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Reassessing ethnic differences in mean body mass index and their changes between 2007 and 2013 in English children

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Contributors

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Competing interests:

We declare that we have no conflicts of interest.

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What is already known about this subject?

- Current assessments of childhood overweight and obesity are based on body mass index (BMI) which has been shown to provide biased assessments for children of South Asian and Black African origins.
- Reported patterns and trends of childhood body fatness, overweight and obesity in these ethnic minority groups in English national survey data are likely to be misleading.

What does this study add?

- This study is the first to apply ethnic-specific BMI adjustments to recent national survey data in English children to reassess trends in BMI levels and overweight-obesity prevalences.
- The use of ethnic-specific BMI adjustments alters the patterns observed, compared to those using unadjusted BMI, in South Asians and Black African children.
- Following adjustment, English children of South Asian origin had extremely high adjusted BMI and overweight-obesity prevalences compared to Whites, which increased over time. Children of Black African origins, with the exception of older girls, had lower (but increasing) adjusted BMI levels and overweight-obesity prevalences compared to Whites.

Reassessing patterns and time trends in body mass index in Black African and South Asian children between 2007 and 2013 in the English National Child Measurement Programme

Abstract

Objective

National body fatness (BF) data for English South Asian and Black children use body mass index (BMI), which provides inaccurate ethnic comparisons. We reassessed BF levels and time trends in the English National Child Measurement Programme (NCMP) between 2007 and 2013, using ethnic-specific adjusted BMI (aBMI) for South Asians and Blacks.

Methods

Analyses were based on 3,195,323 children aged 4-5y and 2,962,673 children aged 10-11y. aBMI values for South Asians and Blacks (relating to BF as in Whites) were derived independently. Mean aBMI levels and five-year (5y) aBMI changes were obtained using linear regression.

Results

In 2007-08, mean aBMIs in 10-11y (boys,girls) were higher in South Asians (20.1, 19.9kg/m²) and Black girls but not Black boys (18.4, 19.2kg/m²) when compared with Whites (18.6, 19.0kg/m²; all P<0.001). Mean 5y changes (boys,girls) were higher in South Asians (0.16, 0.32kg/m²/5y; both P<0.001) and Black boys but not girls (0.13, 0.15kg/m²/5y; P=0.01, P=0.41) compared with Whites (0.02, 0.11kg/m²/5y). Ethnic differences at 4-5y were similar. Unadjusted BMI showed similar 5y changes but different mean BMI patterns.

Conclusions

BF levels were higher in South Asians than in other groups in 2007 and diverged from Whites until 2013, a pattern not apparent from unadjusted BMI data.

INTRODUCTION

High levels of body fatness (BF), overweight and obesity in children represent a major global public health challenge (1). In England, overweight and obesity together (overweight-obesity), defined using body mass index (BMI; kg/m²), affect approximately a third of children aged 2-15 years (2). Excessive weight in childhood is associated with higher short-term health risks including poor psychological health and the development of asthma (3) as well as increased longer-term risks of type 2 diabetes (T2D), cardiovascular disease (CVD) and adult overweight-obesity (4-6). High BF in South Asian and Black children in England is of particular concern, since both ethnic groups have high risks of T2D and CVD in adulthood (7-10) compared with Whites; these risks have their origins in childhood (11, 12). However, reliable evidence on patterns and trends over time of childhood BF in these ethnic groups is limited. Key national data sources, notably the National Child Measurement Programme (NCMP), have used BMI to categorise overweight and obesity, using identical BMI thresholds in all ethnic groups that are based on an exclusively White reference population (13, 14). However, the associations between childhood BMI and BF differ by ethnic group; BMI systematically underestimates BF in South Asian children and overestimates BF in Black children (15, 16). We have recently developed ethnic-specific BMI adjustments, which provide adjusted BMI values (aBMI) for English South Asian and Black children and have the same relation to total BF as in White children, in order to provide more valid comparisons of BF differences between ethnic groups (17). In this study, we have used this approach to reassess patterns and changes over time in childhood BF, overweight and obesity in South Asian, Black and White children using NCMP data between 2007-08 and 2012-13.

