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CARDIOVASCULAR DISEASES RISK PREDICTION USING THE FRAMINGHAM RISK SCORE

By

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Abstract

Introduction: Cardiovascular diseases (CVD) are the world's most common cause of death . The Framingham risk score (FRS) is the most commonly used method for CVD risk assessment. Low risk individuals have 10% or less coronary heart diseases (CHD) risk at 10 years, 10-20% have intermediate risk and 20% or more have high risk. **Aim of Work:** To estimate the risk of developing cardiovascular diseases over next ten years among the administrative staff at Zagazig University, Egypt. **Material and Methods :** A structured questionnaire was used to get data about socio-demographic characteristics, anthropometric measurements was done, laboratory investigations to measure fasting and post brandial blood sugar and lipid profile. The Framingham risk score (FRS) was calculated by using information on age, gender, smoking , diabetes mellitus (DM), systolic blood pressure , treatment for hypertension , and total blood cholesterol and high-density lipoprotein levels for every subject. **Results:** About 55% of the studied sample were males and 44.8% were females, the overall prevalence of systolic hypertension was 45.7% , 36.2% had a positive family history of CVD , 25% were physically active (the majority of them were males),21.5% were diabetic, 63.7% had high blood cholesterol,55.1% had central obesity,68.1% were overweight or obese. FRS mean for males was higher as compared to females (14.3±7.1 and11.9±5.8 respectively). Participants with high CVR risk were mainly inactive, smokers, with positive family history, diabetics, hypertensive, with high blood cholesterol level, high density lipoprotein and with central obesity .A statistically significant positive correlation was observed between FRS and age, cholesterol, systolic blood pressure, blood glucose ,weight , waist circumference and body mass index(BMI) . **Conclusion:** About 42% of our studied subjects were at low anticipated 10-year CVD risk, 30% were

at moderate risk, and 28% of them were at high risk .The most significant risk factors were male gender ,smoking, physical inactivity , hypertension, diabetes mellitus, obesity, abdominal obesity , high levels of total cholesterol and low HDL-cholesterol level in addition to positive family history . CVD is a preventable public health issue; most of its risk factors are modifiable.

Keywords: Cardiovascular diseases, Risk prediction, Framingham risk score, Smoking and Cholesterol.

Introduction

Cardiovascular diseases (CVD) are the world's most common cause of death and the most common cause of disability and reduced quality of life (Mc Namara et al.,2019). Annually, about 17.7 million people die from cardiovascular diseases worldwide, accounting for 31.1% of all deaths, resulting in 151 million Disability-Adjusted Life Years (DALYs) (Roth etal., 2017) . By 2030 CVD will be responsible for more than half of all deaths in Africa (Yuyun et al., 2020) .About 80% of CVD deaths take place in low and middle income countries (Rehan et al., 2016) ,CVD is becoming one of the greatest challenges that threaten the development in such countries ,adding a heavy burden on health services that are barely dealing with communicable diseases (Gupta and Yusuf , 2019).

In Egypt, cardiovascular diseases deaths reached 126,312 or 24.58% of total deaths; thus ranking Egypt as the 18th worldwide (El-Moselhy et al., 2018). More than two hundred and fifty risk factors for cardiovascular diseases have been identified, some are non-modifiable as age, gender, race, and others are modifiable as smoking, obesity, blood pressure, diabetes, and hyperlipidemia (Amiri et al., 2018). Such risk factors don't have independent effects but have synergistic effects with each other (Hajar ,2017) .Many standards and tools have been developed to predict the occurrence of CVD; such tools help identifying high risk people, and change their lifestyle which can decrease even morbidity and mortality (Nakhaie et al.,2018).Many of these models need only data from patient medical history and readily available laboratory tests and have been adjusted for analysis through computer based format or simplified tables or charts in paper (El-Sherbiny and Zaid, 2014). The Framingham risk score (FRS) is the most commonly used tool (Leung et al., 2018) .It is a sex specific algorithm which was developed to predict the 10-year risk of developing coronary

heart disease (Wilson etal., 1998) .The exciting version of the FRS includes age, cigarette smoking, systolic blood pressure measurement, treatment for hypertension, diabetes, total cholesterol, and HDL cholesterol. Low risk individuals were10% or less CHD risk at 10 years, 10-20% were at intermediate risk and 20% or more were at high risk (Leung et al.,2018) . It's therefore useful for patients to change their lifestyle or to use medical treatment to lower blood pressure and cholesterol levels. It is important to recognize men and women at increased risk (Wilson, 2010).

