevalence in Pakistani Year 6 girls
- At national level there is a significant decreasing trend in mean BMI for age over the time period 2007/08 to 2015/16 in Reception boys, and a significant increasing trend in Year 6 girls. These trends are found even after adjusting for factors such as ethnicity and deprivation which may have an influence
- Trends in mean BMI for age (BMI z score) are significantly different (worse or better) for some local authorities from what would be expected if they were following the national trend, even after adjusting for factors such as child deprivation and ethnicity

3. Introduction

This report is the eighth in a series of annual reports which use National Child Measurement Programme (NCMP) data to examine the changes in children's body mass index (BMI) that have taken place in England since 2006/07.^{1,2,3,4,5,6,7} The NCMP is a nationally mandated public health function of local authorities which involves measurement of the height and weight of children aged 4-5 years (Reception) and 10-11 years (Year 6) in England on an annual basis. The programme provides the data for the child excess weight indicators in the Public Health Outcomes Framework⁸ and is a key element in the Government's approach to tackling child obesity. The 2015/16 NCMP was the tenth year of this system of national child measurement.^d

The NCMP has very high levels of participation across all areas of England.⁹ Data completeness and accuracy are very good.¹⁰ The NCMP publication for 2015/16 from NHS Digital has National Statistics status¹¹ and together with previous reports from the National Obesity Observatory (NOO) and Public Health England (PHE) provides a comprehensive description of the distribution of obesity and excess weight prevalence across the NCMP age groups, as well as the patterns by socioeconomic and ethnic group.

This report focuses on identifying trends in prevalence over the full period of NCMP measurements. It examines overall trends in obesity, overweight, excess weight and underweight prevalence as well as changes in BMI over time. Trends within different socioeconomic and ethnic groups are examined to determine whether existing health inequalities are widening or narrowing. The variation in modelled BMI trends between local authorities is also examined.

BMI classification definitions for population monitoring

For population monitoring purposes BMI is classified according to the following table using the British 1990 growth reference (UK90)¹² distribution. Other statistical methods are described in Appendix 1.

BMI classification	Centile of UK90 BMI distribution
Underweight	Less than or equal to 2
Healthy weight	Greater than 2 and less than 85
Overweight	Greater than or equal to 85 and less than 95
Obese	Greater than or equal to 95
Excess weight	Greater than or equal to 85 (overweight plus obese)

^d In 2005/06 the National Childhood Obesity Database collected child measurements of school children in England but participation was low and the data from this programme are not detailed enough, nor of high enough quality, to be used for analysis.

4. Changes in prevalence of obesity, excess weight, overweight and underweight

The NCMP takes measurements from around one million children each year and this results in small confidence limits around most annual national estimates. However the prevalence figures do vary year to year and changes from one year to the next are not always indicative of a long term trend. Sections 4 to 6 of this report use all ten annual data points in order to estimate trends as robustly as possible.

Figure 1 shows the overall trend in the prevalence of obesity, excess weight, overweight and underweight by year of measurement, school year, and sex. Within each cluster of points each point represents one year of measurement, from 2006/07 on the left to 2015/16 on the right. Significant trends are shown using a dashed line.

Reception boys and girls

Significant downward trends in prevalence were found for underweight in Reception boys and girls; and obesity, overweight and excess weight (obesity plus overweight) in Reception boys.

An estimated downward trend for Reception girls' obesity prevalence is smaller than seen last year¹ and is no longer statistically significant.

The estimated annual rates of decline in excess weight and overweight prevalence in Reception boys are a little steeper than the estimates to 2014/15 indicating that prevalence is decreasing here at a slightly faster rate than before. However the downward trend in obesity in Reception boys has slowed down compared to the 2014/15 estimate.

Year 6 boys and girls

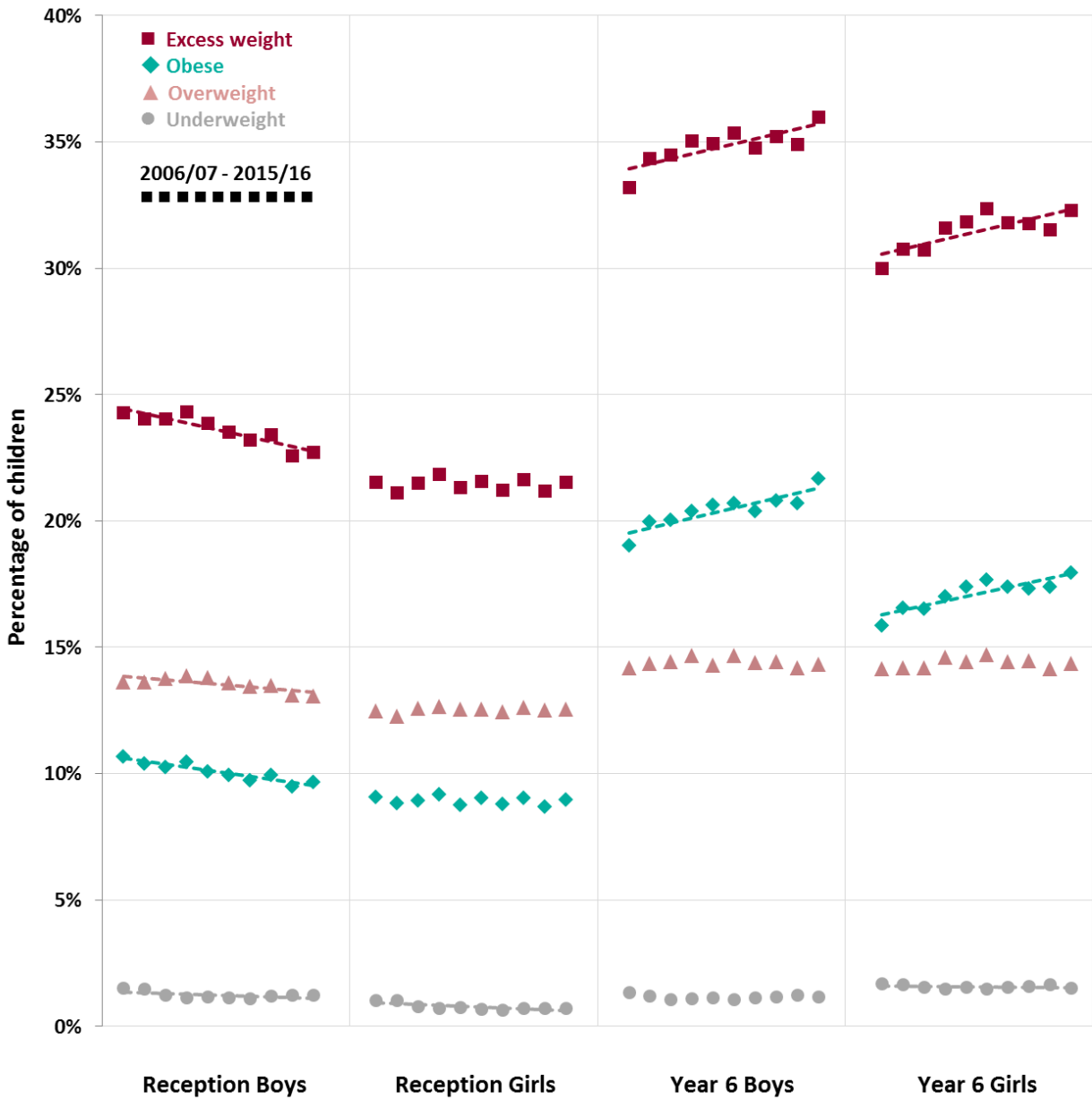
Significant upward trends in prevalence over the time period were found for obesity and excess weight in Year 6 boys and girls.

The estimated increase in prevalence per year is smaller than seen last year for Year 6 girls' excess weight prevalence but is slightly higher for obesity prevalence.

For Year 6 boys both obesity and excess weight estimated trends are higher compared to last year. For example the estimated average increase in obesity prevalence per year in Year 6 boys was 0.17 percentage points last year, but with the 2015/16 data has risen to 0.20 percentage points per year.

There is no significant increasing or decreasing trend in Year 6 boys and girls overweight, or Year 6 boys underweight, but a newly significant small downward trend in Year 6 girls' underweight prevalence of 0.01 percentage points per year.

Figure 1. Prevalence of obesity, excess weight, overweight and underweight by year of measurement, school year, and sex. NCMP 2006/07 to 2015/16. Significant upward or downward linear trends are shown with a dashed line



5. Changes in prevalence of obesity, excess weight, overweight and underweight by socioeconomic group

Child obesity prevalence shows a strong association with socioeconomic deprivation. Obesity prevalence in children living in the 10% most deprived areas of the country is more than double that of children living in the least deprived 10% of areas.¹³

To assess how obesity prevalence has changed over time by socioeconomic status, all children surveyed by the NCMP were grouped into five equal-sized bands (quintiles) based on the Index of Multiple Deprivation (IMD) recorded for each child's place of residence. In this analysis, quintile 5 contains the least deprived 20% of the child population, and quintile 1 contains the most deprived 20%.

Figures 2a to 2d show the association between prevalence of each weight category and deprivation, by year of NCMP measurement.

Reception boys

Figure 2a shows significant declines in prevalence of excess weight and obesity in Reception boys. The declines are steeper in the least deprived IMD quintiles, indicating that the inequality gap is widening. For example the estimated annual rate of decline in obesity prevalence is 0.17 percentage points per year for the least deprived quintile 5 but reduces to 0.06 percentage points per year for the most deprived quintile 1.

The rates of decline in overweight prevalence have steepened in all quintiles compared with the trend up to 2014/15, but for excess weight are only steeper compared to last year's estimates in quintiles 4 and 5, the least deprived. The estimated decline in obesity prevalence is greater compared to last year in least deprived quintile 5 but smaller in the other quintiles.

These differences in trend between quintiles compared to last year indicate that the inequality gap is widening at a faster rate than before.

Estimated year on year declines in underweight prevalence are smaller than the trends estimated up to 2014/15 but remain significant in all quintiles except quintile 4.

Reception girls

Obesity and excess weight continue to show significant declines among Reception girls in the least deprived quintile 5 (Figure 2b) and the downward trend in obesity in quintile 4 also remains significant.

The most deprived quintile 1 now shows significant upward trends in obesity, excess weight and overweight and these are steeper than trends estimated to 2014/15, when the only significant upward trend was in excess weight prevalence.

Taken together these opposing trends indicate a widening inequality gap in Reception girls.

Significant downward trends in underweight prevalence are observed in all quintiles but do not vary systematically with deprivation.

Year 6 boys

Significant declining trends in excess weight, obesity and overweight are seen among Year 6 boys in the least deprived quintile 5 (Figure 2c).

The estimated annual rate of decline has steepened in the least deprived quintile 5 overweight group compared with the trend up to 2014/15 while the excess weight and obesity estimated trends are broadly similar. For example, the annual decline in obesity prevalence in quintile 5 was estimated to be 0.12 percentage points per year last year (with data up to 2014/15) and 0.11 percentage points this year (with data up to 2015/16).

Significant upward trends in excess weight and obesity continue to be seen in quintiles 1 to 3 and the associated estimated rates of annual increase are all higher this year compared to last. The upward trend in quintile 1 overweight prevalence is also now significant.

