Study of cardiovascular disease risk factors among rural schoolchildren in Sousse, Tunisia

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دراسة عوامل اختطار المرض القلبي الوعائي بين تلاميذ مدارس الريف في سوسة، بتونس

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الخلاصة: قمنا بإجراء مسح وبائي على عينة ممثّلة من 793 من تلاميذ مدارس الريف في سوسة، بتونس، لتقييم معدل انتشار بعض عوامل اختطار المرض القلبي الوعائي. وتبيَّن أن معدل انتشار ضغط الدم المرتفع هو 11.2%، ومعدل انتشار فرط كولسترول الدم هو 2.9%، وفرط ثلاثي الغليسريد في الدم هو 1.0%، وارتفاع مستويات كولستيرول البروتينات الشحمية المنخفضة الكثافة 0.6%، والسِّمنة 4%، مما لا يمثّل فروقاً يُعتَدُّ بها إحصائياً بين الجنسين. ومع ذلك فقد كان هناك فرق ملموس بين الجنسين في معدل التدخين (4%) حيث بلغ هذا المعدل 7.3% بين الفتيان و1.2% بين الفتيات. ويجب تشجيع الانخفاض النسبي في مُرتَسم (بروفيل) عوامل اختطار المرض القلبي الوعائي للأطفال التونسيين، بحيث يستمر إلى مرحلة البالغية، مما يبرر ضرورة إنشاء برنامج مدرسي لتعزيز صحة القلب.

ABSTRACT We undertook an epidemiological survey based on a representative sample of 793 rural schoolchildren in Sousse, Tunisia to assess the prevalence of certain cardiovascular disease risk factors. The prevalence of hypertension (11.2%), hypercholesterolaemia (2.9%), hypertriglyceridaemia (1.0%), high levels of low-density lipoprotein cholesterol (0.6%) and obesity (4.0%) showed no statistically significant difference based on sex. However, smoking (4%) showed a significant gender difference (boys: 7.3%; girls 1.2%). The relatively low cardiovascular disease risk factor profile of Tunisian children needs to be encouraged through to adulthood. Thus a school programme of heart health promotion should be established.

Etude des facteurs de risque cardiovasculaires chez des écoliers du milieu rural à Sousse (Tunisie)

RESUME Nous avons entrepris une étude épidémiologique basée sur un échantillon représentatif de 793 écoliers vivant en zone rurale à Sousse (Tunisie) pour évaluer la prévalence de certains facteurs de risque de maladies cardiovasculaires. La prévalence de l'hypertension (11,2 %), de l'hypercholestérolémie (2,9 %), de l'hypertriglycéridémie (1,0 %), des hauts niveaux de cholestérol des lipoprotéines de basse densité (0,6 %) et de l'obésité (4,0 %) n'a indiqué aucune différence significative sur la base du sexe. Toutefois, le tabagisme (4 %) montrait une différence significative entre les sexes (garçons : 7,3 % ; filles 1,2 %). Le profil relativement bas des facteurs de risque de maladies cardiovasculaires des enfants tunisiens doit être encouragé jusqu'à l'âge adulte. Un programme scolaire de promotion de la santé cardiovasculaire devrait donc être mis en place.

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Introduction

Cardiovascular diseases (CVD) remain the leading cause of death and disability in technologically developed countries [*1,2*], despite substantial falls in mortality. With the epidemiological transition [*3*], the adult Tunisian population is currently facing an increase in chronic noncommunicable diseases, particularly in CVD [*4,5*].

While it is well recognized that the process of atherosclerosis underlying the development of CVD in adults begins early in life (previously confirmed by autopsy studies on young soldiers killed in battle [*6*]), there is a lack of data on the distribution of the main CVD risk factors in Tunisian school-age populations. Increasingly, the prevention of CVD is recognized to be dependent on the level of exposure to risk factors in early childhood. The assessment of CVD risk factors in child and teenage populations would therefore provide a greater understanding of the etiology of CVD, and could serve as a basis for public health interventions to minimize the risk of developing CVD later in life [*7*].

The present survey was conducted on a representative sample of rural schoolchildren in the governorate of Sousse, Tunisia. The purpose of the survey was to obtain information on the distribution of CVD risk factors among child and teenage populations which could be used in the design, implementation and assessment of prevention programmes to promote healthy lifestyles in these groups. Specifically, the study sought to determine the prevalence of and relationship between tobacco consumption, obesity, arterial hypertension, and hypercholesterolaemia and other lipid disorders.

