Prevalence and trends in obesity among school boys in Central Saudi Arabia between 1988 and 2005

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ABSTRACT

Objectives: To determine the trends in body fatness and obesity among Saudi primary schoolboys using the data from 2 cross-sectional studies conducted in 1988 and 2005.

Methods: Two sets of data were analyzed. The first set (n=1082) was conducted in 1988 and the second (n=702) set was conducted in 2005. Both studies used multistage random samples involving primary-school boys aged 6-14 years from Riyadh, Kingdom of Saudi Arabia. Measurements included weight (Wt), height (Ht), biacromial (BA) and biiliac (BI) widths, triceps (T), subscapular (S) skinfolds, S/T ratio, body mass index (BMI), body fat percentage (fat%), lean body mass (LBM), and the proportion of obese boys (fat% ≥25% of Wt).

Results: From 1988-2005 there were significant increases in all variables except LBM. The lowest changes were observed in body structures (Ht, BA, and BI) and the highest were in body fatness (T, S, and fat%). During this 17-year period, the mean BMI standard deviation increased from 16.5 ± 2.1 to 18.0 ± 4.0 kg/m^2 and fat percentage increased from 13.2 ± 4.7 to 19.7 ± 10.0%. In addition, S/T ratio increased by 13.5%, indicating shifts toward central obesity over time. However, the biggest increase was seen in the proportion of obese schoolboys (from 3.4% in 1988 to 24.5% in 2005).

Conclusion: Findings indicate rising trends in BMI, body fatness, central obesity, and prevalence of obesity among Saudi schoolboys over the last 2 decades. Increased obesity prevalence among Saudi children is a major public health concern.

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The prevalence of obesity in childhood and adolescence is rapidly rising to epidemic proportions worldwide.[1,2] In the United States for example, the number of overweight children has more than doubled during the past 3 decades,[3] and recent estimate of overweight prevalence among children aged 6 through 19 years reached up to 16%.[4] The prevalence of overweight among Canadian boys increased from 15% during 1981 to 28% during 1996, while obesity prevalence has increased during the same period from 5-13.5%.[5] The mean body mass index (BMI) and the prevalence of overweight and obesity among the Swedish children aged 10-16 years have all substantially increased during the periods from 1987-2001.[6] Moreover, a secular trend in obesity, as determined by skinfolds, was observed in Danish 9-year-old boys between the years 1985-1986 and 1997-1998.[7] Studies from Australia,[8] Japan,[9] Spain,[10] and Bahrain[11] have all indicated rising trends in obesity among school children over the past 2 decades. The increasing prevalence of obesity in young people worldwide is a major global health concern.[1] Obesity in childhood and adolescence has both immediate and future health consequences.[12] The most widespread health consequences of pediatric obesity are psychosocial.[13] Obesity is also strongly associated with the presence and clustering of cardiovascular risk factors including hypertension, hyperlipidemia, and hyperinsulinemia.[14-16] Moreover, increased obesity in childhood and adolescence is most often associated with impaired glucose tolerance,[17] and type 2 diabetes mellitus.[18] Another major concern on childhood obesity is that it somewhat tracks to adulthood.[12,19,20] During the past 2 decades, the Kingdom of Saudi Arabia (KSA) undergone enormous lifestyle-related transformation including dietary habits and physical activity levels. These lifestyle changes have immensely contributed to the increase in obesity prevalence among Saudi children and youth.[21] Recent estimates of obesity prevalence (based on BMI criteria) among Saudi schoolboys ranged from 10.2-13.8 for overweight

and from 15.8-20.5 for obesity.[22-24] In addition to high prevalence rates of overweight and obesity reported for the Saudi boys, there are some limited studies indicating rising trends over the past 2 decades in the prevalence of childhood obesity in the KSA.[25,26] If such phenomenon is substantiated through additional reports, it represents a major public heath concern. Therefore, the aim of the present study was to determine the trends in body fatness and obesity prevalence among Saudi schoolboys using BMI and skinfolds measurements from 2 cross-sectional studies conducted in Riyadh during the years 1988 and 2005. Compared to BMI, skinfold thickness assessment provides more precise indications of the amount of body fat in children and adolescents.[27]

