Variation in the Socioeconomic Gradient of Obesity by Ethnicity – England's National Child Measurement Programme

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Objective: This study examined the prevalence and risk of overweight/obesity among expanded ethnicity categories within boys and girls in England and the differential influence of socioeconomic position using the 2015/2016 and the 2016/2017 cycles of the National Child Measurement Programme.

Methods: This cross-sectional and descriptive study examined surveillance data of weight status among primary school children in England. Data were pooled across data collection years, representing 1.25 million children in Reception (aged 4-5 years) and 1.1 million children in Year 6 (aged 10-11 years). Ethnicity was classified according to National Health Service definitions, and child residence was used to calculate quintiles of Income Deprivation Affecting Children Index. Measured weight status was classified using the International Obesity Task Force's definition. Logistic regression models were run for each sex and year group.

Results: Within each sex, ethnicity- and socioeconomic-specific differentials in overweight/obesity prevalence were evident. For example, among the five most populous ethnic groups in the most deprived quintile, 26.8% of White British girls in Reception had overweight/obesity compared with 20.7% of girls with Pakistani, 31.2% with Black African, 17.1% with Indian, and 22.2% with any Any Other White (e.g., White European) background.

Conclusions: Ethnicity had an independent influence on overweight/obesity risk after adjustment for socioeconomic position.

Study Importance

What is already known?

► Inequalities in childhood obesity risk relating to ethnicity and socioeconomic position have previously been observed, with the most disadvantaged socioeconomic and/or minority population typically with the highest rates of overweight/obesity.

What does this study add?

► In this nationally representative sample of children living in England, those in the most disadvantaged socioeconomic quintile typically had the highest risk for overweight and obesity, although exceptions to this rule were evident. For example, for Black African children, the socioeconomic disparity in overweight/obesity risk was largely removed, highlighting that other environmental and/or cultural factors are driving risk.

► The highest prevalence among the most deprived children in Reception was White Irish girls (32.8%) and boys (24.9%) and among Year 6 children was Black Caribbean girls (45.5%) and Bangladeshi and Any Other Asian boys (38.0%).

How might these results change the focus of clinical practice?

► Widening inequalities highlight the need to implement culturally appropriate interventions. Interventions need to be culturally sensitive and led by researchers, practitioners, and community members from within these communities.

Introduction

The current burgeoning obesity epidemic is projected to have long-term adverse consequences on health expenditure and prevalence of noncommunicable disease (particularly type 2 diabetes, cardiovascular disease, and specific cancers) globally (1). Prevention throughout childhood is of critical public health importance (2) not only to reduce the acute and chronic conditions associated during childhood (3) but also to avert adult obesity because of the high degree of persistence into adulthood (4). In England, the 2016/2017 National Child Measurement Programme (NCMP) found that 22.6% of children in Reception (first year of formal primary school education; aged 4-5 years) and 34.3% of children in Year 6 (aged 10-11 years) had overweight or obesity (5).

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Inequalities in childhood obesity risk relating to ethnic background (6,7) and socioeconomic position (SEP) (8,9) have been observed in many developed economies. In these countries, the children in the most socioeconomically disadvantaged strata or from minority ethnic groups typically have higher rates of overweight and obesity. Although conjecture exists (10) as to whether or not childhood obesity rates have in fact plateaued in several developed countries (11), what is clear is that the inequalities in prevalence are widening. In England, for example, the disparity between the least and most deprived children widened between the 2006/2007 NCMP wave (4.5% difference in obesity prevalence) and the 2016/2017 NCMP wave (6.0% difference in obesity prevalence) (5). However, it is important to highlight that socioeconomic position can have both protective and negative outcomes regarding adiposity because of the fact that it is a multifaceted construct (commonly incorporating educational attainment, income, occupation, etc.) (6). Similarly, ethnicity (commonly defined as "a large group of people who have the same national, racial, or cultural origins, or the state of belonging to such a group" (12)) has both protective and negative influences, with one multinational study (>67 countries) finding that national culture alone explained 53.5% to 62.4% of the variance in BMI among adults (13). A recent framework exploring pathways for racial/ethnic and migrant inequalities in obesity by Kumanyika (14) highlights the intersection of pathways that produce obesity alongside pathways that produce inequalities. In this model, national-level contexts (e.g., social, economic, health system, food system, environmental, national culture, and historical contexts) intersect with race/ethnicity, SEP, and/or migrant status with intermediate health determinants (e.g., stress and trauma, poverty, oppression, discrimination, genetic and behavioral drivers, cultural practices and values, and inadequate health and social care) to influence obesity risk (14). This highlights the complex interplay of social, economic, historical, and cultural forces across different ethnic groups, which requires further investigation to prevent inequalities from widening.

Examinations of the interplay between SEP among specific ethnic groups have revealed contrasting findings (6,7), which suggests that risks posed are not linear for all population groups. For example, the nationally representative Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 in the United States found that the least deprived (highest SEP children) had lower initial BMI z scores among non-Hispanic White children (males and females) but higher BMI z scores for non-Hispanic Black males, but not females, in kindergarten (aged 5.6 ± 0.35 years) (6). In addition, detailed examination of the nationally representative US National Health and Nutrition Examination Survey 2001-2010 waves found that after adjustment for neighborhood SEP, the disparities in childhood overweight and obesity prevalence compared with non-Hispanic White children largely dissipated (7). These studies highlight that those who were among the most deprived were more likely to be from ethnic minority groups, and that it was levels of deprivation driving obesity risk rather than ethnicity drivers.

In the UK, examinations of the combined influence of SEP and ethnicity are limited, and these constructs are often examined in isolation. A systematic review of ethnic differences in obesity among UK children found just under half of the included studies (14/29) indicated differences in BMI by ethnic group; however, no common agreement regarding which ethnic groups had the greatest risk was observed (15). Several studies have described a higher risk for Asian children (16-24) or Black ethnic groups (18-20,24-26), and others have described lower risk for Asian (26,27) and Black ethnic groups

(23). Previous analyses of the 2015/2016 NCMP data found that, compared with White British children, Asian children in Reception and Year 6 had significantly lower BMI z scores after adjustment for SEP and rurality (28), whereas children from Black ethnic groups had significantly higher BMI z scores compared with White British children (28). Within the available literature, there is a need to further examine the combined influence of sex, SEP, and ethnicity on childhood obesity risk, particularly with expanded categories of ethnicity to curtail the compression of diverse cultural and ethnic groups into broader structures. Therefore, in this study, we aimed to examine the prevalence and risk of overweight and obesity using the recent (2015/2016 and 2016/2017) nationally representative cycles of the high-participation-rate (≥95%) (5,29) NCMP within England. It was hypothesized that the relationship between SEP and obesity risk would be nonlinear among specific ethnic groups, with evidence of sex-specific relationships.

