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Short communication
Impact of using national *v.* international definitions of underweight, overweight and obesity: an example from Kuwait

Mira El-Ghaziri[1], Shurooq Boodai[1], David Young[2] and John J Reilly[1,*†]
[1]Life Course Nutrition and Health, Yorkhill Hospitals, University of Glasgow, Glasgow, Scotland, UK:
[2]Department of Mathematics and Statistics, University of Strathclyde, Glasgow, Glasgow, Scotland, UK

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Abstract

Objective: To compare the classification of overweight, obesity and underweight using international *v.* national approaches in Kuwaiti adolescents.
Design: Assessment of underweight, overweight and obesity using a national approach (based on Kuwaiti reference data for BMI-for-age) was compared with assessments obtained using three international approaches: the Cole *et al.* and International Obesity Task Force (IOTF) definitions of thinness and of overweight and obesity (Cole-IOTF); WHO 2007; and US Centers for Disease Control and Prevention (CDC) 2000 reference data and definitions. The degree of agreement between the different methods was assessed using the weighted κ statistic (κ_w).
Setting: Two randomly selected public intermediate schools in Kuwait City.
Subjects: A total of 499 10–14-year-old Kuwaiti adolescents.
Results: Prevalence of overweight and obesity using Kuwaiti reference data (36·7%; 95% CI 32·4, 41·1) was significantly lower than that obtained using international approaches – Cole-IOTF (44·7%; 95% CI 40·3, 49·2), CDC 2000 (44·9%; 95% CI 40·5, 49·4) and WHO 2007 (50·5%; 95% CI 46·0, 55·0) ($P < 0·01$). All three international approaches showed almost perfect agreement: IOTF *v.* WHO ($\kappa_w = 0·82$; 95% CI 0·79, 0·85) and IOTF *v.* CDC ($\kappa_w = 0·90$; 95% CI 0·87, 0·92). However, Kuwaiti reference data showed the lowest agreement with the three international approaches, the poorest being with WHO 2007 ($\kappa_w = 0·54$; 95% CI 0·49, 0·59).
Conclusions: Caution should be exercised when using recently collected national reference data and definitions while assessing underweight, overweight and obesity for clinical and public health applications.

Keywords
Obesity
Overweight
Child
Adolescent
BMI
Underweight

Childhood obesity and underweight are both related to poor health outcomes in the short and long terms[1–5]. The 'double burden' of childhood undernutrition and overnutrition means that appropriate assessment is required at both ends of the spectrum of adiposity. BMI-for-age is the most suitable and simple means of assessing the weight status of children and adolescents[6–10]. BMI is appropriate for public health applications such as surveillance, monitoring the impact of population-based interventions and for clinical applications. However, interpretation of BMI-for-age is complicated by the use of different population reference data and different cut-off points.

The childhood obesity epidemic has been dramatic in the Arabian Gulf States and the Eastern Mediterranean[11,12]. Many nations in this area have, or are developing, BMI-for-age population reference data for the assessment of nutritional status because of the belief that between-nation variations in childhood growth and nutritional status are of biological significance[13,14]. Recent BMI-for-age reference data have been developed in Cyprus[15], Israel[16], the United Arab Emirates[17], Morocco[18], the Kingdom of Saudi Arabia[19], Turkey[20] and Kuwait[21]. However, most of these recent BMI-for-age reference data were constructed after 1997 and might thus reflect the effect of the obesity epidemic.

At present, there is no clear evidence with regard to the impact of using recently developed national *v.* international approaches on BMI-for-age-based definitions of

† Address for correspondence: Physical Activity for Health Research Group, School of Psychological Sciences and Health, University of Strathclyde, Jordanhill Campus, 76 Southbrae Drive, Glasgow G13 1PP, Scotland, UK.

*Corresponding author: Email John.Reilly@Glasgow.ac.uk, john.j.reilly@strath.ac.uk

weight status in older children and adolescents. Therefore, the present study aimed to quantify differences in assessment of weight status arising when recent national (Kuwaiti) and international BMI-for-age approaches and reference data were used with data from the same sample of Kuwaiti adolescents.

