Regional differences in overweight: an effect of people or place?

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ABSTRACT

Objective: To examine UK country and regional differences, within England only, in childhood overweight (including obesity) at three years and determine whether any differences persist after adjustment for individual risk factors.

Design: Nationally representative prospective study

Setting: England, Wales, Scotland, and Northern Ireland

Participants: 13 194 singleton children from the UK Millennium Cohort Study with height and weight data at age three years.

Main outcome measure: Overweight (including obesity) was defined by the International Obesity TaskForce cut-offs for body mass index, which are age and sex specific.

Results: At three years, 23.0% (3102) of children were overweight or obese. In univariable analyses, children from Northern Ireland (odds ratio 1.30, 95% Confidence Interval 1.14 to 1.48) and Wales (1.26, 1.11 to 1.44) were more likely to be overweight than children from England. There were no differences in overweight between children from Scotland and England. Within England, children from the East (0.71, 0.57 to 0.88) and South East regions (0.82, 0.68 to 0.99) were less likely to be overweight than children from London. There were no differences in overweight between children from other English regions and children from London. These differences were maintained after adjustment for individual socio-demographic characteristics and other risk factors for overweight.

Conclusions: UK country and English regional differences in early childhood overweight are independent of individual risk factors. This suggests a role for policies to support environmental changes that remove barriers to physical activity or healthy eating for young children.

INTRODUCTION

Over the past two decades the prevalence of overweight and obesity has increased substantially among young children in all four UK countries.[1-5] Recent estimates suggest that at least a quarter of preschool children are overweight or obese[2-5], similar to levels found in America.[6] Tackling childhood obesity is a priority for the UK Government[4, 7-9] and there is a public service agreement target to reduce the proportion of overweight and obese children to 2000 levels by 2020.[10]

Although data on childhood overweight and obesity are necessary to monitor trends, differences in data collection and interpretation often prevent comparisons between areas. The national health surveys from England, Scotland, and Northern Ireland all report on childhood overweight and obesity, but the dates of the surveys, age ranges, and definitions of obesity are not comparable.[2, 3, 11] The national survey in Wales will be collecting height and weight in children for the first time in 2007.[12] Recently, the Department of Health (England) developed the National Childhood Obesity Database to record the annual height and weight of all children in Reception Year (age 4-5 years) and Year 6 (age 10-11 years). However, in 2006, only 57% of eligible Reception Year children were weighed and measured, with lower levels of overweight reported in areas with low response rates, suggesting bias.[13] Regional differences in obesity have been published using the Health Survey for England, but these were based on a broad age range (2-15 years) due to small sample sizes.[2] Therefore, there are no accurate assessments of regional disparities of overweight or obesity among young children in England, and differences between the four UK countries cannot be assessed because of a lack of comparable data.

Differences in the prevalence of obesity between regions may reflect discrepancies in risk factors for obesity at either the individual level or area level (or both). Regional differences are also important because they may be used for resource allocation and to infer the success or otherwise of area based policies to tackle obesity. We examined country and regional differences in overweight (including obesity) in a nationally representative, contemporary cohort of children aged three years and determined whether the differences persisted after adjustment for individual risk factors for obesity.

METHODS

Participants

The Millennium Cohort Study (MCS) is a nationally representative prospective study of British children born in the new century. A stratified clustered sampling framework was used to over-represent children living in disadvantaged areas and from ethnic minority groups. Families eligible for Child Benefit (a universal benefit for families with children) and resident in England, Wales, Scotland, or Northern Ireland when their child was aged nine months were invited to participate (response rate 72%).[14, 15] The original cohort comprised 18 819 children (18 553 families) born between September 2000 and January 2002. Among the 18 296 singleton infants at the first contact, 80% (14 630) participated at the second when the children were mean age 37.7 months (SD 2.5), which occurred between September 2003 and January 2005.[16] There was a disproportionate loss of children from Northern Ireland, in electoral wards in England defined as ‘ethnic’ (based on the 1991 Census, if at least 30% of residents were from an ethnic minority group), and ‘disadvantaged’ wards from all UK countries (the upper quartile of the Child Poverty Index).[16] Main

respondents (over 99% were natural mothers) were interviewed in the home at both contacts. Data from both surveys were obtained from the UK Data Archive, University of Essex. The MCS received ethical approval from the South West and London Multi-Centre Research Ethics Committees for the first and second contacts, respectively.[17]

