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ORIGINAL RESEARCH

Cardiovascular Risk Among Patients with Controlled and Uncontrolled Type 2 Diabetes: A Sub-Cohort Analysis from the Heart Health Promotion (HHP) Study

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Objective: This study aimed to estimate the risk of cardiovascular disease (CVD) among patients with and without diabetes mellitus (DM) using the Framingham risk score (FRS) and to investigate the effect of DM control on CVD risk.

Methodology: A total of 2432 participants who had their glycosylated hemoglobin (HbA1c) measured within the last three months were included in this study. The study cohort was divided into three categories: non-diabetic, participants with controlled DM (HbA1c<7%), and uncontrolled DM (HbA1c≥7%). The World Health Organization's stepwise approach to chronic disease risk factor Surveillance-Instrument v2.1 was used in this study to collect the anthropometric and biochemical measurements. The Framingham Coronary Heart Risk Score (FRS) was used to calculate the 10-year cardiovascular risk (CVR). The groups were compared concerning the prevalence of metabolic, socioeconomic, and cardiac risks.

Results: Out of 2432 participants, 149 had controlled DM (6.1%), 286 had uncontrolled DM (11.8%), and 1997 participants were normoglycemic (82.1%). Compared to healthy participants, diabetic participants showed more high-risk characteristics across all CVR parameters. Uncontrolled diabetic patients had a graver laboratory and clinical profiles compared to the controlled DM group. As measured by FRS, nearly half of patients with controlled DM (49.9%) and two-thirds of patients with uncontrolled DM (63.3%) were classified as intermediate and high-risk compared to 4.6% of the healthy participants. Compared to healthy participants, patients with controlled DM showed a threefold increased CVR (OR = 3.02, 95% C.I. = 1.41–7.24) while this risk catapulted to 13 times among those with uncontrolled DM (OR = 13.57, 95% C.I. = 6.99–26.36).

Conclusion: Participants with DM are at moderate to high CVR. Individuals with uncontrolled DM showed higher CVR profiles as measured by FRS and have a higher prevalence of obesity, unhealthy diet, and physical inactivity.

Keywords: cardiovascular risk, diabetes, uncontrolled diabetes, Framingham risk score, Saudi Arabia

Introduction

Diabetes mellitus (DM) is one of the rapidly growing health problems in Saudi Arabia; out of a population of 34.8 million people, the estimated prevalence of DM is a staggering 18.3% which is roughly 4.3 million people. Furthermore, according to the latest International Diabetes Federation report, the prevalence of DM in Saudi Arabia is predicted to double by 2045. The Saudi Scientific Diabetes Society reported that more than 50% of patients with DM die due to cardiovascular causes.[1–3]

In DM, cardiovascular diseases (CVD) are multifactorial; controlling cardiovascular risk (CVR) factors leads to a substantial reduction in cardiovascular events. Individuals with type 2 diabetes mellitus (T2DM) tend to develop

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atherosclerosis and CVD because of a combination of comorbid conditions, such as hypertension, insulin resistance, hyperglycemia, obesity, and dyslipidemia.[4] This happens through different pathophysiological mechanisms such as impaired platelet function, abnormal coagulation,[5] and endothelial and vascular smooth muscle cell dysfunction. Additionally, there is an association between insulin resistance, diastolic dysfunction, and ventricular hypertrophy on the macrovascular level.[6] Hyperglycemia also contributes to CVD through advanced glycosylated end products and oxidative stress.[7]

DM was identified as a CVD risk equivalent for the first time in 1999 in a pioneer study that concluded that the risk of CVD death for diabetic patients without previous myocardial infarction (MI) was comparable with that of their non-diabetic counterparts who had a history of MI.[6] Many subsequent studies have been contradictory, with some more recent studies not supporting DM as a CVD risk.[8–10] Moreover, conflicting results have been found on the effects of tighter glycemic control on cardiovascular morbidity and mortality.[3] Therefore, it is imperative for more research to be carried out about DM in different populations as well as continuously updating international guidelines such as the American Diabetes Association.[11] The prevalence of CVD and its risk factors among patients with DM in Saudi Arabia has not yet been well documented; our study aims to investigate CVR among patients with controlled and uncontrolled DM as compared to patients without DM in Saudi Arabia. We aimed to comprehensively study the cardiovascular risks among the diabetic patients. As many of the studies conducted in Saudi Arabia focused mainly on individual cardiac risks among patients with DM as hypertension, smoking or dyslipidemia, our study tried to investigate the clinical risks (hypertension, dyslipidemias and obesity), social risk factors (nationality, education, smoking, diet, and physical inactivity), and we extended our objectives to investigate the Framingham risk score that predict the 10-years risk of developing fatal and non-fatal cardiac events.

