SHORT REPORT

Obesity in Iranian children

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We surveyed 4315 2–5 year olds in Iran. Prevalence of obesity (BMI >95th centile, Iranian reference data) was compared with the recent "IOTF" approach. Prevalence was significantly higher than expected, and increased with age, but contradictory trends were obtained from the two approaches. Monitoring of childhood obesity using the BMI in developing countries is indicated, but differences associated with obesity definition should be considered.

Few data on obesity prevalence, based on the optimum definition using body mass index (BMI), exist for children in developing countries.[1] The aims of the present study were to estimate obesity prevalence from preschool children in Iran and examine differences in prevalence/trends associated with choice of BMI reference data. Iran is unusual in that it has national BMI reference data[2] which provide a baseline against which trends in obesity can be monitored and compared against the new International Obesity Task Force (IOTF) approach.[3] Iran experienced a rapid "nutrition transition" during the 1990s, with population decreases in physical activity, and increases in energy and fat intake. Increased obesity prevalence might therefore be expected.

METHODS

Survey methodology

A survey was carried out in two largely rural provinces of Iran in 1995: Gilan (population 2.2 million, literacy rate 79%) and Sistan (1.7 million, literacy 57%). The survey was designed to provide a random sample of approximately 4000 2–5 year olds (1% of target population) attending community clinics for routine health checks. Body weight was measured to 0.1 kg with children wearing light indoor clothing and no shoes. Height was measured to 0.1 cm.

Overweight and obesity prevalence

Iranian BMI reference data from 1990[2] were used to estimate overweight and obesity prevalence, defined as BMI ⩾85th and 95th centiles respectively, widely used and recommended definitions.[4] Differences between observed and expected prevalence (15% for overweight, 5% for obesity) were tested for significance using χ^2 goodness of fit tests. We also estimated prevalence of overweight and obesity using IOTF definitions.[3] Prevalence estimates are provided for 2–3 (mean age 2.5, SD 0.5 years) and 4–5 year olds (mean age 4.3, SD 0.4 years). Differences in prevalence between boys and girls and between the two provinces were tested for significance using χ^2 tests.

RESULTS

Differences in obesity and overweight prevalence (using national reference data) between children in the two provinces were not significant and data were combined. Prevalence of obesity relative to Iranian reference data significantly exceeded "expected" frequencies and tended to increase significantly with age (table 1). Using the IOTF approach, we found no significant differences in overweight or obesity prevalence between the sexes (in contrast to use of the Iranian reference) or between the two provinces. Obesity prevalence tended to *decline* significantly with age using the IOTF approach. Obesity prevalence with IOTF reference data was significantly higher in the 2–3 year olds than when using the Iranian reference data (table 1).

DISCUSSION

The present study raises a number of important issues for monitoring of childhood obesity worldwide. First, estimates of obesity prevalence using the "international" approach showed the opposite trend with age to that obtained using national reference data. Second, gender differences observed using national reference data were not apparent when the international approach was used. The IOTF cut offs used to define

Abbreviations: BMI, body mass index; IOTF, International Obesity Task Force

Table 1 Prevalence of overweight and obesity

	2–3 year olds, n (%)		4–5 year olds, n (%)	
	Overweight	Obesity	Overweight	Obesity
Iranian reference data				
Boys	312/1283 (24.3)*	97/1283 (7.6)*	241/874 (27.6)**	74/847 (8.7)
Girls	259/1277 (20.3)	67/1277 (5.2)	194/881 (22.0)	66/881 (7.5)
Total	571/2560 (22.3)	164/2560 (6.4)	435/1755 (24.8)	140/1755 (8.0)
IOTF reference data				
Boys	286/1283 (22.3)	133/1283 (10.4)	154/874 (17.6)	62/874 (7.1)
Girls	315/1277 (24.7)	147/1277 (11.5)	167/881 (19.0)	69/881 (7.8)
Total	601/2560 (23.5)	280/2560 (10.9)	321/1755 (18.3)†	131/1755 (7.5)†

Iranian reference. Prevalence significantly exceeded "expected" frequencies except for obesity in 2–3 year old girls. Prevalence of overweight and obesity significantly higher (p<0.05) in 4–5 year olds than 2–3 year olds. Significant difference in prevalence between boys and girls: *p<0.05; **p<0.01.
IOTF reference. No significant differences between the sexes. †Prevalence significantly higher in 2–3 year olds compared to 4–5 year olds (p<0.01).

