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

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دراسة عوامل اختطار الأمراض القلبية الوعائية بين تلاميذ المناطق الحضرية في سوسة، تونس

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خلاصة: أجرينا مسحاً وبائياً شمل 1569 تلميذاً من منطقة سوسة الحضرية من أجل تقدير اختطار إصابة التلاميذ التونسيين بالأمراض القلبية الوعائية. وتم تحديد معدلات انتشار عوامل الاختطار التالية ذات الصلة بالأمراض القلبية الوعائية: ضغط الدم المرتفع وفرط كولستيرول الدم وغيره من اضطرابات الشحميات والسمنة واستعمال التبغ. ولم يُلاحَظ أي اختلاف ذي دلالة إحصائية في ضغط الدم المرتفع وفرط كولستيرول الدم فيما بين الجنسين. ووجد أن فرط كولستيرول الدم وارتفاع مستويات كولستيرول البروتين الشحمي خفيض الكثافة والسمنة، كانت أعلى بدرجة يعتد بها بين الإناث عنها بين الذكور. وكان معدل التدخين أكبر بين الذكور بدرجة يعتد بها. إن الانخفاض النسبي في عوامل اختطار الأمراض القلبية الوعائية بين التلاميذ التونسيين، يستحق التشجيع في مرحلة الرشد. ولذلك ينبغي إنشاء برنامج مدرسي للتوعية حول صحة القلب.

ARSTRACT To assess the risk to Tunisian children of cardiovascular diseases (CVD), we undertook an epidemiological survey of 1569 urban schoolchildren from Sousse. Prevalence rates for the following CVD risk factors were determined: hypertension, hypercholesterolaemia and other lipid disorders, obesity and tobacco consumption. Hypertension and hypertriglyceridaemia showed no statistically significant difference by sex. Hypercholesterolaemia, high levels of low-density lipoprotein cholesterol and obesity were all significantly higher for girls than boys. Smoking was significantly higher among boys. The relatively low CVD risk factor profile of Tunisian schoolchildren should be encouraged in adulthood and a school heart health programme should be established.

Etude des facteurs de risque des maladies cardiovasculaires chez des écoliers du primaire vivant en milieu urbain à Sousse (Tunisie)

RESUME Afin d'évaluer le risque que courent les enfants tunisiens vis-à-vis des maladies cardiovasculaires, nous avons réalisé une enquête épidémiologique sur 1569 écoliers vivant en milieu urbain à Sousse. Les taux de prévalence pour les facteurs de risque des maladies cardiovasculaires suivants ont été déterminés: hypertension, hypercholestérolémie et autres troubles lipidiques, obésité et consommation de tabac. L'hypertension et l'hypertriglycéridémie ne montraient aucune différence statistique en fonction du sexe. L'hypercholestérolémie, les hauts niveaux de cholestérol des lipoprotéines de basse densité et l'obésité étaient tous considérablement plus élevés pour les filles que pour les garçons. Le tabagisme était plus répandu chez les garçons. Le profil des facteurs de risque des maladies cardiovasculaires relativement bas des enfants tunisiens devrait être encouragé à l'âge adulte et un programme scolaire de santé du cœur devrait être mis en place.

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Introduction

Cardiovascular diseases (CVDs) remain the leading cause of death and disability in western, technologically developed economies, despite substantial decreases in mortality [*1–5*]. With the epidemiological transition [*6*], Tunisia's adult population, not unlike the experiences of those in industrialized countries, is currently facing an increase in chronic noncommunicable diseases (NCDs), especially CVDs [*7–9*].

While it is well recognized that the atherosclerosis process underlying the development of CVDs in adults begins early in life, there has been a lack of data on the distribution of the main CVD risk factors in Tunisian school-age populations. That the pathobiological determinants of atherosclerosis intervene very early in life has been confirmed by autopsy studies of young soldiers killed in battle [*10–12*]. The assessment of CVD risk factors in pre-adult populations would better inform us of the etiology of CVDs, and serve as a basis for public health interventions to minimize the risk of CVDs in later life [*13*]. Indeed, the prevention of CVDs is increasingly shown to be dependent on the level of exposure to risk factors in early childhood.