Among the 14 630 singletons, 13 194 had complete and plausible child height and weight data at the second contact. Families were excluded from the analysis if the main respondent was not female (185), there were two cohort children from the same family (10), or the child had a missing height or weight (802) or a height-for-age, weight-for-age, or body mass index-for-age z-score $\leq$ -5 or $\geq$ 5 (BMI is weight/height^2) (467). Some participants had more than one exclusion criterion. Children were significantly less likely to be included in the final sample if they were from an ethnic minority group, lower income family, or if their mother was a lone parent, had a lower academic qualification, or lower socioeconomic circumstances ($p<.01$); however, the absolute differences were small. There were no differences in country or region of residence for those who were or were not included in the final sample ($p=.2$).

Definition of overweight

At the second contact, trained interviewers measured the children's weights and heights without shoes or outdoor clothing. The children were weighed using Tanita HD-305 scales (Tanita UK Ltd), recorded to the nearest 0.1 kg, and height was measured using Leicester Height Measure Stadiometers (Seca Ltd), recorded to the nearest 0.1 cm. The primary outcome measure was childhood overweight (including obesity) defined by the International Obesity TaskForce cut-offs for BMI, which are age and sex specific.[18] There were no gender differences in early childhood overweight ($p=.2$), so results are reported together. No other measurements of body size were collected.

Country and region of residence

The child's country and region of residence at the second contact was categorised as England, Wales, Scotland, or Northern Ireland and, within England, one of the following nine regions: London, East Midlands, East, North East, North West, South East, South West, West Midlands, or Yorkshire and Humberside.

Individual risk factors for overweight

Individual risk factors for overweight were based on maternal self-report. At the first contact, the child's ethnicity was reported by the mother (out of 16 possible choices) and classified according to guidelines from the Office for National Statistics[19], maternal socioeconomic circumstances were categorised according to the National Statistics Socio-economic Classification[20], maternal education was defined as the highest academic qualification attained, and lone motherhood status was defined as being a lone mother when the child was aged nine months. Family income reported at the second contact was used unless missing, when values from the first contact were substituted (1589). At the first contact, mothers reported their prepregnancy weight and current height, and those with BMI $\geq$ 25 were classified as overweight (including obesity). Mothers also reported their age at their first live birth, whether they smoked any cigarettes during the pregnancy with the cohort child, their child's birthweight, duration of breastfeeding, and age at which the infant was introduced to solid foods.

At the second contact, mothers reported the number of hours the child watched television or videos daily.

Statistical analysis

All analyses were conducted using STATA statistical software, version 9.2 SE (Stata Corporation, Texas), with survey commands to account for the clustered sampling framework and obtain robust standard errors. Weighted percentages were derived and logistic regression analyses were conducted using sample and non-response weights to allow for the clustered sampling design and non-response between contacts. Wald tests were used to obtain p-values. Four logistic regression analyses were conducted to calculate odds ratios for childhood overweight at age three years by country and, separately, English region of residence. The first was a univariable regression analysis. The second analysis only adjusted for the child's ethnicity. The third analysis also adjusted for the following socio-demographic characteristics: maternal socioeconomic circumstances, family income, maternal highest academic qualification, lone motherhood status, age at first live birth. The fourth analysis adjusted for the socio-demographic characteristics already listed as well as the following other risk factors for overweight: maternal prepregnancy overweight, smoking during pregnancy, birthweight, breastfeeding duration, introduction of solid foods, television viewing daily.

