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Research Article

Coronary Heart Disease Risk Factors among University Female Students

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ABSTRACT

Background: Coronary heart disease (CHD) is a main cause of morbidity and mortality globally. High levels of cholesterol are considered a major risk factor of CHD. This study sought to find out the prevalence of high cholesterol levels among Qatar University female students.

Methods: Total cholesterol (TC), high-density lipoprotein (HDL) cholesterol and low-density lipoprotein (LDL) cholesterol measurements were examined on 275 female students aged 18-26 years (*M*=21). Each participant completed a questionnaire about age, body mass index (BMI), medical family history, medical conditions and lifestyle. Analysis of data was done using SPSS version 23.

Results: Among the 275 volunteers, 12.4% had high TC, 14.9% had low HDL cholesterol and 15.6% had high LDLcholesterol. Also, a positive statistical significance relation was seen between the different cholesterols (TC, LDL and HDL) and the risk factors (family history, BMI, diet and exercises) except for HDL cholesterol and diet which showed no statistical significance relation.

Conclusion: The cholesterol levels are within the desirable ranges. Students should maintain their cholesterol levels within those ranges and be aware of the factors that can cause hypercholesterolemia.

Coronary heart disease (CHD) is a main cause of morbidity and mortality globally. This study sought to find out the prevalence of high cholesterol levels among Qatar University female students. Total cholesterol, HDL and LDL cholesterols measurements were examined on 275 female students aged 18-26 years (*M*=21). Each participant completed a self-assessment questionnaire. 12.4% had high TC, 14.9% had low HDL cholesterol and 15.6% had high LDL cholesterol. A positive statistical significance relation was seen between the different cholesterols (TC, LDL and HDL) and the risk factors (family history, BMI, diet and exercises) except for HDL cholesterol and diet which showed no statistical significance relation.

Keywords: Heart disease; HDL; LDL; Cholesterol; Female students

Introduction

Cardiovascular disease (CVD) is the main cause of mortality and morbidity worldwide with an estimated death rate of seventeen million people die from the disease each year [1]. Coronary heart disease (CHD) is a complication of CVD that affects blood vessels supplying the heart. A leading cause of CHD is high levels of cholesterol in the blood forming a plaque in the arterial walls [2]. This formation causes narrowing of the arteries and failing to properly oxygenate the heart. Causes of high cholesterol varies and include genetic factors, age, gender, underlying medical conditions such as diabetes and hyperthyroidism, unhealthy diet, smoking, obesity and low activities and exercises [3]. Clinical studies supported a causal relationship between blood lipids and coronary atherosclerosis. Extended follow-up of large cohorts provided evidence that CHD risk increased in a continuous and graded fashion, beginning with cholesterol levels as low as 150-180 mg/dL; this association extended to cholesterol levels measured as early as age 20. During middle age, for each 1% increase in total cholesterol, CHD risk increased by an estimated 3% [4].

Perhaps no other commonly determined medical laboratory values are so much in the public eye as cholesterol levels, making the discussion of blood lipid test results an opportunity for effective patient counseling and therapeutic intervention. The aim of the present study is to evaluate the frequency of high cholesterol among Qatar University female students and to determine the relation between different types of cholesterol (Total Cholesterol (TC), High Density Lipid (HDL) cholesterol and Low Density Lipid (LDL) cholesterol) and the risk factors such as family history, body mass index (BMI), unhealthy diet and exercises.

Risk Factors

High TC and triglyceride levels are major risk factors for CVD. Although cholesterol is considered as potent enemy of health, as it has many vital functions in the human body. It is a crucial element that is necessary for vitamin D formation, fat absorption and digestion and bile acids synthesis. It is also important for many hormones absorption such as testosterone, estrogen, dihydroepiandrosterone, progesterone and cortisol. Cholesterol plays an essential role in conducting nerve impulses and it is also a major component of cell membrane that provides structural support to the cell [5]. However, high amounts of cholesterol can accumulate on the walls of the blood vessels and narrow them, thus increasing the risk of developing CVD. In some cases, it can cause heart attack, stroke and blood clotting [6].