Methods

Sample and sampling frame

The sample was recruited from two randomly selected public intermediate schools in Kuwait City. Schools in Kuwait City were selected because Kuwait is highly urbanized. Of eight intermediate schools selected randomly, two agreed to participate. All 949 potentially eligible pupils in the schools were invited to take part. A total of 499 participants (53 %) and their families provided written informed consent. All were Kuwaiti nationals; there were 317 boys (63·5 %) and 182 girls (36·5 %) aged 10–14 years. The study obtained ethical approval from the Ethical Committee for Medical Research in Kuwait.

Anthropometric measurements

Measurements of weight and height were taken at each school by a trained researcher. Weight was measured with the subject standing, wearing light clothing, to the nearest 0·1 kg using a model TBF-300 scale (Tanita, Amsterdam, the Netherlands). Height was measured without shoes to the nearest 0·1 cm using a portable stadiometer.

Method comparisons: reference data and definitions

Four different approaches based on BMI-for-age were used to assess weight status: national reference data and definitions from recent Kuwaiti population reference data[21]; WHO 2007[6]; US Centers for Disease Control and Prevention (CDC) 2000[10]; and the Cole *et al.* and International Obesity Task Force (IOTF) recent definitions of thinness and more established definitions of overweight and obesity (Cole-IOTF)[8,9].

To define overweight and obesity, the cut-off percentiles used were ≥85th and ≥95th percentile, respectively, relative to the US CDC 2000 and Kuwaiti reference data, and a *Z*-score >+1 SD and >+2 SD, respectively, relative to WHO 2007 reference data, as these cut-off points are widely used and/or recommended[6,10,21]. For the Cole-IOTF definitions of overweight and obesity, the appropriate age- and sex-specific cut-off points that were conceptually equivalent to adult BMI values of 25·0 and 30·0 kg/m^2 were used.

For defining underweight or thinness, the cut-off points used with WHO 2007, US CDC 2000 and Kuwaiti reference data were those used and/or recommended elsewhere[6,10,20]: BMI-for age <5th percentile relative to CDC 2000 and Kuwaiti reference data; and a BMI *Z*-score <−2 SD relative to WHO 2007 reference data. Although no consensus definition of child or adolescent thinness based on BMI-for-age is available, Cole *et al.*[8] have proposed definitions conceptually equivalent to adult definitions based on BMI (with cut-off points equivalent to BMI values of 16·0, 17·0 and 18·5 kg/m^2 at the age of 18 years). A BMI of 17·0 kg/m^2 at 18 years of age is the proposed cut-off point for thinness grade 2[8], corresponding to *Z*-score <−2 SD; therefore, this was the cut-off point used in the present study.

Study participants were considered stunted if their height-for-age *Z*-score was <−2 SD relative to CDC 2000 and/or WHO 2007. Height-for-age *Z*-scores for the Kuwaiti sample were also calculated as a check on the appropriateness of the comparisons between the Kuwaiti sample and the external reference data.

Statistical analysis

Descriptive statistics are presented with mean and SD or median and range, as appropriate, together with 95 % CI.

The two-proportion test was used to compare prevalence of the different categories of weight status given by the different approaches. In order to determine the agreement between the four definitions of underweight/thinness, overweight and obesity at the individual level, the weighted κ statistic (κ_w) was used[22]. The κ_w value was calculated with 95 % CI and with four categories of weight status (underweight, healthy weight, overweight and obese). All κ_w values were interpreted as suggested by Landis and Koch[23]: 0·21–0·40 'fair agreement'; 0·41–0·60 'moderate agreement'; 0·61–0·80 'substantial agreement'; and 0·81–1·00 'almost perfect agreement'. Data collected were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences statistical software package version 14·0 (SPSS Inc., Chicago, IL, USA).

Results

Characteristics of study participants

Characteristics of study participants are provided in Table 1. Relative to the WHO 2007 and CDC 2000 approaches, Kuwaiti children and adolescents had high BMI-for-age *Z*-scores, but height-for-age *Z*-scores showed no statistically significant differences between the Kuwaiti sample and the international references.

