

# Comparison of BMI-for-age in adolescent girls in 3 countries of the Eastern Mediterranean Region

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مقارنة مَنسَب كتلة الجسم بحسب العمر لدى المراهقات في ثلاثة من بلدان شرق المتوسط  
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**الخلاصة:** إن الافتقار إلى مرجع موحد ومتفق عليه لإجراء القياسات، يعرقل المقارنات الدولية لزيادة الوزن والسمنة في المراهقين. وقد قام الباحثون بمقارنة ثلاثة من مراجع القياس هذه على عينات من المراهقات من الكويت، ومصر، ولبنان، وتبين منها جميعاً أن كلا السمنة وزيادة الوزن تبلغ أعلى معدلاتها في الكويت، وأدنى معدلاتها في لبنان. وإذا كان هناك تفاوت طفيف بين أداء المعايير الثلاثة، فإن الباحثين يعتقدون أنها جميعاً تصلح للمقارنة بين بلد وآخر.

**ABSTRACT** International comparisons of adolescent overweight and obesity are hampered by the lack of a single agreed measurement reference. We compared 3 BMI-for-age references on samples of adolescent girls from Egypt, Kuwait and Lebanon. Overweight and obesity was highest in Kuwait and lowest in Lebanon. Performance of the 3 standards differed only slightly although one was particularly applicable in country-to-country comparisons.

## Comparaison de l'indice de masse corporelle (IMC) selon l'âge chez des adolescentes de trois pays de la Région de la Méditerranée orientale

**RÉSUMÉ** La comparaison d'un pays à l'autre du surpoids et de l'obésité chez l'adolescent se heurte à un obstacle, à savoir l'absence d'un instrument de mesure de référence, unique et valide. Nous avons comparé 3 normes de mesure distinctes sur un échantillon d'adolescentes égyptiennes, koweïtiennes et libanaises. Le surpoids et l'obésité se sont avérés plus importants au Koweït et plus faibles au Liban. Nous n'avons guère constaté de différences entre les performances des 3 normes de mesure, bien que nous soyons convaincus que l'une d'entre elles semble plus particulièrement adaptée à des comparaisons d'un pays à l'autre.

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## Introduction

According to the World Health Organization (WHO), adolescents comprise about 19% of the world's population (approximately 1.2 billion people), yet "adolescents remain a largely neglected, difficult-to-measure, and hard-to-reach population, in which the needs of adolescent girls in particular are often ignored" [1].

There are few published studies that focus on overweight and/or obesity among adolescent girls in the Eastern Mediterranean Region of the WHO, even though studies conducted elsewhere in the world indicate that the problem is increasing in prevalence, and a growing health concern. For adults, overweight and obesity have been shown to be associated with increased risk for coronary heart disease, hypertension, osteoarthritis, gall bladder disease and certain cancers [2]. Overweight and obesity and the intake of excessive amounts of energy among adolescents may precipitate chronic diseases in later life [3,4].

This study provides a comparison of adolescent girls from 3 countries (Egypt, Kuwait and Lebanon) of the 22 countries

in the Eastern Mediterranean Region. The Region includes countries in which dietary energy intake is among the highest in the world (e.g. Egypt, Kuwait and Tunisia) and also among the lowest (e.g. Afghanistan and Yemen) [5]. The demographic, health, food security, development and economic situations vary widely in the Region. Table 1 displays selected indicators for the 3 countries compared in this report.

With increases in life expectancy, energy intake and rate of sedentariness in the Region, chronic diseases associated with obesity seem also to be increasing [6]. The area has the highest dietary energy surplus of the developing countries, coupled with large downward shifts in physical activity patterns. These changes are reflected in rising obesity rates and high levels of chronic and degenerative disease [6]. Knowledge of the prevalence of overweight and obesity thus becomes an important foundation for public health action.