Methods

Study design, population, and setting

The NCMP is a nationally mandated surveillance program in England that collects direct measurement of children's height and weight among Reception (aged 4-5 years) and Year 6 (aged 10-11 years) students, using this to monitor overall prevalence levels of obesity, trends, and changes in population weight status (30). The program, which began in the 2006-2007 school year, uses an opt-out (passive) consent approach to invite all Reception and Year 6 children in state primary schools to participate annually and regularly achieves student participation rates ≥92% (past 5 years) (5). Although the program is mandated for state-maintained schools, independent schools and special schools (school for pupils with special education needs and pupil referral units) are encouraged to collect this information, but these data are excluded from the national results to maintain consistency (30). Nationally, the measurement program is coordinated by Public Health England with local authorities typically commissioning school nursing services or other provider teams to collect the information (30). Participating students have their height and weight measured by trained staff within schools. Measurements are submitted annually to an online system that carries out quality checks to identify possible measurement and inputting errors.

Data

We pooled data from the 2015/2016 and the 2016/2017 NCMP data collection years to allow for analyses of expanded ethnic subgroups. Across these 2 years, 1.25 million children in Reception and 1.1 million children in Year 6 participated in the NCMP, with 49% of participants being girls, representing an analysis sample of 2.35 million children. The participation rates for children in Reception in 2015/2016 and 2016/2017 were 95.6% and 95.8%, respectively, and 94.0% and 94.2%, respectively, for Year 6 students (5,28).

Sample weights were not used because the NCMP aims to achieve complete coverage and because very high rates of participation are realized in the target population.

Dependent variable

Height and weight were collected using standard data collection protocols, with students wearing light clothing and shoes removed (30).

Measurements of height and weight were recorded to the nearest 0.1 (centimeter or kilogram), respectively. Two measurements of height and one measurement of weight are recommended to be taken, and the mean of all measurements is used (30). Age- and sex-specific BMI (weight [kg]/height^2 [cm]) growth references were used to examine weight status. The International Obesity Task Force's (IOTF) growth reference was used to classify overweight (IOTF z score=+1 SD) and obesity (IOTF z score=≥+2 SD) (31). Examination data using the British 1990 (UK90) (32) age- and sex-specific BMI growth reference are available in Supporting Information Table S1 (overweight=z score≥+1.33 SD and obesity= z score≥+2 SD). The Stata plugin zanthro was used to append IOTF weight categories to the NCMP data (33). The NCMP IT system automatically appended clinical UK90 weight categories. Overweight and obesity prevalence was summed to produce a single dependent variable for consideration in the statistical models (i.e., combined overweight/obesity).

Independent variables

Sex, school year, ethnicity, and Lower-layer Super Output Area (LSOA) of the child residence were recoded for each participant based on information contained within school records as reported by the parent/caretaker. LSOAs are small geographical units with an average of 672 households per LSOA as used in the UK census (34). Ethnicity was classified according to standard National Health Service (NHS) definitions (35). Quintiles of the Income Deprivation affecting Children Index (IDACI) were appended to the data using the LSOA of child residence (36). IDACI classifies LSOAs according to the proportion of all children aged 0 to 15 living in income-deprived families (36). The IDACI is the official measure of relative deprivation for LSOAs in England, was developed by the UK government, and has 37 indicators across seven domains of deprivation including income, employment, education, skills and training, health and disability, crime, barriers to housing and services, and living environment (36).

Age and month of measurement were also included as independent variables in the models in order to capture any systematic pattern in overweight/obesity prevalence with age or within the school year.

Statistical analyses

Two logistic regression models were run for each sex and year group. These examine in turn each of the two binary dependent variables: overweight/obesity prevalence by IOTF or UK90 growth reference (0=underweight+healthy weight; 1=overweight+obesity]. The independent variables were the same in all models. The independent variables of age and month of measurement were modeled as main effects, whereas the IDACI quintile and ethnicity were modeled as both main effects and with an interaction term.

All models were stratified by sex and school year (Reception or Year 6) and were fitted using logistic regression in R. The R emmeans package (version 1.1) was used to obtain the marginal predicted probability of overweight/obesity by deprivation and ethnicity from each of the fitted models, averaging over the other model variables. The difference in overweight/obesity between the most and least deprived SEP quintiles was calculated as the contrast between the predicted probability of overweight/obesity in the most deprived quintile compared with the least deprived quintile within each ethnic group. To reflect multiple significance testing, an adjustment was made to the width of the contrast confidence intervals (CI) using an approximation to the Dunnett method (R emmeans package).

In Supporting Information Table S2, additional logistic regression models were run for each sex and year group using overweight/obesity prevalence (IOTF) as the dependent variable and independent variables (age, month of measurement, IDACI quintile, and ethnicity) as main effects. These results can elucidate the independent influence of age, month of measurement, IDACI, and ethnicity on combined overweight/obesity risk.

Results

Population characteristics

Table 1 presents the demographic characteristics of participants in Reception and Year 6 by sex. White British children were the most populous ethnic group for both the Reception and Year 6 participants (58% of the population), with Pakistani (4%), Black African (3%), Indian (2%-3%), and Any Other White background (5%-6%) (e.g., White European) among the five most commonly reported ethnic groups. SEP was not equally distributed in the analysis sample, with more than 48% of Reception participants and 47% of Year 6 participants belonging to the two most deprived quintiles. More girls had overweight/obesity than boys in Reception (girls: 21.8% vs. boys: 15.3%) and Year 6 (girls: 28.4% vs. boys: 25.7%) using the IOTF growth reference.

Overweight and obesity prevalence by ethnicity, sex, year level, and SEP (independent)

Table 2 presents the prevalence of combined overweight/obesity by ethnicity and SEP through the IDACI quintiles for Reception and Year 6 children using the IOTF growth reference (UK90 in Supporting Information Table S1). Strong SEP and ethnic differences in overweight/obesity prevalence were evident. For example, among Year 6 girls, the prevalence of overweight/obesity among the most deprived quintile ranged between 24.1% (Chinese girls) and 45.5% (Black Caribbean girls). For most ethnic groups, children in the most deprived SEP quintile had the highest prevalence of overweight/obesity compared with the least deprived SEP quintile. Exceptions included Reception students from Black Caribbean (girls), Black African (boys and girls), and Chinese (girls and boys) backgrounds; and Year 6 students from Bangladeshi (boys and girls), Black Caribbean (boys), and Black African (boys and girls) backgrounds. The population groups with the highest proportion of overweight/obesity in Reception and Year 6 were White Irish girls (32.8%) and Black Caribbean girls (45.5%), respectively, both of whom were in the most deprived quintile. Conversely, the population groups with the lowest proportion of children with overweight/obesity in Reception were White and Asian boys (7.1%) and in Year 6 Chinese girls (11.7%), both of whom were in the least deprived quintile.

