



Public Health
England

Protecting and improving the nation's health

Changes in children's body mass index between 2006/07 and 2013/14 National Child Measurement Programme

About Public Health England

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Public Health England
Wellington House
133-155 Waterloo Road
London SE1 8UG
Tel: 020 7654 8000
www.gov.uk/phe
Twitter: [@PHE_uk](https://twitter.com/PHE_uk)
Facebook: www.facebook.com/PublicHealthEngland

Prepared by: Vicky Copley

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Any enquiries regarding this publication should be sent to: ncmp@phe.gov.uk

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Contents

About Public Health England	2
Contents	3
1. Summary of key findings 2006/07–2013/14	4
2. Introduction	5
3. The National Child Measurement Programme dataset	6
4. Changes in prevalence of obesity, excess weight and underweight	8
5. Changes in obesity prevalence by socioeconomic group	11
6. Changes in obesity prevalence by ethnic group	15
7. Changes in the distribution of children's BMI	21
8. Discussion and conclusions	24
Appendix 1: methods	27
References	28
Reader information	30

1. Summary of key findings 2006/07–2013/14

	Reception		Year 6	
	Boys	Girls	Boys	Girls
Changes in prevalence of obesity Page 8	Significant downward linear trend	No significant upward or downward linear trend	Significant upward linear trend	Significant upward linear trend, higher average increase per year than Year 6 boys
Changes in prevalence of excess weight Page 8	Significant downward linear trend	No significant upward or downward linear trend	Significant upward linear trend.	Significant upward linear trend, higher average increase per year than Year 6 boys
Changes in prevalence of overweight Page 8	Significant downward linear trend	No significant upward or downward linear trend	No significant upward or downward linear trend	Significant upward linear trend
Changes in prevalence of underweight Page 8	Significant downward linear trend		Significant downward linear trend	
Changes by socioeconomic group Page 11	Widening inequality in excess weight, obesity and overweight prevalence. No consistent relationship between trend in underweight prevalence and deprivation quintile		Widening inequality in excess weight, obesity and overweight prevalence. Significant rates of increase in excess weight and obesity in deprivation quintiles 1 (most deprived), 2 and 3. No consistent relationship between trend in underweight prevalence and deprivation quintile	
Changes by ethnic group^a Page 15	White British boys show significant declines in excess weight, obesity and underweight prevalence. Black Caribbean boys show significant declines in underweight prevalence	Significant declines in underweight prevalence in White British, Pakistani and Black African girls. Significant increase in excess weight in Chinese girls	Significant rates of increase in excess weight and obesity in several ethnic groups, particularly high in Pakistani and Bangladeshi boys. Significant increase in obesity prevalence in Chinese boys. Significant decline in underweight prevalence in White British boys	Significant rates of increase in excess weight and obesity in several ethnic groups, particularly high in Pakistani and Bangladeshi girls. Significant decline in underweight prevalence in White British, Pakistani and Bangladeshi girls
Changes in mean BMI for age (mean BMI z score^b) Page 21	Mean BMI for age in the underweight category shows a significant increase over time. No significant upward or downward linear trend in any other weight category	Mean BMI for age in the underweight category shows significant increase over time. No significant upward or downward linear trend in any other weight category	Mean BMI for age in the excess weight and obesity categories shows significant small increases over time	Mean BMI for age in the excess weight, obesity and overweight categories shows significant small increases over time

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

^b 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.

2. Introduction

This report is the sixth in a series of annual reports which use National Child Measurement Programme (NCMP) data to examine changes in children's body mass index (BMI) that have taken place since 2006/07.^{1,2,3,4,5}

The NCMP is a nationally mandated public health programme that measures 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 data for the child excess weight indicators in the Public Health Outcomes Framework and is a key element in the government's approach to tackling child obesity. The 2013/14 NCMP was the eighth year of this system of national child measurement.^c

The NCMP has very good levels of participation across all areas of England. Data completeness and accuracy are of high quality. NCMP analyses previously published by the Health and Social Care Information Centre (HSCIC), the former National Obesity Observatory (NOO) and Public Health England (PHE) provide comprehensive descriptions 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 period of NCMP measurements. It examines trends in obesity, overweight, excess weight and underweight prevalence, as well as changes in mean BMI over time. Trends within different socioeconomic and ethnic groups are also examined to determine whether existing health inequalities are widening or becoming smaller.

BMI classification definitions

BMI has been classified according to the following table using the British 1990 growth reference (UK 90)⁶ distribution

BMI classification	Centile of UK 90 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)

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

3. The National Child Measurement Programme dataset

The 2013/14 NCMP dataset contains the largest number of child measurements collected to date by the programme, with 1,101,611 valid measurements of children from state maintained schools in England. Overall participation (the percentage of eligible children that are measured) was 93.7% in 2013/14, a similar figure to that achieved in 2012/13. Figure 1a shows the number of children measured by year of measurement, school year (Reception and Year 6) and sex. Figure 1b shows the level of participation in the NCMP for each year of measurement by school year (Reception and Year 6).

In Reception, the number of children measured rose for each year of measurement from 2006/07 to 2012/13 but declined slightly in 2013/14. In 2013/14 a total of 587,336 children were measured compared to 587,678 in 2012/13 (Figure 1a). Participation in the NCMP has also generally risen over time for this age group, although there was a very small fall in 2013/14 to 94.2%, compared to 94.4% in 2012/13 (Figure 1b).

In Year 6, a year-on-year decrease in the absolute number of boys and girls measured occurred from 2009/10 to 2012/13 because of demographic changes leading to a fall in the number of children of this age 'eligible for measurement', however in 2013/14 there was an increase in the total number of Year 6 children measured (Figure 1a). The level of participation in this age group has continued to increase over time, reaching 93.6% in 2013/14 with 514,275 child measurements recorded (Figure 1b).

Figure 1a. Number of children measured by year of measurement, school year (Reception and Year 6) and sex