METHODS

National Child Measurement Programme (NCMP)

Study population and data collection

The NCMP is an annual survey of the weights and heights of English primary school children in Reception and Year 6 classes. At the time of the NCMP examination, Reception children are aged

between 4.0 and 5.9 years and Year 6 children between 10.0 and 11.9 years. The survey commenced in 2006-07 and is currently directed by Public Health England; data collection is carried out by Local Authority (LA) public health departments (13). All state primary schools in England (n ~ 17,000) are invited to participate; within participating schools, all relevant pupils are invited to participate on an opt-out basis. LA public health departments recruit, train and supervise assessment teams to measure weight and height. Public Health England provides detailed instructions on instrument choices and measurement techniques. Weight is measured to the nearest 0.1kg, and height with the child's heels together and the head in the Frankfurt plane to the nearest 0.1cm. BMI is calculated as weight/height². School record information on name, date of birth, sex and parentally-defined ethnic group is also collected. Data are entered using the NCMP electronic system and collated by HSCIC.

Ethnic Group

Ethnic groups were based on school records or the child's health records (13) and defined using the National Health Service classification (18). For the present report, children identified as 'White British', 'White Irish' and 'any other White background' were grouped as 'White'. Children identified as 'Black African', 'Black Caribbean' or 'any other Black background' were of presumed African origin and were grouped together as 'Black'. Children of 'Indian', 'Pakistani' or 'Bangladeshi' origin were grouped together as 'South Asian'. Children of 'Chinese' or 'Asian other' origins were grouped as 'Other Asian'. Children of 'any other ethnic background' and 'mixed ethnicity' were grouped as 'Other Ethnicity'. The main ethnic groups for the purpose of this report were Whites, Blacks and South Asians. Ethnic subgroups (Black African, Black Caribbean, Black Other, Indians, Pakistani and Bangladeshi) were also explored in supplementary analyses.

Adjusted BMI values for Black and South Asian children

Ethnic-specific BMI adjustments for Black and South Asian children aged 4-12 years were derived using pooled data from four previous UK based studies (N=1,725 children) which used the deuterium

dilution reference method to make accurate body fat assessments in Black, South Asian and White children; full details are provided in a previous paper (17). BMI adjustments were derived using regression models which ensured that adjusted BMI reflected the same level of BF in the same way as in Whites (17). To obtain robust BMI adjustments across the full age range studied, age-group was fitted in 3-year age-groups (4-6y, 7-9y and 10-12y). BMI was regressed on height-independent fat mass index [FMI] (kg/m^5) fitting ethnic group and age-group in boys and girls separately. All two-way interactions were tested and included (where statistically significant) using a stepwise forwards approach (17). For South Asian children, single sex-specific positive BMI adjustments of +1.12 (95% CI: 0.83, 1.41) and +1.07 (95% CI: 0.8, 1.39) for boys and girls respectively were applicable for all age-groups and FMI levels. For Black children, BMI adjustments were all negative but more complex, varying by age-group and FMI levels because there were statistically significant interactions between black African ethnicity and FMI ($P=0.004$ boys; $P=0.003$ girls) and also between FMI and age group ($P<0.0001$ for boys and girls). Adjustments varied between -0.13 (boys) and -0.12 (girls) in 10-12 year-olds with low unadjusted BMI values and -5.52 (boys) and -5.06 (girls) in 4-6 year-olds with high unadjusted BMI values (17).

Data exclusions

Analyses were restricted to the school years between 2007-08 (the first year in which ethnic group was coded in at least two-thirds of children) and 2012-13 (the most recent year for which data were available to us). During that period, 6,173,500 children participated in NCMP (3,204,915 aged 4-5 years, 2,968,585 aged 10-11 years). We excluded 15,504 children (0.25%) from analyses, including those measured in Local Authority areas with data quality concerns ($n = 12,726$), those outside the study age-range ($n = 2,773$) and those with extreme outlier values of weight, height and BMI obtained from box and whisker plots ($n = 5$). Hence, 6,157,996 children (3,195,323 aged 4-5 years and 2,962,673 aged 10-11 years) were included in further analyses.

Statistical analysis:

Average aBMI levels were determined for the first study year (2007-08) by regressing aBMI, stratified by age-sex groups, on ethnic group, age and the two-way interaction between year (categorical) and ethnic group. Differences in aBMI levels between ethnic groups (compared with Whites) were formally tested using the Wald test for differences. This process was repeated using ethnic subgroups to test for heterogeneity within the Black and South Asian ethnic groups. To assess whether changes over time in aBMI in each ethnic group could be treated as linear, mean aBMI and the corresponding 95% CIs were plotted for each year and the overall changes visually assessed for each age-sex and ethnic group. No appreciable departure from linearity was observed from the graphs therefore linear regression models, stratified by age-sex groups, were used to investigate average changes over time in aBMI in each ethnic group over the six year period. aBMI was regressed against ethnic group, age and the two-way interaction between year and ethnic group, with year fitted as a continuous variable. We calculated the average change in aBMI over a 5-year period and present this as our summary measure of change. The statistical significance of the changes in each ethnic group was determined using the Wald test at the 5% significance level. Differences in the change in aBMI over time between ethnic groups (compared with Whites) were formally tested using the Wald test. In order to test for heterogeneity within ethnic subgroups, regression models were repeated replacing the main ethnic group variable (e.g. white, black, South Asian) with an ethnic sub-group variable (e.g. Indian, Pakistani, Bangladeshi or Black African, Black Caribbean, Black Other). Regression coefficients for the ethnic subgroups were tested for heterogeneity, using Wald tests at the 5% significance level. The prevalences of overweight-obesity (based on aBMI values and using the UK90 thresholds (14)) were calculated for the 2007-08 year for each age-sex group and for each ethnic group. Logistic regression models were used to investigate the average 5-year changes in overweight-obesity prevalence in each ethnic group over the six year period. Analyses of levels and 5-year changes were repeated using unadjusted BMI for comparison with aBMI results.