Supporting Information Tables S2 presents the multivariable logistic regression models of overweight/obesity risk with age, ethnicity, sex, year level, month of measurement, and SEP as independent variables. In these models, each of these variables can be examined for its independent influence on probability of overweight/obesity while adjusting for each independent variable. A strong SEP gradient in overweight/obesity risk was observed for both Reception and Year 6

TABLE 1 Demographic characteristics of boys and girls in Reception and Year 6 in 2015/2016 and 2016/2017 combined NCMP data sets

| | Reception | | | | | | Year 6 | | | | | |
| | Girls | | | Boys | | | Girls | | | Boys | | |
	N	x̄ or %	SD	N	x̄ or %	SD	N	x̄ or %	SD	N	x̄ or %	SD
Age (mo)		59.5	4.05		59.5	4.05		130.3	4.36		130.3	4.36
Ethnicity												
White British	352,119	57.5		369,551	57.8		309,881	57.6		324,147	57.8	
White Irish	1,461	0.2		1,484	0.2		1,286	0.2		1,442	0.3	
Any Other White background	39,098	6.4		40,735	6.4		27,986	5.2		29,402	5.2	
White and Black Caribbean	7,091	1.2		7,354	1.2		6,218	1.2		6,261	1.1	
White and Black African	3,958	0.6		4,308	0.7		3,023	0.6		3,066	0.5	
White and Asian	6,801	1.1		6,959	1.1		4,954	0.9		5,288	0.9	
Any other mixed background	11,826	1.9		12,411	1.9		8,983	1.7		9,206	1.6	
Indian	15,239	2.5		15,900	2.5		12,203	2.3		12,815	2.3	
Pakistani	22,589	3.7		22,995	3.6		20,636	3.8		21,197	3.8	
Bangladeshi	8,092	1.3		8,220	1.3		8,183	1.5		8,380	1.5	
Any Other Asian background	9,620	1.6		10,076	1.6		8,406	1.6		8,992	1.6	
Black Caribbean	4,809	0.8		4,822	0.8		5,552	1		5,810	1	
Black African	15,922	2.6		16,230	2.5		15,017	2.8		15,160	2.7	
Any Other Black background	5,767	0.9		5,846	0.9		5,966	1.1		6,121	1.1	
Chinese	2,507	0.4		2,745	0.4		1,705	0.3		1,744	0.3	
Any Other ethnic group	11,148	1.8		12,071	1.9		9,919	1.8		10,685	1.9	
Not stated or unknown	94,371	15.4		97,607	15.3		87,990	16.4		90,922	16.2	
IDACI quintile												
1 (most deprived)	159,284	26		165,969	26		138,019	25.7		141,143	25.2	
2	136,766	22.3		142,162	22.2		114,690	21.3		119,614	21.3	
3	117,028	19.1		122,186	19.1		99,872	18.6		104,721	18.7	
4	102,940	16.8		107,760	16.9		93,378	17.4		98,355	17.5	
5 (least deprived)	96,400	15.7		101,237	15.8		91,949	17.1		96,805	17.3	
Month measurement (quarter)												
Sept-Nov	127,392	20.8		132,698	20.8		228,047	42.4		235,954	42.1	
Dec-Feb	221,719	36.2		231,819	36.3		150,505	28		157,815	28.1	
Mar-May	213,261	34.8		222,035	34.7		130,108	24.2		135,818	24.2	
June-Aug	50,046	8.2		52,762	8.3		29,248	5.4		31,051	5.5	
Height (cm)		108.9	5.13		109.9	5.12		145.5	7.6		144.8	7.05
Weight (kg)		19.3	3.09		19.6	2.98		40.89	10.2		39.8	9.66
IOTF BMI z score		0.50	1		0.39	1.01		0.59	1.08		0.56	1.09
UK90 BMI z score		0.35	1		0.34	1.08		0.45	1.22		0.59	1.22
IOTF overweight/obesity (%)	133,680	21.8		97,498	15.3		152,541	28.4		144,032	25.7	

IDACI, Income Deprivation affecting Children Index; IOTF, International Obesity Task Force; NCMP, National Child Measurement Programme; UK90, British 1990.

TABLE 2 Overweight and obesity prevalence (IOTF) by ethnicity and IDACI quintile characteristics of boys and girls in Reception and Year 6 in 2015/2016 and 2016/2017 combined NCMP data sets

IDACI quintile[a]	Reception girls			Reception boys			Year 6 girls			Year 6 boys		
	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)
White British												
1	73,033	0.67	26.8%	76,870	0.55	19.0%	61,316	0.73	33.4%	62,597	0.66	29.0%
2	69,487	0.60	24.0%	72,193	0.48	16.5%	57,106	0.65	30.3%	59,671	0.58	26.0%
3	71,328	0.54	21.7%	75,064	0.42	14.4%	61,038	0.56	26.5%	64,191	0.51	23.0%
4	70,715	0.50	19.9%	74,306	0.38	12.9%	64,972	0.48	23.2%	68,361	0.44	20.0%
5	67,556	0.45	18.1%	71,118	0.33	11.5%	65,449	0.39	19.6%	69,327	0.36	17.0%
White Irish												
1	345	0.73	32.8%	330	0.73	24.9%	306	0.75	33.3%	313	0.84	35.0%
2	280	0.69	26.8%	289	0.55	17.7%	245	0.70	30.6%	296	0.72	32.0%
3	314	0.61	26.8%	293	0.54	18.1%	280	0.61	25.0%	297	0.52	22.0%
4	254	0.44	18.1%	277	0.45	11.9%	214	0.42	21.0%	263	0.43	17.0%
5	268	0.55	19.4%	295	0.37	12.9%	241	0.38	14.9%	273	0.26	14.0%
Any Other White background												
1	11,455	0.51	22.2%	11,905	0.45	17.3%	8,673	0.74	34.0%	9,065	0.82	35.0%
2	10,122	0.45	20.1%	10,589	0.38	15.0%	6,781	0.65	31.2%	6,928	0.73	31.0%
3	7,649	0.41	17.8%	7,886	0.36	14.1%	5,105	0.54	26.4%	5,491	0.66	29.0%
4	5,387	0.38	17.3%	5,699	0.30	11.8%	3,778	0.47	23.5%	4,071	0.51	23.0%
5	4,485	0.37	15.9%	4,656	0.29	10.6%	3,649	0.37	18.9%	3,847	0.36	17.0%
White and Black Caribbean												
1	2,834	0.63	26.8%	2,940	0.55	19.0%	2,356	0.97	42.1%	2,393	0.74	31.0%
2	1,814	0.56	24.4%	1,819	0.51	17.5%	1,528	0.86	38.4%	1,484	0.74	31.0%
3	1,170	0.62	25.2%	1,224	0.50	17.2%	1,023	0.75	33.8%	1,013	0.65	27.0%
4	753	0.50	22.2%	776	0.48	15.5%	761	0.63	27.6%	812	0.55	24.0%
5	520	0.53	22.5%	595	0.39	12.4%	550	0.63	30.4%	559	0.47	21.0%
White and Black African												
1	1,446	0.74	30.2%	1,553	0.60	22.3%	1,128	1.02	44.0%	1,081	0.76	31.0%
2	1,006	0.67	27.5%	1,108	0.58	20.8%	762	0.79	34.8%	791	0.71	30.0%
3	686	0.61	23.8%	719	0.55	18.8%	528	0.78	35.2%	539	0.63	26.0%
4	461	0.54	24.1%	564	0.43	16.3%	347	0.67	31.7%	375	0.56	23.0%
5	359	0.54	22.3%	364	0.45	15.4%	258	0.52	25.6%	280	0.54	20.0%
White and Asian												
1	1,561	0.42	20.0%	1,538	0.27	14.6%	1,044	0.71	32.3%	1,018	0.65	31.0%
2	1,431	0.35	17.9%	1,493	0.24	14.4%	1,066	0.56	28.4%	1,127	0.50	28.0%
3	1,316	0.21	13.6%	1,355	0.14	11.5%	983	0.35	22.3%	1,043	0.50	26.0%
4	1,237	0.17	11.6%	1,211	0.10	9.3%	829	0.20	16.0%	973	0.34	20.0%
5	1,256	0.13	10.8%	1,362	0.03	7.1%	1,032	0.19	15.3%	1,127	0.17	14.0%

TABLE 2 (continued).