Differences in the prevalence of underweight, overweight and obesity between international approaches and the national approach

Prevalence estimates for underweight/thinness, overweight and obesity from the various approaches are shown in Table 2. The Kuwaiti reference data provided the highest prevalence of healthy weight status (62·9 %) and the lowest

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Table 1 Summary of anthropometric data for study participants

	Entire sample (*n* 499)			Boys (*n* 317)		Girls (*n* 182)	
	Mean or median	SD or IQR	95 % CI	Mean or median	SD or IQR	Mean or median	SD or IQR
Age (years)	12·30	2·10	12·20, 12·40	12·31	1·15	12·29	1·20
Weight (kg)*	51·0	29·1	48·1, 54·0	51·2	29·3	50·9	28·9
Height (cm)†	151·5	9·7	150·7, 152·4	151·7	10·2	151·2	8·8
BMI (kg/m^2)†	23·4	6·7	22·8, 23·9	23·2	6·7	23·6	6·7
BMI-for-age *Z*-score*							
CDC	0·80	2·09	0·70, 0·93	0·80	2·08	0·82	2·09
WHO	0·99	2·64	0·85, 1·19	0·99	2·65	1·00	2·67
Height-for-age *Z*-score†							
CDC	−0·003	1·00	−0·092, 0·085	0·033	1·00	−0·018	1·24
WHO	−0·011	1·03	−0·102, 0·080	0·036	1·05	−0·092	1·00
	%	*n*		%	*n*	%	*n*
Prevalence of stunting							
WHO 2007	2·20	11		2·16	8	1·65	3
CDC 2000	2·00	10		2·21	7	1·65	3

IQR, interquartile range; CDC, US Centers for Disease Control and Prevention.
*Data are presented as median and IQR because of non-normal distribution.
†Data are presented as mean and SD because of normal distribution.

Table 2 Prevalence estimates for underweight, healthy weight status, overweight and obesity using four different approaches (*n* 499)

	Cole-IOTF			Kuwaiti reference			WHO 2007			CDC 2000		
	%	*n*	95 % CI*	%	*n*	95 % CI*	%	*n*	95 % CI*	%	*n*	95 % CI*
Healthy weight	55·3	276	50·8, 59·7	62·9	314	58·5, 67·8	49·3	246	44·8, 53·9	54·9	274	50·4, 59·3
Overweight and obesity	44·7	223	40·3, 49·2	36·7	183	32·4, 41·1	50·5	252	46·0, 55·0	44·9	224	40·5, 49·4
Overweight	11·8	59	9·1, 15·0	22·0	110	18·5, 25·9	6·0	30	4·1, 8·5	2·2	11	1·1, 3·9
Obesity	32·9	164	28·8, 37·2	14·6	73	11·7, 18·0	44·5	222	40·1, 49·0	42·7	213	38·3, 47·2
Underweight or thinness	0	0	N/A	0·4	2	0·1, 1·4	0·2	1	0·0, 1·1	0·2	1	0·0, 1·1

IOTF, International Obesity Task Force; CDC, US Centers for Disease Control and Prevention; N/A, not applicable.
*The proportion test (www.medcalc.org/manual/testoneproportion) was used to calculate 95 % CI for prevalence estimates.

estimate of overweight and obesity prevalence (36·7 %) and of obesity prevalence (14·6 %). The Kuwaiti reference produced significantly higher prevalence of healthy weight status (two-proportion tests, all $P < 0·01$) and significantly lower prevalence of overweight and obesity compared with all three international approaches (two-proportion tests, all $P < 0·01$).

No significant differences in the prevalence of healthy weight status and combined overweight and obesity prevalence were found between the three international approaches tested.

Agreement in assessment of weight status between the various approaches

Weighted κ values for the four approaches are given in Table 3. All international approaches showed 'almost perfect agreement', the highest being between CDC 2000 and WHO 2007 ($\kappa_w = 0·92$), with Cole-IOTF showing a high agreement with both WHO 2007 ($\kappa_w = 0·82$) and CDC 2000 ($\kappa_w = 0·90$). The Kuwaiti approach had the lowest agreement with the international approaches, the lowest agreement being with the WHO 2007 ($\kappa_w = 0·54$) and CDC 2000 approaches ($\kappa_w = 0·61$).

Table 3 Extent of agreement between the different approaches

	κ_w	95 % CI
Cole-IOTF *v.* CDC 2000	0·90	0·87, 0·92
Cole-IOTF *v.* WHO 2007	0·82	0·79, 0·85
Cole-IOTF *v.* Kuwaiti reference	0·69	0·65, 0·73
Kuwaiti reference *v.* CDC 2000	0·61	0·56, 0·66
Kuwaiti reference *v.* WHO 2007	0·54	0·49, 0·59
CDC 2000 *v.* WHO 2007	0·92	0·90, 0·95

κ_w, weighted κ statistic; IOTF, International Obesity Task Force; CDC, US Centers for Disease Control and Prevention.