Rationale:

Cardiovascular diseases are a growing global public health problem due to its high prevalence and mortality .Lots of discussions over the actual value of population level screening program continue to justify, support for risk-stratified screening is gaining momentum and can be useful in directing cardiovascular diseases prevention public health strategies.

Aim of Work

To estimate the risk of developing cardiovascular diseases over next ten years among the administrative staff at Zagazig University, Egypt.

Materials and Methods

Study design and setting: It is a cross sectional study

Place and duration of the study: The study was done at Zagazig University, Egypt, from the start of June to the end of November 2020.

Study sample: It is a convenient sample. Participants were from the administrative staff at Zagazig University, Egypt. The studied group was considered suitable if they have the following **inclusion criteria**: employee whose entire set of sociodemographic information, blood samples were obtained to determine blood glucose and lipid profiles, more than 20 years of age and interested in taking part in the study. **The exclusion criteria included**: individuals under the age of 20 years, with incomplete questionnaires or laboratory samples, refused to take part in the study, pregnant women and cardiovascular disease patients. Using Epi info version 6 software programs, a sample size of 116 employee (64 male and 52 female) was computed using the following parameters: 80% test power, 95% confidence interval, total number of administrators 7316 and the prevalence of high risk of CHD from published literature was 8.3% (El-Moselhy et al.,2018).

Study methods:

1-A structured questionnaire : comprised a comprehensive socio-demographic profile as: age, sex, family history of cardiovascular disease, past and current medical history, smoking history (a smoker was the one who smoked presently and who stopped smoking less than a year before the assessment) and physical activity (more than 90 minutes exercise per week) . In order to evaluate the content validity, legibility and applicability of the research tool a pilot study was performed on a group of 20 participants (not included in the final analysis) before final data collection. Minor changes were made to facilitate data collection according to the pilot. The improvements of the questionnaire consisted primarily of: shortening sentences, simplifying the language, improving understanding and evaluate the feasibility of the study.

2-Anthropometric measurements: Anthropometric indices (weight and height) were assessed by weight and height scales. The weight has been measured without shoes and with minimal clothing by placing weight scale on a hard floor surface. Body mass index (BMI) was calculated by dividing weight in kg by height in meters squared (kg/m2). BMI was graded into; underweight less than18.5, normal between 18.5 to 24.9, overweight between 25 to 29.9, and obese greater than or equal 30 kg/m2 (El-Moselhy et al.,2018). Waist circumference was assessed at the midpoint between the lowest rib and iliac crest at top of hip bone using a measuring tape. Central obesity was defined as waist circumference more than 90 and more than 80 cm for males and females respectively (El-Moselhy et al.,2018).

3-Clinical examination: blood pressure of the participants was measured using a traditional mercury sphygmomanometer after a 5 minute rest period on left arm of seated subjects, two measurements were taken at an interval of 5 minutes and mean was registered. Hypertension was identified as more than or equals 140 mmHg systolic (El-Sherbiny and Zaid, 2014), or a patient already on anti-hypertensive medication.

4-Laboratory investigations: a venous blood sample was taken by trained technician, after confirming 12 hours of fasting overnight to measure blood sugar and lipid profile. At the end of the working day the sam-

Results

Table (1): Some characteristics of the studied subjects according to gender.

	Male Mean ±SD	Female Mean ±SD	Total Mean ±SD	Student t- test (p value)
Fasting Blood glucose	131.3±76.9	106.5±58.1	120.2±69.9	1.92(0.06)
Weight(Kg)	77.2± 19.1	75.0±15.8	76.2 ± 17.6	0.65(0.5)
Height(cm)	164.6± 8.8	162.1± 8.4	163.5± 8.7	1.58(0.11)
BMI(kg/m^2)	28.4± 6.7	28.5± 5.7	28.5± 6.3	0.1(0.9)
Waist circumference (cm)	88.9±18.4	82.1±21.9	85.8 ±20.3	1.84(0.06)

BMI: Body Mass Index p value < 0.05 is significant

Table (1) showed that there is no statistical significant difference between gender and the all studied parameters.

Table (2): Descriptive characteristics according to Framingham Risk Scores (FRS) in relation to gender.