### Lack of an international reference standard

An important obstacle to the assessment of the prevalence of overweight and obesity in

Table 1 **Background characteristics of 3 countries of the Eastern Mediterranean Region [10]**

Indicator	Lebanon	Egypt	Kuwait
Area (m <sup>2</sup> )	10 452	1 001 450	17 818
Population	4 260 000	66 794 000	2 331 000
Mean age (years)	26.4	23.1	25.9
Population growth rate (%)	1.6	2.1	3.9
Infant mortality rate per 1000 live births	26.0	25.5	9.6
Life expectancy (years)	71.3	69.3	78.4
GDP per capita (US\$)	4 000	1 380	16 777
Female literacy (%)	84.0	50.0	86.5

GDP = gross domestic product.

adolescents is the lack of a single internationally agreed reference or cut-off value. Unlike the body mass index (BMI) cut-offs for adults, which are generally accepted to be 25 kg/m<sup>2</sup> (overweight) and 30 kg/m<sup>2</sup> (obesity), overweight and obesity in adolescents are related to age and sex [7]. There are several references in existence but none has gained consensus as the most sensitive or accurate measure of overweight or obesity across all populations.

This report compared the performance of 3 references—those of Cole et al. [7], Must, Dallal and Dietz [8] and Kuczmarski et al. (CDC 2000) [9]—in adolescent girls from 3 countries.

The Cole et al. reference was among the first to be used that was based on data collected from several different populations [Brazil, Britain, Hong Kong, the Netherlands, Singapore and the United States of America (USA)] [7]. It provides cut-offs that are linked to the widely accepted adult BMI cut-off points.

The reference of Must, Dallal and Dietz uses the National Health and Nutrition Examination Survey (NHANES) I data, collected between 1971 and 1974 in the USA, and is derived from calculated BMI percentiles for individuals 6–74 years of age [8]. For children and adolescents, it classifies overweight as  $\geq 85$ th percentile and obesity as  $\geq 95$ th percentile. This reference was developed using data collected prior to the recent upsurge in overweight and obesity in American children.

In 2000, the US Centers for Disease Control and Prevention (CDC) promulgated new references for the USA that were based on data collected from European Americans, African Americans and Mexican Americans sampled between 1988 and 1994 in the NHANES III study. This surveyed a representative cross-sectional sample of the US civilian non-institutionalized population aged 2 months and older [9].

### Purpose of this study

The aims of this study were to estimate and compare the prevalences of overweight and obesity in adolescent females from Kuwait, Egypt and Lebanon using 3 BMI-for-age references. We also sought to relate the findings to energy intake and to other anthropometric indicators (e.g. BMI) of body composition. We sought to determine how the references performed in adolescent girls in this Region. This type of comparison has not been performed in this population previously.

### Methods

The study populations consisted of healthy non-pregnant girls (10–19 years of age) drawn from studies previously conducted in Egypt, Kuwait and Lebanon. Each sample of adolescent girls was analysed separately. In the case of Egypt, data were drawn from a convenience sample of 340 girls attending public or private middle and secondary schools in the Nile Delta (in Cairo and nearby rural areas). The Egyptian data were originally collected from rural and urban girls to examine the relationship of body mass index to body image [10, 11]. For Kuwait, dietary and blood data were collected for 245 secondary school-aged girls along with anthropometric data to assess anaemia and nutritional status. The study was conducted to contrast nutritional status and dietary intake in anaemic and non-anaemic girls [12]. For Lebanon, data on 336 adolescent girls were taken from a larger representative national nutrition survey of the entire population [13]. This was a national representative survey targeting households in each of the country's 6 governorates and 26 districts and included 10% of the total Lebanese population of 3.4 million. Using a 3-stage stratified cluster design, the sample

( $n = 65\ 000$  households) was self-weighted and was selected based on a probability sample proportional to population size [13]. For the comparison of adolescents in our study, adults and children were excluded.

Table 1 provides a comparison of selected background information on the 3 countries [14]. Kuwait, Egypt, and Lebanon are predominantly Arabic speaking countries. They differ significantly in a number of indices, including per capita income, population, population growth rate and life expectancy at birth. Kuwait is the richest with an estimated gross domestic product (GDP) per capita more than 4 times greater than Lebanon and 12 times greater than Egypt. This higher economic status is reflected in a significantly lower infant mortality rate, higher life expectancy and higher rate of female literacy (Table 1). Kuwait is unique among the 3 countries because only 800 000 of the 2.3 million people residing in the country are citizens.

In each country, trained interviewers collected background demographic, social, and economic information onto structured, pre-tested questionnaires. The studies were approved by the human studies committees or ministries of health in each country and detailed methods have been given previously in publications from original survey data collected for Egypt [10,11], Kuwait [12] and Lebanon [13].