Discussion

Main findings and study implications

The present study was the first to examine the impact of using recently collected national reference data and nutritional status definitions with international approaches using a sample from one of the Gulf states. The present study suggests that there might be fairly similar estimates of the prevalence of healthy and unhealthy weight status when international approaches are applied and also found an 'almost perfect' agreement (κ_w) between the various international approaches.

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The present study showed marked differences in the assessment of weight status between Kuwaiti and international approaches. These differences have important implications for public health applications of nutritional assessment, such as surveillance, identifying secular trends in weight status and evaluating the impact of interventional programmes. The findings of the present study also have clinical implications for Kuwait and other Gulf states. A detailed discussion of the origin of the marked difference between the Kuwaiti approach and the international approaches is beyond the scope of the present study; however, the recent origin of the Kuwaiti reference data (collected in 1999–2000) means that these were probably influenced greatly by the obesity epidemic: 95th percentiles for BMI for boys and girls of mean age 12·0 years from the Kuwaiti reference were 30·0 and 31·1 kg/m^2, respectively, whereas according to the US CDC reference these were 25·0 and 26·3 kg/m^2, respectively[21]. These differences between the Kuwaiti and other reference data probably reflect marked differences in energy balance between the populations used to derive reference data; the absence of significant height differences between the various approaches tested here supports this view[24].

Many nations that have experienced a childhood obesity epidemic have, or are in the process of developing, national BMI-for-age reference data. A debate is underway as to the merits of using national *v.* international reference data for assessment of weight status[7,25]. The present study suggests that public health and clinical decisions regarding whether or not to use national BMI reference data should be made with caution, particularly if the reference data were collected after the advent of the obesity epidemic. Using recently collected national BMI reference data could lead to underestimation of childhood obesity and overweight prevalence, as well as to an absence of clinical or public health interventions when these would be indicated.

Comparisons with other studies

No directly comparable studies from Gulf states have been published. Some studies from other populations have found similarities between the use of the WHO 2007 and US CDC 2000 reference data with regard to prevalence estimates of obesity[26,27], which relate to the large degree of overlap between these reference data sets. The significantly higher overweight and obesity prevalence observed using international references compared with national reference data was found in other populations[26,28], and the 'almost perfect' agreement between IOTF and WHO approaches was also found in one other study[29].

A recent systematic review found that the IOTF definition of obesity was highly conservative[7]. The fact that the Kuwaiti definition of obesity produced even lower estimates of obesity prevalence than the IOTF definition is a clear indication that use of the Kuwaiti approach would be too conservative.

Khasnutdinova *et al.*[30] in a recent study from Russia showed that using national reference data for BMI-for-age provided lower estimates for the prevalence of overweight and obesity compared with the WHO 2007, CDC 2000 and IOTF criteria, but only among boys. The possibility that agreement in the assessment of weight status between national and international approaches might vary greatly between the sexes might be worth exploring in future studies but was not possible in the present study because of lack of power.

Study limitations

The low prevalence of underweight or thinness among Kuwaiti children and adolescents in the present study meant that agreement between the various approaches for underweight could not be examined separately. The present study did not encompass the entire age range for which weight status could be assessed using *Z*-scores and percentile charts; therefore generalisability to younger and older populations would have to be established. The generalisability of the present study within Kuwaiti 10–14-year-old children is probably high, as the sample was recruited from urban public schools typical of those that educate most Kuwaiti nationals, although differential non-consent by weight status may have occurred. Generalisability beyond Kuwait is unclear and must be confirmed by future research. For nations that have collected BMI-for-age reference data recently (after the obesity epidemic), a similar impact on nutritional assessment can be expected.

Although the present study compared the agreement between various approaches, it is difficult to establish the validity of each, because at present no 'gold standard' exists. However, some of the approaches tested in the present study have good evidence of external validity. For example, a recent systematic review found that the Cole-IOTF definition of obesity has high specificity for obesity (defined as excess body fat content) among children and adolescents[7].

Conclusions

The various international approaches to assess weight status produce broadly similar assessments when applied to adolescents in Kuwait. More marked discrepancies in assessment of weight status would be expected with the use of national BMI-for-age reference data. Use of recently collected national reference data for BMI for the purpose of nutritional assessment should be considered with caution and requires a careful examination of whether the advantages outweigh the disadvantages.

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