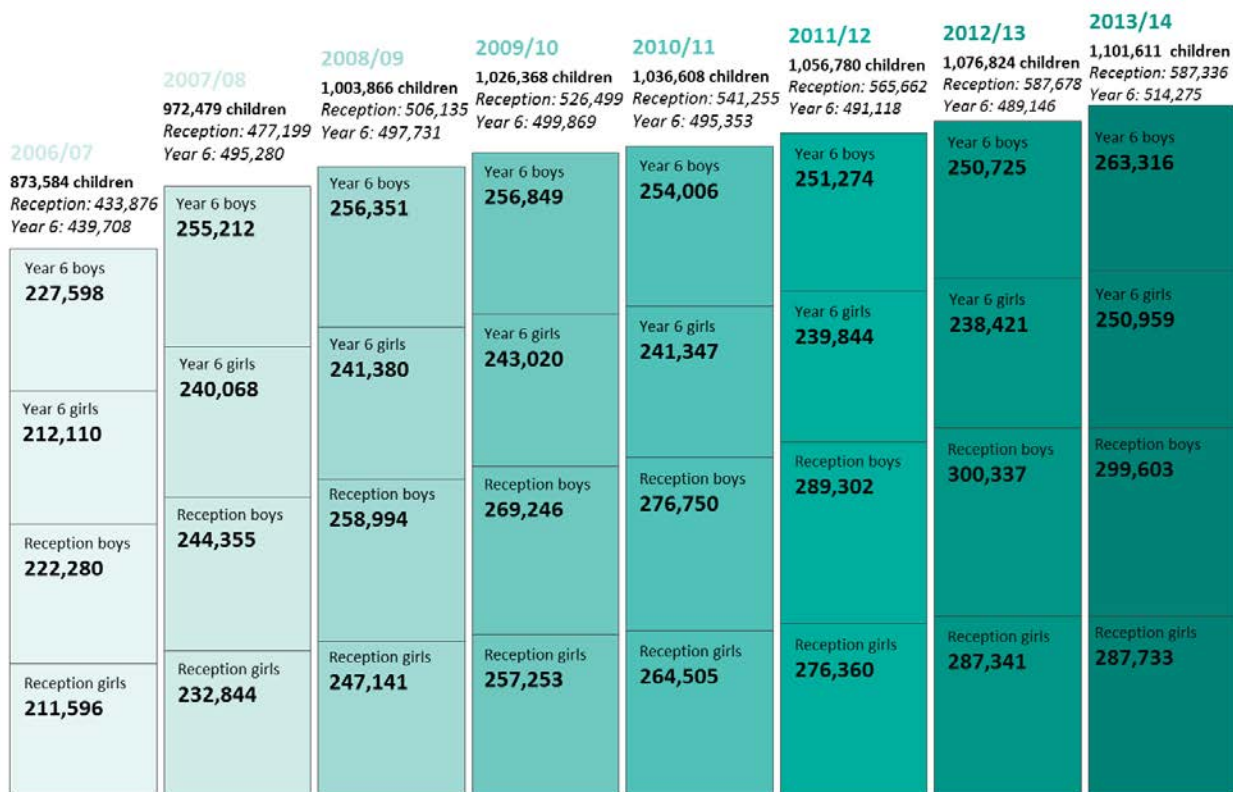
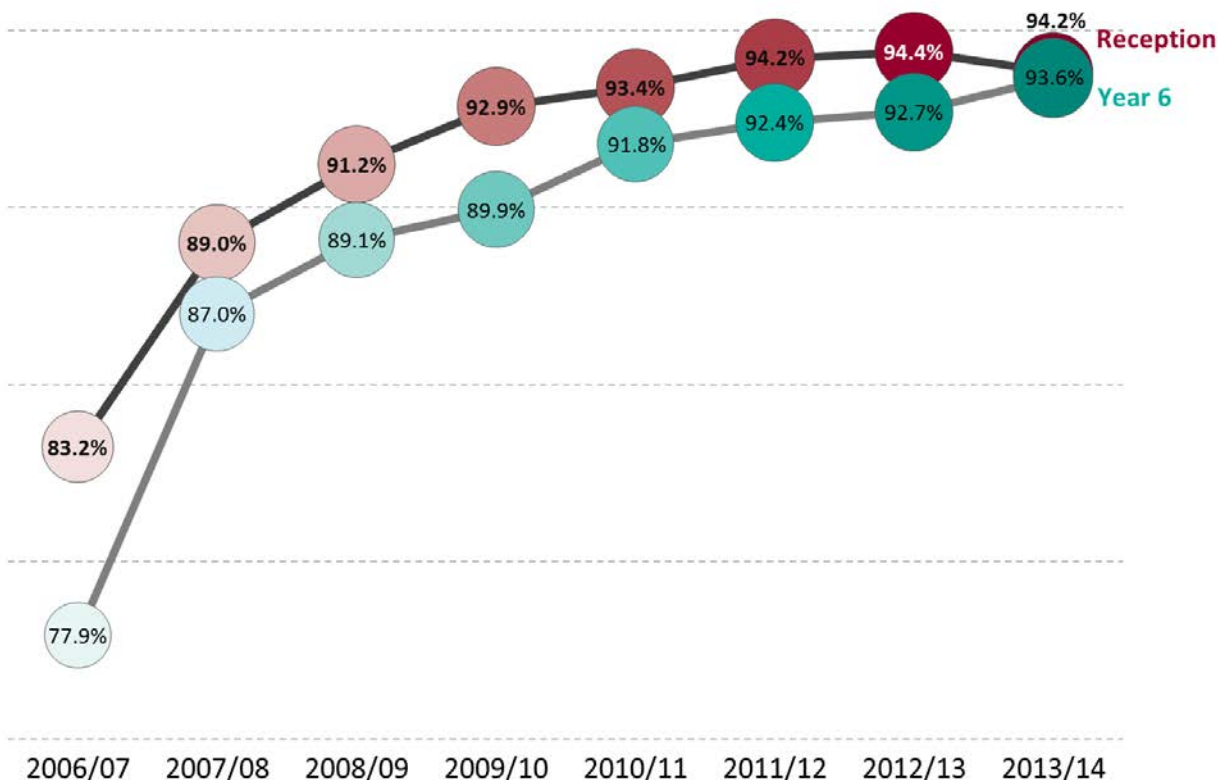


Figure 1b. Level of participation by year of measurement and school year (Reception and Year 6)



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

The fact that the NCMP takes measurements from a very large number of children results in small confidence limits around most national estimates. This means we can be confident that the data are robust. Year-to-year variation around the prevalence figures does exist however, and changes from one year to the next are not always indicative of the long term trend. For example, a statistically significant increase between one year of measurement and the next for any age/sex group may be followed by an apparent decrease the following year. This report therefore assesses the trend over time using as many data points as possible.

The most recent report in this series (Changes in children's BMI between 2006/07 and 2012/13¹) did not include data from 2006/07 in its statistical analyses of Year 6 trends because of relatively low Year 6 participation in this survey year compared to other survey years. However, because the national level participation of Year 6 in NCMP 2006/07 was reasonable (in absolute terms) at 77.9% (Figure 1) and 82.1% for schools where measures were taken⁷, it is included in the analyses presented here. It is worth noting that 2006/07 data will have less influence on any statistical trends compared to reports in previous years as more survey years are now available for analysis.

Trend in the prevalence of obesity, excess weight and underweight from NCMP data

Figure 2 shows the overall trend over time in the prevalence of obesity, excess weight, overweight and underweight by year of measurement, school year (Reception and Year 6) and sex. Each point within each cluster represents one year of measurement from 2006/07 on the left to 2013/14 on the right.

Linear regression models were used to describe the prevalence trends shown in Figure 2. Logistic models were used to assess the significance of the trends (using a Bonferroni correction for multiple hypothesis testing^d), 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. Significant trends are shown in Figure 2 by a dashed line. Significant upward trends in prevalence over the time period were found for obesity and excess weight in Year 6

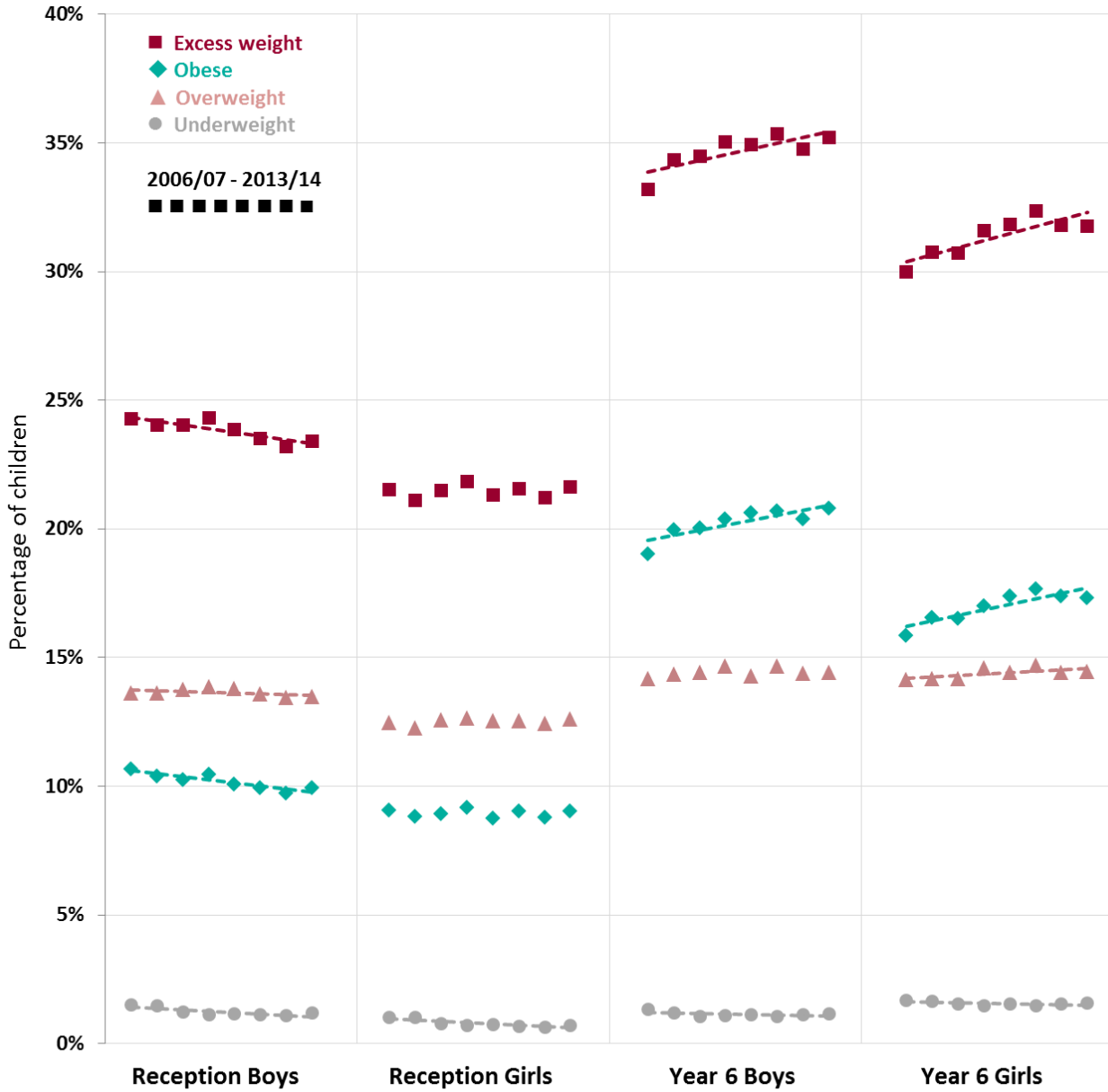
^d The Bonferroni correction lowers the p value at which a test is considered significant, to account for the number of comparisons being performed. To perform the Bonferroni correction we divided the critical p value (α , set to 0.05) by the number of comparisons being made in each year and sex group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

boys and for obesity, excess weight and overweight in Year 6 girls. Significant downward trends in prevalence were found for all years and sexes for underweight, and in addition for obesity, excess weight and overweight in Reception boys. This represents a positive (or healthy) change among these children.