The present survey was conducted on a representative sample of urban schoolchildren in Sousse, Tunisia. The purpose of the survey was to obtain information on the distribution of CVD risk factors among child and teen populations for use 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 CVD risk factors such as arterial hypertension, hypercholesterolaemia and other lipid disorders, obesity and tobacco consumption.

Methodology

Study population

The study population was composed of children aged 13 years and 16 years, drawn from Sousse public secondary schools. A transversal type survey was carried out on a representative sample of children and teenagers. Multistage cluster sampling permitted the selection of two distinct groups: one composed of children mostly aged 13 years (age of puberty) and a second group of mostly 16-year-old children (end of puberty). A sample size of 1600 pupils (400 boys and 400 girls for each age group) was calculated to be 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 was used to measure tobacco consumption by frequency of smoking, age of commencement, age of a regular use and of cessation.

Arterial pressure

To minimize observer bias, blood pressure was measured electronically using a 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 [*14*], the reference values for which were obtained from a previous study in the same population [*15*].

Blood lipids analysis

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. The volume of plasma was used for the enzymatic dosage of cholesterol, triglycerides and lipoproteins. Hypercholesterolaemia was defined as a total cholesterol level greater than 5.2 mmol/L, low-density lipoprotein (LDL) cholesterol was considered high for values greater than 3.4 mmol/L, high-density lipoprotein (HDL) cholesterol was considered low for values less than 0.9 mmol/L and hypertriglyceridaemia was defined as a triglycerides level greater than 1.94 mmol/L. These values are as per those used in the United States of America for children [*16,17*].

Height

Height was measured once, to the nearest 0.5 cm, in a 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 their body mass index (BMI) exceeded 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 maturation of boys and girls, all analyses were stratified according to gender and age. To assess the relationship between the main variables determining risk of CVD, we analysed the data using the chi-squared test, Student *t*-test and ANOVA at the 5% significance level.

Ethical considerations

Appropriate ethical protocols were followed. Authorization was sought and obtained from the Ministry of Education and from the participants' schools, teachers and parents for their participation.

Results

Of the 1569 children sampled, girls represented 52.3% and boys 47.7% of the total sample size. All were clinically examined, with biological data obtained for 1497 participants (a participation rate of 95.4%). The sample size and the number examined by age and sex are summarized in Table 1.

Regarding CVD risk factors (Table 2), girls had a higher mean DBP, total cholesterol, LDL and HDL cholesterol and BMI than boys. Boys' mean SBP was higher than that of the girls.

Mean SBP and DBP increased slowly with age as shown in Table 3, but this trend was not statistically significant. BMI increased significantly with age from 20.19 kg/m^2 at 13 years to 23.90 kg/m^2 at 19 years (Table 3). This trend was statistically significant (ANOVA $F = 14.4, P < 0.0001$). Total cholesterol decreased significantly with age from 4.25 mmol/L at 13 years to 3.80 mmol/L at 19 years (ANOVA $F = 4.12, P < 0.001$). HDL cholesterol also decreased with age from 1.63 mmol/L at 13 years to 1.29 mmol/L at 19 years. This trend was highly significant (ANOVA $F = 30.9, P < 0.0001$).

SBP increased significantly with weight, from 118.19 mmHg for children of normal weight to 127.75 mmHg for over-

weight children ($t = -12.3$, $P < 0.0001$). Mean DBP also increased significantly with weight, from 70.44 mmHg for those of normal weight to 73.52 mmHg for overweight children ($t = -2.28$, $P = 0.023$).

