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Title: Variation in childhood and adolescent obesity prevalence defined by international and country-specific criteria in England and the US

Running head: Childhood obesity prevalence in England and US

Authors' names: Dr Iain A Lang PhD^{1,2a}, Ms Ruth R Kipping MSc^{3a}, Dr Russell Jago PhD⁴, Prof Debbie A Lawlor PhD^{3,5}

^a Joint first authors

Addresses:

¹ PenCLAHRC, Peninsula Medical School, University of Exeter, Exeter, United Kingdom.

² Public Health Directorate, NHS Devon, Exeter, United Kingdom.

³ School of Social and Community Medicine, University of Bristol, United Kingdom

⁴ Centre for Exercise, Nutrition & Health, School for Policy Studies, University of Bristol, United Kingdom

⁵ MRC Centre for Causal Analysis in Translational Epidemiology, University of Bristol, United Kingdom

Corresponding author: Ruth Kipping, School of Social and Community Medicine, University of Bristol, Canynge Hall, 39 Whatley Road, Bristol, BS8 2PS, UK.

Email: ruth.kipping@bristol.ac.uk

Tel +44 (0)117 928 7239, Fax +44 (0)117 928 7325

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Abstract

Objective: To compare childhood obesity prevalence in England and the US using different criteria.

Methods: Participants included 2 to 17 year olds in the Health Survey for England (HSE, n=33,563) and the US National Health and Nutrition Examination Survey (NHANES, n=14,540) 1999 through 2006. Mean BMI and prevalence of obesity were compared using the UK 1990, US 2000 Centers for Disease Control and International Obesity Task Force (IOTF) criteria.

Results: English children at ages 2 through 5 had a higher mean BMI than US children (mean difference (English minus US) =0.41kg/m², 95% CI 0.31 to 0.52). At ages ≥ 8 mean BMI was lower in England (for ages 8 through 11 mean difference= -1.00kg/m², 95% CI -1.26 to -0.75; for ages 12 through 17 mean difference= -1.37kg/m², 95% CI -1.59 to -1.14). The IOTF criteria produced the lowest estimates of obesity prevalence. The 2000 CDC criteria produced the highest estimates in younger children and the UK 1990 criteria produced the highest in adolescents. Children aged 2-5 in England had higher prevalence of obesity than those in the US when using the 2000 CDC and UK 1990 criteria. US adolescents had the highest prevalence of obesity by age group using each of the three criteria.

Conclusion: The 2000 CDC and UK 1990 criteria give a higher prevalence of obesity in England than the US at ages 2 through 5 but at ages ≥ 8 the reverse is true. Estimates of childhood obesity prevalence rely on the criteria used, which has implications for surveillance and clinical practice.

Key words: Adolescent, Body Weight, Child, Epidemiologic Measurements, Obesity, Overweight, Public health

Introduction

Since 1970 the greatest increases in obesity in school children have been in North America and Western Europe (Wang and Lobstein 2006). International comparisons are important for documenting and identifying country-level differences that might be used to suggest causal mechanisms (Cole et al. 2000). However, direct international comparisons are currently difficult because existing studies use different methods to define childhood obesity (Wang & Lobstein 2006).

The International Obesity Taskforce (IOTF) has developed international criteria for overweight and obesity by gender from 2 through 18 years of age, derived using childhood BMI data from six countries. The criteria provide gender-specific values that were equivalent to BMI of 25 and 30 kg/m² and provide a means to compare childhood overweight and obese prevalence internationally (Cole, Bellizzi, Flegal, & Dietz 2000).

To our knowledge, only one study has made comparisons of childhood obesity between countries using different BMI reference criteria. In that study childhood obesity prevalence was compared between the China, Russia and the US using IOTF, WHO weight for height z scores for <10 year olds and WHO BMI percentiles for >10 year olds, and the US percentiles based on NHANES I (Must et al. 1991a; Must et al. 1991b). Obesity prevalence and between country comparisons varied depending upon which criteria were used (Wang and Wang J.Q. 2002).

In this paper we compared mean BMI data and prevalence of overweight and obesity for children and adolescents (aged 2 through 17) from large cross-sectional surveys in England and the US using three criteria: (1) UK 1990 reference charts for BMI from the

Child Growth Foundation; (2) the US 2000 Centre for Disease Control and Prevention (CDC) BMI-for-age charts; and (3) IOTF. Our analysis had two aims: first, to compare the prevalence of overweight and obesity in England and the US by age and gender, because the US is leading the global epidemic of obesity and we were interested in whether childhood obesity prevalence in England (as representative of a Northern European country) had reached US levels. Second, to present these comparisons using the two country-specific methods of defining obesity.