Methods

Study sample

The study sample was composed of children aged 12 to 17 years, drawn from public secondary schools in rural areas of Sousse. A transversal type survey was carried out on a representative sample of children selected by multistage cluster sampling. A sample size of 784 children was calculated as necessary to assess the prevalence of the different risk factors with a required accuracy of ± 3.5% and confidence level of 95%.

Data collection procedures

Tobacco consumption

A self-reporting questionnaire is the most common method for measuring tobacco consumption by young people. We used a modified version of the standard World Health Organization questionnaire for smoking prevalence [*8*], and to determine the frequency of smoking, age of commencement, age of a regular use and of cessation.

Arterial pressure

To minimize observer bias in measuring blood pressure, we used an electronic device for which reproducibility and accuracy of results have been demonstrated. A generous armband size aided accurate measurement, with pressure measured twice at the beginning and end of examination, separated by a rest period of at least 10 minutes. The mean of these two measures was used for further calculation of the percentile distribution. Participants were defined as hypertensive if systolic blood pressure (SBP) or diastolic blood pressure (DBP) was outside the 95th percentile of blood pressure distribution according to age [*9*], the reference values for which were obtained from a previous study in the same population [10].

Blood lipid analysis

To analyse blood lipids, participants were required to fast for 12 hours prior to blood being taken, after which a breakfast was provided. Blood samples (5 mL of blood in a tube containing EDTA 1 mg/mL) were taken by a trained nurse with paediatric experience. After collection, they were rapidly centrifuged. Plasma levels of total cholesterol and triglycerides were measured on frozen samples (–20 °C) using Unimate-5 CHOL and Unimate-7TRIG kits (Roche) respectively. Plasma levels of high-density lipoprotein (HDL)-cholesterol were measured after precipitation of apolipoprotein B-containing lipoproteins using the phosphotungstate–magnesium chloride method (Roche). Concentrations of low-density lipoprotein (LDL)-cholesterol were calculated using the Friedewald formula [11]. Lipid and lipoprotein values were expressed in mmol/L. Hypercholesterolaemia was defined as a total cholesterol level > 5.2 mmol/L, LDL-cholesterol was considered high for values > 3.4 mmol/L, HDL-cholesterol was considered low for values < 0.9 mmol/L and hypertriglyceridaemia was defined as a triglycerides level > 1.94 mmol/L. These values are as per those used in the United States of America for children [12].

Height

Height was measured once, to the nearest 0.5 cm, in standing position, without shoes, on a floor without carpet. Participants stood with their backs against a wall, looking straight ahead.

Weight

Weight was measured once, to the nearest 100 g. As the diurnal variation for children is about 1 kg, all participants' weights were measured during the same interval of time between 08.00 and 12.00. Balances were calibrated in each school. Participants were categorized as obese if they had a body mass index (BMI) exceeding 27 kg/m^2 Overweight was defined as a BMI exceeding 25 kg/m^2.

Data analysis

Because of the substantial variation between the growth and the maturation of boys and girls, all analyses were stratified according to sex and age. To assess the relationship between the main variables determining risk of CVD, we analysed the data using the chi-squared test (to assess the significance of prevalence differences between sub-groups), Student *t*-test (to compare the means of two independent groups) and ANOVA (to compare the means of more than two independent groups). A *P*-value < 0.05 was considered significant.

Ethical considerations

Appropriate ethical protocols were followed in carrying out the study. Authorization was sought and obtained from the

Table 1 **Distribution of participants by age and sex for rural schoolchildren, Sousse, Tunisia**

Age (years)	Males No.	Males %	Females No.	Females %	Total No.	Total %
12	46	12.5	61	14.4	107	13.5
13	56	15.2	58	13.7	114	14.4
14	82	22.2	82	19.3	164	20.7
15	84	22.8	107	25.2	191	24.1
16	51	13.8	60	14.2	111	14.0
17	50	13.6	56	13.2	106	13.4

Table 2 **Distribution of the main cardiovascular risk factors by sex in rural schoolchildren, Sousse, Tunisia**