	Male No=64	Female No=52	Total	Test of significance (p value)
FRS(Mean ±SD)	14.3±7.1	11.9±5.8	13.2±6.6	1.8(0.06) #
Age (years)(Mean ±SD)	43.3 ±7.78	44.8 ±7.5	43.9 ± 7.8	1.04(0.3) #
Cholesterol (mg/dl) (Mean ±SD)	272.8±118.6	288.9±139.6	280.0± 128.1	0.67(0.5) #
HDL(mg/dl) (Mean ±SD)	37.2±6.3	37.0±6.9	37.1±6.5	0.19(0.8)#
Systolic blood pressure (Mean ±SD)	123.4±14.5	119.0±15.5	121.5±15.1	1.5(0.12)#
Treatment for hypertension (No %)	12(18.7)	14(26.9)	26(22.4)	1.1(0.2)##
Smoking (No %)	30.0 (46.8)	0.0 (0.0)	30.0 (25.8)	0.00
Diabetes Mellitus (No %)	15.0 (23.4)	10.0 (19.2)	25.0 (21.6)	0.3(0.5)##

#Student t test was calculated. ## Chi Square test was calculated. p value < 0.05 is significant.

Table (2) showed that FRS for males were higher as compared to females (14.3±7.1and 11.9±5.8 respectively), the mean of cholesterol level were higher among females with no statistically significant difference. The numbers of participants who are smokers and had diabetes mellitus were higher among males with no statistically significant difference.

Fig (1):10-year cardiovascular disease risk of studied subjects.

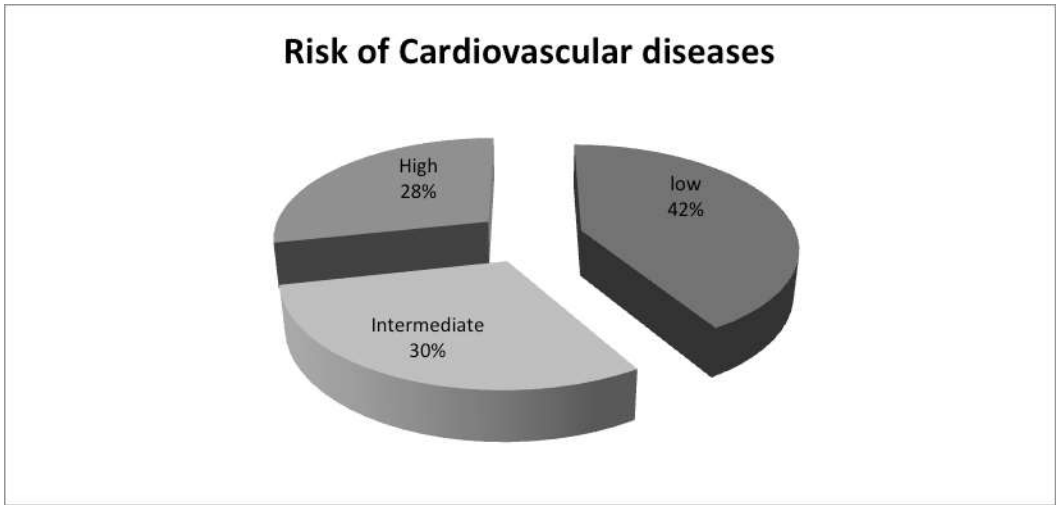

Fig (1) showed that 42% of subjects were at low anticipated 10-year CVD risk, 30% were at moderate risk, and 28% of them were at high risk .

Table (3): Comparison between 10-years cardiovascular disease (CVD) risk and some risk factors.

