

THE PREVALENCE OF CARDIOVASCULAR RISK FACTORS AMONG STUDENTS IN JEDDAH, SAUDI ARABIA

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هدف البحث: وصف معدلات الانتشار لعوامل الخطورة المسببة لأمراض القلب والأوعية الدموية بين طلاب وطالبات المدارس بمدينة جدة .

طريقة البحث: دراسة مقطعية خلال عام 1994م على عينة من الطلاب والطالبات في (49) مدرسة حكومية ، تم اختيارها باستخدام الطريقة العشوائية الطبقة المتعددة الخطوات . تم تعبئة استبانات وعمل قياسات الطول والوزن وسمك الجلد وضغط الدم لهم ، كما تم قياس مستوى السكر والكوليسترول الكلي في الدم لعينة جزئية منهم .

النتائج: بلغ عدد أفراد العينة المختارة (4042) طالباً وطالبة ، مثل الذكور منهم 71% وكان متوسط أعمارهم 15.3 ± 2.7 سنة . وجد أن 23% منهم يعانون من السمنة ، كما أن 6.4% و 9% منهم يعانون من ارتفاع ضغط الدم الانقباضي والانبساطي على التوالي دون أن يكون هناك فرق ذو دلالة إحصائية بين الطلاب والطالبات . ومن بين (1432) طالباً وطالبة وجد أن 4% من الطلاب و2% من الطالبات لديهم ارتفاع في مستوى الكوليسترول بالدم ، كما أن 0.4% من الطلاب و6.0% من الطالبات لديهم ارتفاع في مستوى السكر في الدم . وبالنسبة للتدخين فقد وجد أن 6.9% من الطلاب و5.0% من الطالبات من مجموع طلبة الثانوية والثالثة متوسط (1843) يدخنون حالياً .

الاستنتاجات والتوصيات: بناءً على نتائج الدراسة وحيث أن التوجهات والسلوكيات التي تؤثر على صحة الفرد في حياته المستقبلية من الممكن أن تبدأ في سن الطفولة والمراهقة فإن الجهود الوقائية لمنع حدوث أمراض القلب والأوعية الدموية عند البالغين لا بد أن تبدأ منذ الطفولة وعند الشباب وتعتبر المدارس مجالاً خصباً للرقى بالصحة والوقاية من المرض .

الكلمات المرجعية: عوامل الخطورة لأمراض القلب والأوعية الدموية ، طلاب وطالبات المدارس ، المملكة العربية السعودية .

Objectives: To determine the prevalence of cardiovascular risk factors among students in Jeddah, Saudi Arabia.

Methods: A cross-sectional study was conducted during 1994 on a sample of students selected from 49 public schools using a multistage stratified random sampling technique. For all students, an interview was conducted and anthropometric and blood pressure measurements were obtained. Fasting glucose and total cholesterol levels on a capillary blood sample were measured using Accutrend for a subsample of students.

Results: Of the 4042 students selected, 71% were males and the overall mean age was 15.3 ± 2.7 years. After age adjustment, about 23% of the students were found overweight. In addition, 6.4% and 9% of the students were found to have

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systolic and diastolic hypertension, respectively, with no statistically significant difference between males and females. Among 1432 students, 4% of males and 2% of females had hypercholesterolemia ($p=0.06$). Hyperglycemia was found in 0.4% of males and 0.6% of females. Among 1834 students in the 9th to 12th grades, 6.9% of males and 0.5% of females were current cigarette smokers.

Conclusions: Since attitudes and behaviors that influence future health are established during childhood and adolescence, intervention to prevent cardiovascular diseases (in adult life) should take place in childhood and youth to reduce the risk factors and schools have a great role to play in the promotion of good health.

Key Words: Cardiovascular risk factors, school students, Saudi Arabia.