Methods

Data for these analyses came from two nationally representative cross-sectional surveys. For England, data were from repeated waves of the Health Survey for England (HSE) (<http://www.dh.gov.uk/en/Publicationsandstatistics/PublishedSurvey/HealthSurveyForEngland/index.htm>). Ethical approval for the HSE was obtained from all relevant Multi-Centre and Local Research Ethics Committees. Across the years included here, the number of participants aged 2 through 17 varied from 2,160 (in 2000) to 8,114 (in 2002). Weighting was applied to take account of the under-representation of children in households with more than two children and the clustered, stratified multistage sample design (Sproston K 2006;Sproston K 2003;Sproston K 2004).

US data were from repeated waves of the National Health and Nutrition Examination Study (NHANES). NHANES was approved by the National Centers for Health Statistics institutional review board, and all participants provided written informed consent. To account for the clustered, stratified multistage sample design, complex sampling, weighted estimates of population parameters were computed (National Center for Health Statistics 2006).

From each study we used data on participants aged 2 through 17 for whom complete height and weight data were available from years 1999 through 2006. In HSE, 38,936 participants were eligible for inclusion in this age range and of these 33,563 (86.2%) had usable heights and weights. In NHANES, 15,500 participants were eligible for inclusion and of these 14,540 (93.8%) had usable heights and weights. Characteristics of the participants from the two surveys are shown in table 1.

Measurement of height and weight

In the HSE, height and weight were measured in participants' homes by trained researchers. Height was measured using a portable stadiometer. Informants were asked to remove their shoes. One measurement was taken, with the participant stretching to the maximum height and the head aligned in the Frankfort horizontal plane. Height was recorded to the nearest millimeter. Weight was measured using Soehnle, Seca and Tanita electronic scales with a digital display. Participants were asked to remove their shoes and any bulky clothing. Weight was recorded to the nearest 100g.

In NHANES, height and weight were measured in the body measurement room of the NHANES Mobile Examination Centre by trained health technicians. Height was measured using a fixed stadiometer. One measurement was taken, with participants instructed to breathe in and stand as tall as possible and the head aligned in the Frankfort horizontal plane. Height was recorded to the nearest millimeter. Weight was measured using a Toledo electronic scale with a digital display. Participants were asked to wear only underwear, disposable paper gowns, and foam slippers. Weight was measured in pounds and automatically converted to kilograms, recorded to the nearest 100g.

Growth charts

The UK 1990 age-related BMI reference curves cover the age range from birth through 23 years, and the curves are presented as nine centiles in the format of Cole (0.4th, 3rd, 10th, 25th, 50th, 75th, 90th, 97th and 99.6th centiles) (Cole et al. 1995). The reference sample of children was based on data from 11 surveys on gender, age, height, and weight collected between 1978 and 1990 for 15,636 boys and 14,899 girls, aged from 33 weeks through 23 years. Exact age was calculated from the dates of birth and the dates of the measurements for all participants. Summary centile curves were fitted to the data using Cole's LMS (lambda mu sigma) method and penalised likelihood (Cole, Freeman, & Preece 1995).

The US 2000 CDC BMI-for-age charts for ages 2 through 20 years were developed with data from five national health examination surveys between 1963 and 1994 and limited supplemental data. Smoothed percentile curves were developed in two stages: first, selected empirical percentiles were smoothed with a variety of parametric and nonparametric procedures; in the second stage, parameters were created to obtain the final curves, additional percentiles, and z-scores (Kuczmarski et al. 2002).

The IOTF criteria for obesity were based on international survey data from six large nationally representative cross-sectional growth studies in Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States from birth through 25 years of age (Cole, Bellizzi, Flegal, & Dietz 2000). For each of the surveys, centile curves were drawn that at age 18 passed through the widely used criteria of 25 and 30 kg/m² for adult overweight and obesity. The resulting curves were averaged to provide age- and gender-specific criteria from 2 through 18 years.

Statistical analyses

We estimated the prevalence of overweight and obesity in children and adolescents according to the three sets of criteria from the growth curves described above. Using the UK1990 and 2000 CDC BMI-for-age reference charts for BMI we classified as overweight/obese those who had an age-gender-specific BMI above the 85th percentile, and classified as obese those who had a BMI above the 95th percentile. Using the IOTF classification, we used participants' defined age-gender specific overweight and obesity criteria. This meant that for each of the three methods, each participant was graded as being of recommended weight, overweight/obese, or obese. Where growth charts referred to months rather than years of age we used the nearest mid-year figures. Using the appropriate weighting for each study, as described above, we estimated the proportion of participants in each country who were above the overweight and obesity criteria from the three growth charts. In addition, we compared the trends in mean BMI and prevalence of obesity using the IOTF criteria for two year periods across the eight years for all children combined. All analyses were conducted using Stata SE 10.1 (College Station, Texas).