Table 2 BMI values (kg/m^2) for different definitions of overweight and obesity

Age	Definition: Iran	IOTF	UK	USA
2.0 years				
Overweight				
Boys	18.60	18.41	18.13	18.16
Girls	18.80	18.02	17.83	18.02
Obesity				
Boys	21.80	20.09	19.09	19.34
Girls	22.70	19.81	18.83	19.11
3.0 years				
Overweight				
Boys	17.50	17.89	17.56	17.35
Girls	17.70	17.56	17.39	17.19
Obesity				
Boys	20.10	19.57	18.50	18.27
Girls	20.80	19.36	18.41	18.28
4.0 years				
Overweight				
Boys	16.80	17.55	17.14	16.93
Girls	17.00	17.28	17.23	16.81
Obesity				
Boys	19.00	19.29	18.07	17.84
Girls	19.60	19.15	18.31	18.03
5.0 years				
Overweight				
Boys	16.40	17.42	16.96	16.84
Girls	16.50	17.15	17.17	16.79
Obesity				
Boys	18.30	19.30	17.94	17.92
Girls	18.80	19.17	18.34	18.24

Cut offs refer to 85th (overweight) and 95th (obesity) centiles and are taken from UK 1990 reference[5] and CDC 2000 reference (www.cdc.gov/nchs/about/major/nhanes/growthcharts/datafiles.htm).
IOTF values from Cole *et al*.[3]

obesity were generally lower in the younger children than their Iranian equivalents, but higher in the older children, producing differences in prevalence. While differences in prevalence as a function of different definitions might not be unexpected, they are potentially important. Differences in age trends or between group prevalence differences were more surprising and are also potentially important, particularly if replicated in other countries.

The 95th centile BMI cut offs for 5 year olds in Iran, the USA, and UK[5] are very similar (table 2), although BMI reference values at the lower end of the distribution from Iran are lower. This suggests an unexpected degree of consistency in obesity definition between some populations. The definition BMI ⩾95th centile is also biologically meaningful: presence and clustering of cardiovascular risk factors is significantly more likely in children above this cut off; it successfully classifies the fattest children.[6] The "IOTF" definition has not yet been tested for biological validity,[6] but an assessment of the likely impact of using it can be made by comparing the national and international approach, as here.

Estimates of overweight and obesity prevalence in the present study (Iranian reference data) increased with age, as expected.[1] Our estimates probably underestimate the problem given this increase in prevalence with age and the inclusion of only preschool children in the present study.[1] We might also have underestimated prevalence because the provinces surveyed were largely rural: education and urbanisation are major risk factors for childhood obesity in developing countries.[1] Our estimates were therefore conservative, but showed a higher prevalence in 1995 than in the national dataset. This was probably the result of the rapid transition in diet and activity in Iran during the 1990s. Alternatively, children in the two provinces might have been particularly susceptible to obesity, but this is unlikely in view of their lower levels of education and urbanisation.

In summary, the present study provided conservative but unexpectedly high estimates of overweight and obesity prevalence in young Iranian children. Differences in age trends/gender differences may be associated with choice of BMI reference data (national or international) and these merit further investigation given the increasing use of the "international" obesity definition. This study also highlights a need for further monitoring of global childhood obesity trends, and the need for collection of BMI data in future surveys in developing countries.

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COMMENTARY

ONE CHEER FOR THE INTERNATIONAL DEFINITIONS OF OVERWEIGHT AND OBESITY

The widespread increasing prevalence of overweight and obesity in adults and children has resulted in a proliferation of body mass index (BMI) national reference values of child overweight and obesity.[1–5] Reference values for overweight and obesity are needed for clinical practice and for monitoring changes in their prevalence overtime and between countries and groups. Dorosty and colleagues carried out a survey of preschool children in two rural Iranian provinces and were concerned to find an increasing prevalence of overweight and obesity using Iranian reference values based on children from Teheran.[6] They also highlighted that the estimates of prevalence showed discordant trends by age and gender when using the Iranian[6] and international definitions of obesity and overweight.[7] We had also shown discordances in the UK, but with different characteristics.[8] The diversity of definitions of obesity and overweight is transforming the field into a Tower of Babel in which we are unable to compare results systematically between countries.

BMI in kg/m^2 provides a convenient measure of adults' adiposity for which no population specific reference data are needed. In adults obesity (BMI 30+) and, less so, overweight (BMI 25 to 29.99) are related to morbidity.[9] The extension of BMI to children, although less compelling, may provide unified definitions of overweight and obesity for children and adults. BMI markedly changes with age in children while in adults the change is gradual. Tracing back the meaningful adult cut off points, BMI 25 and 30, along the centile lines in childhood, as proposed by Cole and colleagues, might provide a solution.[7]

Dorosty and colleagues' paper provides an opportunity for reviewing the requirements for a common approach to assess childhood prevalences of overweight and obesity. In the following we discuss measurements techniques, the validity of BMI, international and national definitions of obesity, and what next. It is beyond our purpose to discuss sampling issues, except to note that we would have welcomed an explanation as to whether those attending community clinics for routine health checks were representative of the whole population.

