

Clustering of cardiovascular risk factors among obese urban schoolchildren in Sousse, Tunisia

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تصنيف مجموعات عوامل الاختطار القلبية الوعائية لدى أطفال المدارس الحضرية البدنيين في مدينة سوسة، تونس

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الخلاصة: على خلفية ازدياد معدل حدوث البدانة بين التونسيين قمنا بإجراء دراسة مسحية مستعرضة شمل 1569 من الأطفال الذين تتراوح أعمارهم بين 13-19 عاماً والذين تم اختيارهم بأخذ عينات عنقودية متعددة المراحل لتقييم معدلات انتشار البدانة وتصنيف مجموعات عوامل الاختطار القلبية الوعائية لدى أطفال المدارس البدنيين في المنطقة الحضرية من مدينة سوسة. وقد لوحظ أن لدى الأطفال البدنيين درجات أكثر ارتفاعاً من ضغط الدم، ومستويات أكثر ارتفاعاً من ثلاثي الغليسريد ومقادير أكثر انخفاضاً من البروتين الشحمي الرفيع الكثافة مما لدى الأطفال ذوي الوزن السوي. وفي كلا الجنسين كان الطول والوزن في جميع المجموعات العمرية أعلى مما لدى السكان من الأطفال في تلك الأرياف. وعلى هذا فإن دراستنا تدلُّ على أن للبدانة تأثيرات ضائرة لا تقتصر على البلدان الصناعية.

ABSTRACT Against a background of increasing obesity among Tunisians, we conducted a transversal survey of 1569 children aged 13-19 years selected by multistage cluster sampling to evaluate the prevalence of obesity and clustering of cardiovascular risk factors among obese schoolchildren in the urban area of Sousse. Obese children were found to have higher blood pressure, higher triglyceride levels and lower high-density lipoprotein cholesterol levels than children of normal weight. In both genders, the mean height and weight across all age groups was significantly higher in urban than in rural children. Our study indicates that obesity and the adverse effects of being over the ideal body weight are no longer limited to industrialized countries.

Concentration des facteurs de risque cardio-vasculaire chez des écoliers obèses vivant en milieu urbain à Sousse (Tunisie)

RESUME Devant l'augmentation de l'obésité chez les Tunisiens, nous avons réalisé une enquête transversale chez 1569 enfants âgés de 13 à 19 ans sélectionnés selon une méthode d'échantillonnage en grappes à plusieurs degrés afin d'évaluer la prévalence de l'obésité et la concentration des facteurs de risque cardio-vasculaire chez des écoliers obèses dans la zone urbaine de Sousse. On a trouvé que les enfants obèses avaient une pression artérielle et un taux de triglycérides plus élevés ainsi qu'un taux de HDL-cholestérol plus bas que les enfants ayant un poids normal. Pour les deux sexes, la taille et le poids moyens dans tous les groupes d'âge étaient significativement plus élevés chez les enfants du milieu urbain que chez les enfants du milieu rural. Notre étude montre que l'obésité et les effets néfastes qu'entraîne un excès de poids par rapport au poids idéal se limitent plus aux pays industrialisés.

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Introduction

Obesity is a widespread and growing worldwide problem with significant medical, psychosocial and economic consequences [1-3]. The prevalence of obesity has increased substantially over the last few decades and indications are that this trend will continue [4-6]. In the United States of America, one-third of overweight Americans are at increased risk of developing chronic diseases such as type 2 diabetes, cardiovascular disease, hypertension and certain forms of cancer [3,7,8].

Excess weight in childhood is the leading cause of paediatric hypertension, and overweight children are at a high risk of developing long-term chronic conditions, including type 2 diabetes mellitus and coronary heart disease [9-15].

For the general population in Tunisia, the availability of a high-fat and high-energy diet has steadily increased over the past few decades, while lifestyles have tended to become more sedentary and physically inactive [16]. Obesity and associated risk factors for chronic disease are becoming an important public health issue in developing countries [17,18].

The purpose of this study was to evaluate the prevalence of obesity and the clustering of cardiovascular risk factors among obese schoolchildren in Sousse, Tunisia.

Methods

The population studied comprised children aged 13-19 years, all of whom were students attending public secondary schools in the urban centre of Sousse, Tunisia. A transversal survey was carried out on a representative sample of children selected by a multistage cluster sampling procedure. The sample size calculation was based on the estimation of an unknown prevalence

(50%) with a precision of $\pm 2.5\%$ and a confidence interval of 95%. It was estimated to 1600 children.

All participants completed a questionnaire on their disease history and lifestyle characteristics, including cigarette smoking, alcohol consumption, usual physical activity and dietary intake.