IDACI quintile[a]	Reception girls			Reception boys			Year 6 girls			Year 6 boys		
	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)
Any other mixed background												
1	3,630	0.54	24.9%	3,951	0.45	18.7%	2,525	0.75	35.5%	2,631	0.74	31.0%
2	3,062	0.47	22.2%	3,214	0.35	14.4%	2,102	0.67	32.0%	2,146	0.65	29.0%
3	2,095	0.45	20.6%	2,075	0.35	14.9%	1,670	0.57	27.4%	1,724	0.56	26.0%
4	1,621	0.40	18.3%	1,672	0.29	12.3%	1,363	0.49	24.1%	1,457	0.46	21.0%
5	1,418	0.33	15.3%	1,499	0.25	11.5%	1,323	0.40	20.6%	1,248	0.36	20.0%
Indian												
1	2,839	0.08	17.1%	2,852	-0.04	13.4%	2,350	0.59	32.2%	2,415	0.67	36.0%
2	4,697	0.02	16.3%	5,081	-0.10	12.0%	3,687	0.44	29.1%	3,892	0.56	32.0%
3	3,800	-0.05	13.0%	4,022	-0.17	10.7%	3,007	0.40	26.1%	3,272	0.48	29.0%
4	2,183	-0.08	12.4%	2,242	-0.17	9.9%	1,759	0.38	25.8%	1,855	0.45	27.0%
5	1,720	-0.11	10.9%	1,703	-0.27	7.3%	1,400	0.33	24.0%	1,381	0.39	25.0%
Pakistani												
1	8,257	0.31	20.7%	8,447	0.17	15.8%	7,549	0.65	34.6%	7,889	0.66	35.0%
2	8,577	0.30	20.7%	8,792	0.12	14.9%	7,973	0.61	33.6%	7,973	0.64	35.0%
3	3,613	0.26	18.8%	3,652	0.07	14.0%	3,185	0.55	32.4%	3,333	0.59	32.0%
4	1,397	0.20	17.6%	1,316	0.04	13.4%	1,204	0.48	29.2%	1,252	0.52	31.0%
5	745	0.12	15.3%	788	-0.05	11.0%	725	0.38	24.4%	750	0.56	30.0%
Bangladeshi												
1	4,612	0.29	21.0%	4,718	0.21	17.4%	4,771	0.65	34.5%	4,814	0.76	38.0%
2	2,183	0.24	18.8%	2,259	0.16	17.0%	2,149	0.63	32.9%	2,273	0.82	40.0%
3	800	0.18	16.8%	793	0.14	16.5%	796	0.66	33.0%	850	0.75	37.0%
4	344	0.29	20.9%	302	0.01	12.9%	294	0.60	30.3%	276	0.67	36.0%
5	153	0.25	15.7%	148	0.03	13.5%	173	0.81	39.3%	167	0.67	32.0%
Any Other Asian background												
1	2,882	0.36	20.6%	3,042	0.30	16.7%	2,276	0.60	30.8%	2,479	0.79	38.0%
2	2,838	0.29	20.0%	2,983	0.18	15.2%	2,538	0.57	31.4%	2,774	0.70	34.0%
3	1,958	0.23	17.7%	2,088	0.13	13.4%	1,871	0.54	30.6%	1,994	0.61	31.0%
4	1,104	0.18	15.9%	1,104	0.10	12.9%	983	0.43	25.1%	1,041	0.58	30.0%
5	838	0.12	12.9%	859	0.03	11.2%	738	0.49	27.4%	704	0.53	28.0%
Black Caribbean												
1	2,606	0.53	24.1%	2,676	0.53	20.0%	2,974	1.09	45.5%	3,079	0.83	33.0%
2	1,412	0.58	25.1%	1,283	0.46	17.2%	1,506	0.97	41.6%	1,600	0.83	32.0%
3	488	0.50	20.7%	528	0.45	15.5%	703	0.97	40.8%	706	0.80	35.0%
4	210	0.50	24.3%	245	0.46	18.4%	257	0.91	37.7%	294	0.64	25.0%
5	93	0.57	24.7%	90	0.34	15.6%	112	0.81	37.5%	131	0.49	21.0%

TABLE 2 (continued).

IDACI quintile[a]	Reception girls			Reception boys			Year 6 girls			Year 6 boys		
	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)	N	Mean BMI z score	Prev (%)
Black African												
1	9,098	0.72	31.2%	9,160	0.59	23.3%	8,703	0.94	41.5%	8,647	0.83	35.0%
2	4,201	0.69	29.9%	4,407	0.60	23.1%	3,860	0.97	42.5%	4,020	0.84	34.0%
3	1,552	0.75	31.4%	1,551	0.62	24.1%	1,474	0.98	41.5%	1,463	0.87	36.0%
4	704	0.67	29.4%	736	0.60	22.8%	671	0.94	41.9%	692	0.75	30.0%
5	367	0.66	27.0%	376	0.67	23.9%	309	0.86	38.8%	338	0.83	33.0%
Any Other Black background												
1	3,154	0.64	29.8%	3,144	0.52	20.6%	3,367	0.92	39.8%	3,410	0.78	32.0%
2	1,471	0.56	26.0%	1,529	0.52	19.8%	1,427	0.88	38.3%	1,581	0.76	33.0%
3	681	0.52	25.4%	682	0.47	16.7%	720	0.80	36.2%	661	0.76	33.0%
4	288	0.56	26.0%	283	0.59	20.1%	295	0.80	34.9%	300	0.71	29.0%
5	173	0.60	27.8%	208	0.50	18.8%	157	0.63	27.4%	169	0.57	26.0%
Chinese												
1	781	0.25	14.5%	837	0.37	14.0%	444	0.48	24.1%	441	0.71	33.0%
2	564	0.32	16.8%	627	0.30	13.7%	384	0.41	22.7%	414	0.73	34.0%
3	430	0.21	12.8%	459	0.33	14.2%	295	0.19	16.6%	332	0.56	29.0%
4	369	0.17	11.1%	407	0.19	11.6%	299	0.20	17.4%	287	0.54	25.0%
5	363	0.15	11.3%	415	0.16	9.2%	283	0.04	11.7%	270	0.49	26.0%
Any other ethnic group												
1	4,467	0.52	23.7%	4,998	0.47	19.2%	4,102	0.73	33.7%	4,508	0.83	37.0%
2	3,031	0.48	22.4%	3,167	0.38	17.2%	2,614	0.70	32.7%	2,761	0.78	35.0%
3	1,781	0.43	20.3%	1,933	0.39	15.8%	1,640	0.64	29.8%	1,765	0.71	32.0%
4	1,079	0.42	20.3%	1,145	0.32	13.1%	906	0.60	28.4%	993	0.64	30.0%
5	790	0.39	20.0%	828	0.32	13.9%	657	0.49	23.4%	658	0.56	24.0%
Not stated or unknown												
1	26,284	0.60	26.0%	27,008	0.50	19.0%	24,135	0.75	34.5%	24,363	0.73	32.0%
2	20,590	0.51	22.6%	21,329	0.41	16.6%	18,962	0.66	31.4%	19,883	0.63	29.0%
3	17,367	0.47	20.8%	17,862	0.36	14.6%	15,554	0.59	28.4%	16,047	0.54	26.0%
4	14,834	0.47	19.9%	15,475	0.36	13.1%	14,446	0.49	23.6%	15,053	0.47	22.0%
5	15,296	0.41	17.4%	15,933	0.32	11.6%	14,893	0.43	20.9%	15,576	0.39	19.0%
All	612,418	0.50	21.8%	639,314	0.39	15.3%	537,908	0.59	28.4%	560,638	0.56	26.0%