RESULTS

Socio-demographic characteristics and other risk factors for overweight of children and their families from each UK country are shown in Table 1 and from each English region in Table 2. Overall 18.0% (2411) of children were overweight and 5.0% (691) were obese at age three years; however, this varied by country and region of residence (Table 3). At the country level, the prevalence of early childhood overweight (including obesity), ranked lowest to highest, was England, Scotland, Wales, and Northern Ireland. Within England, the East had the lowest prevalence of overweight and the North East the highest. In univariable analyses children from Northern Ireland and Wales were more likely to be overweight than children from England. Within England, children from the East and South East were less likely to be overweight than children from London. There were no differences in overweight between Scotland and England or the other English regions and London, before or after adjustment.

Among children from Northern Ireland and Wales, the odds ratios attenuated slightly but remained significant after sequential adjustment for the child's ethnicity, individual socio-demographic characteristics and other risk factors for overweight. Within England, the odds of children from the East or South East being less likely to be overweight compared to children from London were maintained after adjustment for the child's ethnicity and the additional socio-demographic characteristics. However, after adjustment for all individual risk factors, there was no longer any significant difference in overweight between children from the South East and children from London.

Table 1. Socio-demographic characteristics and other risk factors by UK country in children and their families from the Millennium Cohort Study.

	All countries Weighted % (n) (N=13 194)	England Weighted % (n) (N=8309)	Wales Weighted % (n) (N=1987)	Scotland Weighted % (n) (N=1610)	Northern Ireland Weighted % (n) (N=1288)
Socio-demographic characteristics					
Child's ethnic group					
White	87.4 (11142)	85.2 (6365)	96.9 (1921)	98.0 (1577)	99.6 (1279)
Mixed	3.0 (359)	3.5 (316)	1.6 (33)	0.4 (6)	0.2 (4)
Indian	1.9 (337)	2.2 (328)	0.1 (4)	0.3 (5)	0 (0)
Pakistani or Bangladeshi	4.0 (791)	4.7 (766)	0.6 (13)	0.7 (11)	0.1 (1)
Black Caribbean or Black African	2.6 (376)	3.0 (362)	0.4 (7)	0.5 (7)	0 (0)