### Anthropometric values

Weights and heights were collected in each survey using standard WHO techniques [1]. Body mass index was calculated as weight (kg) divided by the square of the height (m). Waist-to-hip ratios (for Egypt and Lebanon) were obtained using standard WHO methods [1]. Overweight and obesity were defined according to the age- and gender-specific percentiles of BMI for each of the 3 references [7–9].

### Dietary information

Dietary information was collected (in each country) using the 24-hour recall method by trained dietitians or nutritionists who were experienced in survey/nutrition surveillance field methods. Dietary data were analysed using the *Nutritionist 4* program. Energy and nutrient intakes were estimated separately for adolescents in each country.

### Statistical analysis

The data were analysed using both descriptive and inferential statistics. Mean and frequency were used to describe various indicator variables such as mean BMI or proportion of girls below various BMI references. Inferential statistics (correlations) were used to compare BMI with other variables within country samples.  $P$ -value  $\leq 0.05$  was accepted as indicating statistical significance. *SAS* version 8.1 was used to analyse each data set.

### Results

The study included a total of 922 healthy adolescent girls: 336 Lebanese, 340 Egyptian and 245 Kuwaiti. The girls were students at the middle or secondary level. Table 2 provides a comparison of the age and anthropometric values. The mean ages of the Egyptian and the Lebanese girls were similar. However, Kuwaiti girls were, on average, older because the sample for which dietary data were available included 14–19 year olds only.

The mean weights, heights, and BMIs of Egyptian girls were higher than in Lebanese girls of comparable ages. Mean waist circumference and waist-to-hip ratio of Egyptian girls were also greater than those of Lebanese girls. The mean weight, height and BMI of Kuwaiti girls were higher than those of both Egyptians and Lebanese, even

**Table 2 Comparison of anthropometric indices in adolescent girls in 3 countries of the Eastern Mediterranean Region**

Variable	Egypt (n = 340)		Lebanon (n = 336)		Kuwait (n = 245)	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	14.4	1.8	14.2	2.9	16.1	1.3
Weight (kg)	54.7	14.9	49.1	11.9	57.2	15.1
Height (cm)	155.8	7.4	154.7	10.7	155.9	5.6
BMI (kg/m <sup>2</sup> )	22.5	5.2	20.5	3.5	23.5	5.9
Waist (cm)	71.6	9.9	69.2	8.6	NA	–
WHR	0.77	0.001	0.76	0.06	NA	–

SD = standard deviation.

BMI = body mass index.

NA = not available.

WHR = waist-to-hip ratio.

when the analyses were restricted to those of similar ages, i.e. 14–19 years (Tables 2 and 3).

#### Comparison of BMI-for-age values with the 3 references

For ages 11–17 years (Table 3), Egyptian adolescents had higher mean BMI than

did their Lebanese counterparts. The small sample sizes for 18- ( $n = 5$ ) and 19-year old ( $n = 1$ ) Egyptian adolescent girls precluded meaningful comparison among the 3 countries at these ages. The mean BMI of Kuwaiti girls was greater than that of Lebanese girls at every age over the age range 14–19 years. Egyptian girls had higher BMI

**Table 3 Mean body mass index (BMI) for adolescent girls in 3 countries of the Eastern Mediterranean Region**

Age (years)	Egypt (n = 340)		Lebanon (n = 336)		Kuwait (n = 245)	
	No.	BMI Mean (SD)	No.	BMI Mean (SD)	No.	BMI Mean (SD)
10	1	15.05 –	26	18.40 (3.22)	NA	–
11	10	19.32 (4.37)	29	18.38 (3.46)	NA	–
12	48	19.68 (4.16)	35	18.87 (2.58)	NA	–
13	50	21.01 (5.54)	42	20.39 (3.73)	NA	–
14	59	22.18 (4.94)	32	21.32 (3.65)	16	25.09 (8.07)
15	68	22.61 (4.73)	40	21.76 (3.45)	78	23.17 (5.24)
16	58	23.79 (4.63)	35	20.80 (2.48)	66	23.39 (6.20)
17	40	25.65 (5.54)	32	20.93 (2.16)	43	23.86 (6.10)
18	5	24.05 (3.77)	40	20.63 (2.86)	26	21.91 (3.93)
19	1	23.94 (–)	25	23.03 (4.23)	16	25.40 (6.70)

SD = standard deviation.