INTRODUCTION

Cardiovascular diseases (CVD) account for a major proportion of all deaths during adulthood in both developed and developing countries.¹ The major risk factors in adulthood appear to be determined by patterns of behavior established in childhood and adolescence. Preventing the development of such behavior in childhood is easier than the attempt to reverse the situation and reduce the resulting risk of atherosclerosis in adulthood.² Therefore, schools have a great role to play in promoting good health. Data on the prevalence of CVD risk factors among children and adolescents in Saudi Arabia is scarce. To our knowledge, only one report³ from Saudi Arabia dealt with the prevalence of these risk factors in children. The sample in that study was confined to only one primary school where neither girls nor adolescents were considered. It is the aim of this study to describe the prevalence of CVD risk factors among male and female school children of various ages and at different educational levels and to discuss the potential for future intervention.

MATERIAL AND METHODS

Setting and population

Jeddah with a population of 2.1 million is one of the largest cities in the Kingdom. It has a total of 620 public schools (335 male schools and 285 female schools) with a total number of 200,000 pupils.

Study design

To achieve the objectives of this study a cross-sectional or prevalence study design was followed.

Sample selection and study subjects

A multi-stage stratified random sampling technique with proportional allocation (involving three major stages) was used to choose the required number of schools all over Jeddah at each educational level and the required number of students from the selected schools according to their study grade. The sample size was determined by means of one of the conventional equations with a 90% power, $\alpha=0.05$ and an estimated prevalence

for any CVD risk factor of at least 5%. In order to handle any missing data, as large a sample size as possible was aimed for. Therefore, a total number of 4042 students were selected from 49 public schools (25 male schools and 24 female schools) at the three educational levels (primary, intermediate and secondary) during 1994.

Methods of data and specimen

collection

Medical students trained on interviewing skills, anthropometric measurements, blood pressure measurement, and blood testing using the Accutrend® GC meter were recruited and divided into task groups to conduct the study under the direct supervision of the authors.

All students were interviewed using a structured questionnaire which included information on sociodemographic factors, physical activity and family history. For students in the third grade intermediate and first, second and third grades secondary, additional information on smoking habits were also obtained using a separate self-administered questionnaire. The following measurements were also taken on all students: weight using Seca® (model 777) personal scale to the nearest 0.1 kg and height using a standard measuring tape to the nearest 0.1 cm, both without shoes and lightly clothed from which body mass index (BMI) (weight in kg/height² in meters) was calculated; triceps, skinfold thickness using Slim Guide® skinfold caliper; and blood pressure using Baumanometer® desk model. In addition, fasting glucose and total cholesterol levels on a capillary blood sample were measured for a random subsample of the students using Accutrend® GC, Boehringer Mannheim.

Throughout the study, scales were calibrated at the beginning of each session and each time they were moved. Similarly, different meters were constantly checked for accuracy of reading according to the manufacturer's protocol.

After adjusting for age, cut-off points for BMI and skinfold thickness to determine obese and overweight students, respectively, were based on a published reference data for obesity.⁴ Similarly, cut-off points to determine those with systolic or diastolic hypertension were based on the criteria for arterial hypertension outlined by the WHO⁵ and the third JNC classification of blood pressure,⁶ after adjusting for age. For the age groups 6 - <10, 10 - <14, and 14-18 years, systolic/diastolic hypertension was defined as blood pressure readings of $\geq 120/80$, $\geq 125/85$, and $\geq 135/90$ mmHg respectively. Physical activity was assessed through only the performance of regular physical exercise based on the total number of hours per week and then categorized accordingly. Hyperglycemia was defined as a fasting glucose level of > 120 mg/dl and hypercholesterolemia was defined as a fasting total cholesterol level of ≥ 200 mg/dl. The criteria used follow known scientifically acceptable cut-off points for children of the same age range as the study population.⁷

Data management and statistical analysis

Data were entered in a database file and scrutinized for outliers and influential points.

The statistical analysis was done using SPSS statistical package. Descriptive statistics, chi-square test and t-test were used as appropriate. The analyses of BMI, skinfold thickness and blood pressure were adjusted for age. Level of significance was set to be <0.05 throughout the analysis.