RESULTS:

A total of 3,195,323 children aged 4-5 years (51% male) and 2,962,673 children aged 10-11 years (51% male) contributed to the analyses (Supplementary Table 1). The proportion of participants with unknown ethnic origin declined with improvements in the completeness of ethnic group recording between 2007-08 and 2012-13; the proportions of children of White, Black African and Pakistani origin showed increases over the same period.

Mean aBMI levels in 2007-08 and 5-year changes in aBMI between 2007-08 and 2012-13 for White, South Asian and Black children

Mean aBMI levels in the first year of the study period (2007-08) are summarized for each ethnic group in Table 1 for each age-sex group; 5-year changes in aBMI between 2007-08 and 2012-13 (per 5 years) are presented in Table 2. Mean aBMI levels for each ethnic group in each of the six school years are presented graphically for each age-sex group in Figures 1&2. Mean aBMI levels in 2007-08 and 5-year changes in aBMI between 2007-08 and 2012-13 for each ethnic subgroup are summarised in Tables 1 and 2 respectively and also graphically in Supplementary Figures 1 and 2.

4-5 year-olds: In 2007-08, mean aBMI levels in White boys and girls aged 4-5 years were 16.2. In comparison with Whites, mean aBMI levels were higher in South Asians (boys: 16.9 ; girls: 16.8) and lower in Black children (boys and girls: 15.3) (all $p < 0.001$) (Table 1). There was evidence of heterogeneity in aBMI levels amongst the three South Asian subgroups (boys and girls both $p < 0.001$), with the highest aBMI levels among Bangladeshis and the lowest among Indians. There was also evidence of heterogeneity among the three Black ethnic subgroups (boys and girls both $p < 0.001$) with the highest aBMI levels among Africans. Five-year changes in mean aBMI between 2007-08 and 2012-13 were negative for White boys but null for White girls (boys: -0.04 ; girls 0.00) ($p < 0.001$, $p = 0.56$ respectively). Corresponding five-year changes in aBMI in both South Asian and Black girls were positive (0.06 and 0.04 respectively), more so than in Whites ($p = 0.002$, $p = 0.005$ respectively) (Table 2). In both South Asian and Black boys, changes were close to null but were more positive than in Whites ($p = 0.002$, $p = 0.025$ respectively). 5-year changes in aBMI within the ethnic subgroups (Table 2

& Supplementary Figures 1&2) showed no evidence of heterogeneity except among 4-5 year old South Asian boys ($p=0.02$), in whom changes in Bangladeshis appeared negative (indicating a decline in aBMI) compared with Indians and Pakistanis.

10-11 year-olds: In 2007-08, mean aBMI levels in White boys and girls aged 10-11 years were 18.6 and 19.0 respectively. In comparison with Whites, mean aBMI levels were higher in South Asian children (boys: 20.1 ; girls: 19.9) and in Black girls (19.2) but lower in Black boys (18.4) (all $p < 0.001$) (Table 1). There was evidence of heterogeneity in aBMI levels amongst the three South Asian subgroups (boys and girls both: $p<0.001$), with higher levels among Bangladeshis and Pakistanis than Indians, but not among Black subgroups. Five-year changes in mean aBMI between 2007-08 and 2012-13 were strongly positive for White girls but null for boys (boys: 0.02 kg/m^2 per 5-years, girls: 0.11 kg/m^2 per 5-years); ($p = 0.06$, $p<0.001$ respectively) (Table 2). In comparison with Whites, corresponding five-year changes in aBMI in South Asian children were strongly positive, especially in girls (boys: 0.16 kg/m^2 per 5-years: girls: 0.32 kg/m^2 per 5-years) (both $p<0.001$). Black children also had positive changes (boys: 0.13 kg/m^2 per 5-years: girls: 0.15 kg/m^2 per 5-years) (Table 2), stronger than those in Whites for boys but not girls ($p = 0.008$, $p = 0.41$ respectively). Five-year changes in aBMI within the ethnic subgroups (Table 2 & Supplementary Figures 1&2) showed no evidence of heterogeneity except among 4-5 year old South Asian boys, in whom Five-year changes in Bangladeshis appeared more negative than those in Indians and Pakistanis.