Methods. The present study is a secondary analysis of 2 sets of anthropometric data from Saudi primary schoolboys living in Riyadh, KSA. Both data sets came from 2 published studies and used the same sampling methods and data collection procedures. The first set of data was taken from an earlier growth study conducted in 1988, and used a multistage random sample drawn from the primary schools in 4 geographical areas in Riyadh city. The sampling methods involved selecting 2 schools from each area with one class was being chosen from each grade, thus totaling 48 classes. The sample included Saudi schoolboys from 6-14 years of age. In that study, anthropometric measurements including skinfolds thickness were obtained from schoolboys. The detailed description of the study can be found elsewhere.[28] The second set of data represented a cross-sectional study conducted in 2005 on Saudi schoolboys between 6 and 14 years of age living also in Riyadh.[29] The study collected full anthropometric measurements from the students and investigated the loads imposed upon the primary schoolboys by the school bags as well. This study also used a multistage random sampling technique. In this study, data collected from Riyadh city was divided into 5 geographical areas, and one public school was randomly selected from each area. In addition, one private school was randomly chosen from the major private schools in Riyadh. Only Saudi boys were included in the selection. The number of Saudi boys drawn from each of the public and private schools was proportional to the total number of Saudi boys in each category. One class was chosen at random from all classes in each grade in the selected primary schools. All the Saudi boys in the selected classes were included in the sample. In each study, written consents were secured from the educational directorate of Riyadh schools and school principals. The two studies were conducted in full accordance with the internationally agreed ethical principles for the conduct of medical research. In both samples, the body weight was measured without shoes to the nearest 0.1 kg using the Seca scale (Seca, Germany). Standing height (Ht) was measured barefooted to the nearest 0.1 cm using a calibrated measuring rod. Biacromial (BA) and bi-iliac (BI) widths were measured to the nearest 0.1 cm with Martin-type anthropometer, according to the standard procedures.[30] In addition, triceps (T) and subscapular (S) skinfolds thicknesses were measured on the right side of the body using Harpenden caliper. Body fat percentage (fat%) was then calculated by a prediction equation specific for children and youth.[31] Obesity was defined as body fat content equals or exceeds 25% of the total body mass.[32] Fat content of >25% of the body mass in male (a level of 30% in female) showed higher risk for coronary artery disease in children.[33]

Data entry and statistical analysis were performed using the Statistical Package for the Social Science (SPSS) program, version 10 (Chicago, IL). Since the 2 original studies were conducted at different time of the school year, boys younger than 6 years or older than 14 years were excluded from the analysis. This provided a good matching for age range between the 2 sets of data. Comparisons for the values of BMI, fat%, S to T ratio, and the percentage of obese boys were taken between the first (1988) and the second (2005) data sets. Data were reported as means and standard deviations or as percentages for the whole group as well as across 4 age categories (6-8, >8-10, >10-12, and >12-14 years). The mean age differences between 1988 and 2005 data sets were checked by t-test and found insignificant (p>0.05 level). Differences between anthropometric data were tested using the independent samples t-test. The significance level was set at less than 0.05.

Results. **Table 1** shows the number of participants in the present analysis as well as the mean ± standard deviation values for chronological ages of the boys in the 2 sets of data relative to 4 age categories. There were no significant age differences between the 2 sets of data at any age group. Values for the mean anthropometric and body composition measurements of the 2 sets of data were displayed in **Table 2**. Results of independent samples t-test indicated that except for lean body mass (LBM) all other physical characteristics recorded for the boys in the second (2005) sample were significantly (p<0.005) higher than those observed in the first (1988) sample. Boys in the second data set appear taller, heavier, and have bigger body built compared with the first data set. The BMI increased over the 17 years period by 1.5 kg/m^2. This equals to a relative increase of 9.1%. The increases in body Ht and BA and BI breadths during the same period were the smallest of all, ranging from 1.3-3.9%. However, the largest changes were seen in body fatness and in the prevalence

Table 1 - Chronological ages of the boys relative to age group in the first (1988) and second (2005) data sets. Data are mean ± SD.

Data set	Age group				All
	6 - 8	> 8 -10	> 10 -12	> 12 -14	
1988 (n = 1082)	7.37±0.58	9.13±0.61	11.16±0.61	12.95±0.55	9.83±1.97
2005 (n = 702)	7.36±0.49	9.05±0.59	11.09±0.60	12.87±0.57	9.92±1.95
p value	0.840	0.142	0.122	0.241	0.334

Table 2 - Comparison of anthropometric data between the first (1988) and the second (2005) samples. Data are means ± standard deviations.