Cholesterol and triglycerides are insoluble and utilize lipoproteins for transportation. Lipoproteins are composed of proteins (apolipoproteins) and lipids. The lipoproteins are classified according to the major apolipoproteins and other lipid components present [7].

The most common are high-density lipoprotein cholesterol (HDL) and low-density lipoprotein cholesterol (LDL) cholesterol. HDL cholesterol (or good cholesterol), caries cholesterol from the cells to the liver for excretion or reutilization [6]. It also inhibits LDL cholesterol oxidation, helps endothelial repair and improves endothelial function [8]. LDL cholesterol (or bad cholesterol) carries cholesterol to the cells in the body. It can accumulate in the wall of the arteries which is the first step in atherosclerosis [2]. The relationship between high TC levels and CVD has been well established. In this regard, there is strong epidemiological evidence that considered triglyceride as an independent risk factor for CVD [9].

Cholesterol Sources

There are two major sources for lipids. They can be derived from mobilization of fatty acids in the adipose tissue or from diet. After mobilization of fatty acids, they are transported from the adipose tissue to the liver by albumin. Lipids acquired via diet are transported in the form of triacylglycerol by chylomicron and very low density lipoprotein (VLDL) cholesterol. In the liver, microsomal lipase hydrolyzes triacylglycerol to diacylglycerol and then fatty acids. Later, fatty acids are transported to the reticulum luminal space after they are combined with coenzyme A and esterified again by diacylglycerol acyltransferase [10]. The new triacylglycerols are stored and ready for hydrolysis to free fatty acids and glycerol and return back to the blood stream. The peak of lipid concentrations in the blood stream occurs after 1 to 3 h following a meal and return to normal levels within 6 h [11].

Lipid and Atherosclerosis

Atherosclerosis is a cause of CVD and is characterized by chronic inflammatory lesions on the arterial walls resulting from interactions between modified lipoproteins and many immune components [12]. LDL cholesterol is considered to be atherogenic, while HDL cholesterol is associated with the protective mechanism against atherosclerosis [13]. Moreover, there is an inverse relation between HDL cholesterol and CVD and CHD. Earlier studies showed that for each increase of 1 mg per deciliter in HDL cholesterol, there will be a decrease from 2% to 3% of acquiring CHD later [14]. HDL cholesterol has an antiatherogenic function preventing atherosclerosis progression and promoting lesion regression [8]. In contrast, LDL cholesterol is considered as a biomarker for subclinical atherosclerosis [15]. In the early stages of atherosclerosis, the arterial wall contains oxidative agents and proteolytic enzymes that convert LDL cholesterol to lipid droplets and vesicles [2].

Expert panels have defined high and "borderline high" blood cholesterol levels is to simplify clinical decisions as depicted in Table 1. The Cholesterol Ratio categories illustrated in Table 2 can be important indicators while evaluating the prevalence of CVD [16]. Millán et al. [17] states that the TC/HDL cholesterol ratio, known as the atherogenic or Castelli index and the LDL/HDL cholesterol ratio are two important components and indicators of vascular risk. However the LDL/HDL has a more predictive power if the triglycerides level is also taken into account.

Similar Studies among University Students

Numerous studies indicated an increase in TC levels among adolescent. Spencer [3] in his study reported that 29% of college students in New Jersey had undesirable TC and 18% had more than the recommended level of TC due to unhealthy lifestyles. In 2005, a study carried out in Brazil [18] to study the lipid profile as a risk factor of CVD showed that 11.8% of the students had high levels of TC, 9.8% of LDL cholesterol, 8.5% of triglycerides and 12.4% of HDL cholesterol. Another study in Brazil reported that the prevalence of high cholesterol between university students was observed. Both genders had undesirable levels of TC, LDL cholesterol and triglycerides. In the same study, BMI was also studied and it showed a direct relationship

Table 1: Criteria for cholesterol levels.

Total Cholesterol Level (mg/dL)	Category
Less than 200	Desirable
200-239	Borderline high
240 and above	High
LDL Cholesterol Level (mg/dL)	**LDL Cholesterol Category**
Less than 100	Optimal
100-129	Near optimal/above optimal
130-159	Borderline high
160-189	High
190 and above	Very high
HDL Cholesterol Level (mg/dL)	**HDL Cholesterol Category**
Less than 40	A major risk factor for heart disease
40- 59	The higher, the better
60 and higher	Considered protective against heart disease

Source: National Heart, Lung and Blood Institute

Table 2: Criteria for cholesterol ratios.