The prevalence of hypertension was estimated at 9.6% of the study population—almost the same for boys and girls alike (9.2% and 9.9% respectively), with no statistically significant difference. However, the prevalence of hypertension increased significantly with weight, from 7.3% for normal weight to 23.7% for overweight children. This difference was statistically

Table 1 **Distribution of participants by age and sex in urban schoolchildren, Sousse, Tunisia**

Age (years)	Male		Female		Total	
	No.	%	No.	%	No.	%
13	204	27.27	233	28.38	437	27.85
14	103	13.77	77	9.38	180	11.47
15	91	12.17	118	14.37	209	13.32
16	197	26.34	228	27.77	425	27.09
17	92	12.30	109	13.28	201	12.81
18	30	4.01	41	4.99	71	4.53
19	31	4.14	15	1.83	46	2.93
Total	748	100	821	100	1569	100

Table 2 **Distribution of the main cardiovascular risk factors by sex in urban 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	120.22	69.36	20.87	3.89	2.03	1.44	0.91
s	10.75	11.40	3.69	0.74	0.60	0.31	0.32
n	748	748	748	716	716	716	716
Females							
Mean	118.84	72.23	21.77	4.30	2.34	1.55	0.91
s	11.36	22.97	3.90	0.80	0.69	0.29	0.35
n	821	821	821	781	781	781	781
Total							
Mean	119.50	70.87	21.34	4.11	2.20	1.50	0.91
s	11.09	18.44	3.82	0.80	0.67	0.30	0.34
n	1569	1569	1569	1497	1497	1497	1497

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.

significant ($\chi^2 = 57.8$, $P < 0.00001$). The prevalence of hypertension increased until the age of 15 years (14.4%), decreased thereafter (6.0%), and rose again for age 18 years (15.5%).

Hypercholesterolaemia was observed in 8.1% of the study population and was significantly higher for girls (12.0%) than for boys (3.9%) ($\chi^2 = 32.9$, $P < 0.0001$). The prevalence of hypercholesterolaemia increased with weight, from 7.1% for normal weight to 14.7% for overweight children. This difference was statistically significant ($\chi^2 = 13.6$, $P < 0.0001$). A high

Table 3 **Distribution of main cardiovascular disease risk factors by age in urban schoolchildren, Sousse, Tunisia**

Age (years)		SBP (mmHg)	DBP (mmHg)	BMI (kg/m²)	CHOL (mmol/L)	LDL (mmol/L)	HDL (mmol/L)	TRIGL (mmol/L)
13	Mean	119.13	71.96	20.19	2.19	4.25	1.63	0.94
	s	12.61	26.02	0.67	3.66	0.80	0.31	0.33
	n	437	437	437	401	401	401	401
14	Mean	120.74	69.96	20.95	4.04	2.06	1.56	0.95
	s	11.04	8.21	3.93	0.74	0.62	0.28	0.44
	n	180	180	180	171	171	171	171
15	Mean	120.12	71.27	21.67	4.11	2.20	1.51	0.90
	s	10.56	17.09	4.14	0.77	0.67	0.28	0.26
	n	209	209	209	201	201	201	201
16	Mean	119.21	69.60	21.90	4.07	2.25	1.42	0.88
	s	11.19	7.98	3.69	0.78	0.64	0.27	0.33
	n	425	425	425	416	416	416	416
17	Mean	119.31	71.58	22.15	4.01	2.22	1.39	0.89
	s	8.28	25.49	3.09	0.83	0.70	0.27	0.34
	n	201	201	201	196	196	196	196
18	Mean	118.93	71.35	21.11	4.04	2.22	1.40	0.91
	s	9.93	8.16	3.49	0.92	0.73	0.31	0.30
	n	71	71	71	67	67	67	67
19	Mean	119.68	70.03	23.90	3.80	2.07	1.29	0.95
	s	9.70	7.96	4.72	0.78	0.70	0.29	0.37
	n	46	46	46	45	45	45	45
Total	Mean	119.50	70.67	21.34	4.11	2.19	1.50	0.91
	s	11.09	18.44	3.82	0.80	0.67	0.30	0.34
	n	1569	1569	1569	1497	1497	1497	1497

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

level of LDL cholesterol was observed for 3.9% of the study population, significantly higher for girls (5.8%) than for boys (2.0%) ($\chi^2 = 14.3$, $P < 0.0001$). The prevalence of high LDL increased significantly with weight, from 3.2% for normal weight to 8.8% for overweight children ($\chi^2 = 14.9$, $P < 0.0001$). Low levels of HDL cholesterol were observed in 1.2% of the study population with no significant difference between girls (0.8%) and boys (1.7%). It was also similar for normal weight (1.1%) and overweight children (2.0%).