Overweight-Obesity prevalence in 2007-08 and 5-year changes between 2007-08 and 2012-13 for White, South Asian and Black children

Patterns and changes in overweight-obesity prevalence based on aBMI were very consistent with patterns and changes in mean aBMI. The UK90 thresholds were used to categorise children by overweight and obesity status.

4-5 year-olds: The prevalences of overweight-obesity in White children for 2007-08 were 24.0% and 21.1% for boys and girls respectively (Supplementary Table 2). Corresponding prevalences were

appreciably higher in South Asians (boys: 39.3%, girls: 33.7%) and lower in Black children (boys: 10.2%, girls: 12.2%) than in Whites (all $p < 0.001$). The five-year changes in overweight-obesity prevalence were negative in White boys and less strongly negative in White girls. South Asian girls however had a strong positive trend, while South Asian boys had a weak negative trend; both differed appreciably from Whites (Supplementary Table 3). Changes in Black children did not differ from those in Whites.

10-11 year-olds: The prevalences of overweight-obesity in White children for 2007-08 were 32.8% and 29.6% for boys and girls respectively (Supplementary Table 2). Corresponding prevalences were higher in South Asians (boys: 49.6%, girls: 40.1%) (both $p < 0.001$) and in Black girls but not Black boys (boys: 31.5%, girls: 33.4%) ($p = 0.12$, $p < 0.001$). The five-year changes in overweight-obesity prevalence between 2007-08 and 2012-13 were strongly positive in White girls but close to null in White boys. Both South Asian boys and girls showed positive changes in overweight-obesity prevalence, greater in girls, which were stronger than those in Whites (Supplementary Table 3). Black children also showed positive changes in overweight-obesity prevalence which for boys were stronger than in Whites.

Mean unadjusted BMI levels in 2007-08 and 5-year changes in aBMI between 2007-08 and 2012-13 for White, South Asian and Black children

Analyses of mean BMI levels and 5-year changes were repeated using unadjusted BMI (Supplementary Tables 4&5). Changes in unadjusted BMI between 2007-08 and 2012-13 in Whites, South Asians and Blacks were not materially different from those using aBMI. However, differences were found in the patterns of mean BMI levels in 2007-08 in different ethnic groups from those observed with aBMI. In particular, Black children had the highest mean BMI levels in all age-sex groups. At 4-5 years, South Asian children had the lowest mean BMI levels while at 10-11 years, South Asian boys had higher and South Asian girls lower mean BMI than White children, though these mean BMI levels were lower compared to Black children.

DISCUSSION

We used a novel approach using aBMI values that related similarly to BF in Whites, South Asians and Blacks (17), to better assess patterns and changes in average aBMI levels and overweight-obesity prevalences in these ethnic groups in NCMP between 2007-08 and 2012-13. The results presented in this report based on aBMI emphasize that the burdens of high BMI levels (and overweight-obesity prevalences) among UK South Asian children were already considerably higher than those of both White and Black children in 2007-08 and increased further between 2007-08 and 2012-13, particularly among 10-11 year-olds. These patterns were not observed in unadjusted data, which would have given the impression that, though average BMI levels were increasing in the majority of South Asian children, but were still lower (with the exception of older boys) than those in Whites.

Consistency with previous reports

The higher aBMI levels (and in turn overweight-obesity prevalences) among South Asian children in 2007-08, compared to Whites, at both 4-5 and 10-11 years are consistent with the results of other comparative studies which used more direct measures of BF than BMI, including bioimpedance and dual-energy X-ray absorptiometry (DXA) and observed higher BF in South Asians than in Whites (15, 16, 19, 20). The lower aBMI levels observed in all Black children (except older girls) in 2007-08 are also consistent with the results of earlier studies using more direct BF measures which all showed lower BF in Blacks than in Whites (15, 16, 20). In the present study, five-year changes between 2007-08 and 2012-13 were similar for adjusted and unadjusted BMI level; these changes are broadly consistent with those in a previous NCMP report quantifying ethnic trends in obesity prevalence over a similar period (21). Although that earlier report grouped all Asian children together (rather than focussing on South Asian children), it concluded that among 4-5 year-olds a weak negative trend was present among Whites, with a positive trend in Asian girls. It also reported positive trends in obesity prevalence over time among 10-11 year-old White, Black and Asian children, which are also consistent with the present report. Our findings are also at least partly consistent with the results of a report examining ethnic variations in overweight and obesity over time in the Health Survey for England

between 1998 and 2009 (22), which showed that in overweight and obesity prevalences, though declining in Whites were not doing so among ethnic minority groups, with some (particularly Black Caribbean children in that report) still tending to increase.