Sex	SBP mmHg	DBP mmHg	BMI kg/m²	CHOL mmol/L	LDL mmol/L	HDL mmol/L	TRIGL mmol/L
Males							
Mean	116.28	65.16	19.80	3.53	1.47	1.74	0.71
s	14.21	10.80	3.38	0.69	0.61	0.38	0.29
n	369	369	369	367	367	367	367
Females							
Mean	117.21	67.09	20.67	3.77	1.64	1.80	0.75
s	12.62	9.54	3.55	0.73	0.61	0.39	0.30
n	424	424	424	419	419	419	419
Total							
Mean	116.78	66.19	20.26	3.66	1.56	1.77	0.73
s	13.38	10.18	3.50	0.72	0.61	0.39	0.29
n	793	793	793	786	786	786	786

SBP = systolic blood pressure.
DBP = diastolic blood pressure.
BMI = body mass index.
CHOL = cholesterol.
LDL = low-density lipoprotein cholesterol.
HDL = high-density lipoprotein cholesterol.
TRIGL = triglycerides.
s = standard deviation.

Ministry of Education and, because of the young age of the target population, from the participants' schools, teachers and parents.

Results

Of the 793 children sampled, girls represented 53.5 % and boys 46.5 % of the total sample size. All were clinically examined, with biological data obtained for 786 children (a participation rate of 99.1%). The sample size and the number examined by age and sex are summarized in Table 1.

Girls had significantly higher means for SBP, DBP, BMI, total cholesterol, LDL- and HDL-cholesterol and triglycerides than boys (Table 2). SBP increased significantly with age, from 112.39 mm Hg at 12 years to 124.82 mm Hg at 17 years (ANOVA F = 22.37, P < 0.0001) (Table 3). DBP increased significantly with age, from 63.51 mm Hg at 12 years to 69.72 mm Hg at 17 years (ANOVA F = 5.88, P < 0.0001). BMI increased significantly with age, from 18.86 kg/m² at 12 years to 22.0 kg/m² at 17 years (ANOVA F = 13.23, P < 0.0001). Total cholesterol decreased significantly with age, from 3.83 mmol/L at 12 years to 3.52 mmol/L at 17 years (ANOVA F = 3.06, P = 0.01). HDL-cholesterol also decreased with age, from 1.80 mmol/L at 12 years to 1.73 mmol/L at 17 years. This trend was statistically significant (ANOVA F = 4.03, P = 0.001).

The mean SBP increased significantly with weight, from 115.89 mm Hg for normal weight to 125.28 mm Hg for overweight children (t-test = –5.9, P < 0.0001). Mean DBP also increased significantly with weight, from 65.66 mm Hg for normal weight to 71.29 mm Hg for overweight children (t-test = –4.61, P < 0.0001).

Table 3 **Distribution of the main cardiovascular risk factors by age of rural schoolchildren, Sousse, Tunisia**

Age (years)		SBP mm Hg	DBP mm Hg	BMI kg/m²	CHOL mmol/L	LDL mmol/L	HDL mmol/L	TRIGL mmol/L
12	Mean	112.39	63.51	18.86	3.83	1.68	1.80	0.76
	s	11.36	8.87	3.30	0.64	0.60	0.33	0.28
	n	107	107	107	107	107	107	107
13	Mean	109.58	66.50	19.25	3.79	1.58	1.90	0.68
	s	13.39	9.94	2.96	0.66	0.61	0.35	0.23
	n	114	114	114	113	113	113	103
14	Mean	114.67	64.12	19.87	3.62	1.53	1.77	0.70
	s	13.35	11.08	3.45	0.77	0.64	0.38	0.24
	n	164	164	164	164	164	164	164
15	Mean	119.04	66.94	20.65	3.64	1.57	1.73	0.75
	s	12.47	9.07	3.44	0.72	0.62	0.34	0.31
	n	191	191	191	191	191	191	191
16	Mean	119.96	66.88	20.92	3.60	1.56	1.71	0.73
	s	12.23	9.50	3.08	0.79	0.63	0.42	0.33
	n	111	111	111	109	109	109	109
17	Mean	124.82	69.72	22.01	3.52	1.45	1.73	0.77
	s	12.02	11.60	3.88	0.67	0.58	0.44	0.36
	n	106	106	106	106	106	106	106
Total	Mean	116.78	66.19	20.26	3.66	1.56	1.77	0.73
	s	13.38	10.18	3.50	0.72	0.61	0.39	0.29
	n	793	793	793	786	786	786	786

SBP = systolic blood pressure.
DBP = diastolic blood pressure.
BMI = body mass index.
CHOL = cholesterol.
LDL = low-density lipoprotein cholesterol.
HDL = high-density lipoprotein cholesterol.
TRIGL = triglycerides.
s = standard deviation.