Research technicians recorded body weight to the nearest 0.1 kg using a standard beam balance scale. Subjects were barefoot and wore light indoor clothing. Body height was recorded to the nearest 0.5 cm. Body mass index (BMI) [weight (kg)/height² (m²)] was calculated.

To eliminate the risk of bias due to observation, we measured arterial blood pressure electronically (Spengler Mistral, Paris, France). The reproducibility of measurements and the precision of the device have been demonstrated previously [19]. The patient was rested for 10 minutes, after which we measured blood pressure on the right arm in a sitting position, using an appropriate cuff size, and again after a 15-minute rest. The mean of the two readings was used in later analysis.

For measuring blood lipid levels, we required that the children fast for 12 hours prior to blood being taken, after which a breakfast was provided. A trained nurse with paediatric experience collected a sample of 5 mL of blood in a tube containing EDTA 1 mg/mL which was then rapidly centrifuged. Plasma levels of high-density lipoprotein cholesterol (HDL-cholesterol) were measured after precipitation of apolipoprotein B-containing lipoproteins using the phosphotungstate-magnesium chloride method (Roche). Concentrations of low-density lipoprotein cholesterol (LDL-cholesterol) were calculated using the Friedewald formula. Lipid and lipoprotein values were expressed in mmol/L. The analyses were performed in the clinical

chemistry laboratory of the Medical Polyclinic at the University of Lausanne, Switzerland.

A similar regional survey conducted with the same methodology in rural schoolchildren was used to compare differences in body height and body weight between urban and rural schoolchildren.

With no universal definition of obesity for schoolchildren and limitations on the availability of anthropometric information from previous surveys in Tunisia, we defined overweight and obese based on BMI. We considered children to be overweight if they had a BMI ≥ 25 kg/m² and to be obese if their BMI was ≥ 30 kg/m² [20].

After determining the prevalence of overweight, obesity and percentile distribu-

tion of body height and weight according to gender and age, we compared the differences in general characteristics among children with different categories of obesity by analysing variance (ANOVA) after adjusting for age and with gender specification. A two-tailed value of $P < 0.05$ was considered statistically significant. All statistical analyses were conducted using the statistical package SPSS version 9.0.

Because of the young age of the target population, this investigation was undertaken with prudence and with respect for the rights and the integrity of those involved. We obtained authorizations from the Ministry of National Education, from the teachers, from the school administrators and from the parents of the children. Parents

Table 1 Mean values and standard deviations for selected anthropometric and biochemical characteristics by body mass index (BMI) weight categories in 1569 schoolchildren

Characteristic	Boys			Girls		
	Normal	Overweight ^a	Obese ^a	Normal	Overweight ^a	Obese ^a
Body height (cm)	168.3 ± 10.1	170.6* ± 7.5	171.9 ± 7.6	160.5 ± 6.0	161.2 ± 6.2	161.6 ± 5.6
Body weight (kg)	56.8 ± 11.0	75.8* ± 6.7	91.2* ± 12.3	52.8 ± 7.2	67.2* ± 5.5	79.2* ± 9.9
Systolic blood pressure (mmHg)	119.1 ± 10.2	126.5* ± 8.6	132.6* ± 9.8	117.3 ± 10.1	122.7* ± 17.7	128.8* ± 10.7
Diastolic blood pressure (mmHg)	69.1 ± 11.5	71.1 ± 9.4	71.8 ± 10.4	71.7 ± 22.4	76.6 ± 39.7	73.6 ± 6.1
Fasting blood glucose (mmol/L)	4.9 ± 0.7	5.0 ± 0.5	4.8 ± 0.6	4.8 ± 0.8	5.3* ± 2.5	4.9 ± 0.6
Cholesterol (mmol/L)	3.8 ± 0.7	4.2* ± 0.7	4.1* ± 0.6	4.2 ± 0.2	4.5* ± 0.8	4.4 ± 0.7
Triglycerides (mmol/L)	0.8 ± 0.2	1.0* ± 0.4	1.2* ± 0.4	0.8 ± 0.3	1.0* ± 0.6	1.0* ± 0.3
HDL-cholesterol (mmol/L)	1.4 ± 0.3	1.3* ± 0.2	1.3* ± 0.1	1.5 ± 0.2	1.4* ± 0.2	1.4* ± 0.2
LDL-cholesterol (mmol/L)	1.9 ± 0.5	2.4* ± 0.6	2.3* ± 0.6	2.3 ± 0.6	2.6* ± 0.7	2.5* ± 0.6

^aOverweight: BMI = 25–29 kg/m²; obese: BMI ≥ 30 kg/m².

*Statistically significant at $P < 0.05$ when compared with the same gender normal weight group using ANOVA.

were free to decline their children's participation, although this occurred rarely (5 cases refused to participate).