Risk factors	Low risk (No=48)		Intermediate risk(No=35)		High risk (No=33)		Chi Square test (p value)
	No	%	No	%	No	%	
Sex:							
Male (No=64)	20	41.6	18	51.4	26	78.8	**11.2(0.004)***
Female (No=52)	28	58.4	17	48.6	7	21.2	
Physical activity:							
Inactive(No=87)	28	58.4	30	85.7	29	87.8	**12.1(0.002)***
Active (No=29)	20	41.6	5	14.3	4	12.2	
Smoking :							
Yes (No=30)	6	12.5	7	20.0	17	51.5	**16.4(0.00)***
NO (No=86)	42	87.5	28	80.0	16	48.5	
Family history:							
Yes (No=42)	11	22.9	14	40.0	17	51.5	**7.2 (0.02)***
NO (No=74)	37	77.1	21	60.0	16	48.5	
Diabetes Mellitus:							
Yes (No=25)	6	12.5	5	14.3	14	42.4	**11.9(0.003)***
NO (No=91)	42	87.5	30	85.7	19	57.6	
Hypertension :							
Yes (No=53)	12	25.0	17	48.6	24	72.7	**18.1(0.00)***
NO (No=63)	36	75.0	18	51.4	9	27.3	
Blood Cholesterol level:							
Normal(No=42)	33	68.7	7	20.0	2	6.1	**38.9(0.00)***
Raised(No=74)	15	31.3	28	80.0	31	93.9	
High Density Lipoprotein:							
Normal(No=27)	15	31.3	5	14.3	7	21.2	3.3(0.18)
Abnormal(No=89)	33	68.7	30	85.7	26	78.8	
Waist Circumference:							
Normal(No=52)	37	77.1	8	22.8	7	21.2	**34.4(0.00)***
Central obesity(No=64)	11	22.9	27	77.2	26	78.8	
BMI:							
Normal(No=37)	18	37.5	11	31.4	8	24.2	5.5(0.23)
Overweight(No=41)	18	37.5	14	40.0	9	27.3	
Obesity(No=38)	12	25.0	10	28.6	16	48.4	

BMI: Body Mass Index * p value < 0.05 is significant

Table (3) showed that the number of male participants with high CVD risk was almost three times that of females. Participants with high CVR risk are mainly males, physically inactive, smokers , having positive family history, diabetic, hy-

pertensive , having high blood cholesterol level, high density lipoprotein and with central obesity (statistically significant).

Table (4): Correlation matrix between Framingham risk scores (FRS) and some risk factors.

Items	Age	HDL	Cholesterol	Systolic blood pressure	Blood glucose	Weight	BMI	Abdominal circumference	FRS
Age									
r	1	-0.20	0.45	0.188	0.193	0.238	0.224	0.426	0.529
p		**0.02***	**0.00***	**0.04***	**0.03***	**0.01***	**0.01***	**0.00***	**0.00***
HDL									
r	-0.02	1	- 0.55	-0.35	-0.318	-0.358	-0.36	-0.43	-0.526
p	**0.00***		**0.00***	**0.00***	**0.001***	**0.00***	**0.00***	**0.00***	**0.00***
Cholesterol									
r	0.485	-0.55	1	0.298	0.43	0.41	0.412	0.507	0.665
p	**0.00***	**0.00***		**0.01***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***
Systolic blood pressure									
r									
p	0.188	-0.35	0.298	1	0.189	0.361	0.335	0.387	0.554
	0.04*	**0.00***	**0.01***		**0.04***	**0.00***	**0.00***	**0.00***	**0.00***
Blood glucose									
r	0.193	-0.31	0.43	0.189	1	0.251	0.18	0.371	0.581
p	**0.03***	**0.001***	**0.00***	**0.04***		**0.00***	**0.05***	**0.00***	**0.00***
Weight									
r	0.238	-0.35	0.41	0.361	0.251	1	0.893	0.702	0.431
p	**0.01***	**0.00***	**0.00***	**0.00***	**0.00***		**0.00***	**0.00***	**0.00***
BMI									
r	0.224	-0.36	0.412	0.335	0.18	0.893	1	0.669	0.341
p	**0.01***	**0.00***	**0.00***	**0.00***	**0.05***	**0.00***		**0.00***	***0.00**
Abdominal circumference									
r	0.426	-0.43	0.507	0.387	0.371	0.702	0.669	1	0.648
p	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***		**0.00***
FRS									
r	0.529	-0.52	0.665	0.554	0.581	0.431	0.341	0.648	1
p	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	

HDL: High density lipoprotein BMI: Body Mass Index *Correlation is significant at the 0.05 level

Table (4) showed that as the age advances, the systolic blood pressure, BMI, weight, abdominal circumference increases (r= 0.188, 0.238, 0.224, 0.426 respectively) p = (0.04, 0.01, 0.01, 0.00) respectively. Also statistically significant positive correlation was observed between FRS and age, cholesterol, systolic blood pressure, blood glucose, weight, waist circumference and BMI.

ples were transferred to the laboratory

Discussion

The lifetime risk of cardiovascular diseases (CVD) is significant and often silent or can strike without warning emphasizing the importance of prevention. The Framingham Risk Score was first developed on the basis of data gathered from the Framingham Heart Study to predict the 10-year risk of acquiring coronary heart disease, is critical when taking decisions about screening for individuals. By applying the FRS to the present study, the findings showed that (28%) of the sample had a high 10 years risk and (30%) had a moderate risk (Fig 1). Similar to Chia et al., 2015 in their retrospective cohort study on validation of the Framingham general cardiovascular risk score in a multiethnic Asian population and Saidi et al., 2016 in their work on assessment of cardiovascular risk in Tunisia; both detected that 18%–30% have high risks of CVD. On the other hand, Muthunarayanan et al., 2015, Nakhaie et al., 2017 and AlQuaiz et al., 2019 noted that only 2.5%, 2.9%, 8.2% respectively of their sample were at high risk which was far below the results detected in the current study.