Measurement techniques

A sine qua non of any growth study is that the measurements are well standardised. Height and weight seem easy to measure and the instruments for their assessment usually available, but their quality is sometimes unsuitable. Unfortunately many journals accept manuscripts based on poorly described measurement techniques. Sadly, the study of Dorosty and colleagues is not an exception. The children in their study were measured with "light indoor clothes". If researchers are unable to weigh children without clothes they must provide evidence that this source of variation was taken into account. Toddlers may have changed BMI category simply by wearing a wet nappy when measured. This event may add as much as 200 g and change BMI by 0.2–0.4 units. Measurements were taken "to 0.5 cm and 0.5 kg". The recommended procedure is to record measurements to the last completed digit[10] and correct for the bias, unless an electronic device is used. The authors of the Iranian reference values[6] make it clear that height was recorded to the nearest centimetre and weight to the nearest kilogram and the level of uncertainty is compounded in this study, as the study on which the Iranian reference values are based does not give information on the clothes worn by the children.[6] Height measurement in toddlers is difficult. Trained personnel are needed for ensuring, for example, that heels are near each other and in contact with an upward wall and the head is in the Frankfurt position.[10] Underestimation of height and overestimation of weight can be a source of spurious increase in the prevalence of overweight and obesity.

Validity

In adults, dichotomised BMI and percentage of body fat determined by underwater weighing have been shown to have a kappa statistic of 0.58, denoting only a fair level of agreement.[11] The percentage of body fat corresponding to the 85th centile, varies from 18% to 33% in males and 24% to 37% in the age band 4–19 years.[12] Using best trade off between sensitivity and specificity for BMI, and dual energy *x* ray absortiometry as a criterion, agreement has been shown to vary from reasonable to excellent between 10 and 15 years,[13] but it is not practical to use varying BMI centiles by age and gender to define obesity. Based on bioelectrical impedance, a less satisfactory criterion, Reilly *et al* reported that the 95th centile of the British BMI reference values has a sensitivity of 88% and specificity of 94% for obesity defined as the top 5% of body fat.[14] They reported a sensitivity of 46% in boys and 72% in girls, and a specificity of 99% in each gender, when using the international definitions.[14] The work of Reilly *et al* may indicate that the cut off points of obesity and, probably, overweight, of the international definitions may be less valid than the UK definitions for British children. The validity of BMI in children and adolescents will be uncertain because the proportional contribution of fat and lean mass to total weight will be variable over the ages, but, if possible, we should avoid the use of definitions in which the validity varies by gender.

International and national definitions of BMI

The drawback of separate national reference values is that, given the large variation between them,[1–5] comparison of prevalences of overweight and obesity between countries is unsound. Under the auspices of the International Obesity Task Forces (IOTF), reference values based on surveys carried out in six countries were proposed.[7] It would be advantageous if cut off points were chosen to maximise prediction of health effect,[15] but, although there is evidence that obesity is related to morbidity in children,[16] its main effects are related to adult morbidity.

Dorosty and colleagues showed little difference between genders when using the international definitions, but significant differences when using the Iranian reference values. In Britain we showed that prevalences of overweight and obesity were substantially higher in girls when using the international definitions, varying by a factor of 1.2–2.0 by age and year of the survey.[8] Compared to the UK 1990 reference values, the international definitions created large differences in expected overweight and obesity between genders, being very large in under 9 year olds and decreasing thereafter. The varying difference may be caused by averaging curves of different shapes from six countries.[8 17] The shape of overweight and obesity in the Singapore survey, a contributor of the international definitions, was clearly anomalous, but left in because of its "modest" overall effect.[7] Brazil, another contributor, had the highest z score associated with BMI 25 in males and the second lowest z score in females, hence its inclusion will have had the effect of lowering the prevalence in boys and increasing it in girls. The data from Britain, Iran, and Brazil are showing discordant gender difference in obesity and overweight. This is of great interest as it may be reflecting cultural issues impinging on obesity. This sort of diversity can be documented when national and international definitions are being compared.

Dorosty and colleagues' strategy to compare prevalence of obesity and overweight using Iranian and international definitions is appropriate. However, their use of 85th and 95th centiles as cut off points of overweight and obesity when using the Iranian standards should be avoided. An advantageous feature of the international definitions is that they are based on unifying definitions for adults and children. Tracing back BMI 25 and 30 at 18 years provides consistent definitions of overweight and obesity regardless of age. Using above the 85th and 95th centiles in children and BMI 25 and 30 in adults may cause a change in the status of a child on the 18th birthday without a change in fatness.[18] Such definitions are over dependent on the choice of year to define the standard, and it may be that in 1990 Iranian boys were less overweight than girls.

What next?

International definitions of obesity and overweight are of great epidemiological value. There are so far few comparisons of prevalences of obesity according to the type of definitions and more reports are welcome. These comparisons would inform on the diversity of patterns of obesity by gender and age across countries by economic development and cultural background. We would be able then to take a decision as to whether the international definitions are serving us well. It is our view that international definitions based on the average of six countries would represent the properties of none. We do not see an impediment, except political considerations, for international definitions based on one well designed national survey, provided such a country does not have a very high or a very low prevalence of overweight and obesity that it would unduly hide or inflate estimates of overweight and obesity. If the values were chosen from one country, the z scores would belong to a real population and details such as measurement techniques would be available for comparative purposes.

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