Hypertension prevalence was estimated at 11.2% of the participants and was almost the same for boys (11.7%) as for girls (10.8%) with no significant difference. However, hypertension prevalence increased significantly with weight, ranging from 9.1% for normal weight to 32.0% for overweight children. This difference was statistically significant ($\chi^2 = 35.9$, $P < 0.00001$). The prevalence of hypertension increased significantly with age, from 3.7% at 12 years to 17.9% at 17 years ($\chi^2 = 11.31$, $P = 0.045$). Hypercholesterolaemia was observed in 2.9% of the participants, with no significant difference between boys (2.2%) and girls (3.6%). High levels of LDL-cholesterol were observed for 0.6% of the study sample, with no significant difference between girls (0.3%) and boys (1.0%). Low levels of HDL-cholesterol were observed in 0.6% of the study sample, with no significant difference for girls (0.2%) and boys (1.1%). The prevalence of hypertriglyceridaemia was 1.0%; it was similar for boys (1.1%) and girls (1.0%). Obesity (i.e. BMI $\geq$ 27 kg/m^2) was found in 4.0% of the children with no significant difference between girls (4.5%) and boys (3.5%). Overweight (BMI $\geq$ 25 kg/m^2) was higher for girls (11.1%) than for boys (7.6%), although not significantly different.

As regards smoking, 4.0% of the study sample smoked, with the prevalence among boys (7.3%) significantly higher than for girls (1.2%) (χ^2 = 19.19, $P <$ 0.00001). The prevalence of smoking increased with age for boys, from 3.6% at 13 years of age to 28.0% at 17 years of age. This trend was statistically significant (χ^2 = 38.78, $P <$ 0.0001).

Discussion

The study of CVD risk factors among children started with the Bogalusa Heart Study, which identified a strong relationship between total cholesterol and LDL-cholesterol with grease streaks of combined aortic and coronary arteries [*13*]. Many similar studies followed, establishing CVD risk factor profiles for children in different societies [*14,15*]. Our study, with a global participation rate of 99.1%, shows to some extent that Tunisia's rural schoolchildren have a better CVD risk factor profile than those in Western societies. In fact, the prevalence of smoking among boys in Tunisia is lower (7.3%) than in a similar Belgian population (22.1%) [*16*]. Tunisian girls are still protected from smoking compared to Western societies, where in some countries (e.g. Sweden), studies have shown girls reporting a higher prevalence of smoking than boys [*17*]. In fact, with a smoking prevalence of 1.2%, the rate for Tunisian girls is lower than that of any country in the European Union [*18*].

The prevalence of obesity among rural schoolchildren is lower in Tunisia (4.0%) than in Belgium (15%) or the United States (as high as 24%) [*19*]. In our study, mean total cholesterol was significantly higher for girls (4.3 mmol/L) than for boys (3.88 mmol/L), and was lower than in a similar Swedish population (4.4 and 4.2 mmol/L for girls and boys respectively) [*20*]. Mean total cholesterol was higher for younger children than for older children, a finding similarly observed in many other studies [*21,22*].

Reports of the prevalence of hypertension from studies of children vary greatly [*23–25*], partly because of differences in the definition criteria used. Some authors strongly support using the 97.5 percentile of blood pressure distribution with height [*26*], while others recommended the 95th percentile of blood pressure distribution with age [*9*]. Using this latter criterion, the prevalence of hypertension in our study was similar for boys and girls, and estimated at 11.2%. This prevalence rate is low compared to the results of the studies previously cited [*23–25*].

These results show to some extent that rural schoolchildren in Tunisia remain protected from the extension of CVD risk factors, with low levels of lipid disorders. This profile of low CVD risk must be maintained (by promoting healthy lifestyles and reinforcing the health club initiative in schools, for example). For a rapidly developing country such as Tunisia, primary preven-

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