Hypertriglyceridaemia was observed in 1.3% of the study population, with similar prevalence for boys (1.0%) and girls (1.5%). However, it increased significantly with weight, from 0.8% for normal weight to 4.4% for overweight children ($\chi^2 = 18.6$, $P < 0.0001$).

Obesity (BMI > 27 kg/m^2) was found in 7.7% of the study population. It was significantly higher for girls than for boys—9.7% and 6.0 % respectively ($\chi^2 = 9.02$, $P = 0.011$). Overweight (BMI > 25 kg/m^2) was also significantly higher in girls than boys 17.0% and 11.1% respectively ($\chi^2 = 8.21$, $P = 0.0041$).

Smoking was found to be habitual in 7.6% of the study population, significantly higher for boys than for girls—14.7% and 1.1% respectively ($\chi^2 = 103.4$, $P < 0.00001$). The prevalence of smoking increased with age for boys from 3.4% at 13 years to 32.3% at 19 years. This trend was statistically significant ($\chi^2 = 40.9$, $P < 0.0001$).

Discussion

A global participation rate of 95.4% for an epidemiological study is very high and relatively rare. The study of cardiovascular risk factors among schoolchildren in a developing country such as Tunisia is of great interest for several reasons. Until now, little has been known about the level of risk for urban schoolchildren in populations that are in transition from communicable to non-communicable diseases. The only data available have focused on CVD risk factor profiles of adults aged 20 years in an urban context [*8,9*], and in a rural area of Tunisia [*18*]. There has been a lack of data on the prevalence of major CVD risk factors among children in Tunisia. Assessing CVD risk profiles earlier in life is needed for effective primordial prevention. Such data would assist health officials to adopt a national strategy for preventing CVD risk factors in the population and also serve as a baseline for assessing future trends in the risk factors studied.

The study of cardiovascular risk factors among children started with the Bogalusa Heart Study, which identified a strong relationship between total cholesterol and LDL cholesterol with fatty streaks in the aorta and coronary arteries [*19–21*]. Many similar studies have established CVD risk factor profiles for children in different societies [*22–27*]. Our study showed to some extent that Tunisia's urban schoolchildren have a better CVD risk factor profile than in Western societies. In fact, the prevalence of smoking among boys in Tunisia is lower (14.7%) than in a similar Belgian population (22.1%) [*28*]. Tunisian girls are still less likely to smoke than girls in Western societies, where in some countries (e.g. Sweden), studies have shown girls reporting a higher prevalence of smoking than boys [*29*]. In fact, with a smoking prevalence of 1.1%, the rate for Tunisian girls is lower than that of any country in the European Union [*30*].

The prevalence of obesity among schoolchildren is lower in Tunisia (7.7%) than in Belgian (15%) or the United States

(as high as 24%) [*31*]. In our study, mean total cholesterol was significantly higher in girls (4.3 mmol/L) than in boys (3.88 mmol/L) and was lower than in a similar Swedish population (4.4 mmol/L and 4.2 mmol/L for girls and boys respectively) [*32,33*]. Mean total cholesterol was higher for younger children than for older children, a finding similar to observations in many other studies [*34–37*].

Reports of the prevalence of hypertension from studies of children vary greatly (from 1% to 20%) [*38–40*], partly because of differences in the definition criteria used. Some authors strongly support using the 97.5 percentile of blood pressure distribution with height [*41*], while others recommended the 95th percentile of blood pressure distribution with age [*14*]. Using this latter criterion, the prevalence of hypertension in our study was found to be similar for boys and girls, and estimated at 9.6%. This prevalence is low compared to the results of the studies previously cited [*38–40*].