Other ethnic group	1.1 (162)	1.3 (151)	0.5 (8)	0.1 (2)	0.1 (1)
Missing (n)	27	21	1	2	3
Maternal socioeconomic circumstances					
Managerial & professional occupations	30.5 (3771)	30.5 (2321)	27.3 (500)	33.4 (576)	29.5 (374)
Small employers & own account workers	4.1 (474)	4.3 (317)	3.3 (63)	3.2 (55)	3.4 (39)
Intermediate occupations	18.4 (2299)	18.4 (1439)	16.5 (320)	19.1 (308)	18.4 (232)
Lower supervisory & technical occupations	5.3 (721)	5.1 (411)	6.5 (129)	6.1 (92)	6.8 (89)
Semi-routine & routine occupations	34.9 (4625)	34.5 (2822)	39.3 (803)	35.1 (525)	37.3 (475)
Never worked & long-term unemployed	6.8 (1144)	7.3 (900)	7.0 (146)	3.0 (39)	4.6 (59)
Missing (n)	160	99	26	15	20
Family income					
£0-11000 per annum	22.1 (3056)	21.9 (1922)	25.6 (517)	21.6 (313)	24.7 (304)
£11000-22000 per annum	28.2 (3874)	27.5 (2373)	31.3 (637)	28.8 (445)	33.2 (419)
£22000-33000 per annum	22.5 (2792)	22.8 (1768)	21.1 (406)	22.6 (373)	20.2 (245)
£33000+ per annum	27.2 (3165)	27.9 (2045)	22.0 (401)	27.1 (454)	22.1 (265)
Missing (n)	307	201	26	25	55
Maternal highest academic qualification[a]					
GCSE grades A-C or higher	74.3 (9597)	73.8 (5932)	71.1 (1389)	81.1 (1326)	73.3 (950)
GCSE grades D-G or lower	25.7 (3570)	26.2 (2361)	29.0 (594)	18.9 (282)	26.7 (333)
Missing (n)	27	16	4	2	5
Lone motherhood status					
Non-lone mother	85.9 (11220)	86.5 (7168)	81.8 (1610)	85.1 (1392)	81.7 (1050)
Lone mother	14.1 (1974)	13.5 (1141)	18.3 (377)	14.9 (218)	18.3 (238)
Missing (n)	0	0	0	0	0
Mean age at first live birth (years) (SD)	25.3 (5.6)	25.5 (5.6)	24.3 (5.5)	26.1 (5.8)	25.1 (5.2)
Missing (n)	373	298	19	42	14
Other risk factors					
Maternal prepregnancy overweight					
Normal weight	71.5 (8769)	71.6 (5478)	69.7 (1312)	72.5 (1109)	70.4 (870)
Overweight (including obesity)	28.5 (3651)	28.4 (2257)	30.3 (597)	27.5 (430)	29.6 (367)
Missing (n)	774	574	78	71	51
Maternal smoking during pregnancy					
No	65.4 (8622)	66.4 (5680)	58.3 (1132)	61.9 (1027)	61.8 (783)
Yes	34.6 (4517)	33.6 (2591)	41.7 (848)	38.1 (578)	38.2 (500)
Missing (n)	55	38	7	5	5
Mean birthweight (kg) (SD)	3.4 (0.6)	3.3 (0.6)	3.4 (0.5)	3.4 (0.5)	3.5 (0.5)
Missing (n)	28	18	4	2	4
Breastfeeding duration					
Never breastfed	30.2 (4205)	28.1 (2256)	36.6 (745)	37.9 (560)	50.1 (644)
< 4 months	41.8 (5518)	42.6 (3600)	41.7 (836)	36.4 (605)	36.5 (477)
≥ 4 months	28.0 (3455)	29.3 (2444)	21.8 (403)	25.8 (444)	13.5 (164)