Strengths and limitations

The NCMP is a large-scale, national survey with standardized data collection and quality control procedures. It also benefits from high rates of participation both by state schools and by individuals. In all, ~93% of all English children of primary school age (4-11 years) attend state primary schools, making these schools highly representative of all primary school age children. Although the remaining children, who attend private primary schools, tend to be more socioeconomically advantaged than those who do not, they account for a small proportion of all children (~7%). Furthermore, an average of 91% of all eligible children in state primary schools took part in the survey over the six-year period. No information is collected on the small proportion of children who opt out of the survey and therefore the characteristics of these individuals cannot be compared to those who took part in the survey. However, only if the ethnic differences in non-participant children differed from those in participants (which appears unlikely) would this materially affect our results. We were able to use six school years of data from 2007-08 through to 2012-13, with ethnic group coding completed for at least 67% of participants in 2007-08, rising to 86% by 2012-13. The change in coding rate during the study raises the possibility that differential selection biases may have operated over the analysis period. However, sensitivity analyses excluding the first year (2007-08) had no material effect on the results and analyses examining changes in the earlier and later years separately did not show large differences. Patterns observed within ethnic subgroups broadly follow the patterns seen within the main ethnic groups. The BMI adjustments used were derived in an independent population using the reference deuterium dilution method (23) to obtain fat mass estimates based on a pooled resource of 1725 Black, South Asian and White children drawn from four separate studies. The use of this pooled data resource in 4-12 year-olds to derive adjustments in three 3-year age-groups provided robust

estimates of BMI adjustment factors across the age range studied. Furthermore, the distributions of BMI within the South Asian, Black and White ethnic groups in the studies used to derive BMI adjustments were very similar to those of the children in the NCMP populations used in this report, suggesting that their application to NCMP data was reasonable. Adjustments were available for South Asian and Black children who accounted for 54% of ethnic minority participants across the six years of NCMP data. However, similar adjustments are not so far available for other ethnic minority groups (particularly other Asians and mixed ethnic origin groups) for whom BMI may well provide misleading indications of BF.

Implications

Our results suggest that the use of adjusted BMI values affects the assessment of BMI levels and estimates of overweight-obesity prevalence, rather than trends over time. However, the public health implications of BMI trends and levels are interdependent. Based on unadjusted data, it would have appeared that levels in South Asian children were low, but were increasing towards those of Whites. However, the adjusted results emphasize that the burdens of high aBMI levels (including overweight and obesity) among UK South Asian children were already higher than those of both White and Black children in 2007-08 and increased further between 2007-08 and 2012-13, particularly among 10-11 year-olds. This is of particular concern, given the high long-term risks of overweight-obesity, type 2 diabetes and cardiovascular disease in UK South Asians (7, 8) from childhood (11, 12). The increasing aBMI levels among South Asian children could indicate increasing levels of BF which may lead to a further increase in type 2 diabetes risk in this ethnic group. Moreover, the increasing divergence of BF between South Asian and White children could lead to an increase in the South Asian-White difference in type 2 diabetes risk. A further concern is that the elevated mean aBMI level in older Black girls, which tended to increase over the six year period between 2007-08 and 2012-13. This could strengthen the existing tendency to high overweight-obesity prevalence in young adult UK Black women (7) and reinforce the higher risks of type 2 diabetes among UK Black adults (8, 9). The size of

the BMI differences observed are sufficiently large to be of substantial public health importance. For example, older South Asian children had mean BMI values ~ 1 kg/m² or more higher than in Whites in 2007-08, increasing further by 2012-2013. Such differences, if maintained into adult life, could account for appreciably higher risks of type 2 diabetes (24) and cardiovascular disease (6, 25) among South Asians.

Conclusion

Analyses using aBMI to reassess BF levels in UK children emphasize the high and increasing burden of high BF in South Asian children, both at 4-5 years and especially at 10-11 years, and among older Black girls. Unadjusted BMI does not adequately describe these patterns and tends to underestimate BF in South Asian children and overestimate BF in Black children. These findings emphasize the particular need for early overweight-obesity prevention in South Asian children, in whom the burdens of high BF were very high.