NA = not available.

values between 16 and 17 years. The BMI of Kuwaiti girls was greater than that of Lebanese and Egyptian girls aged 14–15 years. However, at age  $\geq 16$ , Egyptian girls had the highest mean BMI.

### Overweight

The proportion of overweight girls varied by country, by reference and by age (Tables 3 and 4). We compared adolescent girls from 3 countries using sex-specific BMI-for-age references published by Cole et al. [7], Must, Dallah and Dietz [8] and the CDC in 2000 [9] (Table 4). All 3 references indicated that the Egyptian girls had the highest proportion of overweight. The Must, Dallah and Dietz and Cole et al. references gave identical estimates (35.9%) for Egyptian girls, while the CDC 2000 reference gave a slightly lower estimate (34.4%).

All 3 references indicated the lowest proportion of overweight was for Lebanese girls with the Must, Dallah and Dietz reference giving the lowest overall estimate (15.5%). The range, among the references,

for percentage overweight in the sample was greatest for Lebanese girls (15.5%–18.8%). Despite this variation, all of the references indicated roughly half as many Lebanese girls were overweight as Kuwaiti or Egyptian girls.

The Cole et al. reference gave the highest estimate of overweight for all 3 groups. The Must, Dallah and Dietz and Cole et al. references gave identical percentages for overweight for Egyptians, while the CDC 2000 and Must, Dallah and Dietz references gave identical percentages for overweight for Kuwaitis.

### Obesity

All 3 references showed Lebanese girls with the lowest and Kuwaiti girls with the highest percentage of obesity. Comparing the references, the method of Cole et al. gave the lowest percentage estimate, while the CDC 2000 reference tended to give the highest estimate of obesity. The range across the 3 references was lowest for Lebanon (0.6%) and highest for Kuwait (2.1%). There were greater differences in estimating overweight than there were in estimating obesity.

### Dietary data

Table 5 shows a comparison of energy and macronutrient intakes of the adolescent girls. The mean energy intake was highest in Egyptian and lowest among Kuwaiti girls. Mean intakes of protein and fat were also highest in Egyptian girls. The correlations between BMI and total energy intake among Kuwaiti girls was not significant ( $r = 0.83$ ,  $P = 0.196$ ,  $n = 245$ ); while the correlation between BMI and calorie intake among Lebanese girls ( $r = 0.143$ ,  $P = 0.009$ ,  $n = 336$ ) and Egyptian girls ( $r = 0.212$ ,  $P = 0.001$ ,  $n = 340$ ) were significant.

Table 4 Comparison of overweight and obesity in adolescent girls in 3 countries of the Eastern Mediterranean Region using 3 different methods

Country	Cut-off reference Method		
	Cole [7]	Must [8]	CDC 2000 [9]
<i>Lebanon</i>			
Overweight (%)	18.8	15.5	16.4
Obesity (%)	2.1	2.7	2.7
<i>Kuwait</i>			
Overweight (%)	33.1	31.0	31.0
Obesity (%)	12.2	13.5	14.3
<i>Egypt</i>			
Overweight (%)	35.9	35.9	34.4
Obesity (%)	11.2	11.2	13.5



**Table 5 Comparison of selected daily nutrient and energy intakes of adolescent girls in 3 countries of the Eastern Mediterranean Region**

Variable	Egypt (n = 340) Mean (SD)	Lebanon (n = 336) Mean (SD)	Kuwait (n = 245) Mean (SD)
Energy (MJ)	8.1 (2.8)	7.3 (2.8)	7.2 (2.3)
Protein (g)	68.1 (33.4)	54.4 (28.0)	57.7 (22.3)
Fat (g)	59.7 (24.3)	56.6 (25.3)	54.6 (21.8)

SD = standard deviation.