These results show to some extent that urban schoolchildren in Tunisia remain protected from 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 like Tunisia, primary prevention is the most effective and efficient strategy for CVD control.

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References

1. Uemura K, Pisa Z. Trends in cardiovascular disease mortality in industrialized countries since 1950. *World health statistics quarterly*, 1988, 41:155–78.
2. Thom TJ. International mortality from heart disease: rates and trends. *International journal of epidemiology*, 1989, 18:S20–8.
3. Murray CJ, Lopez AD. Mortality by cause for eight regions of the world: Global Burden of Disease Study *Lancet*, 1997, 349:1269–76.
4. Uemura K, Pisa Z. Recent trends in cardiovascular disease mortality in 27 industrialized countries. *World health statistics quarterly*, 1985, 38:142–62.
5. Tuomilehto J et al. Decline in cardiovascular mortality in North Karelia and other parts of Finland. *British medical journal*, 1986, 293:1068–71.
6. Omran AR. The epidemiological transition. A theory of the epidemiology of population change. *Milbank Memorial Fund quarterly*, 1971, 49:509–38.
7. Ghannem H et al. Facteurs de risque des maladies cardiovasculaires dans une communauté semi-urbaine du Sahel Tunisien. [Risk factors in cardiovascular diseases in a semi-urban community of the Tunisian Sahel.] *Revue d' epidémiologie et de santé publique*, 1992, 40: 108–12.

8. Ghannem H, Fredj AH. Transition épidémiologique et facteurs de risque cardiovasculaires en Tunisie. [Epidemiological transition and cardiovascular risk factors in Tunisia.] *Revue d' epidémiologie et de santé publique*, 1997, 45:286–92.

9. Ghannem H, Fredj AH. Prevalence of cardiovascular risk factors in the urban population of Soussa in Tunisia. *Journal of public health medicine*, 1997, 19:392–6.

10. Enos WF et al. Coronary disease among United States soldiers killed in action in Korea: preliminary report. *Journal of the American Medical Association*, 1953, 152:1090–3.

11. McNamara JJ et al. Coronary artery disease in combat casualties in Vietnam. *Journal of the American Medical Association*, 1971, 216:1185–7.

12. Berenson GS et al. Atherosclerosis of the aorta and coronary arteries and cardiovascular risk factors in persons aged 6 to 30 years and studied at necropsy (the Bogalusa Heart Study). *American journal of cardiology*, 1992, 70:851–8.

13. *Prevention in childhood and youth of adult cardiovascular diseases: time for action.* Geneva, World Health Organization, 1990.

14. Report of the Second Task Force on Blood Pressure Control in Children, 1987. Task Force on Blood Pressure Control in Children. National Heart, Lung, and Blood Institute, Bethesda, Maryland. *Pediatrics*, 1987, 79:1–25.

15. Trabelsi L. *Epidémiologie des facteurs de risque cardio-vasculaires chez les jeunes en milieu scolaire à Sousse* [Thèse No. 1227]. [*Epidemiology of cardiovascular risk factors among schoolchildren in Sousse* (Thesis No. 1227).] Sousse, Tunisia, Faculté de Médecine de Sousse, Tunisie, 1998.

16. National Cholesterol Education Program (NCEP): highlights of the Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents. *Pediatrics*, 1992, 89:495–501.

17. Diller PM et al. Definition and application of the discretionary screening indicators according to the National Cholesterol Education Program for Children and Adolescents. *Journal of pediatrics*, 1995, 126:345–52.

18. Papoz L et al. Diabetes mellitus in Tunisia: description in rural and urban populations. *International journal of epidemiology*, 1988, 17:419–22.

19. Newman WP et al. Relation of serum lipoprotein levels and systolic blood pressure to early atherosclerosis. The Bogalusa Heart Study. *New England journal of medicine*, 1986, 314:138–44.