Overall the differences in trends between quintiles indicates a widening inequality gap in obesity, excess weight and overweight prevalence in Year 6 boys.

Year 6 girls

Figure 2d shows newly significant declining trends in excess weight and overweight prevalence in Year 6 girls quintile 5 (the least deprived quintile). These trends were less steep and not significant using data up to 2014/15.

The upward trends for obesity and excess weight prevalence in quintile 1 remain significant but their rates of increase have slowed down compared to last year. In contrast, in quintile 2 the estimated annual rates of increase of obesity and excess weight are slightly higher than last year.

These differences together indicate a slight narrowing of the inequality gap between quintiles 1 and 2 for obesity and excess weight prevalence. However there is a widening of the gap between quintiles 1 and 2 (considered together) and quintiles 3 to 5 in excess weight prevalence.

Figure 2a. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Reception, boys. Significant upward or downward linear trends are shown with a dashed line

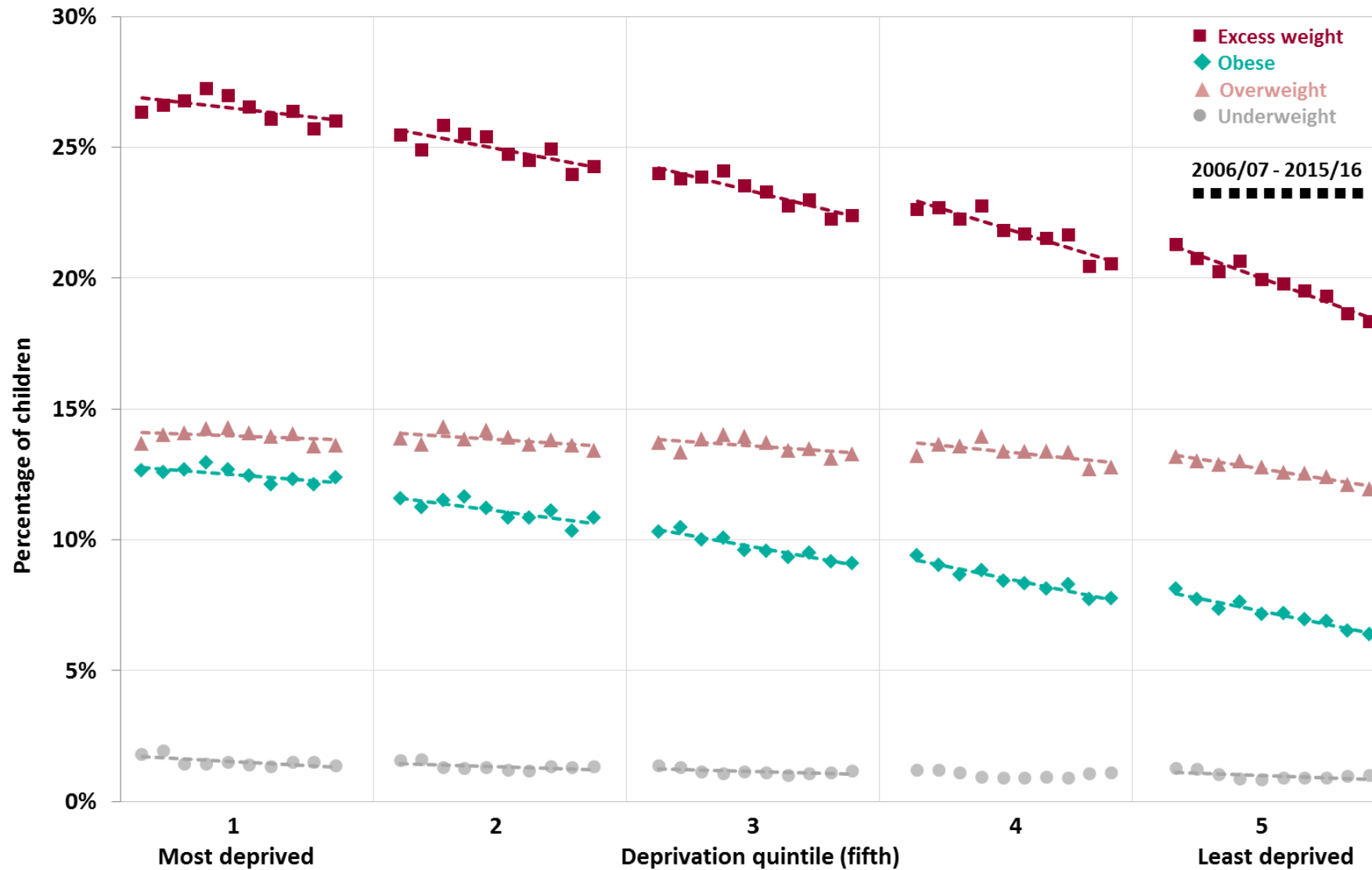


Figure 2b. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Reception, girls. Significant upward or downward linear trends are shown with a dashed line

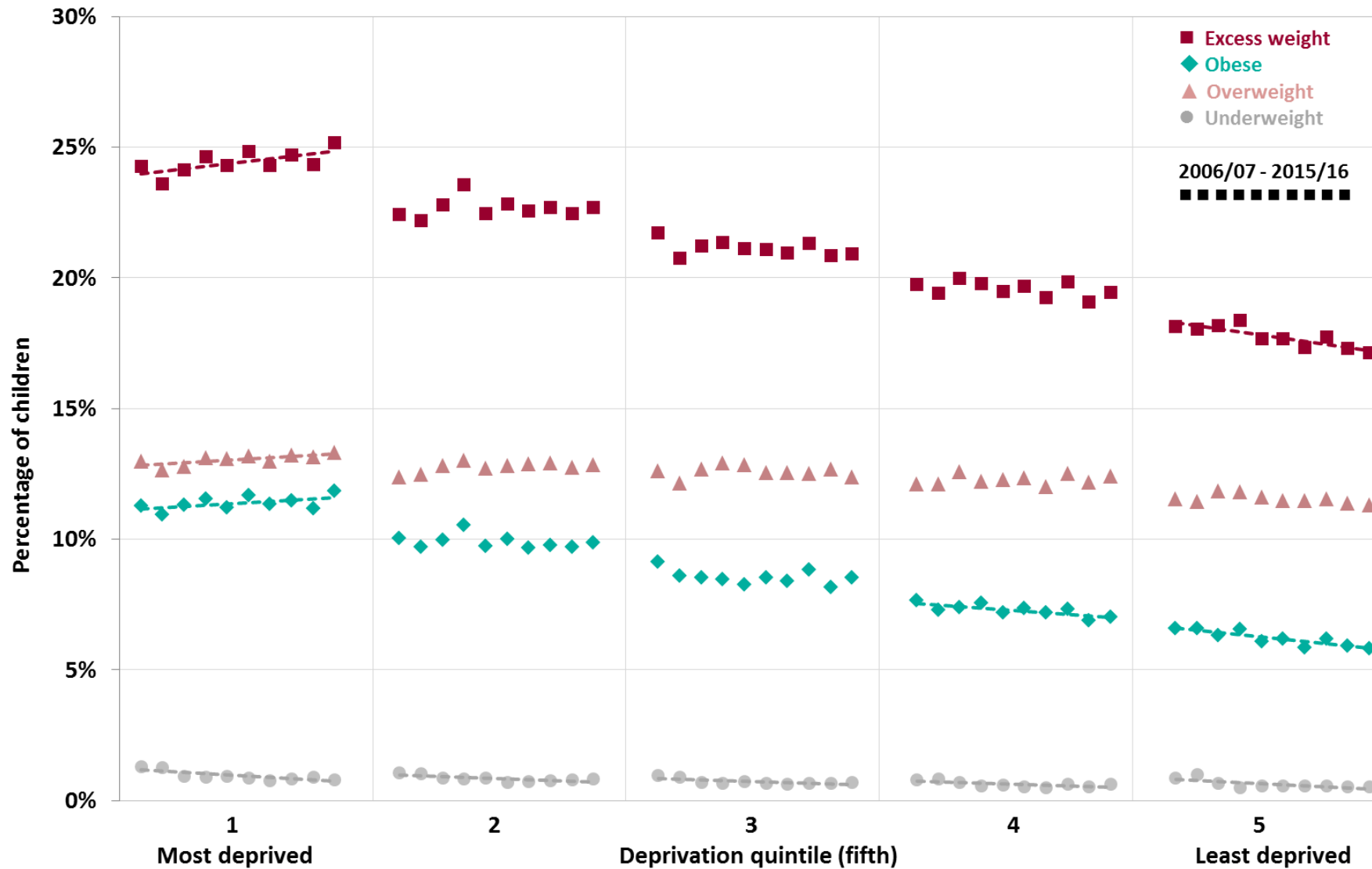


Figure 2c. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Year 6, boys. Significant upward or downward linear trends are shown with a dashed line