Results

Of the 1569 children (748 boys and 821 girls) in the sample population clinically examined, we obtained biological measurements for 1497 subjects (a participation rate of 95.4%). Mean height \pm standard deviation for boys and girls, was 168.6 ± 9.9 cm and 160.7 ± 6.1 cm respectively, and the mean weight \pm standard deviation was 59.9 ± 14.1 kg and 56.3 ± 11.1 kg. The anthropometric and biochemical characteristics for the different weight categories are presented in Table 1.

In general, obese children were found to have higher blood pressure, higher plasma triglyceride levels and lower HDL-cholesterol levels than normal weight children ($P < 0.05$). Overweight children had higher blood pressure, higher plasma triglyceride levels, lower HDL-cholesterol levels and higher LDL-cholesterol levels.

In order to compare the anthropometric profile of urban versus rural schoolchildren in the same region, Table 2 and Figures 1 and 2 show, respectively, the mean values and percentile distributions of height and weight among 13–17-year-old urban and rural schoolchildren in Sousse. In both genders across all age groups, mean height and weight were higher among urban schoolchildren compared to their rural counterparts. The prevalence of being overweight and obese among children, with age and gender specifications, is shown in Table 3.

Discussion

In this survey of 1569 Tunisian schoolchildren, we found that the prevalence of obe-

Table 2 Mean values and standard deviations for height and weight among the rural and urban schoolchildren by age and sex

Age (years)	Urban		Rural	
	n	Mean \pm s	n	Mean \pm s
Height (cm)				
<i>Boys</i>				
13	204	159.5 \pm 8.4	102	152.5 \pm 7.7
14	103	164.7 \pm 8.3	82	161.3 \pm 8.7
15	91	169.8 \pm 7.3	84	166.6 \pm 8.1
16	197	174.7 \pm 6.6	51	171.3 \pm 7.5
17	153	174.9 \pm 6.7	50	173.3 \pm 6.8
<i>Girls</i>				
13	233	159.2 \pm 6.4	119	153.9 \pm 8.1
14	77	159.7 \pm 5.6	82	159.4 \pm 7.0
15	118	161.0 \pm 5.6	107	160.8 \pm 5.9
16	228	161.0 \pm 5.0	60	161.7 \pm 6.7
17	165	161.4 \pm 5.9	56	161.8 \pm 4.9
Weight (kg)				
<i>Boys</i>				
13	204	50.6 \pm 11.8	56	44.5 \pm 8.7
14	103	55.7 \pm 13.5	82	50.6 \pm 10.5
15	91	59.8 \pm 12.2	84	55.1 \pm 9.8
16	197	65.8 \pm 12.7	51	60.2 \pm 8.9
17	153	67.3 \pm 11.8	50	67.0 \pm 7.9
<i>Girls</i>				
13	233	52.3 \pm 11.4	119	47.3 \pm 7.8
14	77	55.4 \pm 10.7	82	51.9 \pm 10.0
15	118	58.3 \pm 12.5	107	55.2 \pm 11.3
16	228	58.3 \pm 10.3	60	55.7 \pm 9.5
17	165	58.2 \pm 9.6	56	56.9 \pm 9.5

s = standard deviation.

sity was higher among urban students compared to rural students: for boys 2.8% versus 1.9% respectively, and for girls 3.7% versus 1.7% respectively. Both obese and overweight children had higher systolic blood pressures and more adverse lipid profiles compared to normal weight children.

For children and adolescents, classifying obesity is complicated, since body

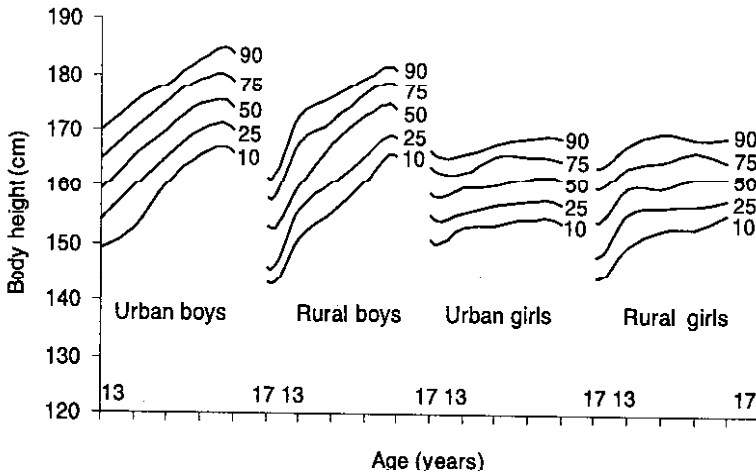


Figure 1 Percentile distribution of body height for the 13–17-year-old schoolchildren, by sex and place of residence

weight and body composition are continually changing [21,22]. BMI is, therefore, the most appropriate measure for clinical assessment of adiposity in children and adolescents [22,23]. Longitudinal data are

best for evaluating the sensitivity, specificity and predictive value of comparative measures of childhood and adolescent adiposity used to identify current and future morbidity [21,22].