Of the significant trends shown in Figure 2 the largest upward trend is in excess weight among Year 6 girls where prevalence increased on average by 0.27 percentage points per year from 2006/07 to 2013/14. Excess weight in Year 6 boys and obesity in Year 6 girls show the next steepest upward trends of 0.22 percentage points per year. In Year 6 boys the increase in obesity prevalence is slightly smaller than that of Year 6 girls, averaging 0.20 percentage points per year.

The steepest downward trends in prevalence are seen in excess weight and obesity in Reception boys. The average decline per year in excess weight prevalence in Reception boys is 0.15 percentage points and the corresponding decline in obesity is 0.12 percentage points per year.

Figure 2. Prevalence of obesity, excess weight, overweight and underweight by year of measurement, school year (Reception and Year 6) and sex. NCMP 2006/07 to 2013/14. Significant upward or downward linear trends are shown with a dashed line



5. Changes in obesity prevalence by socioeconomic group

Child obesity prevalence shows a close 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.⁸

In order to assess how obesity prevalence has changed over time by socioeconomic status, all children surveyed by the NCMP have been grouped into five equal-sized bands (quintiles) based on the Index of Multiple Deprivation (IMD) 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%.

Only children with valid geographical coding (postcode of residence) have been included in this analysis. The proportion of records with such coding has increased over the seven years of the NCMP. In 2006/07 (the first year of the NCMP) around 57% of child records included valid postcode of residence. This increased to 95% in 2007/08, and to over 99% in 2008/09 and subsequent years. This variation in geographical 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.

Figures 3a to 3d show the association between prevalence of each weight category and deprivation, by year of NCMP measurement.

Figure 3a shows declines in prevalence of excess weight and obesity in Reception boys which reflect the overall trend seen in Figure 2, however these declines are generally steeper in the least deprived IMD quintiles, indicating a widening inequality gap. For example the average decline in obesity prevalence per year in IMD quintile 5 (least deprived) is 0.16 percentage points per year whilst the average decline in IMD quintile 1 (most deprived) is only 0.07 percentage points per year. A similar pattern is seen in excess weight: there is a significant downward trend in prevalence in the least deprived quintile (on average 0.26 percentage points per year), but no significant decline in the most deprived quintile, again indicating a widening inequality gap.

Significant declines in underweight in Reception boys were found in all IMD quintiles, however the rate of the decline does not show a consistent relationship with IMD quintile. The greatest decline in underweight prevalence in Reception boys is seen in IMD quintile 1 (most deprived), while the smallest decline is in IMD quintile 3.

The downward trends in underweight prevalence seen in Figure 3b for Reception girls are also significant in all IMD quintiles. Again there is no clear relationship with

deprivation status as the largest decline is in IMD quintile 1 (on average 0.07 percentage points per year) and the smallest in IMD quintile 3 (on average 0.04 percentage points per year).

The only other downward trends which are significant for Reception girls are for excess weight and obesity prevalence in the least deprived IMD quintile. These show an average decline of 0.10 and 0.08 percentage points per year respectively. The only significant increasing trend for Reception girls is for excess weight in the most deprived quintile which shows an average increase of 0.10 percentage points per year. Taken together these two opposing trends indicate a widening inequality gap in Reception girls.

Figure 3c shows the associations between prevalence of each weight category and deprivation for Year 6 boys. Here the only significant declining trends were found for excess weight and obesity prevalence in IMD quintile 5. Significant increasing trends in excess weight and obesity prevalence were found in the more deprived IMD quintiles, with the biggest upward trends seen in quintiles 1 and 2.

A significant declining trend in underweight prevalence was found for quintile 1 in Year 6 girls (Figure 3d). Significant increasing trends were found for quintiles 1 and 2 for obesity and quintiles 1, 2 and 3 for excess weight. The average increasing trend for excess weight in Year 6 girls' quintile 1 is 0.54 percentage points per year which is the largest increasing trend of any of the groups considered in Figures 3a to 3d. These differential trends within the IMD quintiles indicate a widening inequality gap in Year 6 girls.

Figure 3a. 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

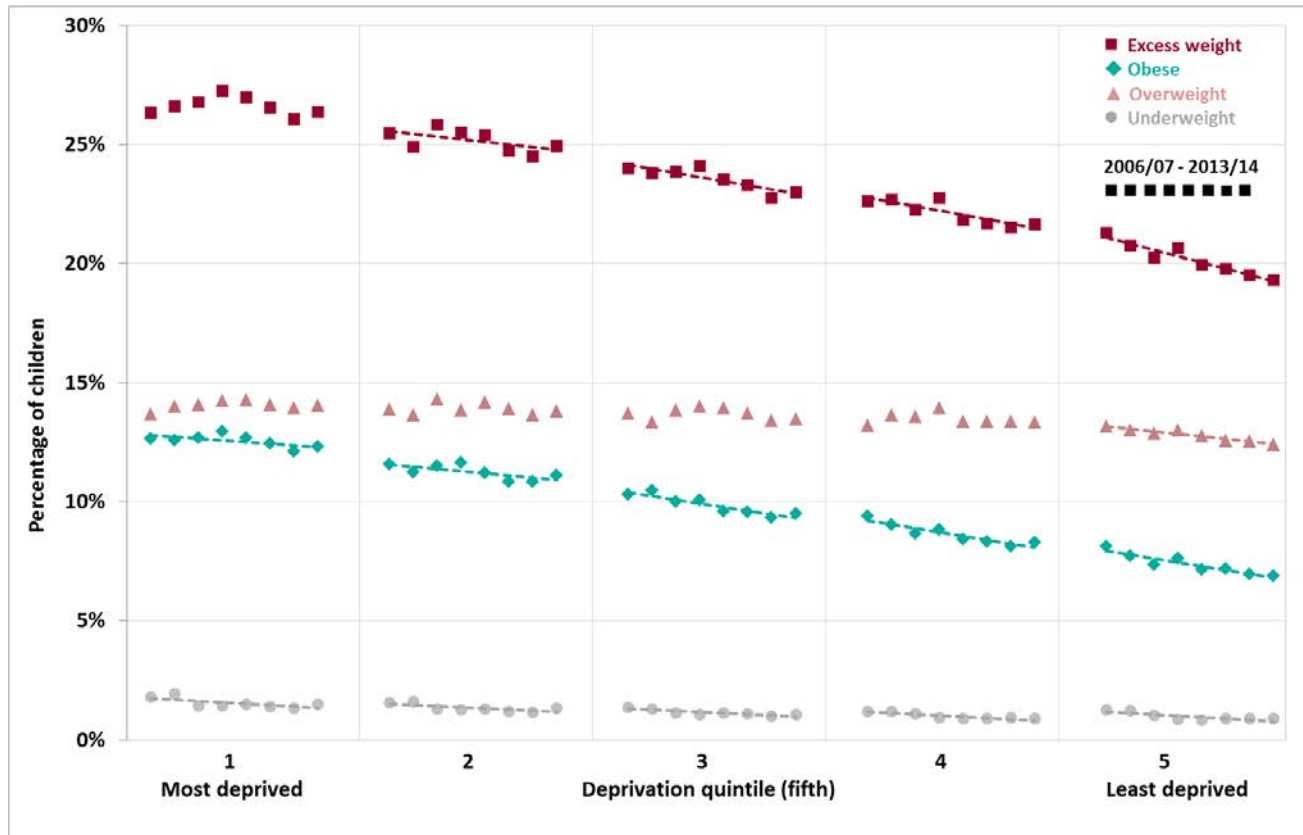


Figure 3b. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Reception girls. Significant upward or downward linear trends are shown with a dashed line