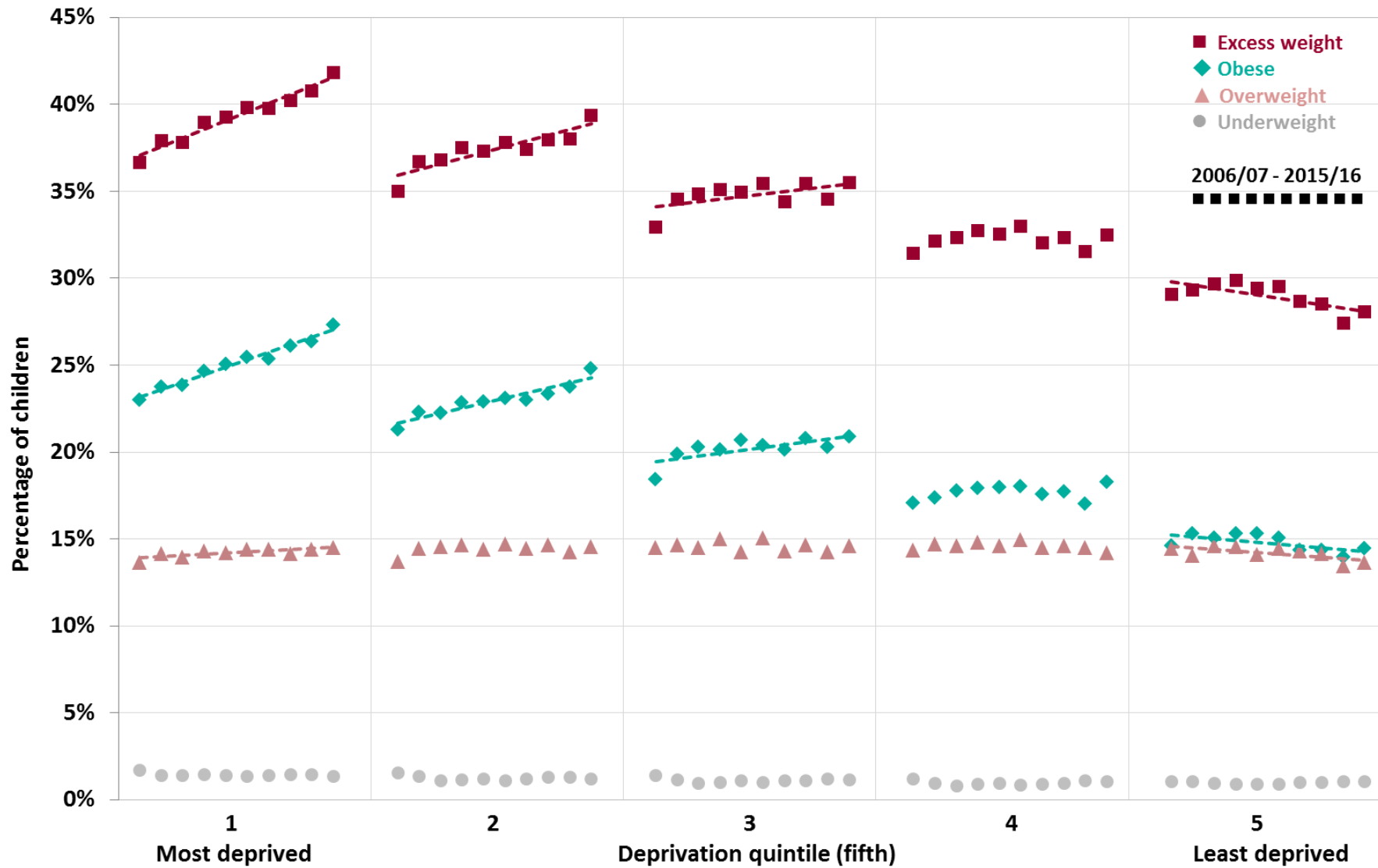
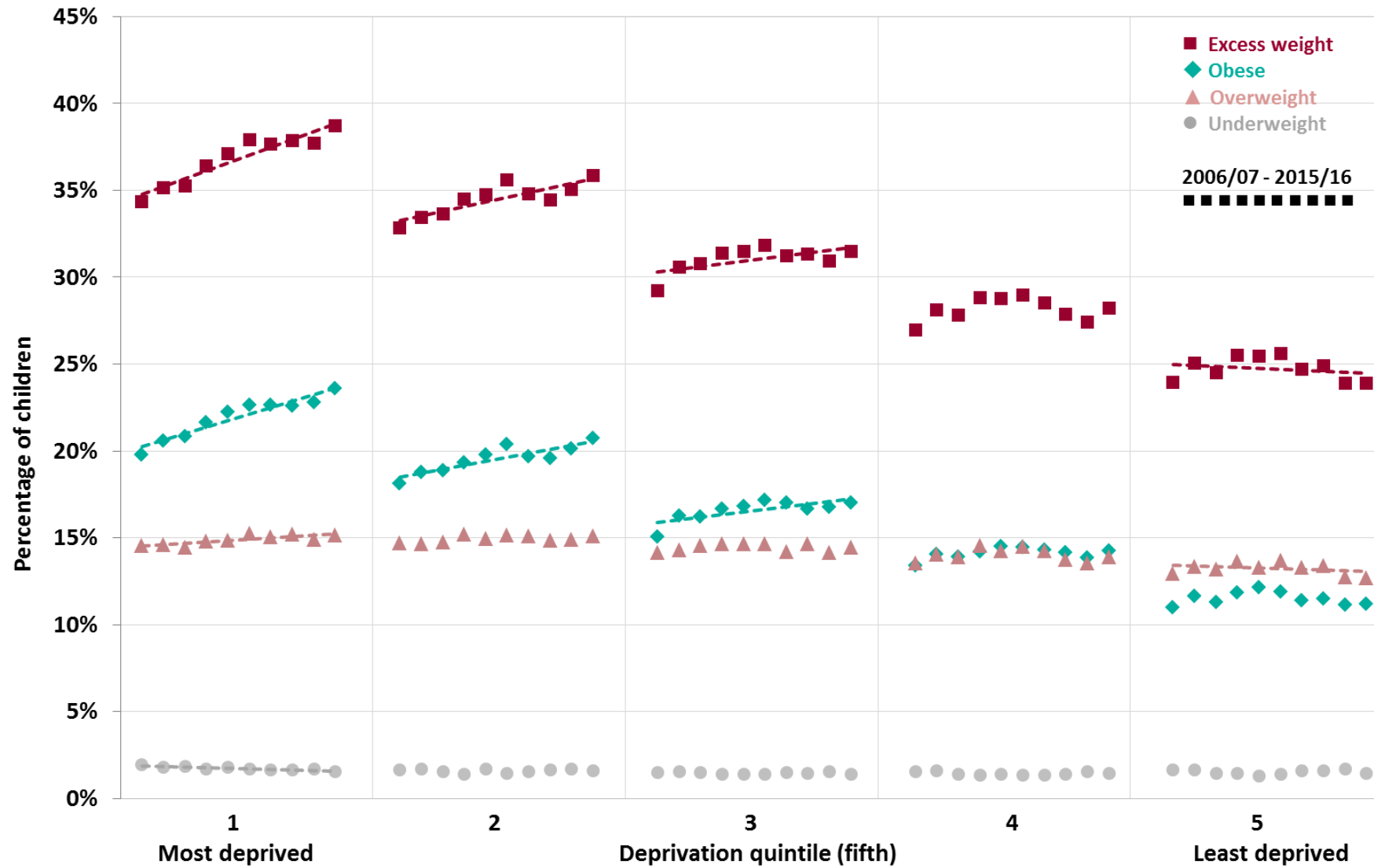


Figure 2d. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Year 6, girls. Significant upward or downward linear trends are shown with a dashed line



6. Changes in prevalence of obesity, excess weight, overweight and underweight by ethnic group

Previous analyses using both NCMP and Health Survey for England (HSE) data have shown that child obesity prevalence varies substantially between ethnic groups^{14,15} and that children classed as White British tend to have lower obesity prevalence than most other ethnic groups. Differences in obesity prevalence between ethnic groups remain when potentially confounding factors such as levels of deprivation and urban environment are controlled for.^{16,17} Confounding factors are not adjusted for in the analyses presented in this section.

The variation in ethnicity coding between NCMP measurement years means that weight category prevalence trends over time by ethnic group must be interpreted with caution as coding percentage might vary with weight status. This would cause some bias in the prevalence estimates, which is hard to detect. Lower rates of ethnicity coding in the earlier years of NCMP also lead to smaller numbers of children in each ethnic group. This can make it difficult to discern trends within ethnic groups as the data is subject to more sampling variation from year to year. NCMP ethnicity coding has been 80-85% complete over the past 7 years.²¹

The ethnicity trend analysis conducted for this report has been based on seven ethnic groups classified according to NHS ethnicity codes. It was not possible to include all groups because of space constraints and the groups presented are the most diverse with sufficient sample size. Figures 3a to 3d show the association between weight category prevalence and these ethnicities by year of NCMP measurement. A greater number of trends are significant compared to last year as an additional year of data has contributed to more precise estimation.

Reception boys

Figure 3a shows newly significant declining trends in excess weight and obesity in Indian Reception boys, and in excess weight in Pakistani boys. These trends are steeper than those estimated with data to 2014/15.

There are continuing significant declines in obesity, excess weight and overweight prevalence in White British boys, and in excess weight and obesity prevalence in Black Caribbean boys. These declining trends are less steep than those estimated last year, with the exception of the trend in overweight among White British boys.

Reception girls

The significant declines seen in Fig 3b for Reception girls' underweight prevalence were also seen in 2014/15 in the same ethnic groups – Black African, Pakistani and White British – although the estimated rates of decline are slightly lower in comparison.

The significant increasing trend in excess weight in Chinese girls found last year is now smaller in magnitude and no longer significant.

Year 6 boys

The only newly significant trend shown in Figure 3c is for obesity prevalence in White British Year 6 boys where the estimated annual increase of obesity prevalence is 0.06 percentage points per year. This compares with an estimate of 0.04 percentage points last year.

The majority of the other significant increasing trends given in Figure 3c have also all increased in magnitude compared to last year, with the exception of obesity in Chinese and Bangladeshi boys, and excess weight in Bangladeshi boys.

The estimated rate of decline in underweight prevalence in Pakistani boys is broadly similar to last year.

Year 6 girls

In Year 6 girls the significant increases in excess weight and obesity prevalence found last year in the majority of ethnic groups remain significant with the addition of the 2015/16 data (Figure 3d). They have been joined by significant upward trends in obesity prevalence in Black African girls, and excess weight prevalence in Black Caribbean girls.

Overweight prevalence in Pakistani girls is also now demonstrating a significant upward increase.

Estimated rates of increase in obesity and excess weight prevalence are slowing slightly compared to last year for Bangladeshi, Pakistani and White British girls, but increasing for Indian and Black African girls. The rate of increase in excess weight prevalence is higher for Black Caribbean girls compared to last year.

A newly significant decline in underweight prevalence is seen in White British girls.

Figure 3a. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Reception, boys. Significant upward or downward linear trends are shown with a dashed line

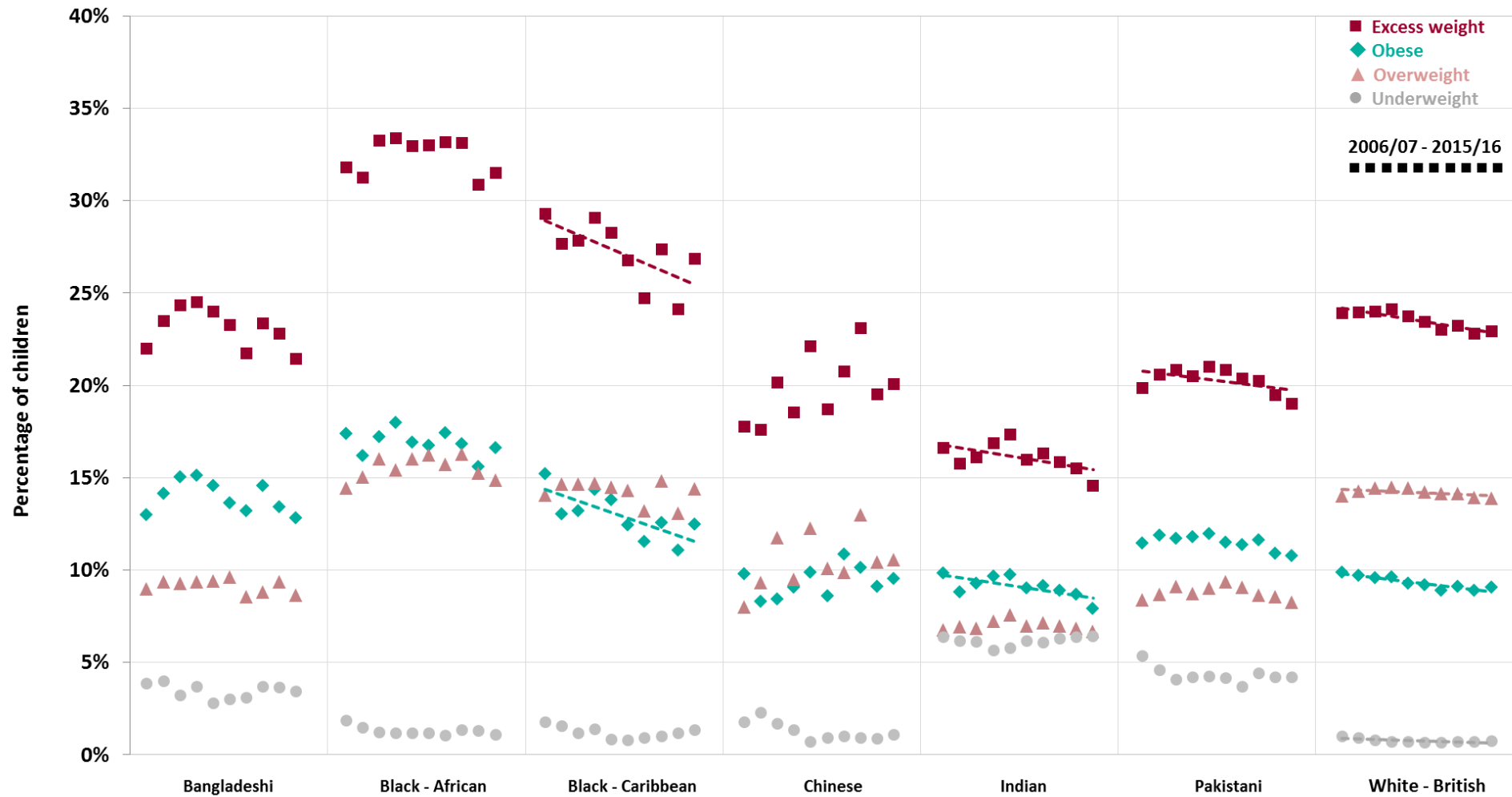


Figure 3b. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Reception, girls. Significant upward or downward linear trends are shown with a dashed line