Missing (n)	16	9	3	1	3
Introduction of solid foods					
≥ 4 months	64.4 (8545)	65.4 (5617)	58.9 (1167)	61.1 (995)	59.8 (766)
< 4 months	35.6 (4638)	34.6 (2685)	41.2 (820)	38.9 (614)	40.2 (519)
Missing (n)	11	7	0	1	3
Television viewing daily					
Less than 1 hour	23.3 (3057)	23.3 (1936)	20.8 (399)	24.6 (398)	26.0 (324)
1-2 hours	59.7 (7748)	59.6 (4841)	58.2 (1147)	60.7 (982)	60.0 (778)
3+ hours	17.0 (2357)	17.1 (1514)	21.0 (435)	14.7 (226)	14.0 (182)
Missing (n)	32	18	6	4	4

[a] GCSE is an abbreviation for General Certificate of Secondary Education: a qualification taken by secondary school students aged approximately 14-16 years.

Table 2. Socio-demographic characteristics and other risk factors by English region in children and their families from the Millennium Cohort Study.

	London Weighted % (n) (N=1381)	East Midlands Weighted % (n) (N=670)	East Weighted % (n) (N=899)	North East Weighted % (n) (N=394)	North West Weighted % (n) (N=1062)	South East Weighted % (n) (N=1265)	South West Weighted % (n) (N=687)	West Midlands Weighted % (n) (N=985)	Yorkshire & Humberside Weighted % (n) (N=966)
Socio-demographic characteristics									
Child's ethnic group									
White	56.3 (638)	90.7 (574)	90.6 (745)	97.0 (382)	86.1 (849)	92.5 (1145)	99.0 (678)	81.6 (659)	84.2 (695)
Mixed	8.1 (110)	3.9 (28)	3.3 (31)	0.6 (2)	2.9 (36)	3.0 (36)	0.9 (5)	3.3 (39)	3.1 (29)
Indian	6.6 (150)	4.3 (55)	0.7 (11)	0.5 (3)	1.2 (25)	1.8 (30)	0.2 (1)	2.7 (40)	0.7 (13)
Pakistani or Bangladeshi	6.1 (124)	0.6 (6)	3.8 (90)	1.8 (7)	7.0 (88)	1.1 (33)	0 (0)	9.7 (203)	11.8 (215)
Black Caribbean or Black African	17.0 (260)	0.3 (2)	1.1 (14)	0 (0)	2.5 (59)	0.4 (6)	0 (0)	1.1 (20)	0 (1)
Other ethnic group	5.8 (98)	0.2 (3)	0.5 (6)	0 (0)	0.4 (5)	1.0 (11)	0 (0)	1.5 (24)	0.3 (4)
Missing (n)	1	2	2	0	0	4	3	0	9
Maternal socioeconomic circumstances									
Managerial & professional occupations	36.6 (457)	29.9 (186)	33.3 (285)	23.8 (89)	23.6 (228)	32.2 (415)	35.7 (242)	31.1 (234)	23.1 (185)
Small employers & own account workers	3.7 (48)	6.6 (40)	5.5 (46)	0.8 (3)	4.4 (41)	4.3 (53)	5.6 (37)	3.0 (24)	3.1 (25)
Intermediate occupations	19.2 (236)	18.1 (118)	18.7 (159)	14.8 (59)	16.8 (176)	23.4 (287)	16.6 (115)	15.2 (144)	16.9 (145)
Lower supervisory & technical occupations	3.1 (44)	7.5 (52)	4.6 (38)	5.1 (22)	5.2 (52)	4.7 (59)	6.5 (45)	5.0 (47)	5.6 (52)
Semi-routine & routine occupations	24.9 (341)	35.1 (242)	34.8 (305)	42.4 (168)	39.1 (404)	32.5 (387)	34.5 (236)	32.7 (330)	42.0 (409)
Never worked & long-term unemployed	12.6 (237)	2.9 (24)	3.1 (56)	13.1 (52)	10.9 (150)	2.9 (43)	1.3 (9)	12.9 (196)	9.3 (133)
Missing (n)	18	8	10	1	11	21	3	10	17
Family income									
£0-11000 per annum	25.5 (353)	16.5 (122)	15.2 (152)	31.1 (126)	29.8 (321)	17.5 (203)	16.4 (108)	23.0 (256)	26.9 (281)
£11000-22000 per annum	18.2 (276)	32.3 (222)	27.9 (261)	33.9 (132)	28.7 (320)	24.0 (306)	29.1 (198)	29.8 (321)	32.9 (337)
£22000-33000 per annum	18.3 (246)	24.7 (154)	25.5 (212)	19.5 (78)	19.7 (205)	24.9 (317)	27.7 (191)	22.1 (184)	21.4 (181)
£33000+ per annum	38.0 (445)	26.4 (160)	31.5 (255)	15.5 (53)	21.8 (196)	33.6 (426)	26.8 (183)	25.1 (189)	18.9 (138)
Missing (n)	61	12	19	5	20	13	7	35	29