Results

Mean BMI

Mean BMI for children and adolescents in England and the US, by age in years and with 95% confidence intervals, are shown in Figure 1 and Table 1. As expected, the distribution of BMI is positively skewed for all age groups and both countries. At younger ages English children had higher mean BMI than their peers in the US but this pattern was reversed in older children. Specifically, higher mean BMI was found in English compared to US children at ages 2 through 5 (mean difference England minus US =0.41kg/m², 95% CI 0.31 to 0.52) but lower mean BMI in English compared to US children/adolescents from ages 8 through 17: at ages 8 through 11 the mean difference was -1.00kg/m² (95% CI -1.26 to -0.75) and at ages 12 through 17 the mean difference was -1.37kg/m² (95% CI

-1.59 to -1.14). At ages 5 through 7 the mean BMI was similar in the two countries (mean difference=0.09kg/m², 95% CI -0.07 to 0.25).

There were gender differences in the ages at which there were the greatest differences in BMI between English and US children. In girls the biggest differences in BMI were at age 4, when English girls had a mean BMI 0.42kg/m² (95% CI 0.25 to 0.60) higher than US girls, and at age 13, when English girls had a mean BMI -1.62kg/m² (95% CI -1.88 to -1.36) lower than US girls. In boys, the biggest differences were at age 2, when English boys had a mean BMI 0.64kg/m² (95% CI 0.43 to 0.84) higher than US boys, and at age 16, when English boys had a mean BMI -2.40kg/m² (95% CI -2.69 to -2.12) lower than US boys.

Prevalence of overweight and obesity

Tables 2 and 3 show the prevalence of overweight/obesity and obesity for England and the US in age- and gender-specific groups according to each of the three criteria. Using the 2000 CDC criteria, the prevalence of obesity in 2- through 5-year-olds (girls and boys combined) reflected the pattern for mean BMI: prevalence of obesity in English children was 14.2% (95% CI 13.1 to 15.3) and in US children in this age group was 11.9 (95% CI 10.2 to 13.6; mean difference = 2.3%, 95% CI -0.3 to 4.3). The mean difference was similar for the UK 1990 criteria (mean difference = 2.0%, 95% CI 0.0 to 3.9). There was little between-country difference in the prevalence of obesity in this age group in either gender using the IOTF criteria (Table 3).

Estimates of obesity for older children were consistent with patterns of mean BMI. Whilst the actual estimates of obesity prevalence varied considerably by the criteria used in both countries, the mean difference in prevalence was similar for each criteria. For example, at

ages 12 through 17 the prevalence of obesity was markedly lower in English than US adolescents using the 2000 CDC criteria for obesity (difference = -7.4%, 95% CI -5.8 to -9.0), using the IOTF criteria (difference = -6.6%, 95% CI -4.7 to -8.5) and using the UK 1990 criteria (difference = -8.3%, 95% CI -10.0 to -6.5). US adolescents (aged 12 through 17) had the highest prevalence of obesity by age group and by country using each of the three criteria, with the highest estimate being 26.4% using the UK 1990 criteria.

Within country and gender groups, patterns by age differed according to the criteria used. For example, applied to English boys the three criteria each suggested a different pattern by age: 2000 CDC criteria indicated a higher prevalence of obesity in 2- through 5-year-olds (15.8%, 95% CI 14.2 to 17.3) than in 12- through 17-year-olds (9.0%, 95% CI 8.1 to 9.9) but the UK 1990 criteria indicated the opposite: a lower prevalence of obesity in 2- through 5-year-olds (14.7%, 95% CI 13.2 to 16.2) than in 12- through 17-year-olds (17.7%, 95% CI 16.5 to 19.0). For the same groups, IOTF criteria showed almost no difference between the 2- through 5-year-olds and the 12- through 17-year-olds, with estimated prevalences of obesity of 6.0% (95% CI 5.0 to 7.1) and 6.1% (95% CI 5.3 to 6.9), respectively. The same pattern of differences, according to the different criteria, was evident for obesity in English girls. In US boys and girls all three criteria identified increasing prevalence of obesity with age but the relative proportions were different: in US girls, for example, the 2000 CDC criteria identified 11.7% (95% CI 9.5 to 13.8) of 2- through 5-year-olds and 16.0% (95% CI 14.1 to 17.9) of 12- through 17-year-olds as obese whereas the UK1990 criteria identified a slightly lower percentage of 2- through 5-year-olds (10.9%, 95% CI 8.9 to 12.9) but a higher percentage of 12- through 17-year-olds (24.3%, 95% CI 22.0 to 26.6) as obese.

Figures 2 and 3 show how the criteria for obesity vary by age and gender. These illustrate why we see the differences in patterns by age, gender and country as described above. For example, in boys the IOTF criteria are higher than either of the two country specific criteria at all ages, resulting in lower prevalences of obesity. In contrast, for girls the IOTF criteria is similar to that of the UK1990 growth curve 95th percentile from ages 2 through 7, higher than both the country specific criteria until age 15, and has criteria similar to the 2000 CDC curve 95th percentile (but not the UK1990 curve) at ages 16 and 17.