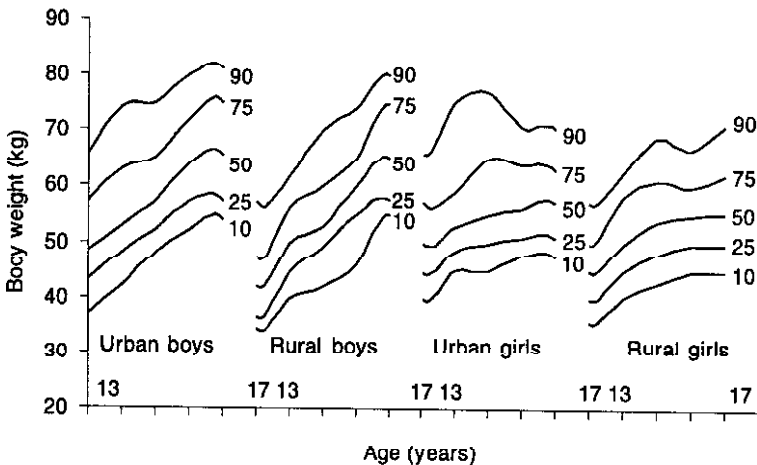


Figure 2 Percentile distribution of body weight for the 13–17-year-old schoolchildren, by sex and place of residence

Table 3 Prevalence of overweight and obesity by sex among 13–17-year-old urban and rural schoolchildren

Age (years)	Urban			Rural		
	<i>n</i>	Overweight ^a (%)	Obese ^a (%)	<i>n</i>	Overweight ^a (%)	Obese ^a (%)
<i>Boys</i>						
13	204	5.9	2.0	102	4.9	1.0
14	103	6.8	2.9	82	3.7	1.2
15	91	8.8	3.3	84	7.1	0.0
16	197	8.1	4.1	51	3.9	2.0
17	153	12.4	2.0	50	10.0	8.0
Total	748	8.3	2.8	369	5.7	1.9
<i>Girls</i>						
13	233	7.7	3.0	119	5.9	0.8
14	77	10.4	6.5	82	8.5	1.2
15	118	12.7	5.1	107	11.2	2.8
16	228	15.8	3.1	60	10.0	1.7
17	165	15.2	3.0	56	14.3	1.8
Total	821	12.4	3.7	424	9.4	1.7

^aOverweight: BMI = 25–29 kg/m²; obese: BMI ≥ 30 kg/m².

The increased prevalence of obesity in urban compared to rural schoolchildren demonstrated in our study is likely to be the result of lifestyle changes, most notably diet and exercise changes, that have been closely associated with increased urbanization and industrialization [24–26], and the culture of consumerism that dominates societies elsewhere.

The relationship between obesity and chronic disease has been documented in numerous studies [1–3, 15]. The economic cost of obesity and its complications is estimated to exceed US\$ 45 billion per year [13, 27]. Furthermore, weight gain and obesity during childhood and adolescence are associated with many risk factors for poor health, including higher blood pressure and adverse lipid profiles [13, 27, 28]. The prevention of excess weight gain and obesity among children and adolescents is

an important factor in the prevention of obesity and decreasing the risk of chronic disease among adults [4, 29, 30].

The causes of obesity are multifactorial and complicated, but it is clear that decreased physical activity is strongly associated with the development of obesity [4, 14, 31]. In general, weight gain is a result of a net positive energy balance where energy intake from food exceeds energy expenditure in physical activity [5, 32].

The increasing prevalence of obesity in urban as compared to rural schoolchildren may be explained by the increasingly sedentary lifestyle of the former, including excessive television watching, lower levels of physical activity, and their being subjected by unregulated advertisers to constant injunctions to consume high sugar, high fat, fast foods and snacks.

Conclusion

Our study demonstrates that the prevalence of overweight and obesity is higher among urban compared to rural schoolchildren in the Tunisian population. Since obesity in adults is associated with the development of chronic disease in later life [4,14,31], effective strategies are required to prevent the occurrence of obesity and the subse-

quent predisposition to cardiovascular risk factors commencing from childhood. A national strategy of primordial prevention must be developed in Tunisia to avoid further morbidity and mortality arising from these leading causes of chronic diseases. Further studies are needed to evaluate these data to better understand and prevent the causes of obesity among children.

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