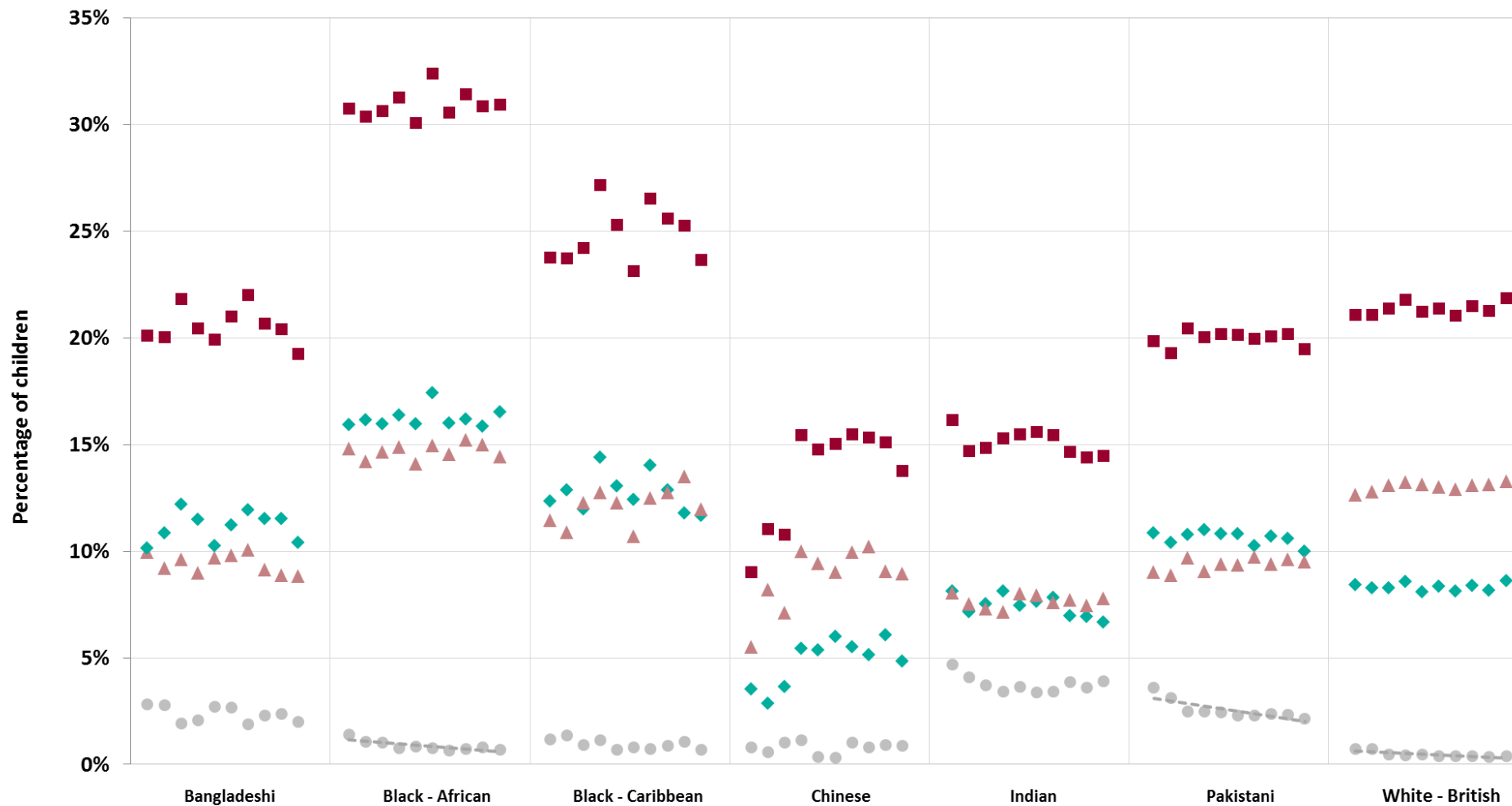


Figure 3c. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Year 6, boys. Significant upward or downward linear trends are shown with a dashed line

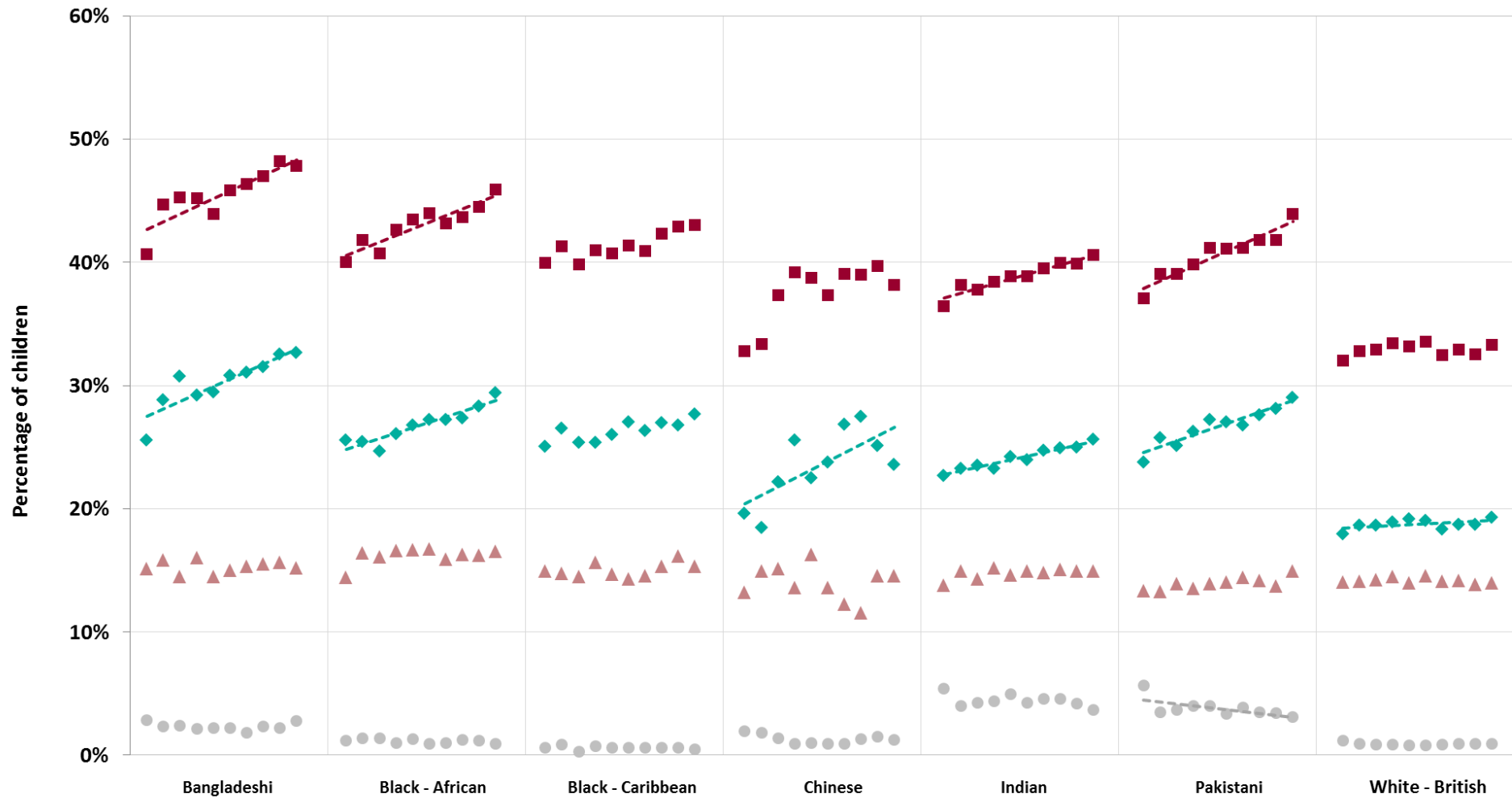
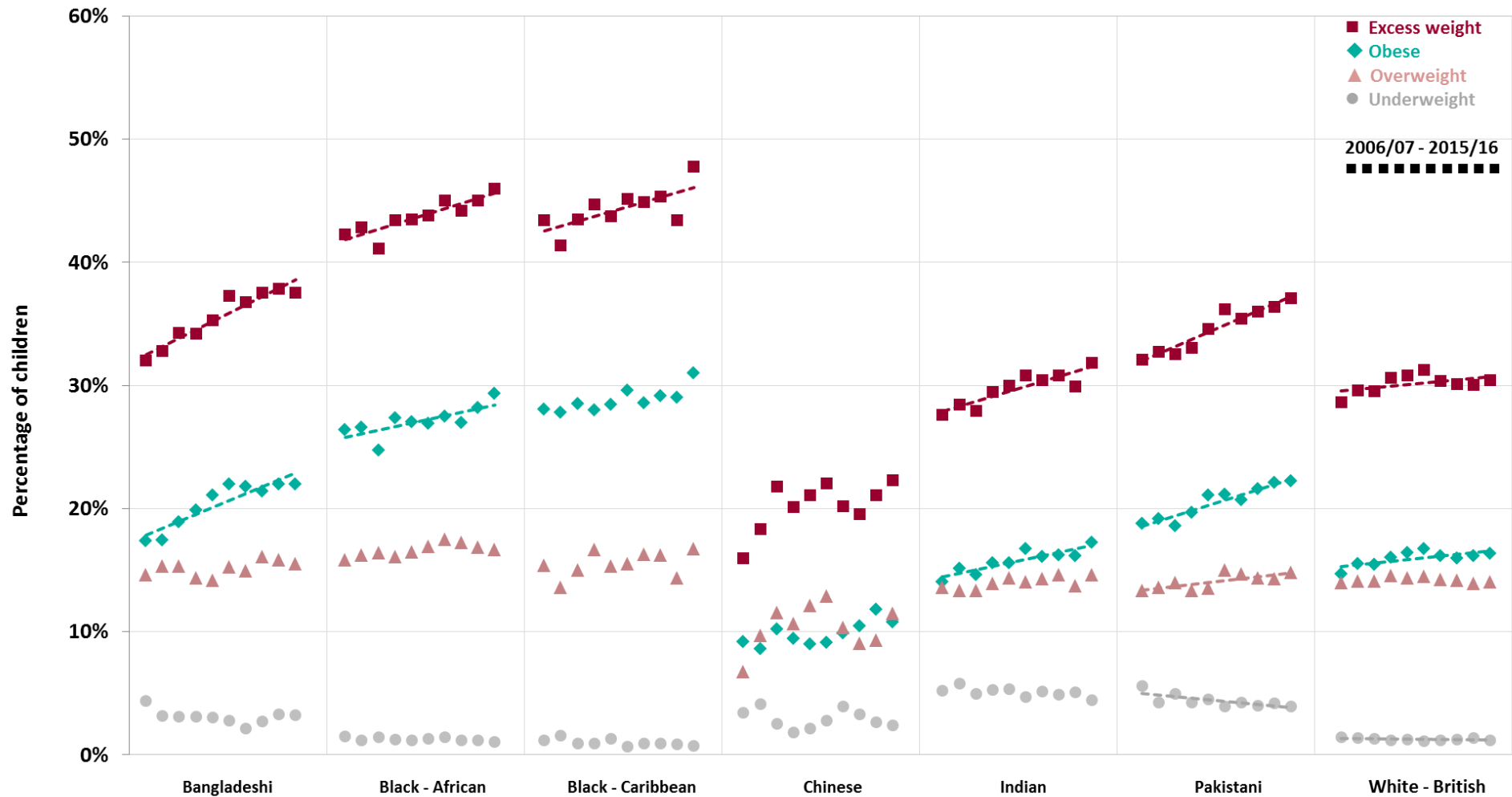