Variable	First Sample (1988)	Second Sample (2005)	*P* value	Relative changes (%)*
Body weight (kg)	29.1 ± 7.2	32.9 ± 11.7	0.000	12.1
Body height (cm)	131.9 ± 10.8	133.6 ± 11.2	0.002	1.3
Biacromial width (cm)	29.5 ± 2.8	30.3 ± 3.1	0.000	2.7
Bi-iliac width (cm)	20.3 ± 2.7	21.1 ± 2.8	0.000	3.9
Body mass index (kg/m^2)	16.5 ± 2.1	18.0 ± 4.0	0.000	9.1
Triceps skinfolds (mm)	8.3 ± 3.0	12.6 ± 7.3	0.000	51.8
Subscapular skinfolds (mm)	5.6 ± 2.4	10.4 ± 9.5	0.000	85.7
Sum of skinfolds (mm)	13.8 ± 5.1	23.0 ± 16.3	0.000	66.6
Body fat percent (%)	13.2 ± 4.7	19.7 ± 10.0	0.000	49.2
Subscapular/ Triceps (%)	68.3 ± 14.5	77.5 ± 34.6	0.000	13.5
Lean body mass (kg)	25.1 ± 5.4	25.5 ± 6.1	0.166	1.6
Proportion of obese (%) **	3.4	24.5	_	620.6

*Calculated as ((value of 2005 - value of 1988)/value of 1988) x 100.
** Boys having body fat percent = 25% of body weight or more.

Table 3 - The proportions (%) of Saudi primary school boys who were classified as obese (having fat percent equals or exceeds 25% of body weight) relative to age group in the first (1988) and second (2005) data sets.

Data set	Age group			
	6 - 8	>8 -10	>10 -12	>12 -14
1988	0.0	3.0	6.1	4.5
2005	6.9	19.8	32.5	39.4

of obesity among boys. The body fat% increase by 6.5% from 1988 to 2005. This equates to a relative increase of approximately 50%. The increase in the proportion of obese boys (fat% ≥25% of body Wt) between 1988 and 2005 was truly remarkable. Obesity prevalence increased from 3.4% in 1988 to 24.5% in 2005 (a relative rise of over 620%). Thus, the yearly observed increments come to 0.38% in fat percentage and 1.24% in obesity prevalence. Furthermore, the ratio of S to T skinfolds increased during the same period by 13.5%, indicating a shift toward central obesity. To further illustrate the substantial changes in body composition occurring to the Saudi boys during the study period, we plotted some indices of obesity across age groups for the 2 sets of data, as shown in **Figures 1-3**. Values of BMI, as shown in **Figure 1**, increased steadily with increasing age group in both data sets. However, the increases in BMI seen in 2005 were more pronounced compared to those of 1988. **Figure 2** demonstrates substantial increases in fat% of the schoolboys from 1988-2005. The relative differences in fat% seen between the boys in the 2 samples are progressively increasing from 35.1% at the age group 6-8 years to 69.9% at the age group 12-14 years. The findings from the present study revealed that boys in the second data set exhibited a trend toward trunk adiposity. **Figure 3** clearly illustrates this trend. Beginning at age group 8-10 years, there were progressive increases in S to T ratio at a rate that was much higher for boys in 2005 than for boys in 1988. Thus, boys in 2005 were not just having more body fat than those in 1988, they also had a substantially more fat in their trunks. Moreover, the proportions of Saudi schoolboys across the 4 age groups who were classified as obese in the 2 data sets are shown in **Table 3**. The increases in the proportions of obesity among boys from 1988 to 2005 are quite remarkable. The differences in obesity prevalence between 1988 and 2005 are notably widening as we move from younger to older age groups.

Discussion. Obesity was determined in the current analysis through fat% derived from skinfolds thickness. Earlier reports indicating rising trends in overweight and obesity in Saudi children and adolescents relied solely on BMI.[25,26] However, due to the cross-sectional comparisons, neither the present study nor the previous 2 reports can shed light on the duration of obesity in these children. In comparison with findings from the present study, similar upward trends in childhood obesity were observed in many developed countries.[3,5,6,8,9] The mean fat% has also increased in Spanish boys 6-14.9 years by approximately 2.5-6% between 1980 and 1995.[10] Such increases were similar to those observed in the present study. Our results of rising trends of overweight