FRS is a gender specific score that comprised some CVD risk factors as: age, smoking, total cholesterol, HDL cholesterol, systolic blood pressure, treatment for hypertension and diabetes.

Regarding gender the present study showed that the FRS mean and 10 year CVD risk were significantly higher among males than females as the number of male participants with high CVD risk was nearly three times that of females and FRS mean for males were higher as compared to females (14.3±7.1, 11.9±5.8) (Tab 2). These results were congruent with Saidi et al., 2016 findings .Although Nakhaie et al., 2017 in their study on prediction of cardiovascular disease risk using Framingham risk score among office workers, Iran, found that FRS mean and 10-year CVD risk was significantly higher among males compared to females; they expect that females will suffer less than males from CVD in the next 10 years. The greater risk among males may be due to smoking, high systolic blood pressure, low HDL level, and higher prevalence of diabetes mellitus compared to females (Borhanuddin et al.,2018) , also due to protective effects of estrogen hormone against CVD among females (Laser et al.,2014).

As age progresses in the present

study; the FRS increases (Table 4) which is similar to the results obtained by El-Moselhy et al.,2018 in their work on coronary artery disease among elderly Egyptian patients who indicates that old age was a significant risk factor for CVD.

The present study found that quarter of the employees surveyed were current smokers (25.8%) and all of them were males (Table 2). This is lower than the findings of El-Sherbiny and Zaid, 2014, who reported that the prevalence of current smoker was 28.3%. Smoking is one of the important risk factor which can lead to the occurrence of CVD .The risk of developing CVD among smokers is 2 to 4 times higher than that of non-smokers (Kasper et al.,2015 and El-Moselhy et al.,2018) .

Matching with all previous findings we found that the majority of smokers (80%) have intermediate or high CVD risk with statistically significant difference (Table3). This is in accordance with the results of Nakhaie et al., 2017 who mentioned that smokers have higher FRS and 10 year CVD risk than nonsmokers.

The mean of cholesterol level in the current study was 280.0± 128.1mg/dl and HDL level was 37.1±6.5 with no statistical difference among male compared to female, also 63.7% of the studied sample have high total cholesterol (Table3). High serum total cholesterol levels, and low level of HDL cholesterol, are an important risk factor for CVD (Bahnasawy's et al., 2013). The results of the present study were less than the findings of Bahnasawy's et al., 2013 which was 78.8% and higher than that of Ibrahim et al 2013 in their study on lipid profile in Egyptian patients with coronary artery disease who detected that it was 58.7% .

The percentage of those who had low HDL cholesterol was 76.7% (Table3) which was higher than the findings of Bahnasawy's et al., 2013 which was 21.2% and that of El-Moselhy et al., 2018 study about coronary artery disease among elderly Egyptian patients which was 55.8%.

In the current study; 93.9% of those with high risk of developing CVD had high total cholesterol and 78.8% had low HDL (Table3) and by increasing total cholesterol level and decreasing HDL level, the FRS increase (Table 4) .These results were in agreement with Almas et al., 2008 and Nakhaie et al., 2017; who found strong positive association between total cholesterol and

the risk of CVD.

In both developed and developing countries 20% of the adult population are suffering from hypertension which is a major risk factor for CVD (Venkatramana and Reddy, 2002). In the present study; the mean of systolic blood pressure was 121.5±15.1mm Hg (Table2) and the prevalence of systolic hypertension was 45.7% with no significant difference between male and female (Table 3). El-Sherbiny and Zaid, 2014 in their study on 10 years risk of coronary heart disease among Tanta Faculty of Medicine administrative employees mentioned that only 30.9 % of the studied population was hypertensive and Bahnasawy's et al., 2013 reported higher prevalence than that which was 83.2%.