RESULTS

A total of 4042 students were studied, 2870 (71.0%) males and 1172 (29.0%) females, with a mean age of 15.3 ± 2.7 years and a range of 9 years to 20 years. The mean age for males was 15.2 ± 2.7 years while for females it was 15.6 ± 2.5 years. The majority of the students were in age groups 13-15 years and 16-18 years (34.3% and 40.0% respectively) (Table 1). About 67% of the students were Saudis and 33.2% were non-Saudis.

Mean values and standard deviations of weight, height, BMI and triceps skinfold thickness, of male and female students are shown in tables 2 and 3. On the average, females between the age of 10 and 14 years had a higher weight than males. But at 15 years of age, the picture was reversed with males weighing more than females. Females were also taller than males between the age of 10 and 13 years but this was reversed at 14 years in favor of the males. With minor exceptions, mean values of both BMI and skinfold thickness for female students were higher than those for males of all ages. Overall mean BMI adjusted for age was 21.0 ± 5.7 . Mean BMI for males was significantly lower than females (20.6 ± 5.6 vs 21.9 ± 5.8 , $p < 0.001$). Overall, 23.5% of the students were obese (23.3% males and 26.4% females were obese, $p < 0.005$). This was confirmed by results of skinfold thickness adjusted for age where 22.7% of the students were found to be overweight.

Table 1: Age distribution of school students by sex

Age Group (Years)	Sex	
	Male	Female
	No (%)	No (%)
9-12	508 (17.7)	129 (11.0)
13-15	963 (33.6)	424 (36.2)
16-18	1114 (38.8)	501 (42.7)
19+	285 (9.9)	118 (10.1)
Total	2870	1172

$\chi^2 = 28.56, p < 0.001$

Overall mean systolic blood pressure was 114.8 ± 12.7 mmHg and mean diastolic blood pressure was 74.4 ± 10.0 mmHg and there were consistent increments with age for both. After adjusting for age, females were of higher mean systolic blood pressure than males ($p < 0.001$). As for mean diastolic blood pressure, no significant difference was noted between males and females after adjusting for age. Analysis among various age groups showed that in the first two groups, females had significantly higher systolic and diastolic blood pressure than males while in the third age group the converse was true (figures 1 and 2).

Figure 1: Mean systolic blood pressure and standard error for school students by age

Figure 2: Mean diastolic blood pressure and standard error for school students by age

Table 2: Mean values and standard deviations of selected anthropometric measurements of male students

Age (years)	No.	Weight (kg)	Height (cm)	BMI* (kg/m ²)	SKF [†] (mm)
9	22	27.8 (7.5)	131.9 (6.6)	15.6 (3.2)	9.1 (2.7)
10	144	30.5 (8.8)	134.7 (8.5)	16.2 (4.2)	10.2 (5.0)
11	147	34.3 (9.5)	139.3 (7.3)	17.0 (3.9)	11.4 (6.6)
12	195	38.1 (11.2)	144.1 (10.2)	17.7 (4.2)	11.7 (5.5)
13	290	41.9 (13.7)	147.8 (10.3)	18.4 (5.0)	11.6 (6.2)
14	360	49.8 (15.1)	156.2 (9.7)	19.8 (5.2)	11.9 (6.0)
15	313	54.2 (15.1)	162.7 (9.2)	19.8 (4.9)	11.5 (6.1)
16	357	58.0 (14.8)	165.5 (9.4)	20.8 (5.5)	11.3 (6.2)
17	407	63.9 (16.6)	168.7 (10.1)	22.2 (6.7)	12.2 (7.0)

18	350	64.9 (15.7)	169.8 (9.0)	22.1 (5.6)	12.2 (7.0)
19	160	64.9 (15.2)	172.2 (6.7)	21.2 (4.6)	11.3 (5.9)
20	83	66.7 (16.2)	171.6 (6.2)	22.1 (5.2)	12.2 (7.0)

* BMI= Body Mass Index †SKF = Triceps skinfold thickness

Table 3: Mean values and standard deviations of selected anthropometric measurements of female students