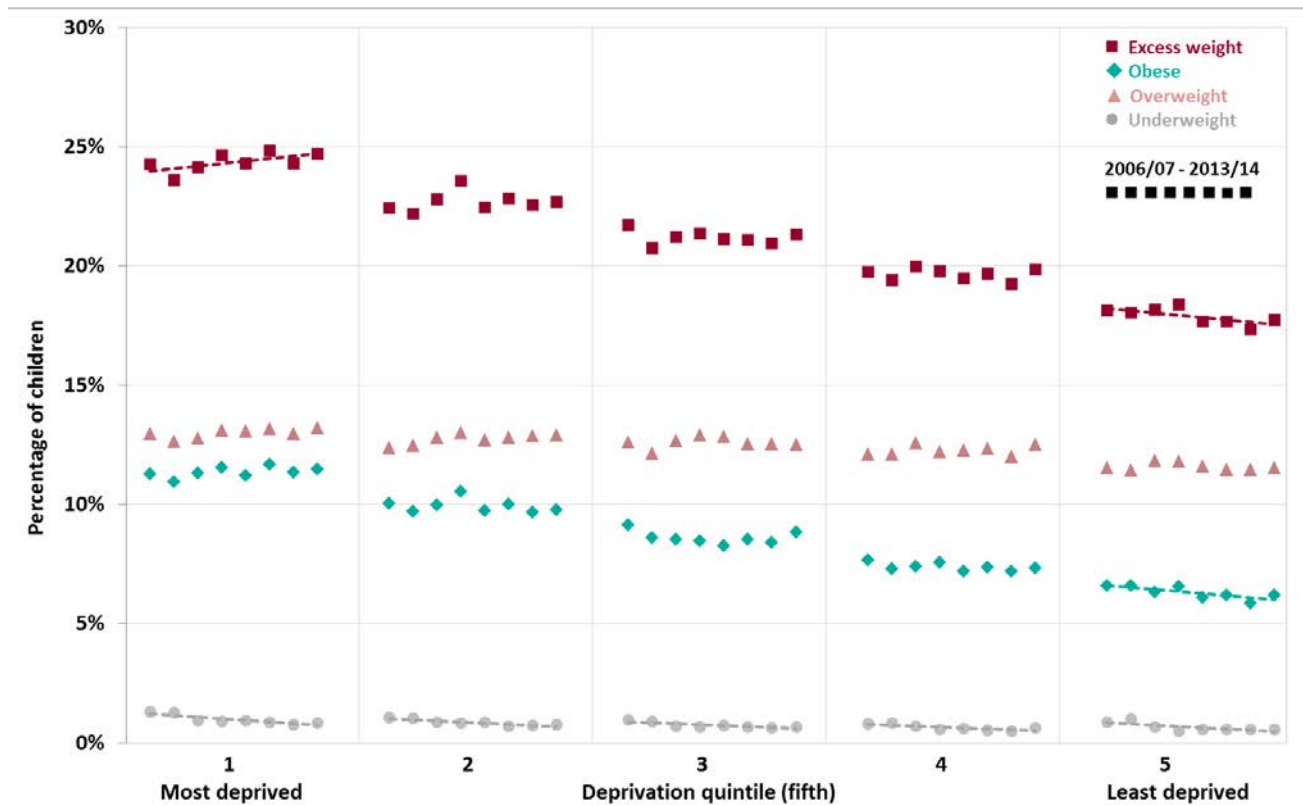


Figure 3c. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Year 6 boys. Significant upward or downward linear trends are shown with a dashed line

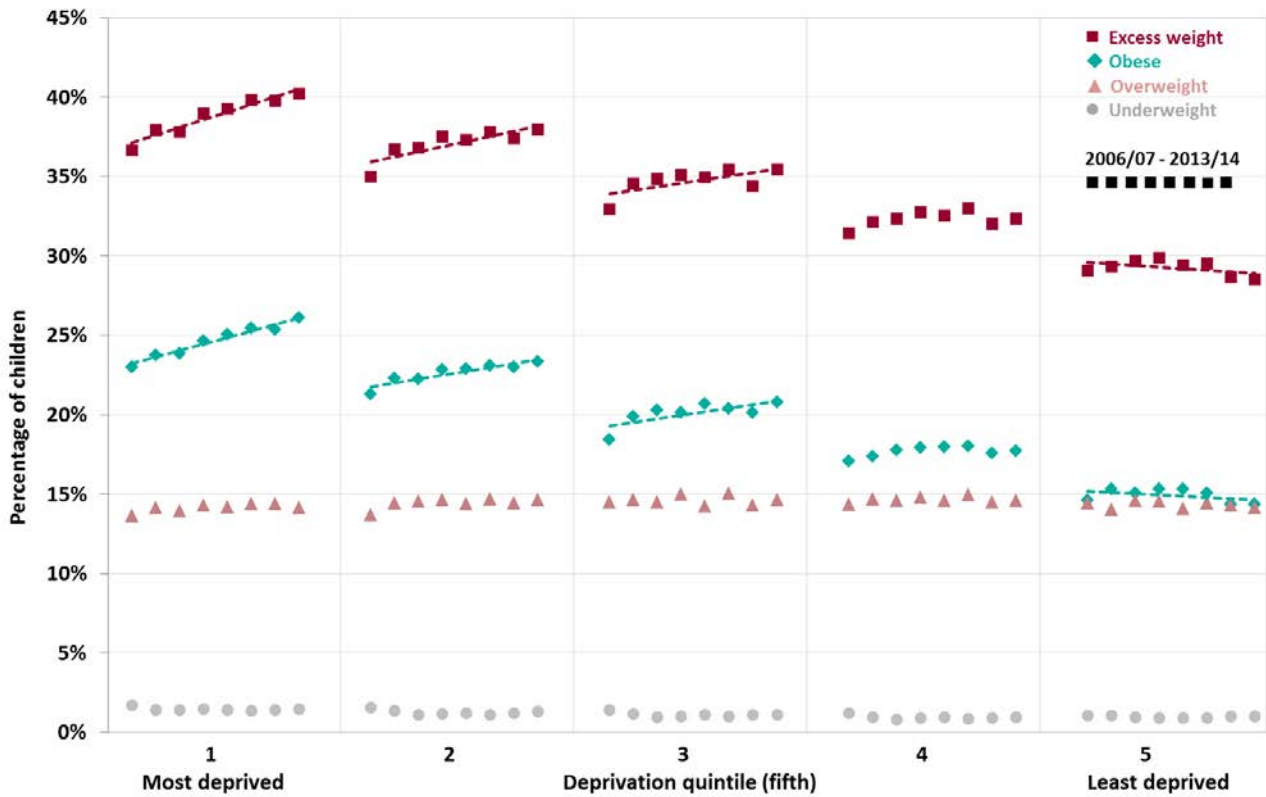
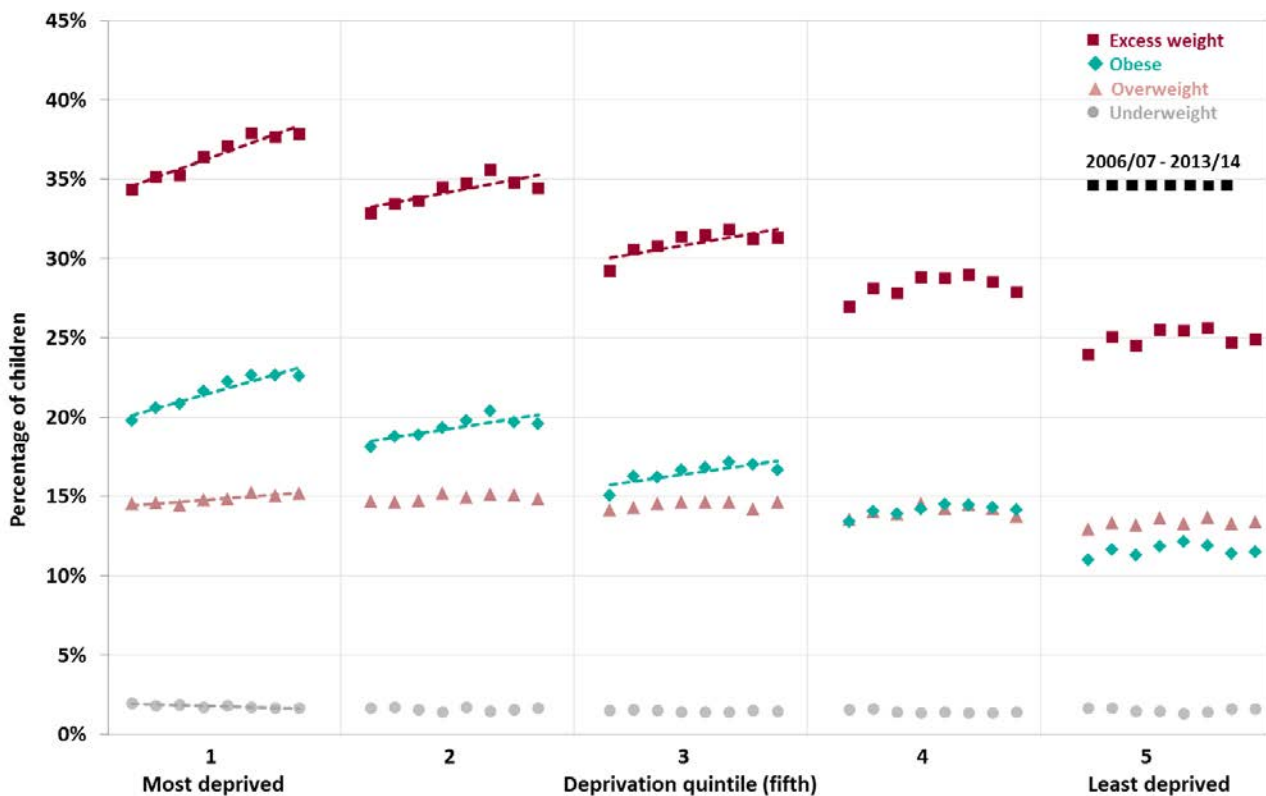