[a]For IDACI quartiles, 1 indicates most deprived and 5 indicates least deprived.
IDACI, Income Deprivation affecting Children Index; IOTF, International Obesity Task Force; NCMP, National Child Measurement Programme.

children. For example, after adjustment for age, month of measurement, and ethnicity, children in the most deprived SEP quintile had a higher probability of having overweight/obesity compared with children in the least deprived quintile (girls: 1.62; 95% CI: 1.60-1.64 and boys: 1.75; 95% CI: 1.72-1.77). Additionally, ethnicity strongly influenced probability of overweight/obesity. For example, compared with White British children, Black Caribbean girls in Year 6 (girls: 1.74; 95% CI: 1.68-1.79) and Bangladeshi boys in Year 6 (boys: 1.69; 95% CI: 1.64-1.73) had the highest probability of having overweight/obesity after adjustment for age, month of measurement, and SEP.

Overweight and obesity prevalence by ethnicity, sex, year level, and SEP (interaction ethnicity × SEP)

Table 3 presents the results of the multivariable logistic regression models using the IOTF growth reference (UK90 in Supporting Information Table S3). This model has been used to derive the predicted probabilities of overweight/obesity by ethnic group and deprivation quintile, which are depicted graphically as differences in overweight/obesity prevalence between the most and least deprived in Figure 1. Strong sex- and ethnic-specific socioeconomic inequalities in risk were evident after adjustment for age and month of measurement (Figure 1C-1D). For example, among the five most populous ethnic groups in Year 6, the disparity in overweight/obesity risk between boys in the least deprived and most deprived groups was Δ12% among White British boys compared with Δ5% for Pakistani, Δ2% for Black African, Δ11% for Indian, and Δ18% in Any Other White backgrounds. Additionally, Table 3 highlights that the risk of overweight/obesity had a nonsteady higher gradient between the least and most deprived; for example, a higher gradient in risk among White Irish boys in Year 6 was evident between quintiles 1 and 2 compared with quintiles 3 and 4. The smallest differences in overweight/obesity prevalence between the most and least deprived IDACI quintiles were generally seen in Black African children, except for girls in Reception and in Year 6 where the smallest differences were found in Black Caribbean and Bangladeshi girls, respectively.

Discussion

This study sought to examine the prevalence and risk of overweight/obesity among expanded categories of ethnicity within boys and girls in Reception and Year 6 school years in England and the differential influence of SEP. Strong ethnic differences between SEP groups were evident. Importantly, the differences in overweight/obesity prevalence between ethnic groups persisted after adjustment for SEP, age at measurement, and month of measurement in a multivariable model. In other words, ethnicity had an independent effect on overweight/obesity prevalence among boys and girls in Reception and Year 6. Furthermore, the inequitable distribution of overweight/obesity between the most and least advantaged widened for most ethnic groups between Reception and Year 6, highlighting the need for culturally appropriate intervention throughout this critical life stage that consists of all the years of primary school. These findings are important for clinicians, public health researchers, community members, and policy makers alike in England and in other developed multicultural societies to address widening inequalities, develop culturally appropriate interventions, and investigate the multifaceted (14) drivers of increased risk.

Our study confirms previous findings based in England that ethnic variations in overweight and obesity persist after adjustment for SEP (28). This study furthers this research by examining expanded categories of ethnicity and also detailing the risk of overweight/obesity by sex, year-level, and SEP-specific ethnic groups. Interestingly, our study shows that ethnicity does have a differential influence among specific sex and SEP groups, which is similar to the Early Childhood Longitudinal Study, Kindergarten Class of 1998–1999 in the United States (6). For example, in the adjusted model for the interaction between ethnicity and SEP, Black African children in Year 6 had very small differentials in overweight/obesity risk between the least and most deprived. This means that the disparity in overweight/obesity risk among Black African children compared with White British children was largely consistent across SEP quintiles, suggesting other environmental and/or cultural factors are driving increased risk. In our study, Black African children were most likely to belong to quintiles 1 to 3 for SEP, and they may face disadvantage on both the individual level and area level, termed deprivation amplification (38). It has previously been observed that persons living in deprived areas experience reduced access to health-promoting environments (e.g., fresh and affordable food, less concentration of fast food outlets, park/recreation facilities, walkability) (39), although evidence to the contrary does exist (40). Further research is needed to confirm these proposed drivers of risk to create evidence-based solutions, as children from a Black African background had higher rates of overweight/obesity compared with those from a White British background across all sexes, both school years studied, and SEP quintiles.

Study strengths include the nationally representative sample of children that was obtained under an opt-out (passive consent) procedure, achieving ≥95% participation rates among Reception and Year 6 students in state-run primary schools. The application of an opt-out (passive) consent procedure reduces the influence of nonparticipation bias on estimates of overweight and obesity, which has been estimated to be as high as −5.4 percentage points under opt-in (active) consent procedures in school-based research (41). The combination of 2 years of the NCMP allowed for examination of 17 distinct ethnicity categories for year-level, sex, and socioeconomic variations in overweight/obesity risk. This is in contrast to previous analyses of the NCMP in which truncated categories of ethnicity were typically used (28). Additionally, the authors believe this is the first known study in England using ethnic groups at granular (as against aggregated) levels to examine the interaction between SEP and ethnicity, highlighting sex-, ethnicity-, and SEP-specific differences in risk. Finally, in the UK, in contrast with other developed countries such as Australia and the United States, the reported residence of children is converted to a very refined measure of area-level deprivation through IDACI as LSOAs reflect small geographic units of around 672 households (34). Although this does not account for individual economic situations, it is far superior to international equivalents, such as the Socioeconomic Index for Areas in Australia, which represents a mean of 8,744 individuals (42). However, the authors acknowledge the approximation of individual income deprivation from area-level information as a study limitation.