Age (years)	No.	Weight (kg)	Height (cm)	BMI* (kg/m ²)	SKF† (mm)
9	7	27.6 (3.8)	127.8 (6.0)	16.6 (2.6)	11.2 (3.9)
10	30	35.9 (14.0)	134.8 (7.8)	19.2 (7.7)	12.2 (4.6)
11	31	35.2 (6.7)	140.2 (5.5)	17.3 (3.0)	12.1 (6.1)
12	61	45.5 (13.2)	147.1 (9.3)	20.6 (6.2)	16.1 (7.4)
13	113	45.2 (11.6)	150.2 (7.0)	19.5 (4.5)	17.4 (6.3)
14	153	50.7 (13.0)	154.0 (7.7)	20.8 (5.2)	20.5 (7.8)
15	158	53.4 (15.6)	154.2 (9.3)	22.0 (6.9)	19.9 (8.3)
16	175	53.3 (13.1)	155.0 (7.6)	21.7 (5.7)	20.7 (8.3)
17	171	54.7 (14.0)	155.5 (6.6)	22.1 (5.3)	20.1 (7.0)

18	155	53.4 (12.1)	154.3 (6.0)	21.9 (5.0)	21.3 (8.2)
19	67	54.3 (13.9)	154.8 (5.9)	22.1 (5.5)	21.1 (9.1)
20	30	57.4 (16.9)	153.7 (7.1)	23.7 (6.5)	21.7 (10.9)

* BMI= Body Mass Index †SKF = Triceps skinfold thickness

After adjusting for age, 6.4% of the students were found to have systolic hypertension while 9.0% of them were found to have diastolic hypertension. More males significantly had systolic hypertension than females ($p < 0.0001$). However, no statistically significant difference was found between males and females in diastolic hypertension.

Overall, 64.8% of the students reported that they perform physical exercise for at least half an hour per week on a regular basis. However, this was more evident among male students than females (78.8% vs 30.5%, $p < 0.001$).

Blood testing for fasting total cholesterol and glucose levels was done on 1432 students. The overall mean total cholesterol was 154.8 ± 13.0 mg/dl. Mean total cholesterol for male students was significantly lower than for females (153.6 ± 11.7 vs 159.8 ± 16.7 , $p < 0.001$). In addition, 2.3% of the students were found hypercholesterolemic and the proportion of female students with hypercholesterolemia was double that for males (4.0% vs 2.0%, $p = 0.06$). Only 0.5% of the students were found to be hyperglycemic with no significant differences between males and females (0.4% vs 0.6%, respectively).

As for smoking, of the students who answered this question, i.e. the 3rd grade of intermediate schools and the three grades of secondary schools ($n = 1834$), the proportion of current cigarette smokers and ex-smokers were 4.8% and 5.9%, respectively. The proportion of both current smokers and ex-smokers was significantly greater among males than those among females (6.9% and 8.5% vs 0.5% and 0.5%,

respectively, $p < 0.0001$). Mean duration of cigarette smoking among current smokers was 3.1 ± 2.1 years and the mean number of cigarettes per day was 11.3 ± 8.8 .

With respect to shisha smoking, 1.6% of the students in the above mentioned grades were current smokers and 2.2% were ex-smokers. The proportion of male students in both categories were significantly higher than female students (2.3% and 3.3% vs 0.3% and 0.2%, respectively).

DISCUSSION

Compelling evidence exists that the atherosclerotic process begins in childhood and progresses slowly into adulthood, when it frequently leads to coronary heart disease (CHD).⁸ In addition, cardiovascular risk factors found in children are potentially predictive of adult CHD⁹. Therefore, identification and modification of CVD risk factors in children together with early development and maintenance of healthy lifestyles are advocated as important precursors to the reduction of adult onset of cardiovascular disease.¹⁰

Obesity is a well-known predisposing factor for CVD especially through its role in the development of other risk factors like diabetes mellitus, hypertension and high blood cholesterol level. BMI, as measure of obesity, increased in our sample with age in both sexes and was found to be higher for females than males, which is consistent with results from previous studies done in Saudi Arabia^{3,11,12} and elsewhere.¹

The proportion of obese students (23.5%) in our sample, although considerably high, is not different from what has been reported previously.^{3,13} However, a greater proportion of females (26.4%) than males (23.3%) were found obese, which is, again, consistent with the finding of Al-Sekait et al¹³ (31.8% of females vs 27.1% of males). This has been further confirmed in our study by the measurement of triceps skinfold thickness indicating a greater fat deposition among females. In fact, these sex-related differences could be explained by lack of physical activity among females in our Saudi society as compared to male students, a situation which was confirmed in this study. This, in turn, calls for the urgent inclusion of physical activity programs in the curriculum of female schools in an appropriate way that does not conflict with the Saudi culture, in addition to dietary intervention for all students.