Figure 3d. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and IMD quintile: Year 6 girls. Significant upward or downward linear trends are shown with a dashed line



6. Changes in obesity prevalence 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.^{8,9} In general such analyses show that children classed as White British 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.^{10,11}

The proportion of records with valid ethnicity coding has increased substantially over the eight years of the NCMP. In 2006/07 only 32% of child records had an informative ethnicity code (ie not 'unknown' or 'not stated'). This increased to 67% in 2007/08, 77% in 2008/09, 83% in 2009/10 and 2010/11, 85% in 2011/12, and 86% in 2012/13. It dropped to 83% in 2013/14. This variation in coding means that trends over time by ethnic group must be interpreted with caution. It is possible that completeness of ethnicity coding may vary with weight status, leading to potential bias in the prevalence estimates. Such bias 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 are subject to more sampling variation from year to year.

The ethnicity trend analysis conducted for this report is based on eight ethnic groups. Figures 4a to 4d show the association between prevalence of weight category and these ethnicities by year of NCMP measurement.

Figure 4a demonstrates that the overall decline in prevalence of excess weight and obesity in Reception boys seen in Figure 2 is not reflected in all ethnic groups. Although excess weight prevalence appears to be broadly declining in White British, White Irish and Black Caribbean boys in Reception, it is increasing in Chinese boys and generally stable in the other ethnic categories. Significant declining trends in prevalence are seen in the following groups: White British excess weight; White British obese; Black Caribbean underweight; and White British underweight. No other trends are significant which is likely to be a reflection of the smaller numbers in some ethnic categories as well as the conservative Bonferroni correction^e applied to correct for multiple significance testing.

^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.

Significant downward linear trends in underweight prevalence in Reception girls are shown in Figure 4b for Pakistani, Black African and White British ethnic groups. Other ethnic groups also show downward trends in underweight prevalence in Reception girls, but these are not significant. Again these trends may be set against the overall declining trend in underweight in Reception girls shown in Figure 2. Some upward trends in excess weight and obesity can also be seen in Figure 4b in various ethnic groups, but only one of these is statistically significant, that of excess weight in Chinese girls.

Figure 4c shows a significant declining trend in underweight in White British Year 6 boys. No other declining trend in this figure is significant. Upward trends in excess weight are significant for Indian, Black African, Pakistani and Bangladeshi Year 6 boys. Upward trends in obesity are significant for Black African, Pakistani, Bangladeshi and Chinese Year 6 boys.

Figure 4d shows significant declining trends in underweight in Year 6 girls in Bangladeshi, Pakistani and White British ethnic groups. The upward trends in excess weight and obesity shown are significant for White British, Indian, Pakistani and Bangladeshi Year 6 girls while the Black African group shows a significant increasing trend in excess weight prevalence.

Figure 4a. 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

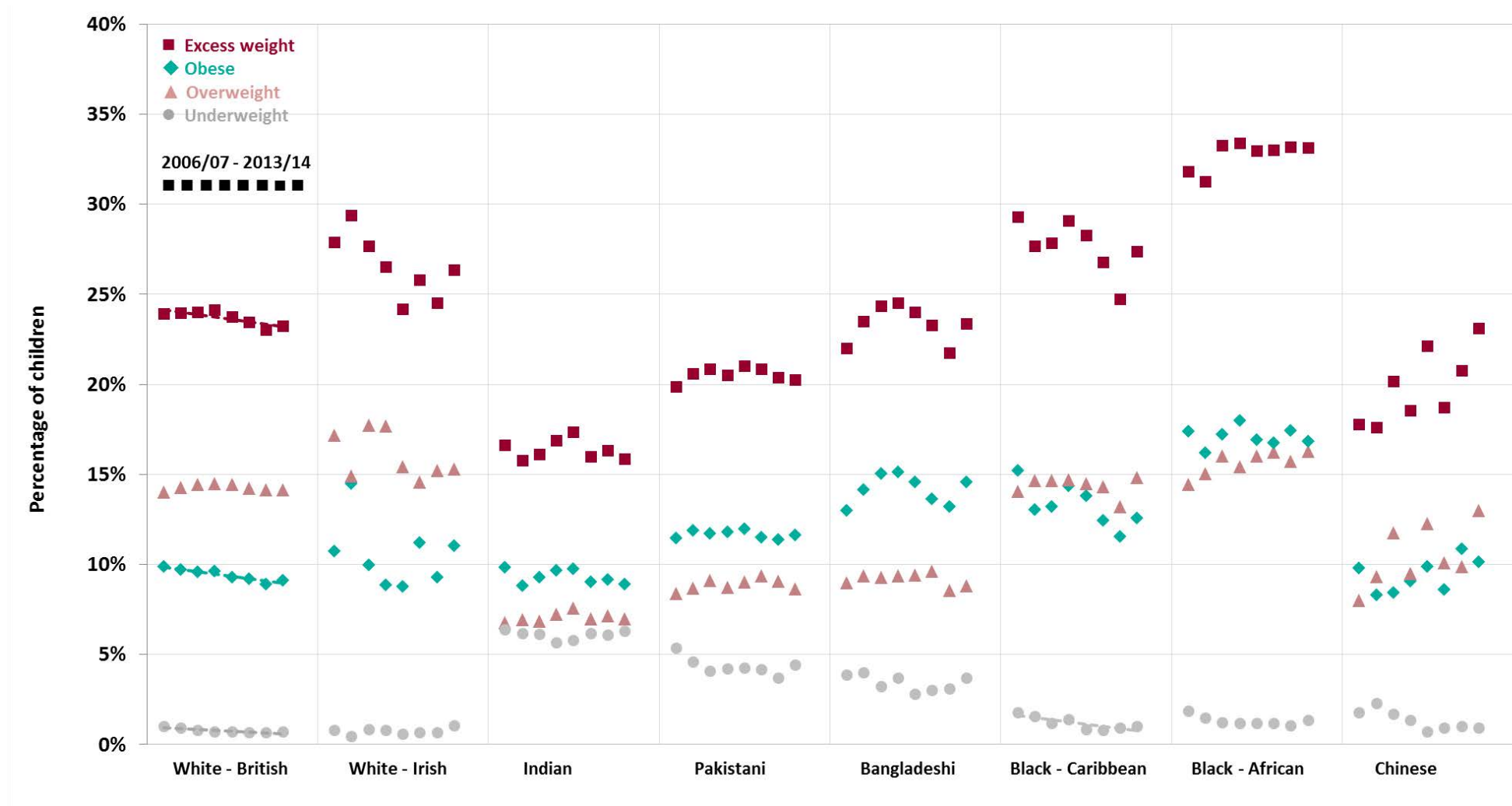


Figure 4b. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Reception girls. Significant upward or downward linear trends are shown with a dashed line