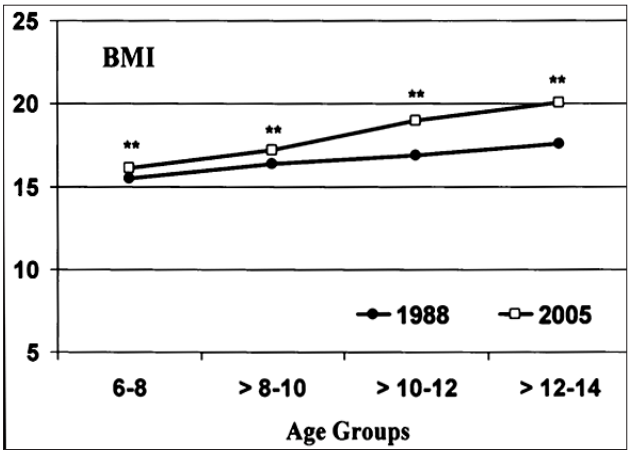

Figure 1 - The mean body mass index (BMI) in kg/m^2 of Saudi primary schoolboys relative to age groups in the first (1988) and second (2005) samples. (**significantly different from 1988 [p<0.005]).

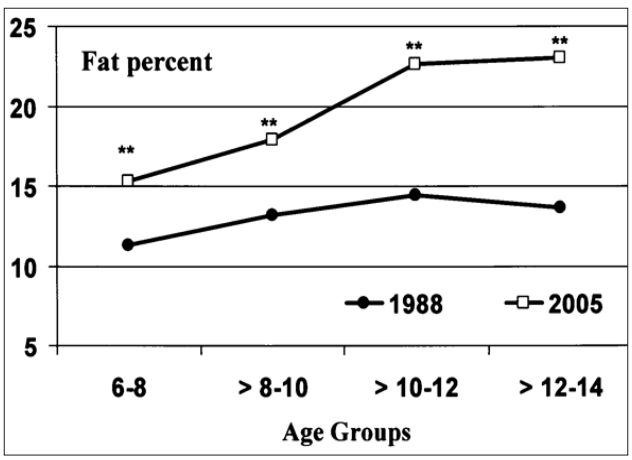

Figure 2 - The mean body fat percentage of Saudi primary schoolboys relative to age groups in the first (1988) and second (2005) samples (**significantly different from 1988 [p<0.000]).

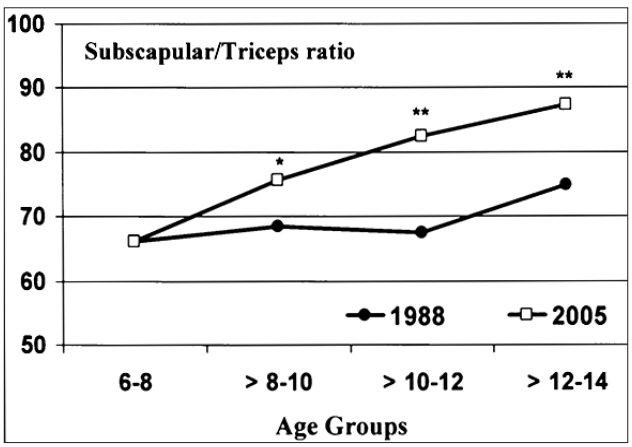

Figure 3 - Subscapular to triceps skinfolds ratio (%) of Saudi primary schoolboys relative to age groups in the first (1988) and second (2005) samples (significantly different from 1988 at *p<0.02 and **p<0.000).

and obesity prevalence in Saudi boys over the recent years are also consistent with findings from a similar study in the neighboring country of Bahrain.[11] Thus, obesity is now becoming a global epidemic,[1] and is no longer present only in well-developed countries of the world. Our findings indicated that the increase in fat% of the schoolboys between 1988 and 2005 is greater than the increase in BMI during the same period. This is in agreement with findings from a recent study involving Spanish boys 6-15 years.[10] Moreover, BMI is more a measure of overweight than adiposity. Using growth data for Saudi boys 6-14 years of age, it was well demonstrated that while BMI was increasing from 11-13 years of age, body fat content (as measured by skinfolds thickness) was not.[34] The BMI has also been shown to be dependent on Ht, gender, and pubertal status in children and adolescents.[35] The present study showed no significant difference (p <0.05) in the mean LBM between boys in 1988 and 2005, indicating that the majority of increases in the body mass were fat tissues.