We analysed the mean BMI and obesity prevalence (using only the IOTF criteria) for the age groups 2-5, 6-11, 12-19, by two year periods to check if there were between country differences in trends across time in BMI and obesity prevalence (Table 4 web-reference). There is no evidence of a difference between the countries in trends overtime. However, the numbers within each time period strata are small. There is also no evidence of a difference between consecutive two year periods for the prevalence of obesity or the mean BMI.

Discussion

Mean BMI differed between the countries by age, with English children having a higher mean BMI than their US peers at ages 2 through 5 but lower mean BMI at ages 8 and above. For public health the prevalence of obesity is particularly important but because population distributions of BMI are positively skewed, the patterns of mean BMI do not necessarily reflect patterns of obesity. We found US adolescents (ages 12 through 17) had the highest prevalence of obesity of all age groups and in either country by all three criteria (UK 1990, 2000 CDC, and IOTF).

A key finding of our analyses is that there were marked differences in obesity prevalence in each country and by age and gender when applying each of the three different criteria. However, general differences in the prevalence between England and the US were consistent irrespective of which criteria were used, except at younger ages where for all three criteria we found English children aged 2-5 to have a higher prevalence than US children, which was least marked for the IOTF criteria.

These findings have important implications for public health surveillance, clinical practice, and research into childhood obesity. For example, the higher prevalence of obesity in young children in England compared to the US might suggest efforts to prevent childhood obesity in England should focus on surveillance and intervention research in pre-school children. Furthermore, using IOTF criteria the overall prevalence of childhood obesity in both England and the US in all age groups was considerably lower than using either of the country-specific criteria, which is in keeping with studies which have found that the IOTF criteria have poor sensitivity for obesity (Reilly et al. 2000; Reilly et al. 2010; Zimmermann et al. 2004). Using the IOTF criteria one would be likely to estimate the magnitude of the childhood obesity epidemic as far smaller than when using the country-specific analyses.

Strengths and weaknesses of the study

A key strength of this analysis is the use of data collected as part of nationally representative surveys with standardized methods. We have used three established methods of classifying children and adolescents as overweight/obese and obese. International comparisons of the prevalence of obesity have relied on published studies from single countries using whatever classification system and years of coverage were used in the initial publication (Wang & Lobstein 2006). Our findings suggest relying on

country-specific classifications is likely to present problems in terms of making meaningful comparisons between as well as within countries.

A limitation of this study is that the prevalence estimates by age and gender are pooled over an 8-year period, during which time the prevalence of obesity increased and more recently has appeared to plateau (though longer term trends are required before it can be concluded that the epidemic has reached its peak in these countries) (Ogden et al. 2008;The Information Centre. 2008). The relatively small numbers of obese children/adolescents in each age group by year make it impossible to draw conclusions about annual differences between countries, however there appeared to be no difference between the two countries in trends over time when we examined the data in two-year periods. The mean and median age of the 2-5 year old English children was slightly older than the US children; this is unlikely to explain the differences seen in mean BMI because older children in the 2-5 year age group have decreasing BMI. We have not attempted to distinguish how the prevalence of obesity differs between the two countries in relation to these ethnicity and socioeconomic profiles because the two surveys assess these factors differently.

Two studies suggest all three criteria for defining childhood obesity used here have similar and high specificity but that the IOTF criteria may have lower sensitivity when compared to a gold standard of high body fat (Reilly, Dorosty, Emmett, & The ALSPAC Study Team 2000;Reilly, Kelly, & ilson 2010;Zimmermann, Gubeli, Puntener, & Molinari 2004). It could be argued that the best method for defining childhood obesity should be that which best predicts adverse obesity related short- and long-term outcomes. We therefore recommend that the IOTF and one or more country-specific criteria are used and compared in research

studies until it is clear which provides the best method for identifying children at greatest adverse consequences from obesity.

US adolescents aged 12 through 17 had the highest prevalence of obesity by age group compared to England using each of the three criteria assessed. In contrast, English children aged 2 through 5 had higher mean BMI and higher prevalence of obesity. It is unclear what factors drive these between country differences as there is currently a lack of high-quality studies exploring country-level differences in risk factors for obesity and examining how these explain the observed differences. Differences in the age of adiposity rebound and onset of puberty could account for some of the differences in mean BMI and obesity; both have been documented to occur earlier in US compared to European populations (Euling et al. 2008; Wang 2004; Wyshak and Frisch 82 A.D.). However, it has not been possible to examine this further using this data.

Our results demonstrate very marked differences in the prevalence of childhood obesity by age, gender and country when different, established methods for defining childhood obesity are applied to the data. For public health surveillance, clinical practice, research, and to permit meaningful international comparisons in prevalence of childhood obesity, it would be ideal to identify a gold-standard method of defining childhood obesity and to apply this method universally. Until there is clear evidence for adopting one method to apply to all data both IOTF and one or more country-specific criteria should be reported in future country-level surveillance systems and research. This would make international comparisons feasible and contribute to our understanding of the best method for defining childhood obesity, whilst preventing selective use of different criteria for political or publication reasons.