Materials and Methods

The study was approved by King Saud University's Institutional Review Board (IRB) (reference number 13–3721) and it followed the standards of the Helsinki Declaration. Informed consent forms were signed by all participants before questionnaire completion and blood sample withdrawal. The original cohort recruited 4500 individuals from employee clinics at King Saud University Hospital that provide care for both employees and their families.[12] The study included participants who were at least 18 years old and had no gender or ethnicity restrictions. For this study, there were a total of 2432 participants who had their glycosylated hemoglobin (HbA1c) measured within the past three months; the classification of controlled and uncontrolled DM was confirmed for all participants. The World Health Organization (WHO) stepwise approach to chronic disease risk factor Surveillance-Instrument v2.1 was used and included the sociodemographic data (age, gender, and educational level), data on tobacco use, history of hypertension and DM, anthropometric, and biochemical measurements.[13] Fasting for at least 12 hours was required by all participants before giving blood samples for measuring high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglycerides. Also, blood samples were taken for serum calcifediol (25(OH)D) quantification by using a commercial enzyme-linked immunosorbent test (ELISA) (K2110, Immunodiagnostic [Dutch Company], Holland). The processed sera were kept at −80°C until they were analyzed.

The Framingham risk score (FRS), one of the most popular CVR calculators in clinical practice, was used to determine the 10-year risk of CVD. It accurately determines high-risk patients by estimating the 10-year risk of CVD by putting into consideration many factors including age, gender, smoking status, lipid profile, and blood pressure. A low CVD risk was estimated by an FRS of 10% or less; a score of 10–19% was considered moderate risk, and a high risk was a score of 20% or more.[14]

Definitions

- Diabetes mellitus: According to American Diabetes Association (ADA), HbA1C ≥ 6.5% (48 mmol/mol) is considered DM.[15] Controlled DM is considered if HbA1c <7.0% (<53 mmol/mol), in this studied sample, the minimum HbA1c among diabetic patients was 6.6% so no patient was categorized as tightly controlled (HbA1c 6–6.5%).

- Current smokers: Smokers were defined as those who had smoked a cigarette per day for the past six months, one cigar per week for the past six months, or one water pipe tobacco smoke/shisha session a month for the past three months.[16]
- Physical inactivity: Inactivity was defined as not meeting any of the following WHO physical activity standards: 150 minutes of moderate activity or 60 minutes of vigorous activity per week.[13]
- Low fruit and vegetable intake: Unless a subject consumes more than five servings of fruit and/or vegetables (400gm) per day - as recommended by the WHO- their intake is considered inadequate.
- Hypertension: Both systolic and diastolic pressures were measured, at two readings, set five minutes apart and the average of the two readings was used. Hypertension was defined as a previous hypertension diagnosis and taking antihypertensive medications or having high blood pressure readings according to JNC7.[17]
- Dyslipidemia: Dyslipidemia was considered according to definitions adopted by the National Cholesterol Education Program (NCEP) criteria for dyslipidemia (elevated cholesterol, elevated TG, high HDL-C level, and low LDL-C).[18]

Statistical Analysis

Data were analyzed using the SPSS (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp). Continuous variables were reported as means with standard deviations, while categorical variables were presented as frequencies with equivalent percentages. Pearson's Chi-square/ Fisher's Exact tests for comparing different proportions and *t*-test for comparing numerical variables were used. Regression models were developed to test the independent effect of controlled DM and the risk of developing CVD after adjustment of different confounders. For logistic regression statistical analysis, patients with moderate and high risk for CVD as measured by FRS were considered as one category compared to those with low risk. Adjusted Odds Ratio (OR) and its 95% Confidence Intervals (CI) were reported and a P-value of less than 0.05 was considered statistically significant.