Figure 3d. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Year 6, girls. Significant upward or downward linear trends are shown with a dashed line



7. Changes in BMI z score by lower tier local authority

The analyses presented here use multilevel regression models to estimate a linear trend in BMI z score for each lower tier (district and unitary) local authority in England using nine years of NCMP data, from 2007/08 to 2015/16. The aim is to identify the extent of variation in BMI z score between local authorities after adjustment for other factors including child deprivation and ethnicity. This enables the identification of local authorities with trends which are significantly different from the national average and may contribute to the development of targeted public health interventions to tackle child obesity.

BMI z scores, rather than actual BMI values, have been used to examine change in mean BMI over time in order to standardise the average age at measurement of children in Reception and Year 6 in different measurement years. BMI z scores (measured in standard deviations from the mean) show how a child's BMI compares to the British 1990 reference population, taking the child's age and sex into account.

Four models are estimated (Table 1), one for each of Reception boys, Reception girls, Year 6 boys and Year 6 girls. All models also include various individual child characteristics such as age in months and ethnicity in order to adjust for the differences in these characteristics between local authorities. The overall trend in BMI z score at national level is also included. This enables identification of the local authority trend after its population makeup and the overall trend have been taken into account.

All models are adjusted for year of measurement, age at measurement, child deprivation quintile, broad ethnic group, and the rurality of the child residence – whether urban, town or village. The 'urban' classification includes both inner city areas and the urban fringe. 2006/07 data was not used in the modelling because only 58% of records from this year have a valid child postcode¹⁰ and thus information on child deprivation quintile is very incomplete. Further details of the model estimation procedure are given in Appendix 1.

Table 1 gives the regression coefficients estimated for each of the four models and their associated standard errors. The standard errors measure the extent of the variation around the estimated coefficients. Coefficients marked with one asterisk show statistical significance at the 5% level while those marked with two asterisks show stronger statistical significance (at the 1% level).

Variable categories which are marked as 'reference' in Table 1 are the categories against which other categories of that variable are compared. Thus 1 (most deprived) is

the reference category for IMD quintiles 2 to 5; White is the reference category for the other ethnicities; and urban is the reference category against which towns and villages are compared.

A significant upward overall trend in BMI z score of 0.002 units of z score per year is found in Year 6 girls while a significant downward trend of 0.007 units of z score per year is found in Reception boys. (These are the results given in the 'NCMP Year' row in Table 1.) The overall trends for Reception girls and Year 6 boys are not significant.

Table 1. Coefficients (and standard errors) from four multilevel multivariable regressions of BMI z score on potential determinants, by sex and year group

Variable	Reception boys	Reception girls	Year 6 boys	Year 6 girls
Age in months	-0.017** (0.001)	-0.007** (0.001)	-0.010** (0.001)	-0.008** (0.001)
Age in months²	0.005** (0.001)	0.002** (0.001)	-0.003** (0.001)	0.003** (0.001)
IMD quintile				
1 (most deprived)		reference		
2	-0.047** (0.002)	-0.047** (0.002)	-0.035** (0.002)	-0.054** (0.003)
3	-0.092** (0.002)	-0.086** (0.002)	-0.081** (0.003)	-0.127** (0.003)
4	-0.136** (0.002)	-0.127** (0.002)	-0.135** (0.003)	-0.197** (0.003)
5 (least deprived)	-0.183** (0.002)	-0.168** (0.002)	-0.212** (0.003)	-0.290** (0.003)
Ethnicity				
White		reference		
Asian	-0.372** (0.003)	-0.323** (0.002)	-0.022** (0.003)	-0.130** (0.003)
Black	0.096** (0.003)	0.098** (0.003)	0.154** (0.004)	0.279** (0.004)
Not stated or unknown	-0.039** (0.002)	-0.041** (0.002)	0.011** (0.002)	0.001 (0.003)
Other	-0.038** (0.004)	-0.072** (0.004)	0.104** (0.005)	-0.004 (0.005)
Urban environment				
Urban		reference		
Town	0.007** (0.003)	0.006* (0.003)	-0.009** (0.003)	-0.002 (0.003)
Village	0.014** (0.003)	0.0003 (0.003)	-0.007* (0.003)	-0.039** (0.003)
NCMP year (overall trend)	-0.007** (0.001)	0.0001 (0.001)	-0.001 (0.001)	0.002** (0.001)
Number of child measurements	2,547,644	2,436,276	2,313,046	2,198,831
Number of LAs	326	326	326	326
LA intercept variance	0.0030	0.0026	0.0031	0.0033
LA trend variance	0.0002	0.0001	0.0001	0.0001
Residual variance	1.1181	0.9743	1.4250	1.4340

*p<0.05; **p<0.01

As noted elsewhere in this report there is a strong association between deprivation and BMI and the models reflect this. For example a Year 6 boy living in the least deprived deprivation quintile has a BMI z score which is on average 0.212 units lower than an equivalent boy living in the most deprived quintile (Table 1). The models confirm that the association between child ethnicity and BMI z score remains after deprivation is accounted for.

The association between urban environment and BMI z score persists after deprivation and ethnicity are accounted for. However Table 1 indicates that the association changes direction between Reception and Year 6. For example a boy in Reception living in a village has a BMI z score which is on average 0.014 units greater than an equivalent boy who lives in an urban area (city). However a Year 6 boy living in a village setting has a BMI z score which is on average 0.007 units lower than an equivalent boy who lives in an urban setting.

Figure 4 shows the estimated differences from the modelled national trend in BMI z score for Reception boys for all 326 lower tier local authorities included in the analysis. Figure 5a is an extract of Figure 4 and displays the 20 lower tier local authorities with the largest negative estimated differences from the overall modelled national trend for Reception boys. Figures 5b to 5d show similar extracts for Reception girls, Year 6 boys and Year 6 girls respectively. The line at zero represents no difference from the national trend. Confidence intervals are displayed around each local authority value. A local authority whose confidence interval does not overlap zero therefore has an estimated trend which is significantly different from zero at the 5% level.

The estimates in Figures 4 and 5 represent the variation in BMI z score at local authority level which remains after all the other factors in Table 1 have been taken into account. For example after accounting for age at measurement, deprivation, ethnicity, rurality and the national trend, the estimated annual change in BMI z score for the average Reception boy in Luton is 0.02 units of z score lower than would have been predicted from these factors alone (Figure 5a).

Depending on the direction of the national trend a negative difference can mean that on average BMI is increasing more slowly than national trend, or decreasing at a faster rate. A positive difference from the national trend can mean that BMI is increasing more quickly than the overall national trend, decreasing more slowly, or even increasing while the overall national trend is one of decline.

For Reception boys the overall national trend is negative (a decrease of 0.007 units of z score per year, Table 1). The 20 local authorities in Figure 5a have estimated trends which are significantly lower than this. This means that on average BMI is decreasing at a faster rate than the national trend in Reception boys in these local authorities. The

local authorities shown in Figures 5b to 5d also have overall downward trends in BMI for the average child, even though the overall trend is slightly upward in the case of Reception girls and Year 6 girls (Table 1).

The figures for 'LA variance' and 'LA trend variance' given in Table 1 are small in relation to the 'residual variance', which indicates that only a very small proportion of the total variation in BMI z score is accounted for at local authority level. It is much smaller than the variation which is due to deprivation or ethnicity for example (compare Figure 4 and Table 1). Consequently in spite of the differences presented in Figures 4 and 5 local authorities with, for example, a high proportion of children in more deprived quintiles are likely to have a higher average BMI z score compared to local authorities with a lower proportion of such children.

It is likely that the local authority variation in BMI z score trend found here could be at least partly explained by variables which were not available to this analysis, and this could be an avenue for future work. Figures 5a to 5d show that some local authorities have estimated trends which are consistently lower than the national average, which is they appear on more than one of the four charts. This indicates where it might be important to explore the specific local context in depth, which is in those local authorities which differ substantially from the national trend in prevalence. The identification of other contextual factors which it was not possible to consider here could contribute to the development of customised and targeted public health interventions to tackle child obesity.

A spreadsheet giving details of estimated trends for all lower tier local authorities is available as a supplement to this report.