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TABLE 1: MEAN ADJUSTED BODY MASS INDEX (KG/M²) IN EACH MAJOR ETHNIC GROUP (TOP) AND ETHNIC SUBGROUP (BOTTOM) IN 2007-08: BY AGE-GROUP AND SEX

Ethnic Group	4-5 Year Olds						10-11 Year Olds						
	Males			Females			Males			Females			
	Mean aBMI (kg/m ²)	SE	P-Value	Mean aBMI (kg/m ²)	SE	P-Value	Mean aBMI (kg/m ²)	SE	P-Value	Mean aBMI (kg/m ²)	SE	P-Value	
Whites	16.2	0.00	N/A	16.2	0.01	N/A	18.6	0.01	N/A	19.0	0.01	N/A	
Blacks	15.3	0.02	<0.001	15.3	0.02	<0.001	18.4	0.03	<0.001	19.2	0.04	<0.001	
South Asian	16.9	0.01	<0.001	16.8	0.01	<0.001	20.1	0.03	<0.001	19.9	0.03	<0.001	
Ethnic Subgroup													
Blacks	African	15.3	0.02	<0.001	15.4	0.02	<0.001	18.4	0.05	<0.001	19.2	0.05	<0.001
	Caribbean	15.2	0.03	<0.001	15.2	0.03	<0.001	18.4	0.06	<0.001	19.2	0.06	<0.001
	Other	15.2	0.04	<0.001	15.2	0.04	<0.001	18.4	0.09	0.002	19.1	0.10	0.208
S.Asians	Indian	16.7	0.02	<0.001	16.6	0.03	<0.001	19.9	0.05	<0.001	19.7	0.05	<0.001
	Pakistani	17.0	0.02	<0.001	16.9	0.02	<0.001	20.1	0.04	<0.001	20.1	0.05	<0.001
	Bangladeshi	17.2	0.03	<0.001	17.0	0.03	<0.001	20.5	0.06	<0.001	20.1	0.07	<0.001

Age adjusted means presented
P-Value for ethnic difference in aBMI from Whites

TABLE 2: MEAN FIVE-YEAR CHANGE IN ADJUSTED BODY MASS INDEX (KG/M²/5YEARS) IN EACH MAJOR ETHNIC GROUP (TOP) AND ETHNIC SUBGROUP (BOTTOM) BETWEEN 2007-08 AND 2012-13: BY AGE-GROUP AND SEX