Category	TC to HDL Ratio	LDL to HDL Ratio
Very low (0.5x Average)	Less than 3.3	1.5
Average risk	5.0	3.2
Moderate risk (2x average)	7.0	5.0
High risk (3x risk)	Above 11	6.1

Source: National Heart, Lung and Blood Institute

Table 3: Criteria for BMI.

Body Mass Index (BMI)	Category
18.5-24.9	Normal weight
25.0-29.9	Overweight
30 or greater	Obese

Source: National Heart, Lung and Blood Institute

with lipid profile; the higher the BMI the higher the level of these parameters (Table 3) [19].

Another study performed in the Kingdom of Bahrain in Arabian Gulf University on 166 students who were non-smokers and aged between 16-30 years old showed an increase in the percentage of hypercholesterolemia [1]. the study reported 26.5% of the students had primary hypercholesterolemia (PHC). The test was repeated 2-3 weeks later after the subjects undergoing health counseling and the percentage of students with PHC was reduced to 15.6%. Another study examined 1,331 different subjects for overweight, obesity, hyperglycemia, hypertension and dyslipidaemia among Gulf Arabian countries. The prevalence of overweight with body mass index between 25 and 30 was found to be between 25% and 50%. Additionally, the prevalence of obesity with BMI more than 30 was between 10% and 50%. Also, the prevalence of hyperglycemia in adults ranged from 10% and 20% and it showed an association with females [20].

Methodology

Female students at Qatar University were invited to participate in the study. The study was approved by the institutional review board. The researchers of the study explained the procedure to the participants and a consent form was signed by those who agreed to volunteer. The volunteers completed a questionnaire about age, weight, medical family history, cardiovascular history and lifestyle. Volunteers taking cardiac active drugs or any drugs that may interfere with the analysis were excluded. After collecting the blood samples, researchers explained the results to the participants. Educational brochures and suggestions for reducing heart disease risk were distributed.

Sample and data collection

Collection and analysis of samples were performed in the facilities inside the Qatar University. TC, HDL cholesterol LDL cholesterol measurements were obtained from all the volunteers by SD LipidoCare analyzer. Fresh capillary whole blood samples were collected from each volunteer by finger stick. Each sample (35 μL) was immediately applied to a test strip. Results were displayed within 3 min. The analyzer showed quantitative measurements for TC and HDL cholesterol and a calculated measurement for LDL cholesterol.

SD lipido care test principle

SD Lipidocare test is based on enzymatic reaction and solid phase techniques to measure TC, HDL cholesterol and triglycerides. The reactions start when a sample of blood-capillary or venous blood – is applied to the SD lipidoCare Lipid Test strip. The blood reacts to produce a color. The resulting color is read using reflectance photometry and the intensity of color is proportional to the concentration of analyties [21].

Total cholesterol: Cholesterol ester in the blood is hydrolyzed by cholesterol esterase. The resulting cholesterol is then oxidized by cholesterol oxidase to cholesterol-3-one and hydrogen peroxide. Once the hydrogen peroxide is present, it will react oxidatively with 4-aminoantipyrine (4-APP) and toluidine in the presences of peroxidase to produce quinoneimine (colored dye).

HDL cholesterol: First VLDL and LDL cholesterols are depleted and then cholesterol ester in the blood is hydrolyzed by cholesterol esterase. The resulting cholesterol is then oxidized by cholesterol oxidase to cholesterol-3-one and hydrogen peroxide. Once the hydrogen peroxide presents, it will react oxidatively with 4-aminoantipyrine (4-APP) and toluidine in the presences of peroxidase to produce quinoneimine (colored dye).