The present study showed that 72.7% of those with high risk of CVD were hypertensive (Table3). Nearly similar results were detected by Ibrahim et al., 2013 who found that among cardiac patients in Egypt; 56.7% were hypertensive. Also strong positive correlation was found between systolic blood pressure and FRS (Table4). Nakhaie et al., 2017 showed that people with systolic blood pressure less than 130 mm Hg had significantly lower FRS and 10 year CVD risk than people with systolic blood pressure higher than 130 mm.

Diabetes mellitus prevalence in the current work was 23.4% among males, 19.2% among females (Table 2). Similar results were obtained by El-Sherbiny and Zaid, 2014 who detected that one fifth of their studied group had diabetes , but Bahnasawy's et al., 2013 detected higher diabetes prevalence rate of 57.52% of his studied sample. The disparity in socio-demographic profiles may explain the difference between both studies.

Among diabetic subjects; 42.4% are at high risk of CVD (Table 3). A strong positive correlation was noted between blood glucose and FRS with significant difference (Table 4). These results were in agreement with the findings of other researchers as Ali et al., 2010 in their study on diabetes and coronary heart disease in India and Abbasi et al., 2012 in their research work about the risk of coronary artery disease in Iran; who reported that diabetes especially Type 2 has a special association with CVD and diabetics have higher risk of developing CVD two to four times than non diabetics.

In addition to the previous risk factors included in FRS there is many other

factors thought to be implicated in occurrence of CVD as physical inactivity, positive cardiac family history, obesity and high waist circumference (Table 3).

Concerning physical inactivity; the finding of the current study was consistent to that of Khalid, 1995 and El-Sherbiny and Zaid, 2014 as most of their studied samples were inactive and women were less active compared to men.

Both Arsenault et al., 2010 and Borhanuddin et al., 2018 showed that those with high physical activity level have significantly lower risk of CVD which is similar to the findings of the current work which demonstrated that 85.7% and 87.8% among those with intermediate and high risk respectively are physically inactive (Table3). El-Moselhy et al., 2018 reported that CVD risk were three times higher among physically inactive individuals. Also Khera et al., 2016 mentioned that lifestyle changes reduce CVD risk by 50% .In contrast to all previous data; Yang et al., 2015 detected that there is no association between physical activity and CVD risk. However, we can consider the fact that the majority of studies have consistently shown that the increase in the physical activity will decrease the modifiable CVD risk factors (West-Pollak et al., 2014).

The results of the current work showed that 91.5% of those with positive cardiac family history was at intermediate or at high CVD risk (Table 3) which is higher than the finding of Waly et al., 1997 and Bahnasawy's et al., 2013 as both recorded that 53.1% and 46.9% respectively, of their cardiac patients who were with a positive family history of heart disease. Also Rehan et al., 2016-found that the presence of a positive family history of heart disease increase the risk of cardiac diseases

Matching with all previous data the present study showed that 48.4% among those with high risk are obese and 27.3% were overweight and 78.8% of them have central obesity (Table 3). In addition to the presence of strong positive correlation between FRS and weight, BMI and waist circumference (Table 4).Similar results were obtained by El-Sherbiny and Zaid, 2014. Overweight and obesity promotes or exacerbate the atherogenic risk factors that predispose people of all ages to cardiac events (Al-Nozha et al., 2004 and El-Moselhy etal., 2018). All the anthropometric measurements have positive correlation with the FRS and waist circumference may be used to complement

the FRS (Framingham Risk Score) for the prediction of CVD risk (Moy et al., 2008). In Ibrahim et al., 2013 study about lipid profile in Egyptian patients with coronary artery disease; detected that 23.0% of the CVD burden is due to overweight and obesity and 25.8% of Egyptian cardiac patients were obese. Whereas, Bahnasawy's et al., 2013 reported a higher results; as 96.5% of their cardiac patients were obese or overweight.

Conclusion and Recommendations:

The current study detected that about 42% of the studied subjects were at low anticipated 10-year CVD risk, 30% had moderate risk, and 28% of them were at high risk. Also CVD is a major preventable public health issue; most of its risk factors are modifiable. So, it is necessary to pay more interest to raise awareness among people and health care team regarding modifiable risk factors that can play an efficient role in preventing and improving the treatment of cardiac diseases, and promoting the health of patients. Subjects over the age of 40 should be screened routinely for early detection and better control of CVD. Furthermore, it's a priority to set up a national program to address this issue. Further researches on larger samples of all ages are needed to better understanding the actual epidemiology of cardiac diseases in Egypt.

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Conflict of Interest

The researchers announced that there is no conflict of interest.

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