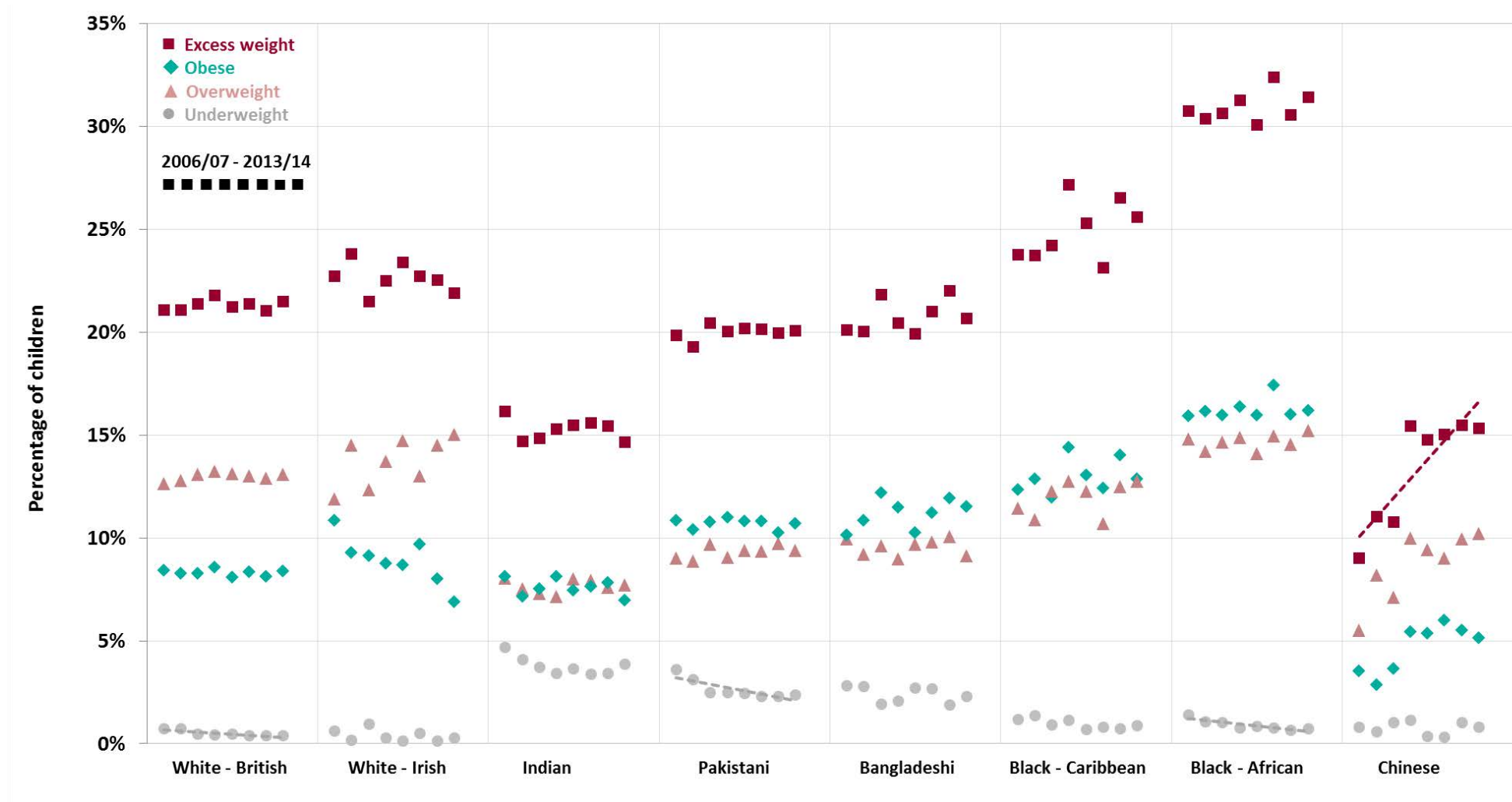


Figure 4c. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Year 6 boys. Significant upward or downward linear trends are shown with a dashed line

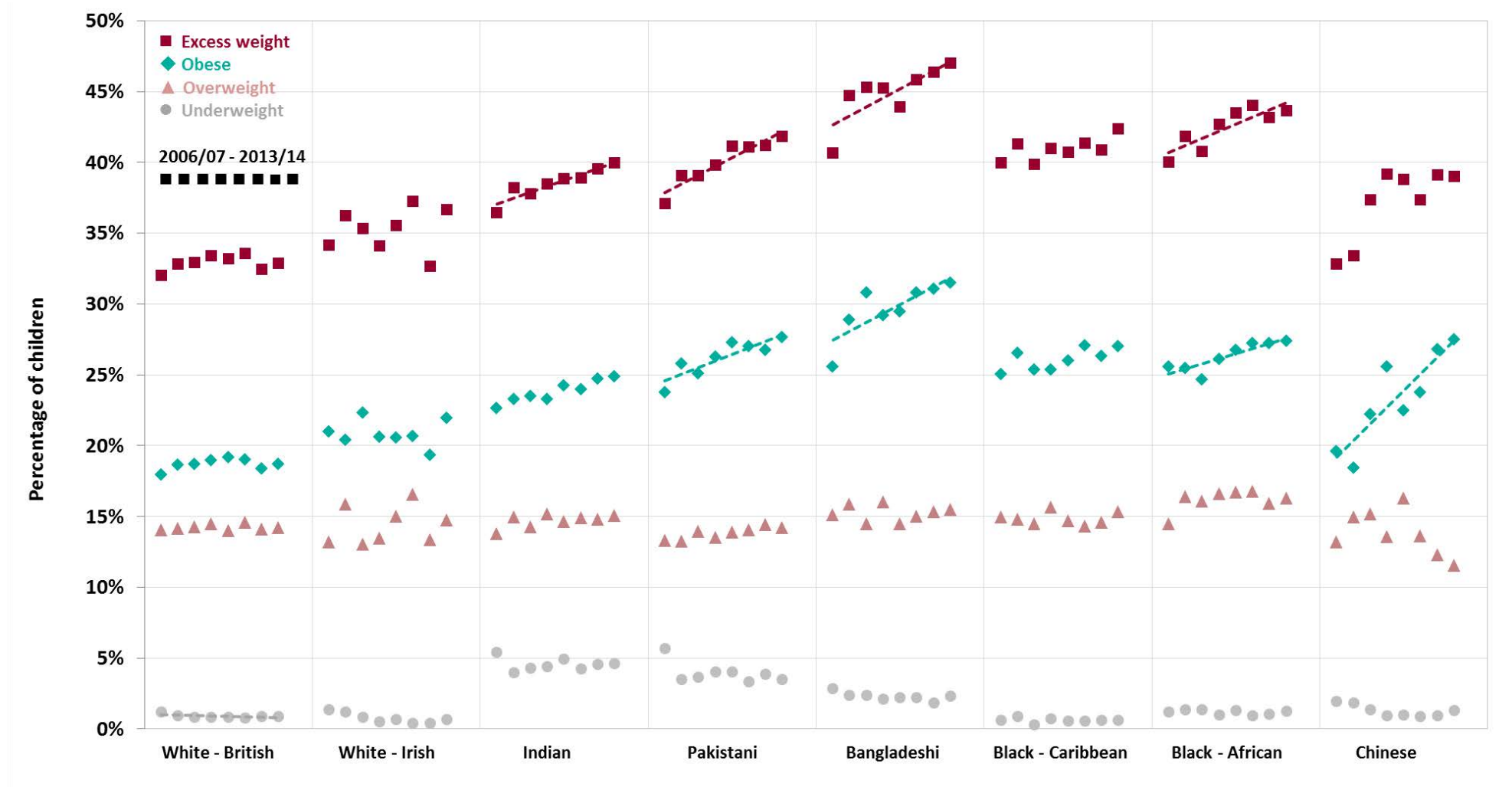
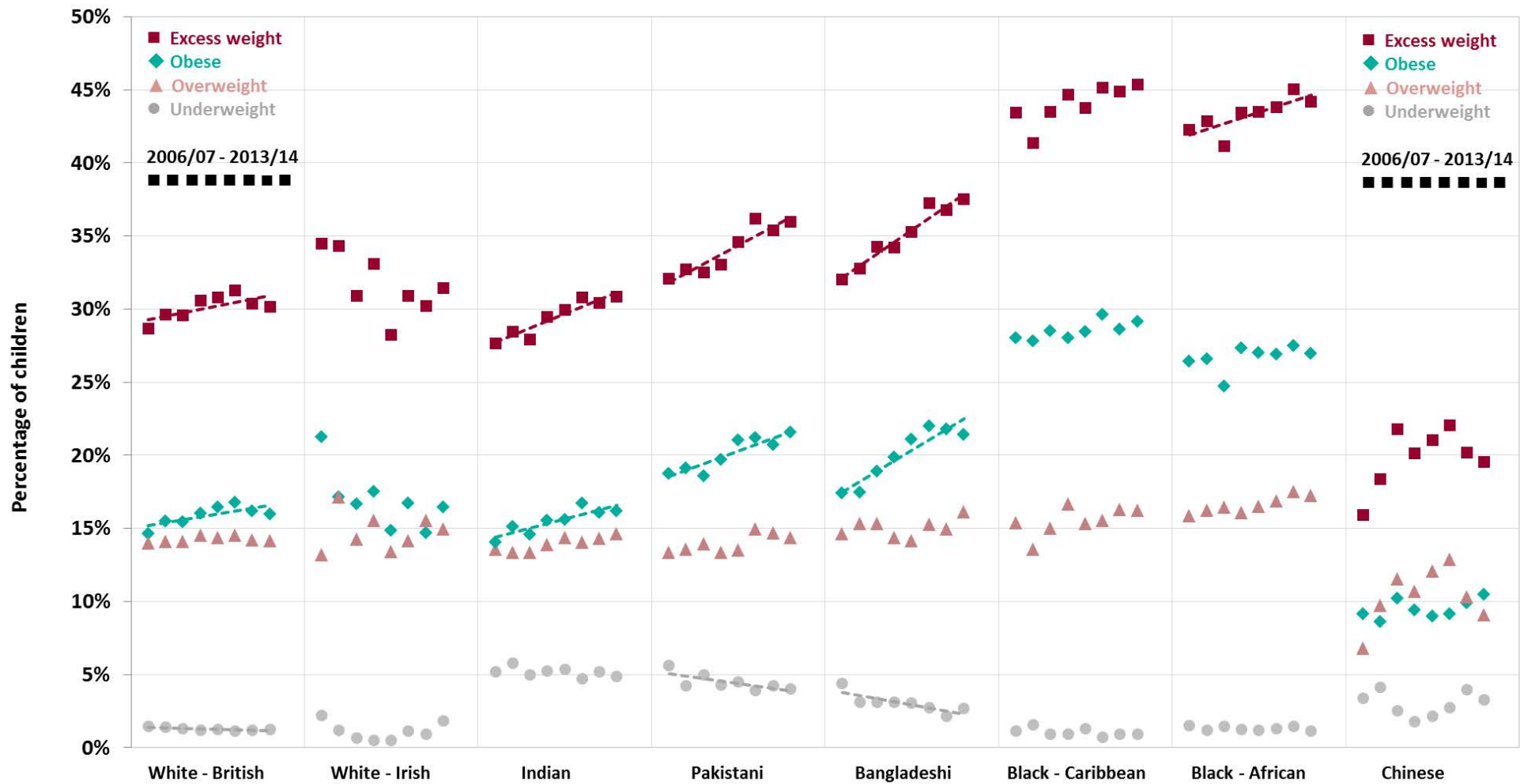