Results

In the current sub-cohort analysis, patients with controlled DM were 149 (6.1%) and patients with uncontrolled DM 286 (11.8%), and participants with no history of DM 1997 (82.1%). There was a comparable proportion of controlled and uncontrolled DM among males and female participants (p-value = 0.64). Uncontrolled DM was more prevalent among Asian participants (19.3%) compared to Saudis (12.1%) and Non-Saudi Arabs (9.0%). Additionally, there was an escalating trend of both DM and uncontrolled DM with advancement of age reaching the highest prevalence among individuals aged above 60 years. Compared to participants with higher educational levels, controlled and uncontrolled DM were at the highest figures (25.6% and 46.3% respectively). Moreover, ex-smokers, and those with a family history of premature death of first-degree relatives showed higher prevalence of both controlled and uncontrolled DM (Table 1).

Compared to non-diabetic participants, both controlled and uncontrolled DM showed more high-risk characteristics across all CVR parameters. Almost a quarter of controlled and uncontrolled patients were morbidly obese (26.2% and 25.2% respectively) compared to only 9.4% of non-diabetic participants ($p<0.01$), they were less likely to consume vegetables/fruits daily, and more likely to be physically inactive (Table 2).

Patients with uncontrolled DM had a graver laboratory and clinical profiles compared to the controlled DM group; they were significantly more hypertensive (54.4% versus 49.7%), had more chronic renal diseases (2.1% versus 1.4%), had more vitamin D deficiency/inadequacy (54.6% versus 40.9%) and needed insulin more frequently (24.2% versus 10.1%). However, all dyslipidemia parameters were nearly comparable between patients with controlled and uncontrolled DM, yet still far higher than the non-diabetic participants (Table 2).

Collectively, the 10-year cardiac risk measured by the FRS showed that nearly half of the patients with controlled DM (49.9%) and two-thirds of uncontrolled DM (63.3%) were at intermediate and high risk compared to their non-diabetic counterparts, where only 4.6% of them were at intermediate or high risk (Table 2).

Table 1 Sociodemographic Profile of the Studied Sample

	Normal	Controlled DM	Uncontrolled DM	P-value
	N = 1997	N = 149	N = 286	
	(82.1%)	(6.1%)	(11.8%)	
Gender				
Male	785 (82.1)	54 (5.6)	117 (12.2)	0.64¶
Females	1212 (82.1)	95 (6.4)	169 (11.8)	
Nationality				
Saudi	1419 (81.8)	105 (6.1)	210 (12.1)	<0.01¶
Arab Non-Saudi	487 (85.7)	30 (5.3)	51 (9.0)	
Asian	79 (69.3)	13 (11.4)	22 (19.3)	
Others	12 (75.0)	1 (6.3)	3 (18.8)	
Age (years)				
18–29	836 (98.1)	4 (0.5)	12 (1.14)	<0.01#
30–39	599 (91.2)	24 (3.7)	34 (5.2)	
40–49	331 (75.6)	38 (8.7)	69 (15.8)	
50–59	182 (55.0)	45 (13.6)	104 (31.4)	
>60	49 (55.0)	38 (24.7)	67 (43.5)	
Marital Status				
Married	1360 (77.1)	137 (7.8)	266 (15.1)	<0.01#
Single	588 (97.0)	7 (1.2)	11 (1.8)	
Widow or divorced	49 (77.8)	5 (7.9)	9 (14.3)	
Education				
College and above	1386 (84.7)	92 (5.6)	158 (9.7)	<0.01¶
Essential Education	588 (82.4)	36 (5.0)	90 (12.6)	
Illiterate	23 (28.0)	21 (25.6)	38 (46.3)	
Smoking				
Current smoker	164 (87.7)	6 (3.2)	17 (9.1)	0.02#
None-smoker	1783 (82.0)	137 (6.3)	254 (11.7)	
Ex-smoker	50 (70.4)	6 (8.5)	15 (21.1)	
Family history of premature death	151 (69.6%)	20 (9.2%)	46 (21.2)	<0.01

Notes: Variables are presented as frequency (N) and percentages (%). ¶Chi-square test was used, #Fisher's Exact test was used.
Abbreviation: DM, diabetes mellitus.