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Supplementary information is available at The European Journal of Clinical Nutrition's website.

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Table 1. Characteristics of participants in English and US surveys

Characteristics	Distribution	England (n=33,563)		US (n=14,540)	
		Male	Female	Male	Female
2-5y children					
Age	Mean (SD)	3.50 (1.12)	3.50 (1.11)	3.31 (1.14)	3.33 (1.16)
	Median (IQR)	4.00 (3)	3.50 (1)	3.00 (2)	3.00 (2)
	Skewness	-0.011	0.016	0.233	0.180
Weight	Mean (SD)	17.99 (3.98)	17.41 (3.96)	17.43 (4.54)	16.82 (4.04)
	Median (IQR)	17.6 (4.8)	16.9 (4.8)	16.5 (5.0)	16.2 (5.1)
	Skewness	2.097	1.432	1.970	1.307
Height	Mean (SD)	103.39 (9.43)	102.2 (9.64)	102.05 (9.83)	101.11 (9.73)
	Median (IQR)	104.0 (14.1)	102.4 (14.5)	101.20 (15.5)	101.0 (15.5)
	Skewness	-0.142	0.093	0.257	0.151
BMI	Mean (SD)	16.75 (2.52)	16.56 (2.19)	16.53 (2.05)	16.29 (1.97)
	Median (IQR)	16.45 (1.96)	16.3 (2.03)	16.19 (1.93)	15.93 (2.11)
	Skewness	6.568	3.310	2.401	1.519
6-11y children					
Age	Mean (SD)	8.50 (1.71)	8.52 (1.71)	8.48 (1.70)	8.50 (1.72)
	Median (IQR)	9.00 (3.00)	8.00 (3.00)	8.00 (3.00)	8.00 (3.00)
	Skewness	-0.012	0.004	0.014	0.009
Weight	Mean (SD)	32.20 (9.68)	32.82 (10.45)	34.74 (12.64)	35.36 (13.55)
	Median (IQR)	30.2 (11.8)	30.6 (13.1)	31.7 (14.7)	31.8 (17.4)
	Skewness	1.238	1.181	1.605	1.315
Height	Mean (SD)	133.67 (11.61)	133.55 (12.17)	134.75 (11.76)	134.98 (13.08)
	Median (IQR)	133.5 (17.0)	133.1 (17.7)	134.40 (17.0)	134.00 (20.1)
	Skewness	0.048	0.146	0.190	0.214
BMI	Mean (SD)	17.67 (3.07)	18.01 (3.36)	18.63 (4.30)	18.80 (4.36)
	Median (IQR)	16.9 (3.3)	17.2 (3.9)	17.31 (4.70)	17.49 (5.19)
	Skewness	1.544	1.953	1.800	1.390
12-17y adolescents					
Age	Mean (SD)	14.24 (1.66)	14.40 (1.68)	14.53 (1.73)	14.45 (1.70)
	Median (IQR)	14.00 (3.00)	14.00 (3.00)	15.00 (3.00)	14.00 (3.0)
	Skewness	0.186	0.088	-0.040	0.062
Weight	Mean (SD)	58.80 (15.38)	56.74 (12.80)	66.16 (20.44)	61.01 (16.82)
	Median (IQR)	57.6 (19.5)	55.1 (15.1)	63.1 (22.9)	57.1 (18.1)
	Skewness	0.799	0.934	1.240	1.501
Height	Mean (SD)	166.01 (11.51)	160.01 (7.27)	168.10 (10.82)	159.97 (7.10)
	Median (IQR)	167.2 (16.9)	160.2 (9.5)	169.2 (14.5)	160.1 (9.3)
	Skewness	-0.296	-0.301	-0.425	-0.052
BMI	Mean (SD)	21.008(3.98)	22.05 (4.27)	23.12 (5.80)	23.73 (5.88)
	Median (IQR)	20.3 (4.6)	21.22 (4.99)	21.75 (6.67)	22.14 (6.71)
	Skewness	1.270	1.194	1.592	1.488

Table 2. Percentage of children and adolescents overweight/obese¹ by age group and study for 1999 through 2006 (95% Confidence Intervals)