Our study has several limitations. First, classification of ethnicity was based on information contained within school records and according to NHS definitions (35). This classification does not allow for level of acculturation of the individual or the family to be calculated. In Australia, it was found that children who maintained their traditional (African) culture as opposed to adopting the new Australian culture (assimilation) had lower BMI scores (43). Investigating the levels

TABLE 3 Odds ratios (OR) for the multivariable regression models of overweight and obesity (IOTF), by sex and year group

	Reception girls	Reception boys	Year 6 girls	Year 6 boys
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age (mo)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	1.00 (0.99-1.00)	1.00 (1.00-1.00)
Quarter of measurement				
Sept-Nov	ref	ref	ref	ref
Dec-Feb	0.91 (0.89-0.93)	0.88 (0.86-0.90)	1.00 (0.99-1.02)	1.02 (1.00-1.03)
Mar-May	0.91 (0.89-0.93)	0.87 (0.85-0.89)	1.01 (0.99-1.02)	1.04 (1.02-1.06)
June-Aug	0.85 (0.83-0.88)	0.80 (0.77-0.83)	1.02 (0.99-1.05)	1.04 (1.01-1.07)
IDACI				
1 (most deprived)	1.65 (1.63-1.68)	1.79 (1.76-1.82)	2.06 (2.03-2.08)	2.01 (1.99-2.04)
2	1.42 (1.40-1.45)	1.52 (1.48-1.55)	1.78 (1.75-1.81)	1.72 (1.69-1.75)
3	1.25 (1.22-1.27)	1.29 (1.26-1.32)	1.48 (1.45-1.50)	1.46 (1.43-1.49)
4	1.12 (1.10-1.15)	1.14 (1.11-1.17)	1.24 (1.21-1.26)	1.24 (1.21-1.26)
5 (least deprived)	ref	ref	ref	ref
Ethnicity				
White British	ref	ref	ref	ref
White Irish	1.09 (0.79-1.40)	1.15 (0.81-1.49)	0.72 (0.36-1.07)	0.81 (0.47-1.15)
Any Other White background	0.86 (0.77-0.94)	0.91 (0.81-1.00)	0.95 (0.87-1.04)	1.00 (0.91-1.09)
White and Black Caribbean	1.32 (1.11-1.53)	1.10 (0.85-1.34)	1.79 (1.61-1.97)	1.30 (1.10-1.51)
White and Black African	1.30 (1.05-1.55)	1.41 (1.12-1.69)	1.41 (1.13-1.69)	1.22 (0.92-1.51)
White and Asian	0.55 (0.37-0.73)	0.59 (0.38-0.80)	0.74 (0.57-0.91)	0.79 (0.62-0.96)
Any other mixed background	0.81 (0.67-0.96)	0.99 (0.83-1.15)	1.06 (0.93-1.20)	1.22 (1.08-1.36)
Indian	0.56 (0.41-0.71)	0.61 (0.42-0.79)	1.29 (1.17-1.42)	1.64 (1.52-1.76)
Pakistani	0.82 (0.62-1.02)	0.96 (0.73-1.18)	1.32 (1.15-1.49)	2.08 (1.93-2.24)
Bangladeshi	0.84 (0.41-1.28)	1.20 (0.73-1.68)	2.66 (2.35-2.96)	2.32 (2.00-2.65)
Any Other Asian background	0.67 (0.47-0.87)	0.97 (0.76-1.19)	1.54 (1.38-1.71)	1.87 (1.70-2.03)
Black Caribbean	1.49 (1.02-1.96)	1.43 (0.86-2.00)	2.46 (2.07-2.84)	1.26 (0.84-1.69)
Black African	1.68 (1.45-1.91)	2.42 (2.18-2.65)	2.60 (2.37-2.83)	2.35 (2.13-2.58)
Any Other Black background	1.76 (1.42-2.09)	1.80 (1.45-2.14)	1.54 (1.19-1.89)	1.71 (1.37-2.05)
Chinese	0.58 (0.25-0.90)	0.77 (0.44-1.11)	0.54 (0.18-0.91)	1.73 (1.46-2.00)
Any other ethnic group	1.13 (0.96-1.31)	1.25 (1.05-1.44)	1.25 (1.07-1.44)	1.55 (1.37-1.73)
Not stated or unknown	0.96 (0.91-1.00)	1.01 (0.95-1.06)	1.09 (1.04-1.13)	1.11 (1.06-1.15)
IDACI and ethnicity interaction				
White Irish, 1 most deprived	1.22 (0.84-1.60)	1.24 (0.82-1.66)	1.39 (0.96-1.82)	1.64 (1.23-2.05)
2	1.06 (0.66-1.47)	0.95 (0.50-1.41)	1.41 (0.97-1.86)	1.62 (1.20-2.04)
3	1.22 (0.82-1.61)	1.15 (0.70-1.60)	1.29 (0.84-1.73)	1.13 (0.69-1.57)
4	0.82 (0.38-1.26)	0.81 (0.31-1.30)	1.23 (0.75-1.71)	0.98 (0.51-1.45)
5 least deprived	ref	ref	ref	ref
Any Other White background, 1 most deprived	0.91 (0.82-1.01)	0.99 (0.88-1.10)	1.08 (0.98-1.18)	1.28 (1.18-1.37)
2	0.93 (0.84-1.03)	0.99 (0.87-1.10)	1.09 (0.99-1.20)	1.28 (1.18-1.38)
3	0.92 (0.81-1.02)	1.07 (0.96-1.19)	1.05 (0.94-1.15)	1.36 (1.26-1.47)
4	0.98 (0.87-1.09)	0.99 (0.87-1.12)	1.07 (0.95-1.18)	1.19 (1.07-1.30)
5 least deprived	ref	ref	ref	ref
White and Black Caribbean, 1 most deprived	0.76 (0.53-0.98)	0.91 (0.65-1.17)	0.81 (0.61-1.01)	0.83 (0.60-1.05)
2	0.78 (0.54-1.01)	0.98 (0.71-1.26)	0.80 (0.59-1.01)	0.97 (0.74-1.20)
3	0.93 (0.68-1.17)	1.14 (0.85-1.43)	0.79 (0.57-1.02)	0.96 (0.71-1.21)
4	0.87 (0.60-1.14)	1.13 (0.82-1.44)	0.71 (0.47-0.95)	0.93 (0.67-1.19)
5 least deprived	ref	ref	ref	ref
White and Black African, 1 most deprived	0.91 (0.63-1.18)	0.87 (0.56-1.18)	1.11 (0.81-1.42)	0.88 (0.56-1.20)
2	0.92 (0.64-1.21)	0.94 (0.62-1.26)	0.87 (0.55-1.19)	1.01 (0.68-1.34)
3	0.87 (0.56-1.17)	0.98 (0.64-1.32)	1.07 (0.74-1.40)	0.95 (0.60-1.30)

TABLE 3 (continued).