The independent effect of DM was investigated using the logistic regression analysis with adjustment of age, gender, and BMI. Compared to non-diabetic participants, patients with controlled DM showed a threefold increase in CVR (OR = 3.02, 95% C.I. = 1.41–7.24) while this risk accelerated to 13 times among those with uncontrolled DM (OR = 13.57, 95% C.I. = 6.99–26.36) (Table 3).

Table 2 Cardiovascular Risk Profile and Vitamin D Level Among the Studied Sample

	Normal	Controlled DM	Uncontrolled DM	P-value
	N = 1997	N = 149	N = 286	
	(82.1%)	(6.1%)	(11.8%)	
Obesity				
Underweight	66 (3.3)	1 (0.7)	0 (0.0)	<0.01
Normal	697 (34.9)	7 (4.7)	26 (9.1)	
Overweight	693 (34.7)	38 (25.5)	99 (34.6)	
Obese	353 (17.7)	64 (43.0)	89 (34.6)	
Morbid obesity	188 (9.4)	39 (26.2)	72 (25.2)	
Diabetes treatment				
Insulin	-	15 (10.1)	69 (24.2)	<0.01
Antihyperglycemic drugs	-	77 (51.7)	200 (69.9)	<0.01
Controlled diet regimen	18 (0.9)	66 (44.3)	162 (56.6)	<0.01
Lifestyle				
Healthy diet	11 (0.55)	3 (2.0)	0 (0.0)	0.04#
Physical inactivity	1475 (73.9)	126 (84.6)	216 (75.5)	0.01
Vitamin D and Calcium				
Deficiency (<30 nmol/L)	610 (30.6)	26 (17.4)	71 (25.0)	<0.01
Inadequacy (30–49 nmol/L)	602 (30.2)	35 (23.5)	84 (29.6)	
Sufficiency (50–125 nmol/L)	733 (36.8)	84 (56.4)	121 (42.7)	
Harmful (>125 nmol/L)	49 (2.5)	4 (2.7)	8 (2.8)	
Calcium	2.3±2.3	2.5±2.1	2.7±6.0	0.28
Blood Pressure				
SBP	114.7±13.2	125.6±12.7	128.3±16.0	<0.01
DBP	69.3±11.2	72.8±8.8	74.7±10.5	<0.01
Hypertension	213 (10.7)	74 (49.7)	156 (54.4)	
Kidney Function				
Serum creatinine	69.5±16.0	71.6±15.7	72.3±33.7	0.05
Uric Acid	282.5±78.9	307.9±85.7	280.5±79.6	<0.01
Chronic Kidney Disease	6 (0.3)	2 (1.4)	6 (2.1)	<0.01#
Lipid Profile				
Cholesterol (mmol/l)	4.7±0.8	4.9±1.0	4.9±3.7	<0.01
TG	1.09±0.8	1.6±1.3	1.8±1.2	<0.01

(*Continued*)

Table 2 (Continued).

	Normal	Controlled DM	Uncontrolled DM	P-value
	N = 1997	**N = 149**	**N = 286**	
	(82.1%)	**(6.1%)**	**(11.8%)**	
LDL-C	2.9±0.8	3.0±0.9	3.0±0.8	0.98
HDL	1.3±0.4	1.2±0.4	1.2±0.3	<0.01
TC/HDL Ratio	0.18±0.4	0.3±0.4	0.3±0.5	<0.01
Dyslipidemia				
High triglycerides	271 (13.6)	103 (69.1)	129 (45.1)	<0.01
High total Cholesterol	637 (31.9)	58 (38.9)	108 (37.8)	0.04
High LDL	587 (29.4)	55 (36.9)	103 (36.0)	0.02
Low HDL	511 (25.6)	59 (39.6)	113 (39.5)	<0.01
TC/HDL Ratio ≥ 5	366 (18.3)	41 (27.5)	93 (32.5)	<0.01
Glycemic indices				
Fasting Blood Glucose	4.4±0.7	6.4±1.8	9.4±3.7	<0.01
HbA1c	5.2±0.3	6.7±0.2	8.7±1.4	<0.01
Framingham cardiovascular risk score				
Low risk <10%	1905 (95.4)	75 (50.3)	105 (36.7)	<0.01
Intermediate risk 10–20%	68 (3.4)	49 (32.9)	89 (31.1)	
High risk >20%	24 (1.2)	25 (16.8)	92 (32.2)	

Notes: Chi-square test was used in all comparisons with only one case where. #Fisher's Exact test was used.
Abbreviations: DM, diabetes mellitus; SBP, systolic blood pressure; DBP, diastolic blood pressure; TG, triglycerides; TC, total cholesterol; LDL-C, density lipoprotein; HDL, high-density lipoprotein.