Statistical analysis

The descriptive analysis is carried out to evaluate the frequency of high cholesterol among Qatar University female students. The chi-square test and crosstabs are used to examine the association between different types of cholesterols (TC, HDL and LDL) and the risk factors (family history, diet, BMI and exercise). The non-parametric Mann-Whitney and Kruskal-Wallis tests are utilized to detect the comparative differences in the cholesterol levels across the levels of risk factors; BMI, diet and exercise. Also, the parametric ANOVA were used due to the central limit theory in statistics used to detect the mean differences of the cholesterol levels across the risk factors with more than two categories. The statistical analyses have been done using the Statistical Package for the Social Sciences (SPSS) version 23. A p-value<0.05 is considered as a benchmark for statistically significant results.

Results

Participants

Two Hundred Seventy five (275) female students ranging in age between 18 and 26 years old (M=21) volunteered to participate in this study.

Screening for cholesterol levels: Based on the sample data of 275 participants, the total cholesterol (TC) is found to be ranging between 100 to 275 mg/dL (M=158 mg/dL; IQR=139-

182; SD=34.38). The TC above 200 mg/dL is considered as undesirable (borderline high) and 240 mg/dL or above as at risk. It is found that 7.3% (n=20) of the students have undesirable TC and 5.4% (n=14) are at risk. The range for the HDL cholesterol is found to be from 24 to 186 mg/dL (M=56 mg/dL; IQR=45-67; SD=21.35). The HDL cholesterol below 40 mg/dL as a risk and it is found that 14.9% (n=41) of the participants fell into the at-risk category. The range for the LDL cholesterol is found as 175 mg/dL (M=85; IQR=71-114; SD=35.06). The LDL cholesterol below 100 mg/dL is considered as 'optimal' and 100 to 129 is considered as nearly optimal. Collectively, the LDL cholesterol below 129 mg/dL is considered as desirable; and the LDL cholesterol above 130 mg/dL is said to be at risk. It is found that 15.7% (n=43) of the participants are at risk as per the defined criteria for LDL cholesterol.

The TC: HDL and LDL: HDL ratios are also calculated to analyze the risk for the CVD among participants. The TC: HDL ratio is found to be ranging between 0.3 to 2.0 (M=0.5; IQR=0.33-0.67; SD=0.65). The LDL: HDL ratio ranges between 0.3 to 4.0 (M=0.5; IQR=0.33-1.00; SD=0.33). The optimum ratio is defined as 3.5: 1 and the lower ratio indicates the lower risk of cardiovascular disease. Both of the ratios show the desirable proportions of the cholesterol categories and depicting that the participants are at low-risk for CVD.

Self-reported measures: The analysis of self-reported measures (responses from 275 females) show that 60% (n=165) had no family history of CVD. The obesity is found to be less prevalent by only 16.7% (n=46) among the female students at Qatar University. 52% of the female students reported that they consume the cholesterol-rich foods (fast food, egg, shrimps and shellfish) less often (only sometimes); showing a healthy behavior towards diet. 27.3% (n=75) of the respondents usually consume such food in a regular way, while 18.7% (n=50) students do not care at all about the cholesterol content present in their diet. The students were asked about the frequency of participating in physical activity/exercise. 61.8% (n=170) students claim that sometimes they are involved in physical activity/exercise, while 25.5% (n=70) never got onto the exercise plans. 10.9% (n=30) students claim that they usually do the exercise, while only 1.8% (n=5) students showed a consistent behavior towards exercise.

Statistical findings

The Chi-square Test is performed to determine whether the risk factors, i.e., BMI, family history of CVD, diet and exercise are related to different types of cholesterol (TC, HDL, LDL). The TC and LDL cholesterol levels are statistically significant associated with the weight (measured by BMI) of the respondents; (TC: x^2=6.850, df=1, p=0.009; LDL: x^2=7.904, df=1, p=0.005). The TC is significantly associated with the intake of high-cholesterol food among participants; (TC: x^2=9.885, df=1, p=0.002). The total cholesterol (TC) level is also significantly associated with the frequency of doing exercises; (TC: x^2=5.658, df=1, p=0.017).

Correlational analyses (using Spearman's rho), show the statistical significance between some of the risk factors and the cholesterol types. There is a significant positive relationship between TC & LDL and the BMI, while the correlation is negative for HDL cholesterol; (TC: r=0.157, p=0.009; HDL: r=-0.166, p=0.006; LDL: r=0.132, p=0.029). The TC and the intake of cholesterol-rich food are positively related (r=0.169, p=0.005).