	Reception girls	Reception boys	Year 6 girls	Year 6 boys
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
4	0.98 (0.65-1.31)	0.94 (0.58-1.30)	1.09 (0.73-1.46)	0.99 (0.61-1.37)
5 least deprived	ref	ref	ref	ref
White and Asian, 1 most deprived	1.25 (1.03-1.47)	1.23 (0.98-1.49)	1.28 (1.07-1.50)	1.37 (1.16-1.59)
2	1.26 (1.04-1.49)	1.44 (1.19-1.69)	1.23 (1.02-1.45)	1.39 (1.17-1.60)
3	1.04 (0.80-1.28)	1.32 (1.05-1.58)	1.07 (0.85-1.30)	1.46 (1.24-1.68)
4	0.97 (0.72-1.22)	1.17 (0.89-1.46)	0.85 (0.60-1.11)	1.21 (0.98-1.45)
5 least deprived	ref	ref	ref	ref
Any other mixed background, 1 most deprived	1.11 (0.94-1.27)	0.99 (0.81-1.17)	1.04 (0.88-1.20)	0.89 (0.73-1.05)
2	1.11 (0.94-1.28)	0.86 (0.67-1.05)	1.02 (0.86-1.19)	0.95 (0.78-1.12)
3	1.15 (0.97-1.33)	1.05 (0.85-1.25)	0.99 (0.81-1.16)	0.98 (0.81-1.16)
4	1.10 (0.91-1.29)	0.94 (0.73-1.16)	0.99 (0.81-1.18)	0.85 (0.66-1.04)
5 least deprived	ref	ref	ref	ref
Indian, 1 most deprived	1.02 (0.83-1.20)	1.10 (0.89-1.32)	0.73 (0.58-0.88)	0.84 (0.69-0.99)
2	1.11 (0.94-1.28)	1.15 (0.94-1.35)	0.73 (0.59-0.88)	0.82 (0.68-0.96)
3	0.97 (0.79-1.15)	1.19 (0.98-1.40)	0.76 (0.61-0.91)	0.84 (0.69-0.98)
4	1.02 (0.82-1.22)	1.22 (0.99-1.45)	0.89 (0.73-1.06)	0.89 (0.73-1.05)
5 least deprived	ref	ref	ref	ref
Pakistani, 1 most deprived	0.87 (0.66-1.08)	0.84 (0.61-1.07)	0.80 (0.62-0.97)	0.63 (0.46-0.79)
2	1.01 (0.80-1.22)	0.93 (0.69-1.16)	0.88 (0.70-1.06)	0.73 (0.56-0.89)
3	1.02 (0.81-1.24)	1.01 (0.77-1.26)	1.01 (0.82-1.19)	0.77 (0.60-0.95)
4	1.05 (0.81-1.30)	1.09 (0.82-1.37)	1.03 (0.82-1.24)	0.84 (0.64-1.03)
5 least deprived	ref	ref	ref	ref
Bangladeshi, 1 most deprived	0.87 (0.43-1.31)	0.76 (0.28-1.24)	0.39 (0.08-0.71)	0.64 (0.31-0.97)
2	0.87 (0.42-1.32)	0.87 (0.38-1.35)	0.43 (0.11-0.74)	0.81 (0.47-1.15)
3	0.86 (0.39-1.33)	0.98 (0.47-1.49)	0.52 (0.18-0.86)	0.86 (0.51-1.22)
4	1.26 (0.75-1.77)	0.83 (0.25-1.41)	0.54 (0.15-0.94)	0.95 (0.55-1.36)
5 least deprived	ref	ref	ref	ref
Any Other Asian background, 1 most deprived	1.06 (0.84-1.28)	0.89 (0.65-1.12)	0.57 (0.39-0.76)	0.81 (0.62-0.99)
2	1.18 (0.96-1.41)	0.93 (0.70-1.17)	0.68 (0.50-0.87)	0.79 (0.61-0.98)
3	1.16 (0.93-1.40)	0.95 (0.70-1.20)	0.79 (0.60-0.98)	0.80 (0.61-0.99)
4	1.14 (0.88-1.40)	1.02 (0.74-1.30)	0.72 (0.50-0.94)	0.89 (0.67-1.10)
5 least deprived	ref	ref	ref	ref
Black Caribbean, 1 most deprived	0.58 (0.10-1.06)	0.75 (0.17-1.33)	0.68 (0.29-1.07)	0.95 (0.51-1.38)
2	0.71 (0.23-1.20)	0.74 (0.15-1.33)	0.67 (0.27-1.06)	1.06 (0.63-1.50)
3	0.64 (0.12-1.16)	0.77 (0.15-1.39)	0.78 (0.37-1.19)	1.41 (0.95-1.86)
4	0.87 (0.30-1.44)	1.06 (0.41-1.72)	0.82 (0.36-1.28)	1.05 (0.55-1.55)
5 least deprived	ref	ref	ref	ref
Black African, 1 most deprived	0.74 (0.50-0.97)	0.54 (0.29-0.78)	0.54 (0.31-0.78)	0.55 (0.32-0.78)
2	0.80 (0.56-1.04)	0.63 (0.38-0.88)	0.65 (0.42-0.89)	0.62 (0.38-0.86)
3	0.98 (0.73-1.24)	0.78 (0.51-1.05)	0.76 (0.51-1.01)	0.80 (0.55-1.05)
4	1.00 (0.71-1.28)	0.82 (0.53-1.12)	0.92 (0.64-1.20)	0.73 (0.45-1.01)
5 least deprived	ref	ref	ref	ref
Any Other Black background, 1 most deprived	0.66 (0.32-1.00)	0.62 (0.26-0.98)	0.85 (0.50-1.21)	0.68 (0.33-1.03)
2	0.64 (0.28-0.99)	0.70 (0.32-1.07)	0.93 (0.56-1.29)	0.81 (0.45-1.17)
3	0.71 (0.33-1.08)	0.67 (0.27-1.08)	1.02 (0.64-1.41)	0.96 (0.58-1.34)
4	0.81 (0.38-1.23)	0.95 (0.49-1.40)	1.15 (0.73-1.58)	0.96 (0.53-1.38)
5 least deprived	ref	ref	ref	ref

TABLE 3 (continued).