Figure 4. Estimated differences from modelled national trend in BMI z score by lower tier local authority, with 95% confidence intervals: Year R, boys. Each horizontal line represents one local authority (326 in all)

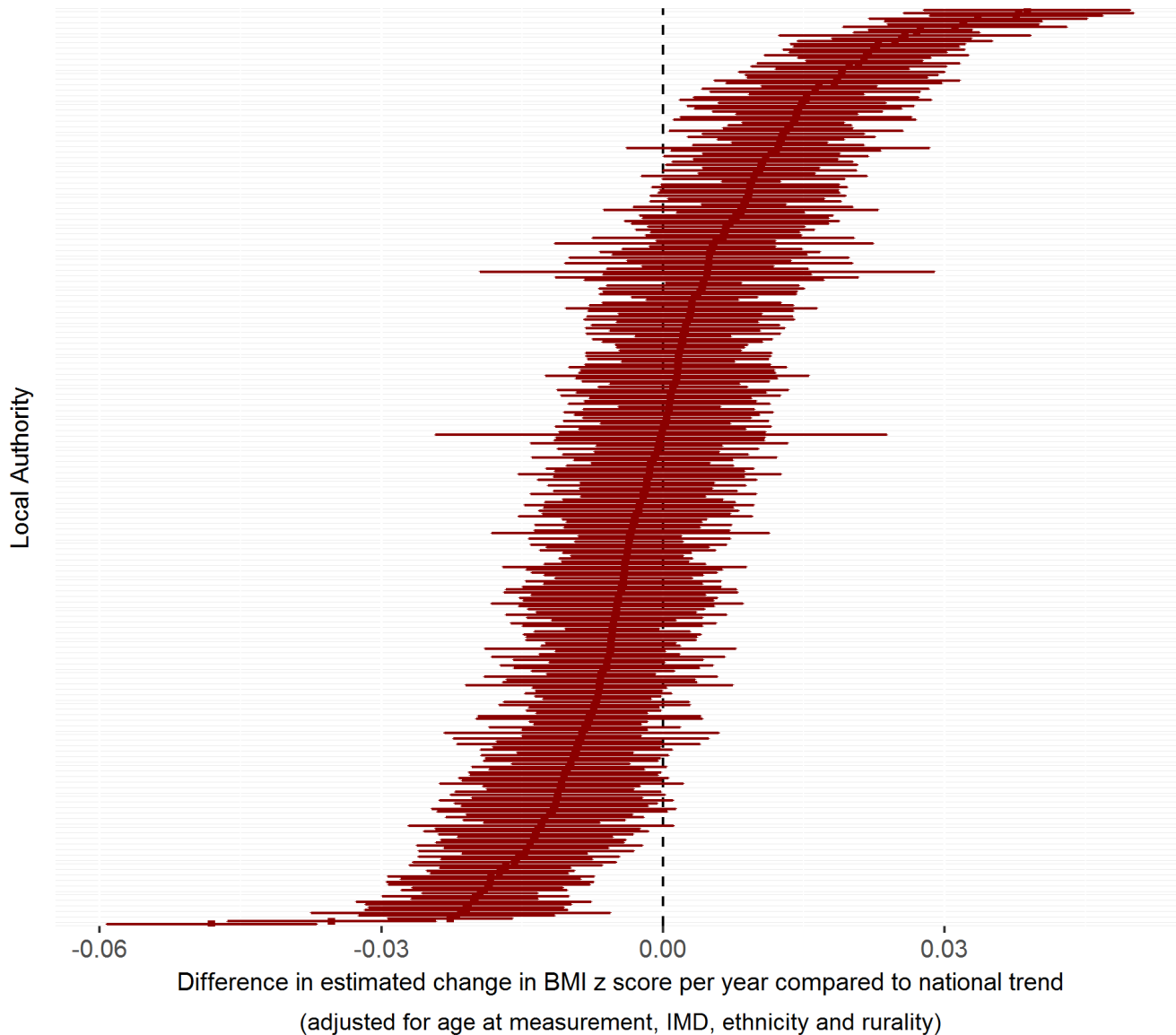


Figure 5a. Lower tier local authorities with largest negative differences from modelled national trend in BMI z score, with 95% confidence intervals: Year R, boys

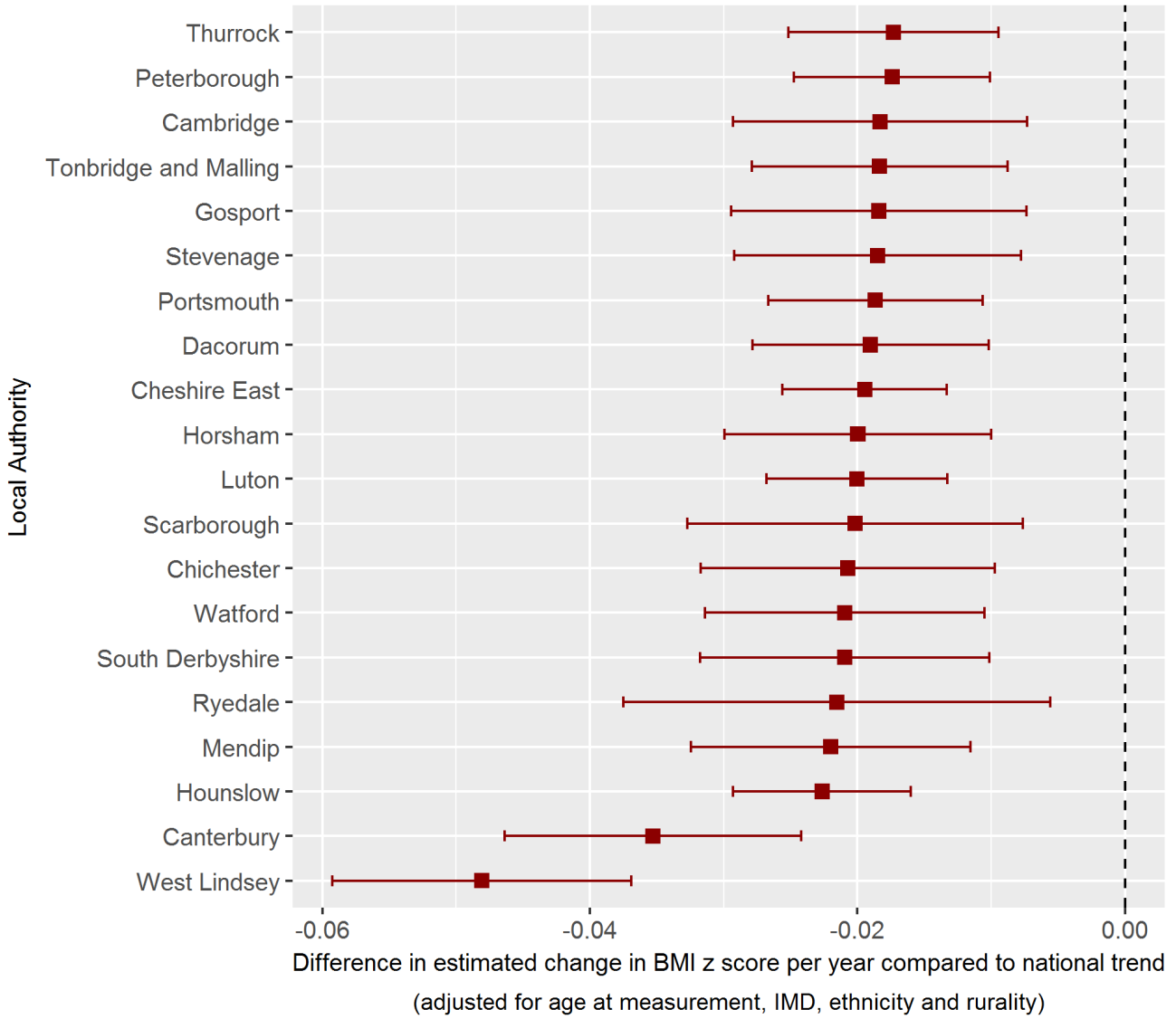


Figure 5b. Lower tier local authorities with largest negative differences from modelled national trend in BMI z score, with 95% confidence intervals: Year R, girls

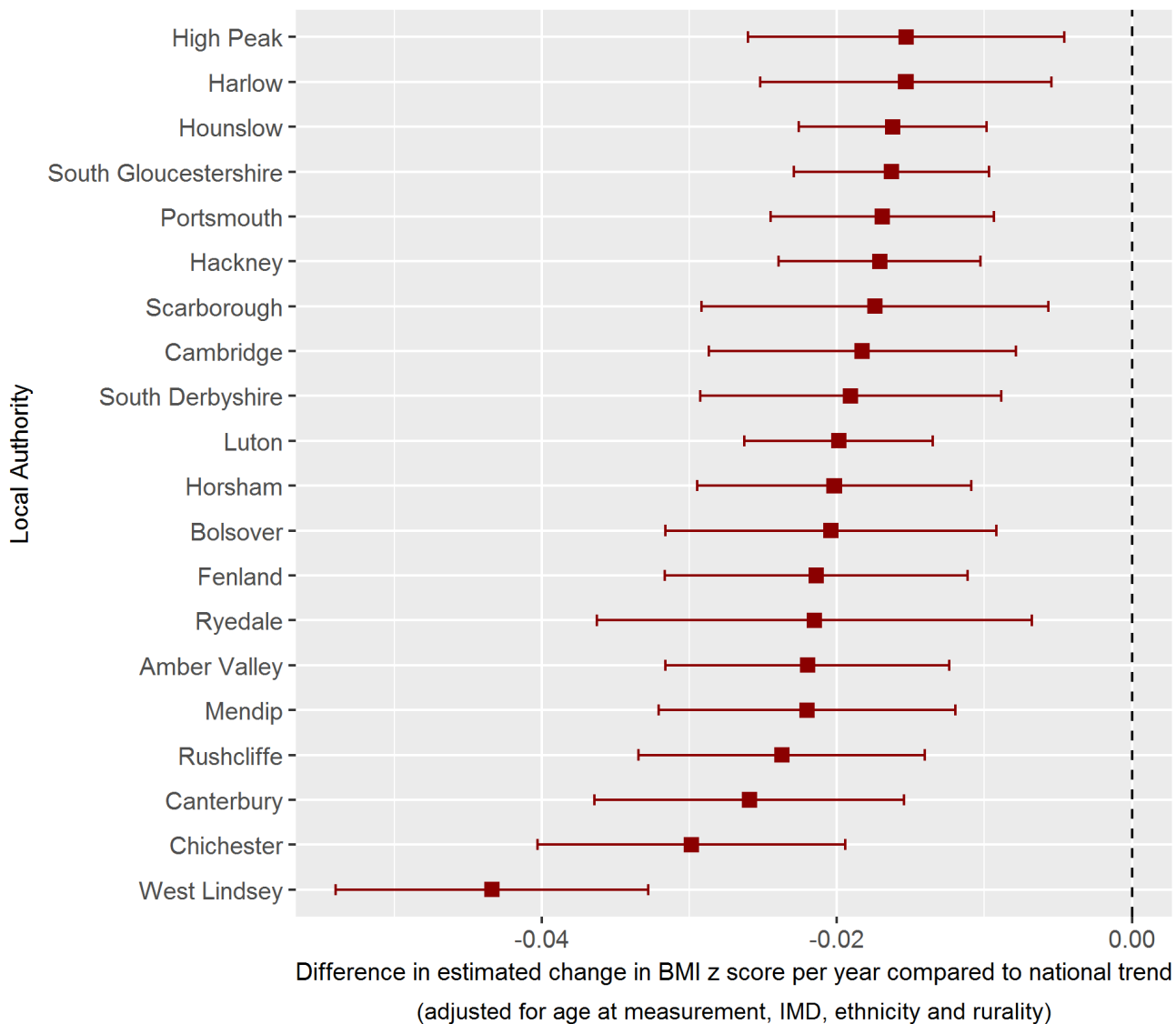


Figure 5c. Lower tier local authorities with largest negative differences from modelled national trend in BMI z score, with 95% confidence intervals: Year 6, boys