	2000 CDC			UK 1990			IOTF		
	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)
<i>Boys</i>									
2 - 5	32.2 (30.4 to 34.1)	24.9 (21.7 to 28.0)	7.4 (3.7 to 11.0)	29.2 (27.4 to 31.0)	22.1 (19.1 to 25.2)	7.1 (3.6 to 10.6)	20.7 (19.0 to 22.3)	15.3 (12.9 to 17.7)	5.3 (2.4 to 8.3)
6 -11	25.7 (24.3 to 27.1)	33.1 (30.0 to 36.3)	-7.4 (-4.0 to -10.9)	30.3 (28.9 to 31.8)	37.5 (34.2 to 40.7)	-7.2 (-3.6 to -10.7)	21.6 (20.3 to 22.9)	29.2 (26.3 to 32.1)	-7.6 (-4.5 to -10.7)
12 -17	22.4 (21.0 to 23.8)	33.0 (30.5 to 35.5)	-10.7 (-7.9 to -13.5)	31.1 (29.5 to 32.6)	43.0 (41.1 to 45.0)	-12.0 (-9.5 to -14.4)	23.7 (22.3 to 25.1)	34.5 (32.2 to 36.8)	-10.8 (-8.1 to -13.5)
2 -17	26.0 (25.1 to 26.9)	31.2 (29.2 to 33.2)	-5.2 (-3.1 to -7.4)	30.3 (29.4 to 31.3)	36.1 (34.2 to 37.9)	-5.7 (-3.7 to -7.8)	22.2 (21.3 to 23.0)	28.0 (26.3 to 29.8)	-5.9 (-4.0 to -7.8)
<i>Girls</i>									
2 -5	31.5 (29.5 to 33.4)	23.2 (20.6 to 25.8)	8.2 (5.0 to 11.4)	25.9 (24.1 to 27.7)	20.2 (17.8 to 22.6)	5.7 (2.7 to 8.7)	24.0 (22.2 to 25.9)	18.4 (16.0 to 20.8)	5.6 (2.6 to 8.6)
6 -11	27.1 (25.7 to 28.6)	30.7 (27.7 to 33.7)	-3.5 (-0.0 to -6.8)	29.4 (28.0 to 30.9)	33.3 (30.2 to 36.4)	-3.9 (-0.5 to -7.2)	27.0 (25.5 to 28.4)	30.9 (27.9 to 34.0)	-4.0 (-0.7 to -7.3)
12 -17	26.5 (25.1 to 27.9)	31.5 (28.8 to 34.1)	-4.9 (-2.0 to -7.9)	33.6 (32.0 to 35.2)	38.4 (35.8 to 41.1)	-4.8 (-1.7 to -7.9)	27.4 (26.0 to 28.9)	32.6 (30.0 to 35.2)	-5.2 (-2.3 to -8.1)
2 -17	27.9 (27.0 to 28.8)	29.2 (27.4 to 34.1)	-1.3 (0.1 to -3.3)	30.2 (29.2 to 31.2)	32.2 (30.4 to 33.4)	-2.0 (-0.0 to -4.0)	26.5 (25.6 to 27.4)	28.6 (26.8 to 30.4)	-2.2 (-0.0 to -4.2)
<i>All</i>									
2 -5	31.8 (30.5 to 33.2)	24.0 (21.8 to 26.3)	7.8 (4.9 to 9.9)	27.6 (26.2 to 28.9)	21.2 (19.1 to 23.3)	6.4 (3.9 to 8.8)	22.3 (21.1 to 23.6)	16.9 (15.1 to 18.7)	5.5 (3.3 to 7.7)
6 -11	26.4 (25.3 to 27.4)	31.9 (29.4 to 34.5)	-5.5 (-2.9 to -8.2)	29.9 (28.8 to 30.9)	35.4 (32.9 to 38.0)	-5.6 (-2.9 to -8.3)	24.2 (23.3 to 25.2)	30.1 (27.6 to 32.5)	-5.8 (-3.2 to -8.4)
12 -17	24.4 (23.4 to 25.4)	32.2 (30.2 to 34.3)	-7.8 (-5.6 to -10.1)	32.4 (31.2 to 33.5)	40.8 (39.0 to 42.5)	-8.4 (-6.4 to -10.4)	25.6 (24.5 to 26.6)	33.6 (31.6 to 35.5)	-8.0 (-5.8 to -10.0)
2 -17	26.9 (26.2 to 27.6)	30.2 (28.6 to 31.8)	-3.3 (-1.6 to -5.0)	30.3 (29.6 to 31.0)	34.2 (32.7 to 35.6)	-3.9 (-2.3 to -5.5)	24.3 (23.6 to 25.0)	28.3 (26.8 to 29.9)	-4.0 (-2.4 to -5.7)

¹ Overweight is defined as having age-gender specific Body Mass Index (BMI) above the 85th centile in the 2000 CDC/ UK1990 growth charts or above the criteria for overweight in the IOTF classification.