The ratio of S (trunk) to T (limb) skinfolds offers a useful index of centralized obesity. The present study showed a trend toward increased trunk adiposity over time, which is similar to the secular changes in body fat patterning in Spanish children and adolescents between 2 cross-sectional studies conducted in 1980 and 1995, indicating a shift toward central adiposity.[36] Such a large increase in central fatness more than general fatness should represent greater concern, since central obesity associates with cardiovascular disease risk. In addition, greater trunk skinfolds values with high BMI in boys increase the risk of centralized obesity at adulthood.[37] The proportions of obese schoolboys observed in 2005 data set compared to those of 1988 were remarkably high. Obesity is a complex disease with genetic and lifestyle both playing important roles in determining a child Wt and body composition. However, despite the strong influence of genetic determinants on obesity, the genetic composition of the population does not change rapidly. Thus, the increasing prevalence of obesity over the past decade in Saudi children and youth must be the result of major changes in lifestyle related factors, namely, the lack of physical activity, unhealthy eating habits or a combination of the two factors.[38] In recent years, the high-energy food snacks are becoming readily available to the majority of Saudi children and adolescents. Furthermore, modern life has systematically reduced the total energy expenditure to a great extent. Major factors that contributed to youth inactivity in the KSA include a reliance on cars rather than walking for short distance travel including trips to and from schools,[29] enormous time devoted to television viewing, videos and computer games, a lack of safe space for free play

and sports games, and inadequate physical education time in schools. Indeed, sedentary lifestyle is extremely becoming prevalent among Saudi children and youth. Recent data indicated that 60% of children and 71% of Saudi youth do not engage in physical activity of sufficient duration and frequency.[16,39,40] Elsewhere, insufficient vigorous physical activity was shown to be a risk factor for higher BMI for adolescent boys and girls.[41] Findings from a cross-sectional survey involving youth 10-16 years from 34 countries demonstrated that physical activity levels were lower and television viewing times were higher in overweight compared to normal weight youth. The study concluded that increasing physical activity participation and decreasing television viewing should be the focus of strategies aimed at preventing and treating overweight and obesity in youth.[2] Moreover, a multicenter European study conducted on 9-10 year old children observed a significant difference in sum of 5 skinfold thickness between children who accumulated more than 2 hours of moderate and vigorous physical activity per day and those who accumulated less than one hour per day.[42] In another study, physical activity was also found to be negatively associated with, while television watching and video game use was shown to positively linked to being overweight in Canadian children.[43] The increasing trends in childhood obesity that were prominent in the older boys may suggest a different lifestyle pattern in this age group of schoolboys. Consequently, there is a need for an effective strategy aimed at combating obesity in this target age group. The focus of attention should be towards the promotion of healthy nutrition and physical activity throughout childhood and adolescence. Such early intervention may proof to be most useful in preventing an obese child from becoming an obese adult, especially since the tracking of obesity from childhood into adulthood has been well established.[12,19,20] In addition, it is well documented that physical activity tends to decline as children grow older.[44] Longitudinal assessment of a group of Saudi boys from childhood to early adulthood showed that while physical activity levels were drastically reduced, television-viewing time was substantially increased.[39] Recent research, however, suggests that efforts to decrease time spent in sedentary activities resulted in weight loss among obese children.[45]

Finally, the present study of obesity prevalence and trends among Saudi schoolboys over the 17 years period has some limitations. First, the 2 sets of data used in the current analysis came from 2 cross-sectional studies. Despite using very similar sampling technique and methodology, this type of research designs, as apposed to longitudinal analysis, is not considered the best approach to track trends across the time. Therefore, the findings from the present study must be carefully interpreted. Second, the 2 sample sets used in the present analysis were drawn from the primary schools in Riyadh. This may limit the findings generalisability to other Saudi children living outside Riyadh. However, a recent analysis of BMI in 2 national growth studies involving Saudi boys 10-20 years showed similar obesity trend to that seen in the present study.[26]

In conclusion, based on the analysis of 2 sets of data conducted in 1988 and 2005 on Saudi schoolboys from Riyadh, the findings of the present study provided compelling evidences on the rising trends in BMI, fat%, central obesity, and the prevalence of obesity among schoolboys 6-14 years. Increased obesity prevalence in Saudi children is of major public health concern, and should make a strong case for greater efforts directed at treatment and prevention of childhood obesity in the KSA. Efforts designed to combat childhood obesity must include education, research and intervention. Furthermore, policy makers, health cares providers, educators, and parents should all be involved in such efforts.

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