Maternal highest academic qualification[a]									
GCSE grades A-C or higher	74.8 (1001)	73.8 (484)	78.7 (689)	63.7 (249)	68.1 (703)	77.6 (992)	81.4 (560)	70.3 (630)	68.4 (624)
GCSE grades D-G or lower	25.2 (374)	26.2 (184)	21.3 (207)	36.3 (145)	32.0 (359)	22.4 (273)	18.6 (126)	29.7 (354)	31.6 (339)
Missing (n)	6	2	3	0	0	0	1	1	3
Lone motherhood status									
Non-lone mother	82.5 (1131)	90.7 (603)	93.3 (839)	81.4 (318)	79.9 (842)	88.1 (1131)	89.4 (619)	85.6 (849)	86.7 (836)
Lone mother	17.5 (250)	9.3 (67)	6.7 (60)	18.6 (76)	20.1 (220)	11.9 (134)	10.6 (68)	14.4 (136)	13.3 (130)
Missing (n)	0	0	0	0	0	0	0	0	0
Mean age at first live birth (years) (SD)	26.6 (5.8)	25.5 (5.4)	26.1 (5.5)	24.0 (5.6)	24.3 (5.5)	26.5 (5.4)	26.4 (5.5)	24.4 (5.3)	24.2 (5.4)
Missing (n)	105	15	25	1	38	22	5	64	23
Other risk factors									
Maternal prepregnancy overweight									
Normal weight	72.0 (883)	71.3 (452)	68.6 (582)	67.7 (246)	74.2 (707)	72.9 (873)	74.1 (489)	69.6 (620)	71.1 (626)
Overweight (including obesity)	28.1 (342)	28.7 (187)	31.5 (270)	32.3 (123)	25.8 (261)	27.1 (338)	25.9 (169)	30.4 (293)	28.9 (274)
Missing (n)	156	31	47	25	94	54	29	72	66
Maternal smoking during pregnancy									
No	73.6 (1059)	64.1 (434)	67.5 (621)	56.3 (219)	61.1 (665)	65.1 (836)	66.4 (461)	71.5 (726)	66.4 (659)
Yes	26.4 (314)	35.9 (234)	32.5 (276)	43.7 (172)	38.9 (393)	34.9 (423)	33.7 (225)	28.5 (254)	33.6 (300)
Missing (n)	8	2	2	3	4	6	1	5	7
Mean birthweight (kg) (SD)	3.3 (0.6)	3.4 (0.5)	3.3 (0.6)	3.4 (0.5)	3.3 (0.6)	3.4 (0.6)	3.4 (0.6)	3.3 (0.6)	3.3 (0.6)
Missing (n)	6	0	2	1	1	0	1	2	5
Breastfeeding duration									
Never breastfed	17.9 (208)	30.7 (202)	22.9 (203)	49.2 (198)	37.3 (370)	23.9 (284)	22.0 (149)	32.2 (307)	33.8 (335)
< 4 months	41.0 (575)	42.7 (285)	48.3 (442)	36.6 (146)	41.6 (466)	42.9 (548)	40.1 (277)	41.2 (433)	44.9 (428)
≥ 4 months	41.2 (597)	26.6 (183)	28.8 (253)	14.2 (49)	21.1 (226)	33.2 (433)	37.9 (260)	26.6 (244)	21.3 (199)
Missing (n)	1	0	1	1	0	0	1	1	4
Introduction of solid foods									
≥ 4 months	77.7 (1113)	60.3 (413)	66.8 (614)	57.5 (224)	62.5 (689)	64.3 (832)	63.2 (436)	63.1 (654)	65.0 (642)
< 4 months	22.3 (266)	39.7 (257)	33.2 (284)	42.5 (170)	37.5 (373)	35.7 (433)	36.8 (250)	36.9 (330)	35.0 (322)
Missing (n)	2	0	1	0	0	0	1	1	2
Television viewing daily									
Less than 1 hour	23.7 (339)	18.3 (121)	23.4 (211)	21.2 (82)	21.3 (226)	25.0 (319)	27.1 (186)	24.3 (221)	22.7 (231)
1-2 hours	58.4 (782)	63.8 (419)	63.9 (557)	57.8 (228)	58.2 (602)	58.7 (745)	58.3 (399)	60.1 (580)	57.5 (529)
3+ hours	17.9 (258)	17.9 (130)	12.7 (130)	21.0 (84)	20.5 (228)	16.3 (199)	14.6 (99)	15.7 (183)	19.8 (203)

Missing (n)	2		0		1		0		6	
	2		3		1		3			

[a] GCSE is an abbreviation for General Certificate of Secondary Education: a qualification taken by secondary school students aged approximately 14-16 years.

Table 3. Univariable and adjusted odds ratios (OR) (95% CI) for overweight (including obesity) by country and region of residence in children aged 3 years.