² Difference is England percentage minus US percentage, i.e. positive values indicate English figure higher than US, negative values indicate lower English figure

Table 3. Percentage of children and adolescents obese¹ by age group and study for 1999 through 2006

	2000 CDC			UK 1990			IOTF		
	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)	England % (95% CI)	US % (95% CI)	Difference ² % (95% CI)
<i>Boys</i>									
2 - 5	15.8 (14.2 to 17.3)	12.1 (9.9 to 14.3)	3.6 (1.0 to 6.3)	14.7 (13.2 to 16.2)	11.6 (9.4 to 13.8)	3.1 (-0.5 to 5.7)	6.0 (5.0 to 7.1)	4.6 (3.3 to 5.8)	1.5 (0.0 to 3.1)
6 -11	10.5 (9.5 to 11.5)	17.5 (15.3 to 19.7)	-7.0 (-4.7 to -9.4)	17.0 (15.8 to 18.2)	25.0 (22.4 to 27.5)	-7.9 (-5.1 to -10.7)	5.5 (4.7 to 6.2)	9.9 (8.3 to 11.5)	-4.4 (-2.7 to -6.1)
12 -17	9.0 (8.1 to 9.9)	17.9 (16.1 to 19.7)	-8.9 (-6.9 to -10.9)	17.7 (16.5 to 19.0)	28.5 (26.2 to 30.8)	-10.8 (-8.2 to -13.3)	6.1 (5.3 to 6.9)	14.1 (12.4 to 15.8)	-8.0 (-6.2 to -9.8)
2 -17	11.1 (10.5 to 11.8)	16.4 (15.2 to 17.7)	-5.3 (-3.9 to -6.6)	16.7 (16.0 to 17.5)	23.2 (21.6 to 24.9)	-6.5 (-4.7 to -8.3)	5.8 (5.3 to 6.3)	10.3 (9.3 to 11.3)	-4.5 (-3.4 to -5.6)
<i>Girls</i>									
2 -5	12.6 (11.2 to 14.0)	11.7 (9.5 to 13.8)	1.0 (-1.6 to 3.4)	11.7 (10.3 to 13.1)	10.9 (8.9 to 12.9)	0.8 (-1.6 to 3.2)	6.2 (5.1 to 7.3)	6.7 (5.1 to 8.3)	-0.4 (-1.3 to 2.3)
6 -11	11.1 (10.1 to 12.1)	15.5 (13.3 to 17.6)	-4.3 (-2.0 to -6.6)	16.2 (15.0 to 17.4)	21.5 (18.9 to 24.0)	-5.2 (-2.5 to -8.0)	7.3 (6.5 to 8.1)	11.6 (9.5 to 13.7)	-4.7 (-2.5 to -6.9)
12 -17	10.1 (9.0 to 11.1)	16.0 (14.1 to 17.9)	-5.9 (-3.8 to -8.1)	18.7 (17.4 to 20.0)	24.3 (22.0 to 26.6)	-5.6 (-3.0 to -8.2)	7.5 (6.6 to 8.4)	14.1 (12.4 to 15.8)	-6.8 (-5.0 to -8.6)
2 -17	11.1 (10.4 to 11.7)	14.8 (13.3 to 16.1)	-3.7 (-2.2 to -5.2)	16.1 (15.3 to 16.9)	20.1 (18.5 to 21.7)	-4.0 (-2.2 to -5.7)	7.1 (6.6 to 7.7)	11.4 (10.2 to 12.7)	-4.5 (-3.2 to -5.8)
<i>All</i>									
2 -5	14.2 (13.1 to 15.3)	11.9 (10.2 to 13.6)	2.3 (-0.3 to 4.3)	13.2 (12.2 to 14.3)	11.3 (9.5 to 13.0)	2.0 (0.0 to 3.9)	6.1 (5.3 to 6.9)	5.6 (4.6 to 6.6)	0.5 (-2.4 to 1.3)
6 -11	10.8 (10.1 to 11.5)	16.5 (14.7 to 18.3)	-5.7 (-3.8 to -7.6)	16.6 (15.8 to 17.5)	23.3 (21.2 to 25.3)	-6.6 (-4.5 to -8.8)	6.4 (5.8 to 6.9)	10.7 (9.3 to 12.1)	-4.3 (-2.1 to -6.5)
12 -17	9.5 (8.8 to 10.2)	16.9 (15.4 to 18.5)	-7.4 (-5.8 to -9.0)	18.2 (17.3 to 19.1)	26.4 (24.6 to 28.3)	-8.2 (-6.2 to -10.2)	6.8 (6.2 to 7.4)	14.1 (12.8 to 15.5)	-6.6 (-4.7 to -8.5)
2 -17	11.1 (10.6 to 11.6)	15.6 (14.5 to 16.7)	-4.5 (-3.3 to -5.7)	16.4 (15.9 to 17.0)	21.7 (20.3 to 23.1)	-5.3 (-3.8 to -6.7)	6.4 (6.1 to 6.8)	10.8 (10.0 to 11.8)	-4.3 (-3.0 to -5.6)

¹ Obesity is defined as having age-gender specific Body Mass Index (BMI) above the 95th centile in the 2000 CDC/ UK 1990 growth charts or above the criteria for obesity in the IOTF classification.