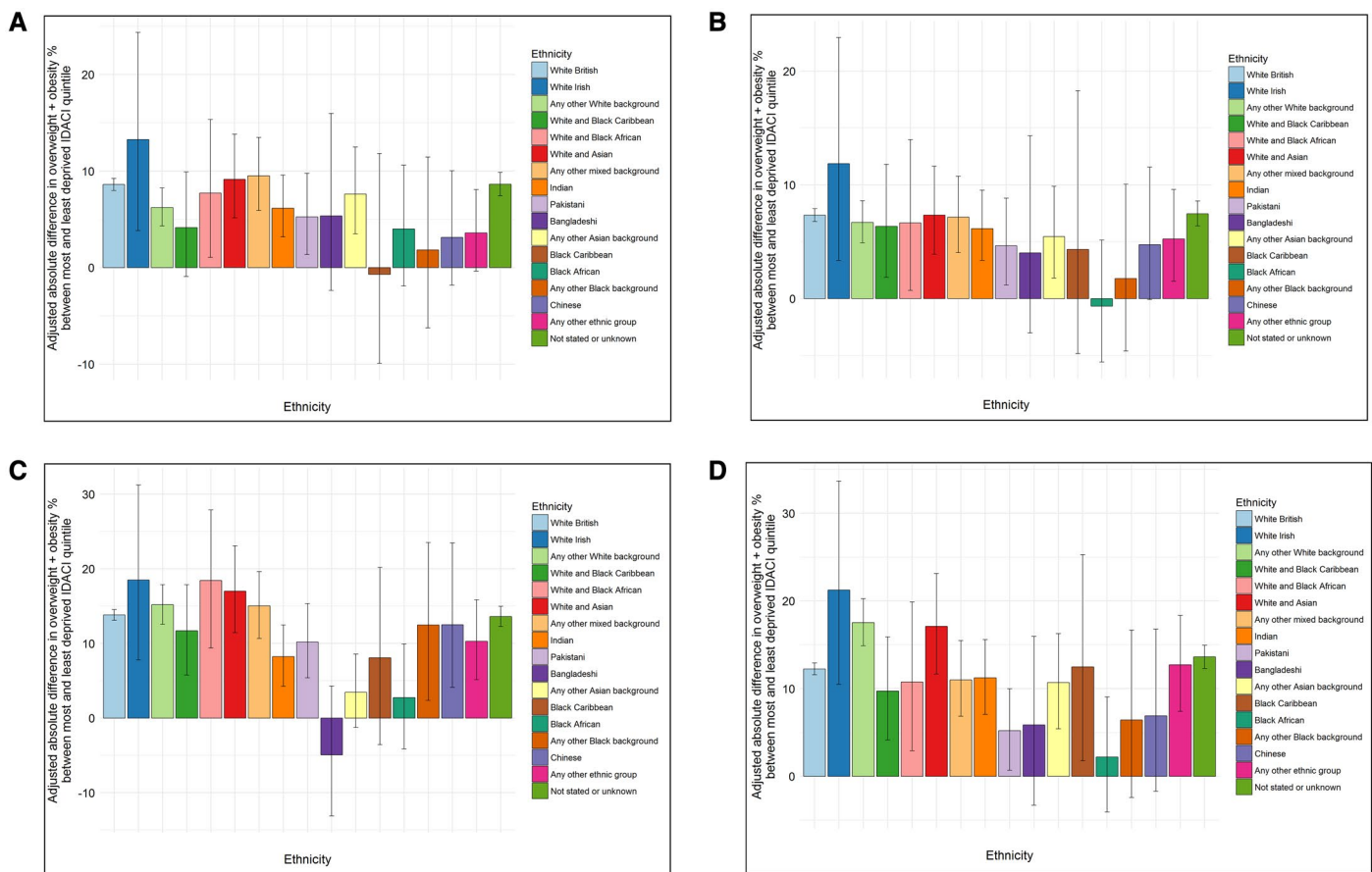|	Reception girls	Reception boys	Year 6 girls	Year 6 boys
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Chinese, 1 most deprived	0.80 (0.42-1.18)	0.90 (0.51-1.28)	1.17 (0.75-1.59)	0.69 (0.36-1.03)
2	1.12 (0.72-1.51)	1.04 (0.63-1.44)	1.25 (0.81-1.68)	0.83 (0.49-1.17)
3	0.92 (0.49-1.35)	1.27 (0.85-1.70)	1.02 (0.55-1.50)	0.77 (0.41-1.13)
4	0.87 (0.41-1.33)	1.14 (0.69-1.59)	1.29 (0.82-1.76)	0.75 (0.37-1.13)
5 least deprived	ref	ref	ref	ref
Any other ethnic group, 1 most deprived	0.75 (0.56-0.94)	0.82 (0.61-1.03)	0.81 (0.61-1.00)	0.91 (0.72-1.10)
2	0.81 (0.61-1.01)	0.85 (0.63-1.07)	0.89 (0.69-1.09)	0.98 (0.79-1.18)
3	0.81 (0.60-1.02)	0.91 (0.67-1.14)	0.94 (0.73-1.15)	1.00 (0.80-1.21)
4	0.90 (0.67-1.14)	0.82 (0.56-1.08)	1.05 (0.81-1.28)	1.06 (0.83-1.29)
5 least deprived	ref	ref	ref	ref
Not stated or unknown, 1 most deprived	1.01 (0.96-1.07)	1.01 (0.94-1.07)	0.97 (0.91-1.02)	1.03 (0.98-1.09)
2	0.98 (0.92-1.04)	1.01 (0.94-1.08)	0.97 (0.91-1.03)	1.05 (0.99-1.10)
3	1.00 (0.94-1.06)	1.02 (0.95-1.09)	1.01 (0.95-1.07)	1.04 (0.98-1.10)
4	1.05 (0.98-1.11)	1.01 (0.94-1.09)	0.95 (0.89-1.01)	1.01 (0.95-1.07)
5	ref	ref	ref	ref

Figure 1 Predicted adjusted difference in combined overweight and obesity prevalence between most deprived IDACI quintile and least deprived quintile within ethnic group among (**A**) Reception girls, (**B**) Reception boys, (**C**) Year 6 girls, and (**D**) Year 6 boys. IDACI, Income Deprivation affecting Children Index based on the Lower-layer Super Output Area of the child residence. [Color figure can be viewed at wileyonlinelibrary.com]

of acculturation, sociodemographic mobility or social mobility, and other important environmental, social, and behavioral drivers of childhood obesity (e.g., parent obesity, parent education, neighborhood environment, physical activity, dietary intake) would provide further insights into the reasons behind the strong SEP and ethnicity risks for obesity.

Second, despite combining 2 years of the NCMP, some ethnic minority and SEP subgroups had very low participant numbers, which may have influenced the observed associations. This is particularly relevant for White Irish children and those in the least deprived quintile as more than 50% of participants were in the two most deprived quintiles. We were also unable to analyze specific combinations of ethnicity within the "Any other mixed background" because of low participant numbers and an absence of this information being collected in school records. Furthermore, by combining overweight and obesity, we may have found stronger or weaker associations with ethnicity than would have been the case from consideration of obesity alone. Future research should look at comparing the earliest years of the NCMP (2006/2007 and 2007/2008) with the most recent years (2017/2018 and 2018/2019) to examine whether the inequity gap between the most and least deprived is widening over time, particularly with overweight, obesity, and severe obesity examined separately.

Third, it has been observed that BMI may not be an accurate proxy for excess body fat among Black African (overestimation) and South Asian (underestimation) children in the UK (44). To allow for international comparison, the IOTF age- and sex-specific BMI growth reference was used in this study to classify overweight and obesity and was developed from representative national data sets from six countries (UK, United States, Netherlands, Brazil, Singapore, and Hong Kong) (31). The application of proposed UK ethnic-specific BMI cut points for Black African and South Asian children (45) would have altered the observed results. However, the authors highlight that there is insufficient evidence to switch to the proposed ethnic-specific references for surveillance purposes (vs. screening) as they were developed using $N = 1,999$ children drawn from convenience samples of children in London (student response rates ranging from 52% to 64%) (45) and they are unlikely to be representative of South Asian and Black African children across England. In 2004, the World Health Organization faced a similar conundrum and decided against lowering the standard international adult classification for overweight (BMI = 25 kg/m^2) and obesity (BMI = 30) for Asian adults (46) but recommended the use of additional public health cut points for overweight and obesity (BMI = 23 and BMI = 27.5) to reflect increased risk among Asian adults. The authors acknowledge this as a limitation and welcome advancements and consensus in this field.

Conclusion

This study highlights that ethnicity, reflecting cultural drivers, has an independent influence on overweight/obesity risk after adjustment for socioeconomic status, age, and month of measurement. Overweight/obesity risk was significantly higher for several ethnic minority groups compared with White British children. Additionally, inequity in overweight/obesity risk between the most and least disadvantaged was highest for several ethnic minority groups, with this gap widening between Reception and Year 6. This highlights the fact that interventions that focus on wider drivers of risk (e.g., national contexts, intermediate

health risks) in addition to socioeconomic drivers need to be developed and implemented.**O**

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