Figure 4d. Prevalence of obesity, excess weight, overweight and underweight by year of measurement and selected ethnicity: Year 6 girls. Significant upward or downward linear trends are shown with a dashed line



7. Changes in the distribution of children's BMI

Changes in mean BMI z score

BMI z score,^f rather than actual BMI values has been used to examine change in mean BMI over time. This is in order to standardise for changes in the average age of measurement of children in Reception and Year 6 in different measurement years. Figures 5a and 5b show trends in mean BMI z score by weight category, age and sex for all years of NCMP measurement.

Figure 5a shows a broadly constant mean BMI z score over time in the overweight category for both boys and girls in Reception, and for boys in Year 6. Small significant increases in mean z score are apparent over time for obesity and excess weight in Year 6 boys and girls, and for overweight in Year 6 girls. Small nonsignificant decreases in mean BMI z score over time are seen for obesity and excess weight in Reception, for both boys and girls.

Figure 5b shows that mean BMI z score is generally increasing over time in the underweight category for each year group and sex combination, but that this trend is only significant for Reception girls and Reception boys.

^f 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.

Figure 5a. Mean BMI z score by weight category, year of measurement, school year, and sex. NCMP 2006/07 to 2013/14. Significant upward or downward linear trends are shown with a dashed line

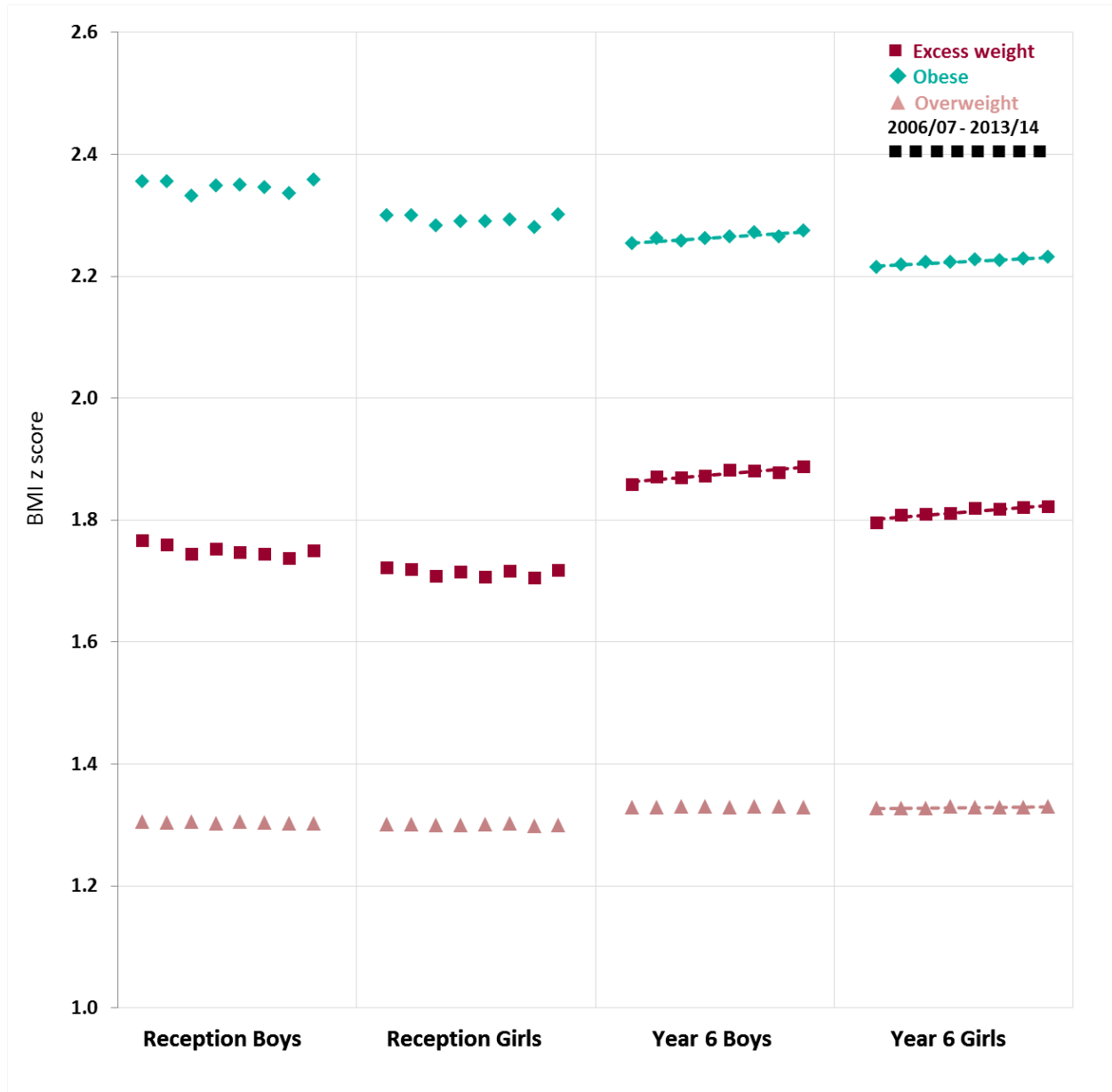
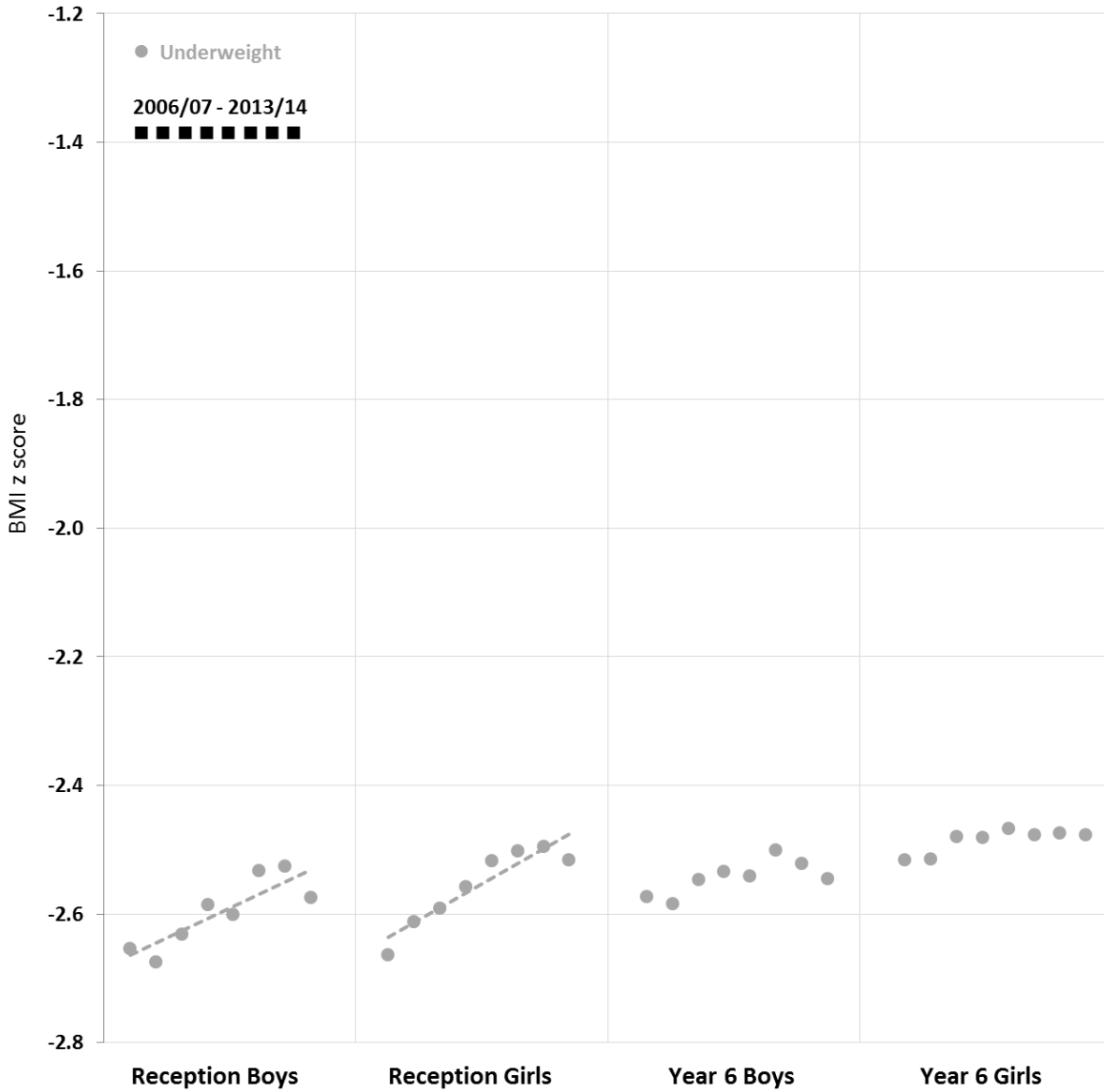