## Discussion

### Prevalence of obesity

This analysis revealed that Kuwaiti adolescents had the highest percent of obesity and this was true irrespective of which of the 3 references was used. Lebanese girls had the lowest obesity. Egyptians were intermediate, but were closer to the Kuwaitis in overall obesity prevalence. When Cole et al. applied their cut-off values to their 6 populations, they obtained a wide range of prevalence estimates [7]. For example, at age 18 the prevalence of overweight ranged between 5% and 18% and the prevalence of obesity ranged between 0.1% and 4.0%. Our ranges were slightly smaller, indicating general agreement of the references in these samples from 3 countries.

### Differences between the 3 references

There was greater disparity among the references in estimating overweight than there was for obesity.

For Lebanon, all 3 references gave similar percentages for obesity with 2 references giving identical results. The percentage of obese girls in Egypt and Kuwait was significantly higher than in Lebanon. However, all 3 reference methods showed that the Kuwaiti girls had higher percentages of obesity than the Egyptian girls. Thus, these

results may indicate that in populations with higher rates of obesity, there is greater variability between the references than in populations where there is a lower prevalence of obesity. This may be related to the data on which the references were based. The Must, Dallah and Dietz standard was based on data collected prior to the dramatic increase in overweight and obesity that was seen with the newest CDC reference data, where significantly greater percentages of the USA population were overweight or obese. The Cole et al. data were based on populations in whom overweight and obesity was a fraction of that in the USA [7].

Kuwaiti girls 14–15 years of age had higher BMI values than did 14–15-year-old girls from the other 2 countries. However, by age 16, Egyptian girls had higher BMI values than either their Lebanese or Kuwaiti counterparts. The reasons for the consistently lower BMI values in Lebanese girls of comparable ages are not known. However, it is reasonable to assume that those differences were due either to lower energy intakes, a higher level of energy expenditure, or to a combination of those factors. Lower intakes may be related to lower incomes since in many developing countries BMI has been shown to be lower in less affluent compared to more affluent individuals [15]. Increased awareness of body image and desire for thinness may also be a factor that

lowers energy intake. Studies in many parts of the world have shown that body dissatisfaction by adolescent girls may influence energy intake and body mass [16]. One study conducted at the American University of Beirut found there was an acute awareness of energy intake and a desire to be thin among university students [17].

Studies on Egyptian girls have also shown an increased awareness of body image and a strong desire on the part of some girls to be thin [11,17,18]. The desire for thinness was higher in urban than rural girls, possibly indicating influences from the international media. It is clear that various media have had an impact on body image in the 3 countries; certainly this is true for Egypt and Lebanon [11,17–19]. Television viewing (with its European and American influences) may be more widespread in Kuwait than in the other countries due to the generally higher per capita disposable incomes, ubiquitous presence of satellite televisions, and the highly urbanized nature of Kuwaiti society.

### Energy intakes and body composition

The energy intake of the Egyptian adolescent girls was substantially higher than for the girls in Lebanon and Kuwait. Although the Egyptian and Lebanese girls overall were similar in mean age, they had very different mean energy, protein and fat intakes. Despite the fact that the mean age of the Kuwaiti girls in this sample was 2 years older and they were from a population with a higher income, they had lower energy intakes than their Lebanese or Egyptian counterparts. High energy intakes have been observed previously in Egyptian adolescents [6]. In the National Food Consumption survey conducted by the National Nutritional Institute in 2000, mean overall energy intake of adolescent girls was 9.57

MJ (standard deviation 3.21). The higher overall energy, protein, and fat intakes of Egyptian girls compared to Lebanese girls may be reflected in their higher overall anthropometric values (Table 2) and percentage of overweight (Table 4). The correlation of calorie intake with BMI was significant ( $P < 0.05$ ) among Egyptian girls.

Surprisingly, the mean energy intake of the Kuwaiti girls was the lowest of the 3 cohorts, despite the fact that obesity was the highest in this group. This may be due to several causes. First, each 24-hour-recall represents just one day's food intake. The data derived from it may not be reflective of the usual intake of these adolescent girls. The correlation between BMI and energy intake was not statistically significant in the Kuwaiti girls. Our findings are, however, consistent with those of previous dietary studies conducted in Kuwait in 1983 and 1992 [20,21]. Both studies found that significant numbers of Kuwaiti females consumed lower than adequate amounts of several recommended nutrients and energy. Al Shawi showed that these women consumed only 87% of the recommended daily energy allowance (on average 7.53 MJ/day) [21]. Our findings were very similar (7.20 MJ/day).