A Mann-Whitney U Test indicates that on average, the HDL cholesterol level is statistically significant higher in the respondent with normal weight (Mean Rank=153.40) as compared to the ones falling in overweight category (Mean Rank=113); (U=6658, p-value=0.000). Also, the LDL cholesterol level showed up to be significantly lower for normal weight (Mean Rank=128.35) as compared to overweight (Mean Rank=151.83); (U=7590, p-value=0.016). The relation of the cholesterol levels with family history turned out to be statistically insignificant; indicating no significant differences in the cholesterol levels for the ones with family history of CVD and those whose families do not have such a history.

The Kruskal-Wallis Test is utilized to detect the comparative differences in the cholesterol levels across the levels of risk factors; BMI, diet and exercise. The results show that the HDL and LDL cholesterols levels differ across the BMI categories; (HDL: H=16.64, df=3, p-value=0.001; LDL: H=13.04, df=3, p-value=0.005). The pairwise differences between 'obese – normal weight' and 'overweight – normal weight' are significant for the HDL cholesterol level. For LDL cholesterol, the significant pairwise differences have been observed for 'underweight – overweight' and 'underweight – obese'. The HDL and LDL cholesterol levels also differ across the diet behavior (towards the food with high cholesterol levels) of the respondents; (HDL: H=12.65, df=3, p-value=0.005; LDL: H=8.98, df=3, p-value=0.030). The significant pairwise differences in the cholesterol levels are observed between the food intake levels as 'never – sometimes' (for both HDL and LDL) and 'never – always' (for HDL).

The two-independent samples (T-test) are used to test the mean differences among cholesterol levels against the risk factor family history of CVD (a binary variable). The results turned out to be statistically insignificant with mean difference of 5.86 mg/dL for the family history. The one-way analysis of variance (ANOVA) is used to detect the mean differences of the cholesterol levels across the risk factors with more than two categories. The mean difference across the BMI levels is significant for the LDL cholesterol, F (3, 271)=4.22, p=0.006. A Tukey HSD post-hoc test revealed the significant mean difference between the participants who are underweight and those who are categorized as obese (per BMI criteria); obesity can lead to the higher LDL levels.

Discussion

This study was aimed to evaluate the prevalence of high cholesterol levels among Qatar University students. The results are based on the sample of 275 female students in Qatar University. The prevalence of high cholesterol is found to be very low as 5.4% among the university students. However, 7.3%

of the students had undesirable TC levels and up to 87.6% were above recommended levels for TC, HDL and LDL cholesterols. The prevalence of high cholesterol is taken as the risk factor for heart disease, and is found to be 'low' among the female students of Qatar University.

The screening for the other risk factors revealed that the female students at Qatar University are health conscious and they are less prone to the heart disease. The obesity (as a risk factor for CVD) is found to be at 16.7%; however 24.4% of the students have been categorized as overweight. A high proportion of students (54.5%) avoid consuming the food comprising of high saturated fat, and those who always take such food are low in proportion (18.7%). Most of the students (61.8%) regularly follow the exercise routine. The overall results show that the students are less prone to the heart disease as per their BMI, diet and behavior towards physical activity.

Conclusion

Less than the half of sample students (50%) had a family history of cardiovascular disease and almost half of the students' weights are normal. However, the family history is not found to be statistically associated with the levels of TC, HDL cholesterol and LDL cholesterol. Though the sample of female students at Qatar University indicates a healthy lifestyle among students, however a nominal proportion of the students are also at risk of cardiovascular disease. The most important risk factors are BMI, diet and exercise in relation to the cholesterol levels (which is considered as the main indicator used as a CVD) risk. In summary, it can be concluded that the female students at Qatar University are at 'low' risk for heart disease (based on the sample of 275 students).

Limitations of the Study

A main limitation of the study was that measurement of cholesterol levels was performed on non-fasting subjects. Another limitation was that the participants were limited to students in the female campus of the university. Moreover, the cultural and social stigma of smoking tobacco, in particular among females, could have contributed to the findings of the study. Future studies could be expanded to include male and female students and to require participants to be fasting.

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