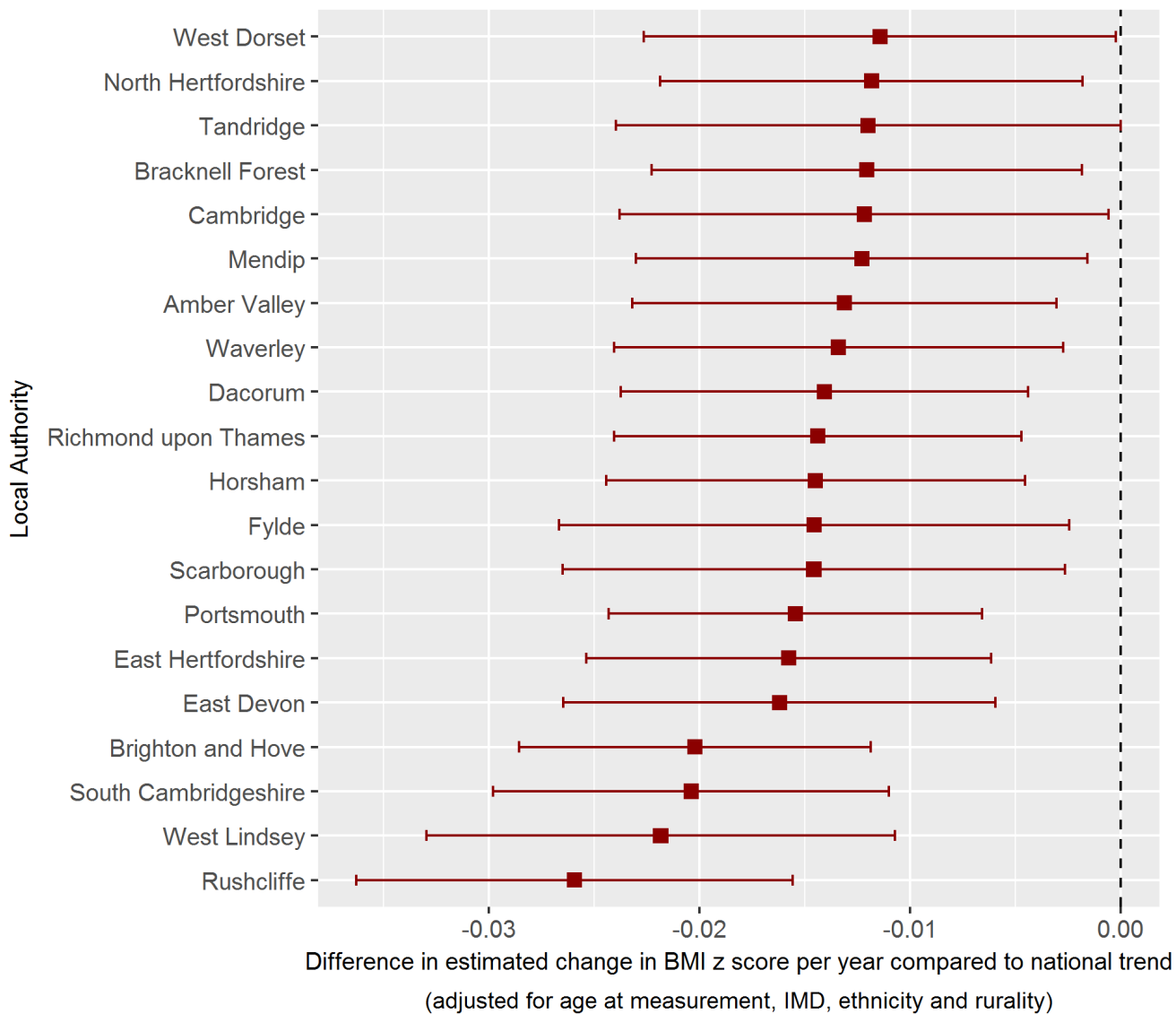
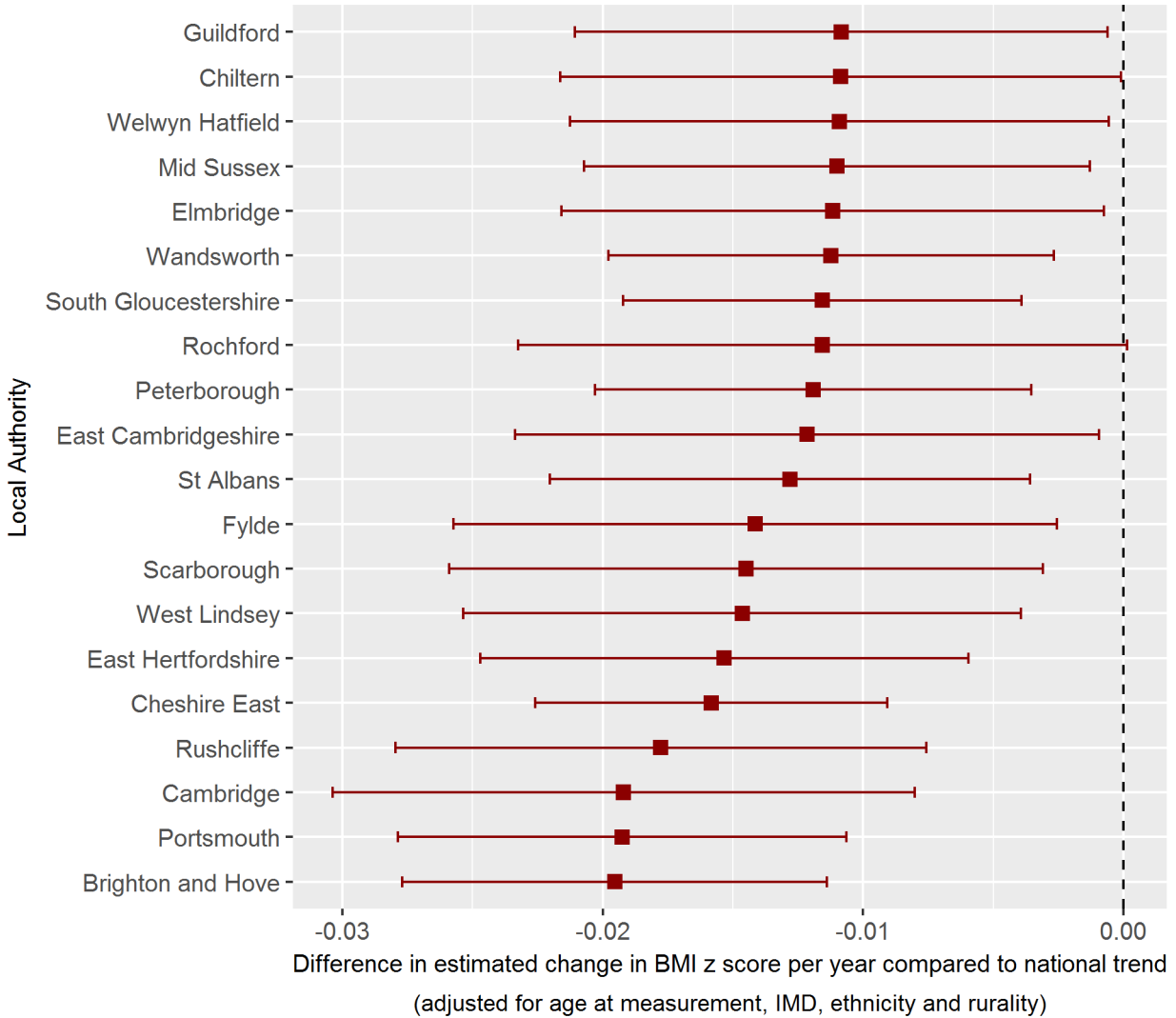


Figure 5d. Lower tier local authorities with largest negative differences from modelled national trend in BMI z score, with 95% confidence intervals: Year 6, girls



8. The National Child Measurement Programme dataset

The 2015/16 NCMP dataset contains the largest number of child measurements collected to date by the programme with 1,169,941 valid measurements of children from state maintained schools in England. Overall participation (the percentage of eligible children that are measured) was 94.9% in 2015/16. Figure 6a shows the level of participation in the NCMP for each year of measurement by school year. Figure 6b shows the number of children measured by year of measurement, school year (Reception and Year 6) and sex.

In Reception participation in the NCMP has risen over time although there was a very small fall in 2013/14 to 94.2%. In 2015/16 Reception year participation was 95.6% (Figure 6a). The number of children measured in this age group has also risen steadily over the years 2006/07 to 2015/16. In 2015/16 a total of 625,326 children were measured compared to 610,636 in 2014/15 (Figure 6b).

The level of participation for children in Year 6 has continued to increase over time, reaching 94.0% in both 2014/15 and 2015/16 (Figure 6a). A year-on-year decrease in the absolute number of Year 6 boys and girls measured occurred from 2009/10 to 2012/13 because of demographic changes leading to a fall in the number of children 'eligible for measurement'. In 2015/16, the total number of Year 6 children measured increased compared to 2014/15 with 544,615 child measurements recorded (Figure 6b).