Although previous dietary intake surveys in Kuwait have involved small non-probability samples, they were performed by different investigators, using different methods (24-hour recall; 3-day diet records) and were separated by 3 decades (1980s, 1990s, and 2000s) [12,20,21]. Despite this, mean energy and nutrient levels were consistent. The American NHANES routinely collect 24-hour recall data and those data have been shown to be a good approximation to the true dietary intake of the population in the USA. A limitation of the 24-hour recall method is that it relies on memory recall and thus may lead to over- or under-



estimates of nutrient intakes. The Lebanon sample was collected in a similar manner to that of the NHANES surveys, i.e. using a multistage cluster sample approach [13].

We did not collect data on sexual maturity as a determinant of differences in body composition, and thus are not able to ascertain its contribution to the etiology of the differences between Lebanese and the other Arab girls. However, based on previous studies of menarcheal ages, there is no reason to surmise that girls of comparable age in these countries would have vastly different ages of menarche. A study among 1051 Kuwaiti adolescent girls revealed that their average age of menarche was 12.7 years [22]. The age of menarche of 1365 Egyptian girls was even earlier at 12.59 years [23]. Differences in rates of obesity are more likely to be related to differences in energy intake and expenditure (daily exercise).

Body image and exercise are 2 important factors that affect energy expenditure. It is well known that the high ambient temperatures that exist in Kuwait preclude outdoor exercise during summer months (i.e. May–October). Kuwaiti summers are very hot and dry, with daily average highs ranging from 42 °C to 46 °C and often reaching over 50 °C, even in shaded areas. Temperatures in Cairo average between 29 °C and 34 °C during this same period. Summer daytime temperatures in Lebanon average 30 °C.

According to related studies, over 50% of Kuwaiti families [12] (compared with 5% of Lebanese families [13]) have maids to help with household chores, some of which might otherwise be performed by adolescent girls. Thus, there may also be decreased opportunities for daily energy expenditure by Kuwaiti adolescents. These factors may help explain the lower levels of energy intake and the concomitant higher

rates of adiposity among Kuwaiti adolescents.

### Relationship between waist-to-hip ratio and waist circumference

Table 2 presents data on waist circumference and waist-to-hip ratios for the Egyptian and Lebanese girls. These data show that Egyptian girls not only had more adipose tissue (i.e. slightly higher BMI values) but had greater central distribution of adiposity than did Lebanese girls. Increases in body fatness were significantly correlated with increases in abdominal adiposity. Abdominal (central) fat distribution is generally considered to be a risk factor for co-morbidities in adolescents and adults [2].

### Conclusions

The 3 references provide only slightly different estimates of overweight and obesity in these 3 groups. Thus, the rationale for using one reference as opposed to another should be determined by the intrinsic characteristics of the reference itself. One advantage of the Cole et al. reference is that it is based on international data from 6 different populations and thus may be more defensible as universal and therefore more generally acceptable for use in international comparisons [7]. Another advantage is that this reference was developed as a curve to pass through a BMI value of 25 kg/m<sup>2</sup> for overweight and 30 kg/m<sup>2</sup> for obesity in 18-year-olds. Thus, this reference attempts to relate and link overweight and obesity in children and adolescents to criteria established for adverse outcomes in adults. This provides consistency and continuity in cut-off values for adults and children in screening surveys.

Adolescent obesity and its measurement are concerns because it has been shown

previously by Gunnell et al. that there is a relationship between BMI measured in childhood and adult all-cause and cardiovascular mortality [24]. In that 57-year cohort follow-up study, a direct association was found between childhood BMI and mortality from cardiovascular disease in adults. Even though there is no definitive experimental data showing adverse outcomes, several other studies have been able to relate adverse outcomes to these specific reference cut-off points (25 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup>) in children and adolescents. Moreover, the number of studies suggesting adverse outcomes is increasing [4,25].

Further studies employing larger samples are needed on the prevalence of overweight and obesity among adolescents in this Region to clarify the most appropriate reference to use to classify overweight and obesity. Nevertheless, we believe that the use of the Cole et al. reference will allow researchers to ascertain the prevalence of overweight and obesity in their respective populations, to compare prevalences from country to country, and to make sound, data-derived recommendations concerning overweight and obesity in the Region.

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