Figure 5b. Mean BMI z score by underweight category, year of measurement, school year, and sex. NCMP 2006/07 to 2013/14. Significant upward or downward linear trends are shown with a dashed line



8. Discussion and conclusions

Over the 2006/07 to 2013/14 period covered by the NCMP, obesity prevalence shows a significant downward linear trend only in Reception boys. Obesity prevalence in Reception girls is broadly stable over the period and does not show a significant increase or decrease, however significant increases in obesity prevalence over the period are seen in Year 6 boys and girls. The fastest rate of increase is found in Year 6 girls. Trends in excess weight prevalence follow the same pattern, again with the fastest rate of increase in Year 6 girls. Overweight prevalence is stable in Reception girls and Year 6 boys, but shows a significant downward trend in Reception boys and a significant upward trend in Year 6 girls. Only underweight prevalence shows a significant downward trend in all year and sex groups.

In addition to the general increase in obesity and excess weight prevalence in Year 6, increases seen in mean BMI z value indicate that the children in these weight categories are also on average getting heavier (given their height) over time.

Analysis by IMD quintile highlights prevalence trends which generally reflect the overall trends in each weight category, but with slightly different rates of change in each quintile. These indicate a widening inequality gap in the overweight, obesity and excess weight categories for all four age and sex groups. For example, in Reception boys, although all IMD quintiles show on average a decline in excess weight prevalence over time, this decline is only significant for quintiles 2 to 5, and not significant for the most deprived quintile where the downward trend is smaller. The average per year downward trend in excess weight prevalence in Reception boys in quintile 5 (least deprived) is moreover greater per year than that seen in any other quintile.

Similar patterns by deprivation quintile occur in the other age and sex groups for overweight, obesity and excess weight. Notably in Year 6 boys and girls there is a significant upward trend in excess weight and obesity in quintiles 1 (most deprived), 2 and 3. In Year 6 girls this upward trend in quintiles 1, 2 and 3 is reflected also in the overweight category. Where prevalence is declining overall, it is generally declining at a slower rate (or even increasing) in the most deprived quintiles compared to the least deprived; and where prevalence is increasing overall it is increasing at a faster rate in the most deprived quintiles.

An exception to the general trends by deprivation quintile noted above is found in the underweight category. Here the overall prevalence figures for all four age and sex groups show a significant decreasing trend over time, but the magnitude of this decline does not exhibit a consistent relationship with IMD quintile. For example in Year 6 girls the largest average per year decline in underweight prevalence is seen in quintile 1 (most deprived), whilst in Year 6 boys it is in quintile 2. In Reception girls the largest

decline per year is in quintile 5 (least deprived), but the next largest decline is in the most deprived quintile 1.

Trends in prevalence of obesity, excess weight, overweight and underweight by ethnic group are potentially subject to some bias both because of the variation in NCMP ethnic category coding over time, and because (even in recent years) informative ethnicity coding is some way below 100%, currently standing at around 80–85%. Those ethnic groups which show significant trends in prevalence over time are those with larger sample sizes and/or trends of higher magnitude. The trends seen in the White British ethnic group reflect the overall results because of the high proportion of this group in the NCMP as a whole.

Underweight prevalence is decreasing generally in many ethnic groups. Significant downward trends are seen mostly in girls – among Pakistani girls in both Reception and Year 6, Black African girls in Reception and Bangladeshi girls in Year 6 as well as among White British girls in both Reception and Year 6. The downward trends in the black and minority ethnic girls are steeper than those seen for the corresponding White British girls, although this may be partly because, given that underweight prevalence is already quite low, they started from a higher prevalence initially. Among boys the decreasing trend is significant only in White British boys in Reception and Year 6 and Black Caribbean boys in Reception.

Pakistani and Bangladeshi Year 6 boys and girls in particular have on average higher rates of increase per year for excess weight and obesity prevalence than White British children. Note that ethnicity is partially confounded with deprivation and as this has not been corrected for the patterns seen for the various ethnic groups will reflect deprivation to some extent.

Our analyses have assumed that trends in weight category prevalence over time are linear. Figures 2–5 indicate that this appears to be a reasonable assumption in most cases, but this is nonetheless a limitation of our approach. It will be possible to more robustly model nonlinear trends in future as more years of NCMP data become available.

In summary, only boys in Reception show overall signs of a decline in obesity, excess weight and overweight prevalence. In Reception girls there are overall signs of a levelling off. However there are no such positive signs in Year 6 where significant upward trends can be seen in obesity and excess weight prevalence among boys and girls; and also in overweight prevalence among girls. The steepest rates of increase in excess weight and obesity prevalence are found in Year 6 girls.

In addition, both in Reception and Year 6 inequalities in obesity, excess weight and overweight prevalence are widening between White British and other ethnic groups,

and between children resident in the most and least deprived quintiles of the population. When this is seen in the context of overall obesity prevalence doubling between Reception and Year 6⁹ the scale of the public health challenge that child obesity represents is evident.

⁹ Around 9% of children in Reception are classified as obese compared to around 19% of children in Year 6 (NCMP 13/14)

Appendix 1: methods

This report is based on the NCMP datasets for the eight years 2006/07, 2007/08, 2008/09, 2009/10, 2010/11, 2011/12, 2012/13 and 2013/14.

Only data for pupils attending state-maintained schools have 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 remaining after data cleaning by the HSCIC for the eight years of measurement is shown in Figure 1a, broken down by school year and sex.

Children with a BMI greater than or equal to the 95th centile of the British 1990 growth reference (UK90)⁶ for BMI have been classified as obese and those with a BMI greater than or equal to the 85th centile and less than the 95th centile have been classed as overweight. This definition is the most commonly used for child obesity prevalence figures in England, and is consistent with the definition used in the HSE and NCMP reports published by the HSCIC. In line with the HSCIC's NCMP analysis the 2nd centile of the UK90 reference has been used to define underweight. Excess weight is a term used to mean 'overweight plus obese'.

Average trends over time have been determined using linear regression. The significance of trends has been assessed using logistic regression with a Bonferroni correction applied to correct for multiple testing.

All analysis was performed in R.¹²

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Reader information

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Authors	Vicky Copley and Catherine Bray, Public Health England
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Electronic location	www.noo.org.uk
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