² Difference is England percentage minus US percentage, i.e. positive values indicate English figure higher than US, negative values indicate lower English figure

Legends for figures:

Figure 1. Mean BMI in English and US children and adolescents for 1999 through 2006 by age, boys and girls combined, with 95% Confidence Intervals

Figure 2. BMI thresholds for defining obesity by gender and age, boys aged 2 through 17

Figure 3. BMI thresholds for defining obesity by gender and age, girls aged 2 through 17

Figure 1.

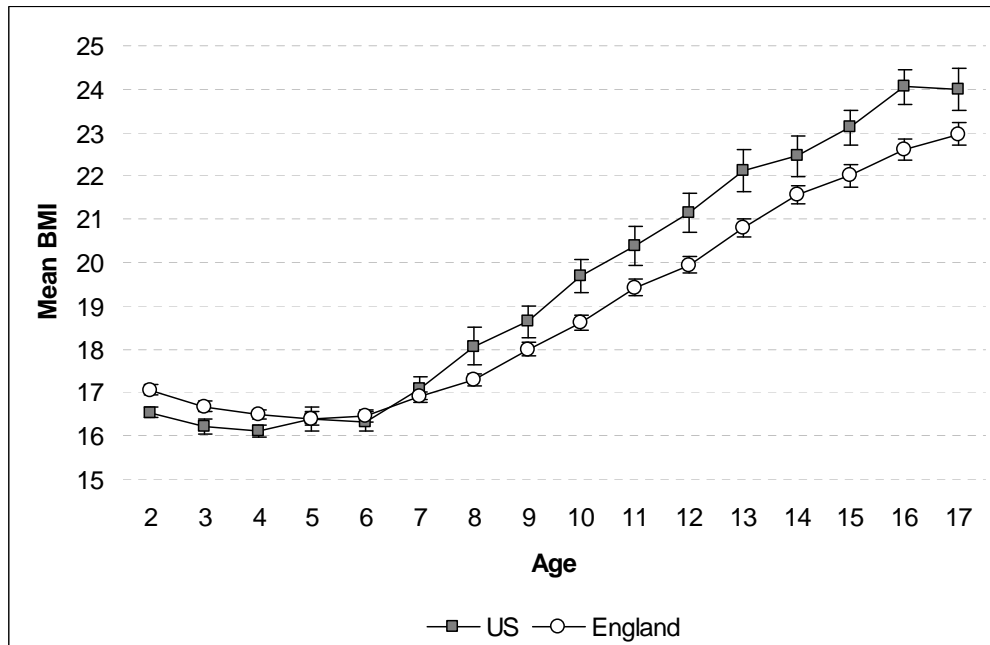


Figure 2.

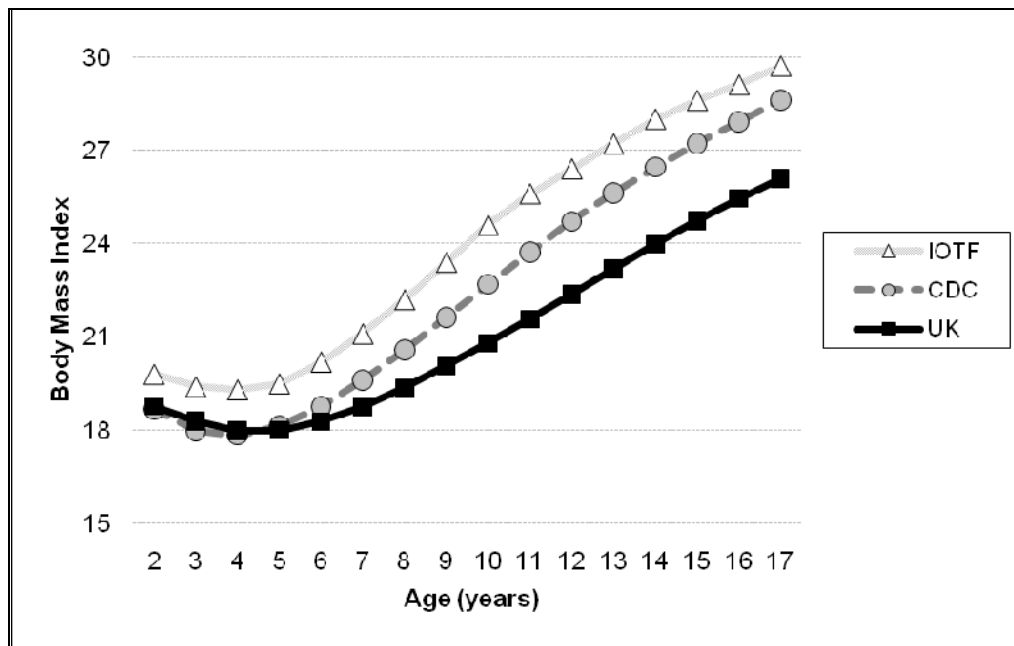


Figure 3.