	N	Overweight[a]/ obesity (Weighted %)	Univariable OR	OR adjusted for child's ethnicity	OR adjusted for child's ethnicity and socio-demographic characteristics[b]	OR adjusted for all individual risk factors[b,c]
UK Country (N=13 194)						
England	8309	17.5/5.0	1	1	1	1
Wales	1987	21.6/5.2	1.26 (1.11 to 1.44)	1.25 (1.09 to 1.43)	1.23 (1.07 to 1.42)	1.24 (1.08 to 1.43)
Scotland	1610	18.9/5.0	1.08 (0.94 to 1.25)	1.07 (0.93 to 1.24)	1.09 (0.94 to 1.26)	1.06 (0.91 to 1.24)
Northern Ireland	1288	21.2/6.1	1.30 (1.14 to 1.48)	1.28 (1.12 to 1.46)	1.29 (1.12 to 1.47)	1.26 (1.10 to 1.45)
Region in England (N=8309)						
London	1381	17.1/7.3	1	1	1	1
East Midlands	670	16.0/5.8	0.87 (0.64 to 1.17)	0.88 (0.66 to 1.17)	0.85 (0.62 to 1.16)	0.90 (0.65 to 1.25)
East	899	14.2/4.5	0.71 (0.57 to 0.88)	0.70 (0.57 to 0.86)	0.71 (0.57 to 0.90)	0.71 (0.57 to 0.90)
North East	394	21.9/5.1	1.15 (0.88 to 1.49)	1.13 (0.88 to 1.46)	1.10 (0.84 to 1.43)	1.10 (0.84 to 1.44)
North West	1062	18.4/5.2	0.96 (0.77 to 1.19)	0.95 (0.77 to 1.17)	0.92 (0.73 to 1.16)	0.97 (0.77 to 1.23)
South East	1265	17.2/3.7	0.82 (0.68 to 0.99)	0.81 (0.68 to 0.98)	0.82 (0.68 to 1.00)	0.82 (0.67 to 1.01)
South West	687	20.0/3.9	0.97 (0.80 to 1.19)	0.95 (0.78 to 1.15)	0.96 (0.77 to 1.19)	1.01 (0.81 to 1.27)
West Midlands	985	20.0/4.0	0.98 (0.78 to 1.22)	1.00 (0.82 to 1.22)	0.99 (0.78 to 1.24)	1.00 (0.78 to 1.28)
Yorkshire & Humberside	966	15.7/5.7	0.84 (0.67 to 1.05)	0.84 (0.67 to 1.04)	0.84 (0.66 to 1.07)	0.83 (0.63 to 1.09)

[a] Overweight excluding obesity

[b] Adjusted for child's ethnicity and socio-demographic characteristics: maternal socioeconomic circumstances, family income, maternal highest academic qualification, lone motherhood status, age at first live birth

[c] Adjusted for other risk factors: maternal prepregnancy overweight, maternal smoking during pregnancy, birthweight, breastfeeding duration, introduction of solid foods, television viewing daily

DISCUSSION

Three year olds in Northern Ireland and Wales were more likely to be overweight than children in England and these differences were maintained after adjustment for individual risk factors for overweight. Within England, children from the East were less likely to be overweight than children from London both before and after adjustment for individual socio-demographic characteristics. Children from the South East were also less likely to be overweight than children from London after adjustment for the child's ethnicity and other socio-demographic characteristics.

The rich individual- and family-level information collected in this large contemporary, nationally representative cohort of UK children provided an opportunity to examine regional differences in overweight at age three years and assess whether they were dependent on individual risk factors for overweight. Previous analyses of regional differences in childhood overweight have not taken into account individual characteristics of the children and families within the regions, partly due to a lack of data.