Table 3 Multivariate Logistic Regression Modeling of Intermediate/High Cardiac Risk

	Adjusted Odds Ratio (95% CI)
Diabetes Mellitus	
Normal	Ref
Diabetes	3.02 (1.41–7.24)*
Uncontrolled Diabetes	13.57 (6.99–26.36)*
Gender	
Males	Ref
Females	0.09 (0.05–0.17)*
Body Mass Index (BMI) (continuous variable)	1.04 (0.99–1.09)
Age (continuous variable)	1.26 (1.21–1.32)*

Notes: Multivariate logistic regression model to define the independent effect of diabetes control on developing a moderate or high cardiac risk-adjusted for age, gender, and body mass index. *P<0.05.

Discussion

This is possibly the first screening research in Saudi Arabia in which the 10-year CVD risk was explored among a large cohort of both healthy and diabetic subjects using the FRS. Compared to non-diabetic participants, both controlled and uncontrolled diabetic patients showed more high-risk characteristics across all CVR parameters. Furthermore, patients with uncontrolled DM had a graver laboratory and clinical cardiovascular profiles when compared to patients with controlled DM. Meanwhile, physical inactivity, unhealthy dietary intake, obesity, and smoking were reported more frequently among the uncontrolled DM group.

A Finnish study found that diabetic patients without previous CVD events had equal coronary mortality to non-diabetic individuals with prior coronary events. DM also increased the risk of coronary artery disease, which lead to a worse prognosis compared to non-diabetics following the first CVD incident.[19] These concerns raised the importance of screening patients with DM for CVD risk using scoring tools - whether these tools were for the general population or tailored for patients with DM for proper management of these patients.[17] Moreover, according to a Danish study, in individuals with DM, a single round of DM screening and CVR assessment in general practice was associated with a considerable reduction in the risk of all-cause mortality and CVD events.[20] To personalize treatment, it is critical to stratify CVR. Even if the five-year risk appears to be comparable, those who are diabetic are expected to have a higher lifetime risk than those who are not diabetic. Factors that can contribute to the development of CVD are age over 40, being male, and poor clinical and biochemical characteristics such as high blood pressure, renal dysfunction, and high LDL-C.[4] Refining risk estimates in patients with DM may aid in the efficient and cost-effective implementation of prevention methods, as well as lowering the potential negative effects of preventive medications.[21]

In the current study, patients with DM (controlled and uncontrolled) showed graver CVD profiles; being diabetic increased the odds of having higher CVD three times as compared to non-diabetics, in addition, about half of diabetics met the criteria of intermediate/high CVD risk as screened by FRS. This higher CVD risk among individuals with DM was ascertained by previous research from different populations, and geographical regions and through different study designs. In a similar study performed in Bangladesh,[22] subjects at moderate CVD risk identified by FRS were 38.8% while 36.7% were at high risk. Another study performed on the Omani diabetic population demonstrated that CVR detected by FRS for low, moderate, and high risks were 32%, 20%, and 24% respectively.[11] Similar proportions of all risk categories were obtained by a study performed on the Qatari diabetic population evaluated by FRS where the proportion of moderate, high, and very high risk were 30.2%, 24.1%, and 33.5% respectively.[23] Furthermore, a meta-analysis of 102 prospective studies has found that, regardless of other risk factors, DM culminated in a two-fold increased risk of cardiovascular events.[8]