20. Freedman DS et al. Black–white differences in aortic fatty streaks in adolescence and early adulthood: the Bogalusa Heart Study. *Circulation*, 1988, 77:856–64.

21. Relationship of atherosclerosis in young men to serum lipoprotein cholesterol concentrations and smoking. A preliminary report from the Pathobiological Determinants of Atherosclerosis in Youth (PDAY) Research Group. *Journal of the American Medical Association*, 1990, 264:3018–24.

22. Srinivasan SR et al. Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors: the Bogalusa Heart Study. *Metabolism*, 1996, 45:235–40.

23. Berenson GS et al. Epidemiology of hypertension from childhood to young adulthood in black, white, and Hispanic population samples. *Public health reports*, 1996, 111(suppl. 2):3–6.

24. Freedman DS et al. The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics*, 1999, 103:1175–82.

25. Berenson GS et al. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. *New England journal of medicine*, 1998, 338:1650–6.

26. Labarthe DR et al. Childhood precursors of high blood pressure and elevated cholesterol. *Annual review of public health*, 1991, 12:519–41.

27. Lauer RM et al. Level, trend and variability of blood pressure during childhood: the Muscatine Study. *Circulation*, 1984, 69:242–9.

28. *Santé en Hainaut: tableau de bord de la santé des jeunes.* [*Health in Hainaut. Management report of the health of young people.*] Brussels, Belgium, Imprimerie provinciale, 1998:85.

29. Bergstrom E et al. Cardiovascular risk indicators cluster in girls from families of low socioeconomic status. *Acta paediatrica*, 1996, 85:1083–90.

30. Van Reek J, Adriaanse H. Daily smoking among adolescents in the European Community. *Revue d'epidémiologie et de santé publique*, 1995, 45:169–70.

31. Shear CL et al. Secular trends of obesity in early life: the Bogalusa Heart Study. *American journal of public health*, 1988, 78:75–7.

32. Bergstrom E et al. Serum lipid values in adolescents are related to family history, infant feeding, and physical growth. *Atherosclerosis*, 1995, 117:1–13.

33. Bergstrom E et al. Insulin resistance syndrome in adolescents. *Metabolism*, 1996, 45:908–14.

34. Hickman TB et al. Distributions and trends of serum lipid levels among United States children and adolescents ages 4–19 years: data from the Third National Health and Nutrition Examination Survey. *Preventative medicine*, 1998, 27:879–90.

35. Webber LS et al. Tracking of serum lipids and lipoproteins from childhood to adulthood. The Bogalusa Heart Study. *American journal of epidemiology*, 1991, 133:884–99.

36. Schulpis K, Karikas GA. Serum cholesterol and triglyceride distribution in 7767 school-aged Greek children. *Pediatrics*, 1998, 101:861–4.

37. Muchacka M, Maùecka-Tendera E, Koehler B. Stæýenie cholesterolu, HDL-cholesterolu, LDL-cholesterolu i trójglicerydów w surowicy krwi dzieci úlàskich. [Levels of cholesterol, HDL-cholesterol, LDL cholesterol and triglycerides in blood serum of children from Silesia.] *Pediatria polska*, 1995, 70:127–32.

38. Ibsen KK. Blood pressure in Danish children and adolescents. *Acta paediatrica scandinavica*, 1981, 70:27–31.

39. André JL, Deschamps JP, Guegnen R. La tension artérielle chez l'enfant et l'adolescent. Valeurs rapportées à l'age et à la taille chez 17 067 sujets. [Arterial blood pressure in 17 067 children and adolescents. Variation with age and height.] *Archives francaises de pediatrie*, 1980, 37:477–82.

40. Fixler DE et al. Hypertension screening in schools: results of the Dallas study. *Pediatrics*, 1979, 63:32–6.

41. Broyer M, André JL. Nouveaux regards sur l'hypertension artérielle de l'enfant. [New look at arterial hypertension in children]. *Archives francaises de pédiatrie*, 1980, 37:429–32.