The MCS was based on a stratified clustered sampling framework suggesting that children from some regions were more likely to be included in the sample than others. Within each country, wards were divided into three strata: 'ethnic', 'disadvantaged' (both defined previously), and 'advantaged' (all remaining wards). The sample was then selected separately for each stratum.[15] It is possible that children from a region may not be representative of the entire region because only certain wards were selected; however, the analyses were conducted using both survey commands and sample weights to take into account the sampling design. If children moved regions between the first and second contacts, influences on their body mass may derive from their original region of residence rather than the region they resided in at age three years. However, only 3.6% (476) of the children and their families moved regions between contacts. There was also attrition between contacts and approximately 9% of children had incomplete or implausible height, weight or BMI data at the second contact. Although exclusion of these children may have biased the estimated prevalence of overweight or obesity, the proportions of children who were overweight or obese in the MCS are similar to those reported in surveys of young children from all four UK countries.[1-5] Furthermore, sample and non-response weights were used to correct for the non-response and make the results generalisable to the UK population.

Despite the high prevalence of early childhood overweight and obesity across all four UK countries, it is difficult to directly compare levels using the national health surveys. The MCS is therefore a valuable resource for comparing levels of overweight and obesity between countries. The MCS data at age nine months and three years will be enhanced in planned contacts when the children are aged five and seven years; this will complement data collected at the regional level, as in the National Childhood Obesity Database (NCOD), and through national health surveys. There are also limited data on national levels of obesity in preschool age children across resource-rich countries[21], which prevents between-country comparison. National surveys defining childhood obesity by the IOTF cut-offs will also enhance international comparison.[18]

The NCOD and Health Survey for England (HSE) examined regional differences in childhood overweight. Although the NCOD results should be interpreted with caution because of possible bias associated with low response rates, the Reception Year (age 4-5 years) children from Yorkshire and Humberside had the lowest prevalence of overweight or obesity and children from the North East had the highest.[13] In 2002 the HSE found that boys aged 2-15 years from London had the highest prevalence of overweight or obesity, while those from Yorkshire and Humberside had the lowest. In contrast, girls aged 2-15 years from the South East and South West had the lowest prevalence of overweight or obesity while those from the North East had the highest.[2] In the MCS, children from the North East had the highest levels of overweight or obesity, which is consistent with previous results; however, children from the East and South East had the lowest levels. There was no evidence of differential uptake in the collection of the MCS children's height and weight at the second contact by region in England (data not shown), so regional differences are unlikely to be due to selective non-measurement of overweight or obese children. Discrepancies between studies could be attributed to the ages of the children or sampling.

Differences in early childhood obesity between areas found in the MCS, and reported by others, may be due to differences in characteristics of the individuals living there, features of the country or region itself, or the implementation of policies there. Our findings suggest that country and region of residence may influence early childhood overweight over and above individual characteristics. These influences may derive from features of the environment in these locations or the implementation of policies which affect children's weight gain. Although there is potential for residual confounding due to unmeasured individual characteristics, we adjusted for a wide range of risk factors for overweight that have been identified in the literature.[22, 23] Regions which have low levels of early childhood overweight or obesity may have environmental, cultural or policy-related (e.g. infrastructure) characteristics that provide or support opportunities for physical activity and/or access to a healthy diet. Further work is needed to measure environmental and community-level factors in the East and South East and determine how these areas may promote the adoption of a more active and healthy lifestyle. Our results also suggest that area level policies should continue to support environmental changes that remove barriers to physical activity or healthy eating for young children.

In conclusion, differences in early childhood overweight between UK countries and English regions appear to be largely independent of individual risk factors, suggesting that environmental differences may be important in mediating overweight in early childhood. This provides support for policies that target the 'obesogenic' environment and promote opportunities for families with young children to be physically active and access healthy foods.

What is already known on this topic

- Although country and regional differences in early childhood obesity have been reported in the UK, direct comparison is limited due to lack of comparable data and small sample sizes from existing national surveys.
- Previous analyses of regional differences in childhood obesity have not taken into account individual characteristics of the children and families within these regions.

What this study adds

- Overweight (including obesity) in children aged 3 years varies by country and region of residence in the UK.
- Differences in early childhood overweight between UK countries and English regions are independent of individual risk factors.

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COMPETING INTERESTS
All authors have no conflicts of interest to declare.

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