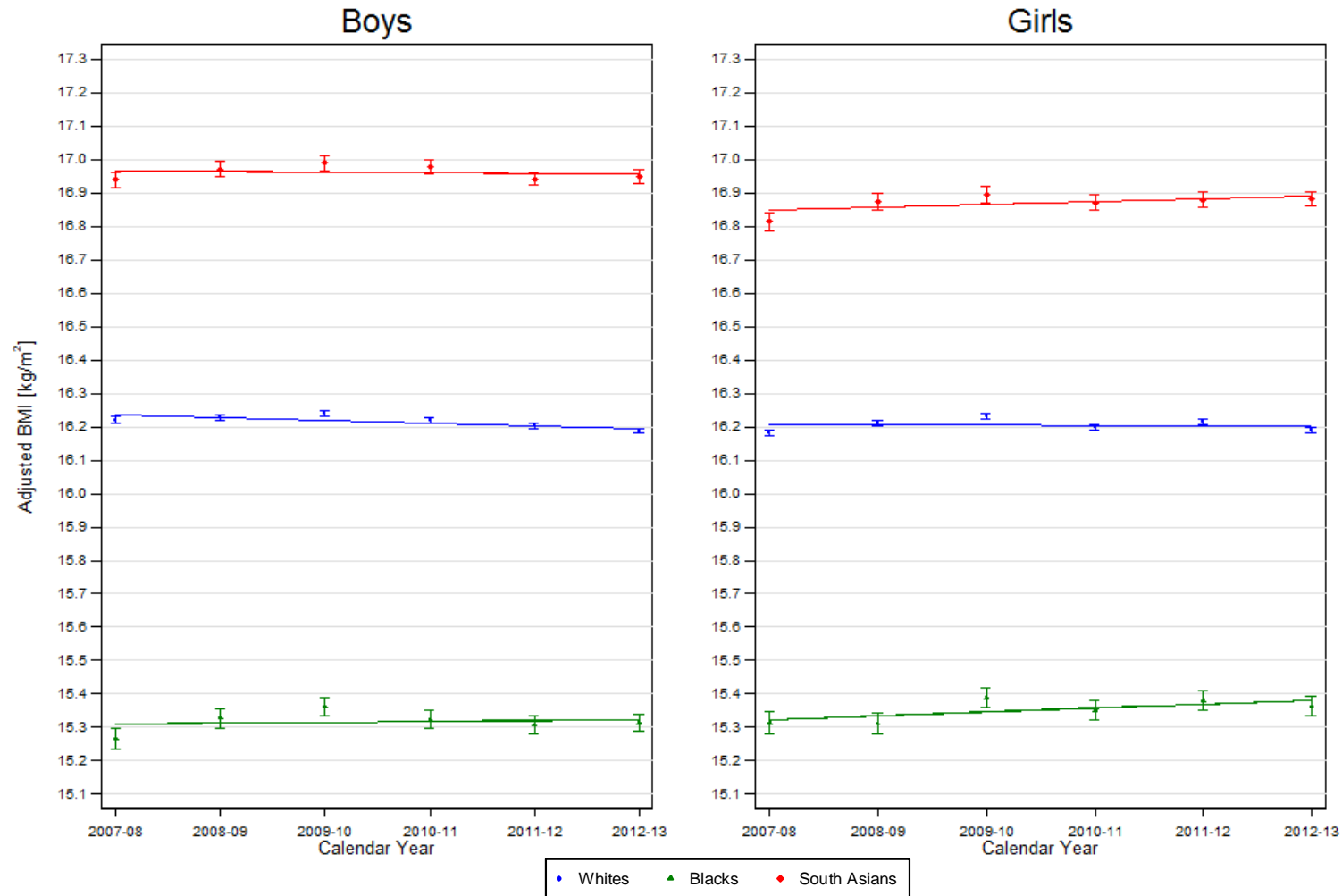
Ethnic Group	4-5 Year Olds								10-11 Year Olds								
	Males				Females				Males				Females				
	BMI Change in 5years (kg/m ²)	SE	P-Value1	P-Value2	BMI Change in 5years (kg/m ²)	SE	P-Value1	P-Value2	BMI Change in 5years (kg/m ²)	SE	P-Value1	P-Value2	BMI Change in 5years (kg/m ²)	SE	P-Value1	P-Value2	
Whites	-0.04	0.00	<0.001	N/A	0.00	0.01	0.556	N/A	0.02	0.01	0.064	N/A	0.11	0.01	<0.001	N/A	
Blacks	0.01	0.02	0.455	0.002	0.06	0.02	0.003	0.002	0.13	0.04	0.001	0.008	0.15	0.04	<0.001	0.407	
South Asian	-0.01	0.01	0.425	0.025	0.04	0.02	0.006	0.005	0.16	0.03	<0.001	<0.001	0.32	0.03	<0.001	<0.001	
Ethnic Subgroup																	
Blacks	African	0.03	0.02	0.138	<0.001	0.05	0.02	0.048	0.040	0.15	0.05	0.004	0.015	0.18	0.06	0.001	0.242
	Caribbean	-0.07	0.03	0.048	0.457	0.05	0.04	0.211	0.186	0.07	0.07	0.315	0.470	0.16	0.08	0.041	0.571
	Other	-0.01	0.04	0.764	0.456	0.03	0.05	0.550	0.507	0.17	0.10	0.072	0.114	0.12	0.10	0.231	0.946
S.Asians	Indian	0.02	0.02	0.381	0.009	0.06	0.03	0.036	0.030	0.13	0.05	0.017	0.046	0.20	0.06	<0.001	0.168
	Pakistani	0.01	0.02	0.453	0.004	0.05	0.02	0.014	0.011	0.17	0.05	<0.001	0.002	0.29	0.05	<0.001	<0.001
	Bangladeshi	-0.08	0.03	0.012	0.273	0.03	0.03	0.320	0.282	0.17	0.07	0.014	0.032	0.44	0.07	<0.001	<0.001

Mean five-year changes in aBMI were obtained from age-group and sex stratified regression models which adjusted for age (continuous)

P-Value1 denotes the p-value from testing whether the 5-year changes in aBMI is different from zero in each ethnic group

P-Value2 denotes the p-value from testing whether the 5-year changes in each ethnic group is different from the respective 5-year changes in White