Recent studies¹⁴⁻¹⁷ have shown that levels of blood pressure and serum cholesterol in childhood are predictive of levels during adulthood. Apart from diastolic blood pressure (DBP) for females in the age group 10 to <14 years, both male and female students exhibited consistent increase in systolic blood pressure (SBP) and DBP with age which conforms to a previous report.³

Moreover, for students <14 year-old, females had both higher mean SBP and DBP than males which is the opposite of what held for students of 14 years and above. This could be partly explained by the fact that blood pressure level is influenced by various factors including physiological and emotional state of the child, which could vary between males and females.

The proportion of hypertensive students in the present study was higher than that reported from a similar study in Japan (1%)¹⁸ or that found in another study done in Saudi Arabia (0-4%),³ but similar to some other studies¹⁹⁻²¹ done elsewhere. Many factors could explain these variations including genetic, environmental, dietary pattern, technical and methodological issues.

The mean values of total cholesterol reported in this study are generally lower than those levels reported previously from Saudi Arabia³ and several other studies on European and American children,^{10,20,22,24} but similar to some other studies done elsewhere.^{25,26} Although national dietary pattern might partly explain these differences, the comparison of these values between different studies could be affected by various technical and methodological considerations.²⁷

The finding in our study that female students have higher total cholesterol levels as compared to males confirms to a similar study from USA.¹⁰ This might indirectly confirm the general trend in our study that females have higher BMI and skinfold thickness than males.

Measuring blood cholesterol levels in children and adolescents is important. This is supported by numerous indications including the aggregation in children (as in adults) of elevated cholesterol levels with other CVD risk factors, tracking of high cholesterol levels (and of other risk factors) from childhood to adolescence and early adulthood, and the association of risk factors in children with a parental history of cardiovascular disease.²⁸ However, advocating screening programs in children and adolescents is a controversial issue that should be determined on the basis of its cost effectiveness and other technical criteria as well as the availability

of effective preventive measures. Interestingly, the 2.3% of school students with hypercholesterolemia reported in our study was much lower than that reported by Al-Hazzaa (22.9%)³ in his study from Riyadh or that reported by Wynder et al²⁹ in the study from 15 countries, but similar to others.^{18,29}

The adverse effects of tobacco smoking are now well known. Prevalence rates vary considerably among children and young people by age, sex and country. The percentages of current smokers among either male (6.9%) or female (0.5%) secondary school students in this study were less than that reported by a study³⁰ from the Riyadh region conducted among secondary health institutes (17.5% for males and 8% for females), and much less for male secondary school students compared to that (24.8%) reported from Cairo, Egypt.³¹ However, much higher percentages were reported from developed countries like England³² where 33.3% and 29.9% of male and female secondary school students, respectively, were current smokers. In spite of these low percentages in our sample, effective measures to prevent smoking among school students should be implemented and schools should have a greater role in health education.

Studies among children have shown that children's smoking rates and nutrition habits can be influenced and their serum cholesterol levels can be modified.^{33,34} In fact, the promotion of lifestyles that are likely to result in optimum levels of CVD risk factors in youth is the basis for early prevention of CVD and promotion of health.³³ Thus, the inclusion of cardiovascular health education in general educational studies of children should be a major objective of the future.³⁵ However, it should be clear that an integrated school policy which calls for the promotion in schools of healthy heart implies not only health education lessons in the classroom but also a healthy workplace for teachers and a healthy school environment complemented

with parents' involvement since most of the curricula used in successful interventions were aimed at parents as well as children.^{1,36}

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