Figure 6a. Percentage participation by year of measurement and school year

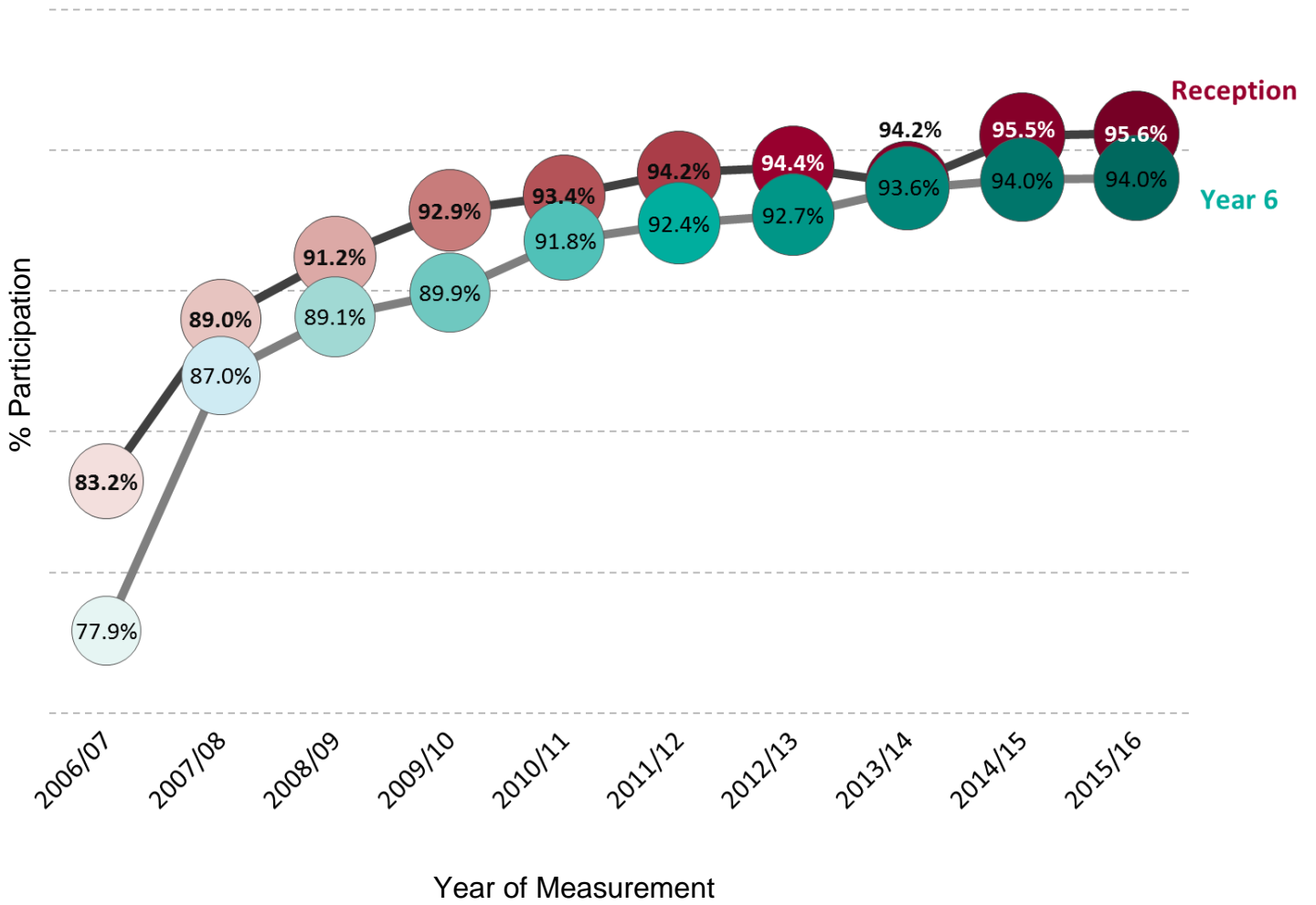
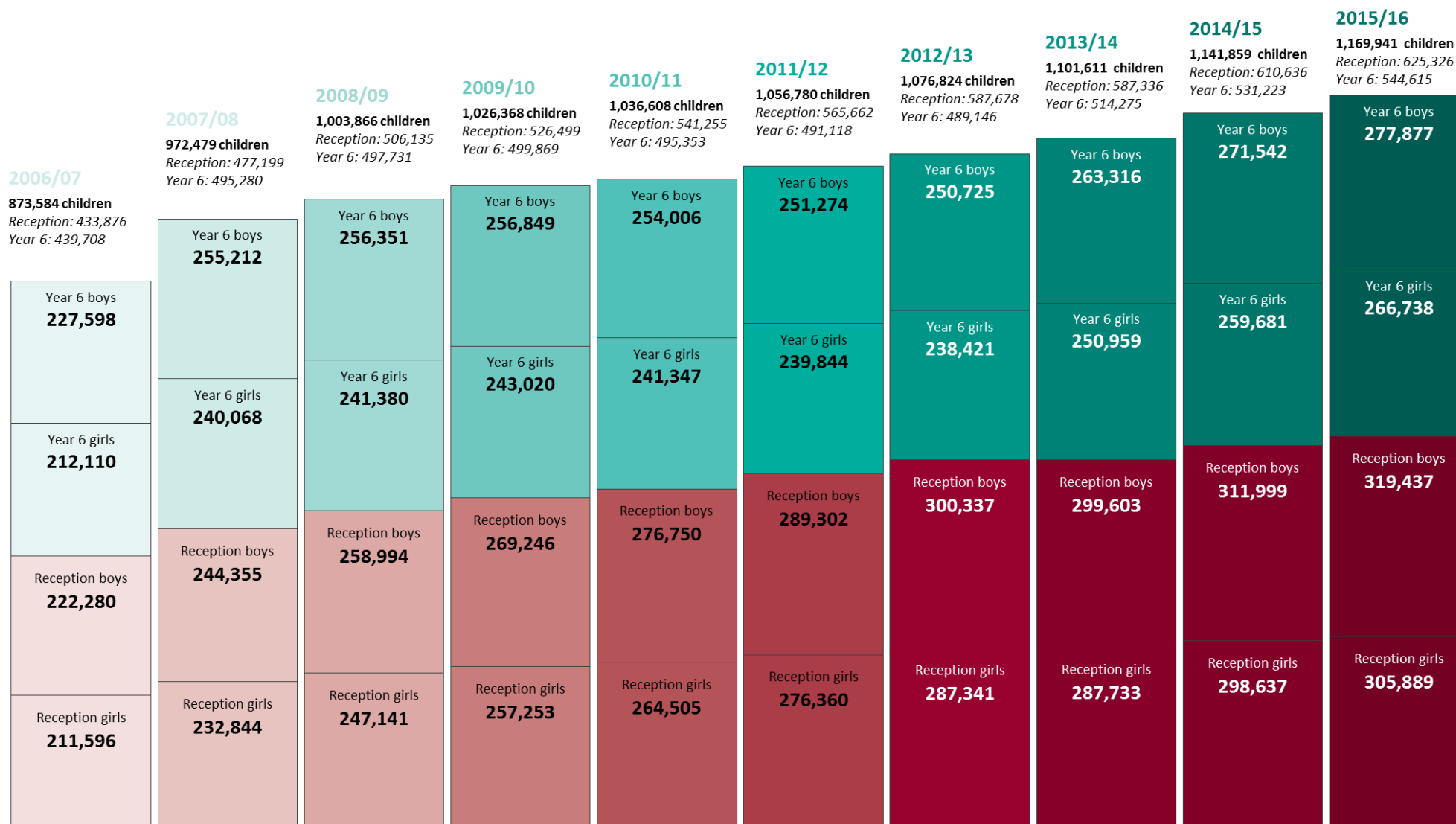


Figure 6b. Number of children measured by year of measurement, school year, and sex



9. Discussion and conclusions

Obesity prevalence shows a significant downward linear trend for Reception boys overall from 2006/07 to 2015/16. Using data up to 2014/15 such a downward trend was found in both Reception boys and girls.¹ The estimated rate of decline in Reception boys has slowed down compared to the 2014/15 estimate while the weak downward trend in obesity prevalence found in Reception girls in 2014/15 has not been sustained and is no longer significant.

The trends in obesity prevalence in Year 6 boys and girls continue to show year-on-year increases, at higher rates compared to 2014/15. The estimated annual increase in excess weight prevalence is smaller than the trend to 2014/15 in Year 6 girls but higher compared to last year for Year 6 boys. Underweight prevalence in Year 6 girls shows a significant downward trend and there is still a significant small annual reduction in underweight prevalence among Reception boys and girls.

Analysis by IMD quintile continues to show a widening inequality gap in the overweight, obese and excess weight categories for boys and girls in Reception and Year 6. In Reception boys, where prevalence is declining overall, it is declining at a slower rate in the most deprived quintiles compared to the least. In Year 6 boys and girls where the prevalence of obesity and excess weight is increasing overall, it is increasing at a faster rate in the most deprived quintiles.

In some cases the inequality gap is widening at a faster rate than estimated last year. This can be seen when comparing this year's and last year's trend estimates. For example in Reception boys the estimated decline in obesity prevalence is greater compared to last year in least deprived quintile 5 but smaller in the other quintiles. In Reception girls the upward trends in obesity and excess weight in quintile 1 are steeper than trends estimated to 2014/15, while the corresponding estimated declines in quintile 5 have accelerated compared to last year.

Estimates of trends in weight category prevalence by ethnic group are potentially subject to bias due to the variation in NCMP ethnic category coding over time, and because ethnicity coding in the dataset is below 100% (80-85% complete over the past 7 years). Ethnic groups which show significant trends in prevalence over time have larger sample sizes, trends of higher magnitude, or both. The addition of a further year of data has obviously boosted sample size and compared to last year's findings there are newly significant declining trends in excess weight and obesity in Indian Reception boys, and in excess weight in Pakistani Reception boys. The upward trend in obesity prevalence in White British Year 6 boys is also now significant, as are the upward trends in obesity prevalence in Black African Year 6 girls, excess weight prevalence in

Black Caribbean Year 6 girls and overweight prevalence in Pakistani Year 6 girls. A newly significant decline in underweight prevalence is seen in White British Year 6 girls.

Analysis of trends in BMI z score has confirmed the associations which are known to exist with deprivation and ethnicity and indicated a change in direction of the association between BMI z score and urban environment between Reception and Year 6. It has also provided estimates of the national trend in BMI z score over the time period 2007/08 to 2015/16 by year group and sex, as well as estimates of differences from this trend at local authority level. Although these local authority effects are small in comparison to the associations with deprivation and ethnicity it is likely that they could be at least partly explained by variables which were not available to this analysis and this is an avenue for future work.

Ten years of NCMP data representing over 10 million child measurements have been summarised in this report and it provides a comprehensive picture of weight trends in the year groups which it monitors. There are some limitations. Our analyses have assumed that trends in weight category prevalence over time are linear. Figures 1 to 3 indicate that this appears to be a reasonable assumption in most cases, but this is nonetheless a potential drawback. We have not assessed changes in estimated trends between last year and this year for statistical significance and they should be interpreted with caution.

10. Appendix 1: methods

This report is based on the NCMP datasets for the ten years 2006/07 to 2015/16, apart from section 7 which is based on nine years of data from 2007/08 to 2015/16.

Only data for pupils attending state-maintained schools has been included in the analysis. Only a very small proportion of independent and special schools are covered in the NCMP datasets and for consistency over time and between areas these records have been excluded. The number of valid records for the ten years of measurement is shown in Figure 6b, broken down by school year and sex.

Only children with valid geographical coding (postcode of residence) have been included in the analysis by 2011 IMD quintile. The proportion of records with this coding has increased over the ten years of the NCMP. In 2006/07, the first year of the NCMP, around 57% of child records included valid coding for place of residence. This increased to 95% in 2007/08, and to over 99% in 2008/09 and subsequent years.¹⁰ The variation in coding has the potential to bias the estimates of prevalence by IMD quintile and findings for 2006/07 in particular must be interpreted with caution.

Linear regression models have been used to describe prevalence trends in sections 4 to 6. Logistic models were used to assess the significance of the trends (using a Bonferroni correction for multiple hypothesis testing^e) and differences from last year's report while least squares models were used to obtain the average increase or decrease in prevalence per year over time for descriptive purposes. These models assume that the trends are linear: both because there are too few data points to accurately capture a non-linear trend; and to facilitate more straightforward comparison between the weight, sex and year categories. Logistic model trend estimates obtained with NCMP data from 2006/07 to 2015/16 were compared with trend estimates obtained for last year's report¹ using data from 2006/07 to 2014/15, but were not assessed for statistical significance. All analysis was performed in R.¹⁸

The multilevel models described in section 7 were fitted using the lme4 package in R.¹⁹ Multilevel models consist of fixed effects and random effects. The variables given in Table 1 were modelled as fixed effects while local authority was modelled as a random effect with both random intercept and trend. Although the dependent variable BMI z score standardises for age, an age term is included in the models in order to capture any systematic pattern (trajectory) in z score with age. The random terms are assumed to follow a multivariate normal distribution with a mean of zero and were examined for

^e The Bonferroni correction lowers the p value at which a test is considered significant, to account for the number of comparisons being performed. To perform the Bonferroni correction we divided the critical p value (α , set to 0.05) by the number of comparisons being made in each year and sex group for each type of analysis.

significance using likelihood ratio tests. The R package stargazer was used to obtain formatted regression tables.²⁰

Trend estimates described in this report may differ from those reported in the Public Health Outcomes Framework⁸ (PHOF) and other PHE online data tools including the NCMP LA Profile²¹ because of differences in methodology and data used. The online tools currently use a chi-squared statistical test for trend²² with the most recent five data points but if this trend is not significant, go back further in time and test for a significant trend again. NCMP data published in the PHOF and the NCMP LA Profile also combines annual measurements for boys and girls, in contrast to the analyses presented here which consider boys and girls separately.

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12. Reader information

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