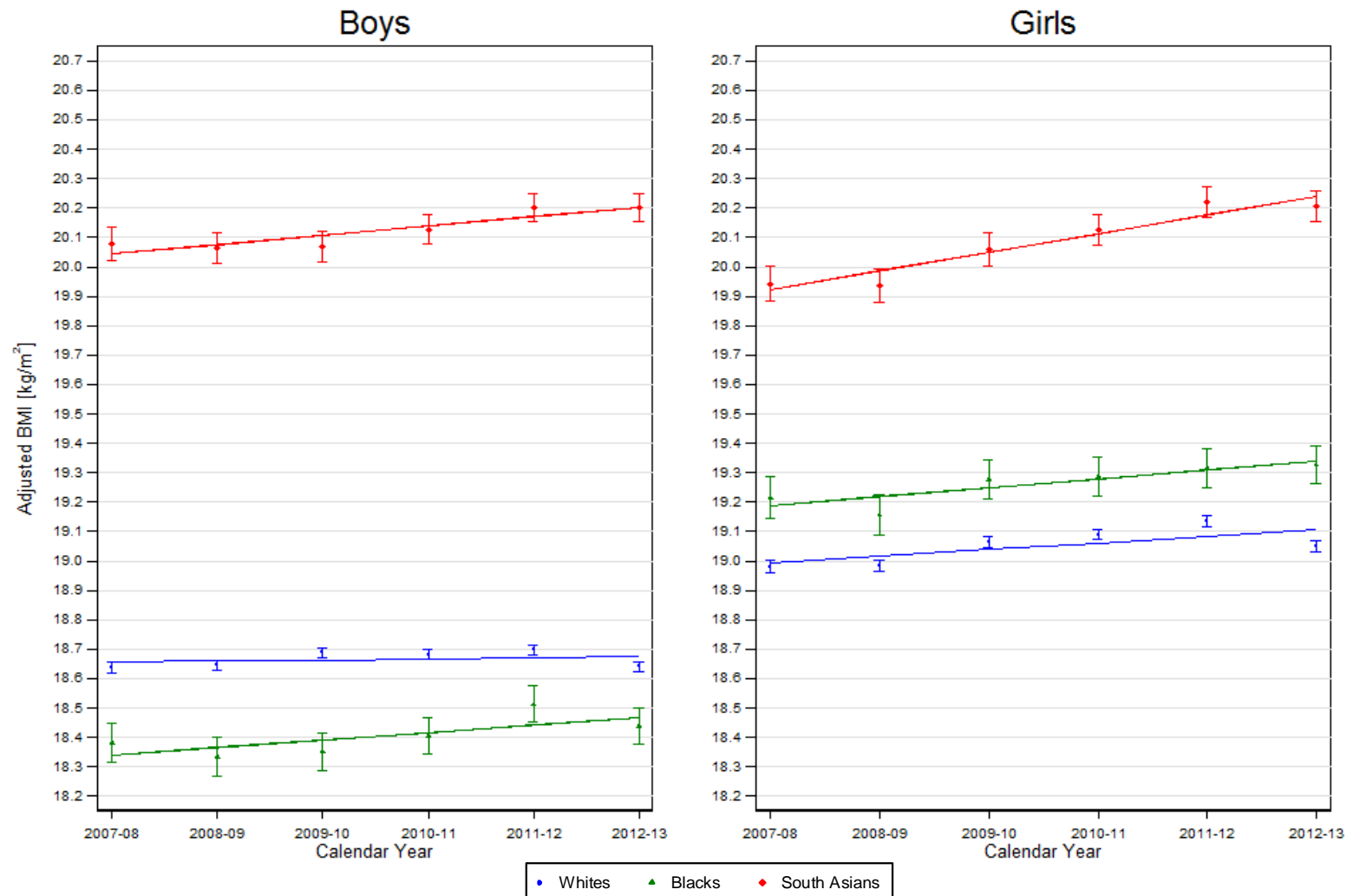
FIGURE 1: ADJUSTED BODY MASS INDEX FOR 4-5 YEAR OLD CHILDREN IN EACH MAJOR ETHNIC GROUP BETWEEN 2007-08 AND 2012-13: BY SEX



Lines represent mean annual change in BMI in each ethnic group across the six years from age-group and sex stratified regression models of aBMI against ethnic group, an interaction between ethnic group and year and age (continuous)

Points and corresponding 95% CI show the mean aBMI level (age-adjusted) for each school year

FIGURE 2: ADJUSTED BODY MASS INDEX FOR 10-11 YEAR CHILDREN IN EACH MAJOR ETHNIC GROUP BETWEEN 2007-08 AND 2012-13: BY SEX



Lines represent mean annual change in BMI in each ethnic group across the six years from age-group and sex stratified regression models of aBMI against ethnic group, an interaction between ethnic group and year and age (continuous)

Points and corresponding 95% CI show the mean aBMI level (age-adjusted) for each school year