Besides the higher CVD risk scores of the studied sample, other risk factors were also prominent in this population including higher blood pressure, obesity, dyslipidemias, sedentary lifestyle, and unhealthy dietary habits. These findings are consistent with many earlier population cross-sectional studies in Saudi Arabia which revealed a high prevalence of hypercholesterolemia, hypertension, smoking, physical inactivity, and DM.[24–27] Patients in Saudi Arabia come with acute coronary syndromes and acute heart failure almost a decade younger than those from developed countries, which puts them at a higher risk for cardiovascular complications and death.[28] The Saudi population also suffers from very alarming rates of obesity; many studies expect this to get worse as the years progress.[29] This adds significantly to the CVD risk among patients with and without DM as CVD is directly attributed to obesity via changes in cardiac function, including decreased cardiac output, increased peripheral resistance, abnormal mass and wall thickness of the left ventricle, and poor ventricular systolic function.[30,31] Cardiovascular risk factor reduction in adults with T2DM requires lifestyle modification such as DM self-management education and support, medical nutrition therapy, physical activity, and smoking cessation, should be provided.[31] Thus, CVD incidence and mortality can be reduced substantially in adults with T2D who adhere to an overall healthy lifestyle, and patients with T2D who are overweight or obese can benefit considerably from intensive lifestyle interventions through moderate and sustained weight loss.[7]

Encouragingly, CVD mortality is decreasing in the general population in high-income nations, owing to reductions in cardiovascular risk factors and recent advancements in prevention, treatment, and management. This trend has also been found in patients with DM.[32] Using data from the national health insurance system, Jung et al[33] assessed trends in CVD

in adults with and without DM in South Korea. The findings reveal that improvements in patient care and management have resulted in a considerable reduction in CVD risk among those with DM. In many developing nations, however, where the prevalence of DM is rapidly increasing and lifestyle habits are changing, an increase in CVD risk factors among people with DM is anticipated.[20,34]

A long-standing debate exists about the relationship between glucose management and cardiovascular outcomes in T2DM. In a multiethnic study published in 2016, high glycemic levels increased the risk of CVD in individuals with T2DM; an increase in HbA1c of 1 unit increased the risk of macrovascular disease (MI and stroke) by 18% and achieving a target of HbA1c of 7% reduces CVD risk by 37% for 11 years.[35] On the other hand, results from clinical trials differ from those coming from observational studies; clinical trials that targeted tight control of glycemia (HbA1c <6.5%) did not confirm the beneficial effect that was expected on reduction of CVD mortalities, and unfortunately risked the participants to have hypoglycemic attacks, especially among older participants.[36] The studies clarified that the possible therapeutic benefit depends on age, the length of the patient's DM and previous glucose control, cardiovascular illness, and the risk of hypoglycemia.[37] The current study supports the evidence coming from observational studies that uncontrolled DM adds significantly to the CVD risk experienced by individuals with DM, however, no participant in our study was tightly controlled (HbA1c <6.5%) which hindered the analysis of the outcomes from such population.

The strength of our study is the large sample size which provides enough power and a useful framework to assess the CVD with DM control. This creates a common scale for comparing the potential population-level impact of disease prevention interventions.

The main limitation of this study is the lack of data on the duration and progression of CVD risk factors. Furthermore, information on the duration of DM was unavailable. As a result, some residual confounders cannot be ruled out. Another limitation is that we only collected data from adults 18 years and older when selecting the patient population. As a result, our findings may not apply to children or adolescents.

Conclusion

A considerable proportion of participants with DM are at moderate to high risk of developing CVD. Individuals with uncontrolled DM showed higher CVR profiles as measured by FRS and through their higher prevalence of obesity, unhealthy diet, and physical inactivity. Screening diabetic patients for CVD risk is an important strategy for detecting and managing patients with DM using therapeutic interventions along with lifestyle modification.

Implication to Clinical Practice

Although there is a growing body of research on metabolic disorders and cardiovascular health in Saudi Arabia, data from large cohort studies are regarded as being essential for organizing and prioritizing healthcare services not only among healthy Saudi adults but also among those suffering from DM. Given the high prevalence of DM and the increased risk of CVD that comes with it, it is critical that we implement an effective diabetes-related CVD management program in Saudi Arabia, or the burden of CVD associated with diabetes will increase dramatically. The findings of this paper will aid policymakers in understanding the importance of implementing CVD risk assessment and primary care management guidelines for individuals with DM, guiding clinicians in the selection of therapeutic and preventive strategies, as well as guiding subjects in the adoption of a healthy lifestyle. Following thereafter, the ultimate and combined doctors-patient measures will assist in minimizing future CVD burdens.

Data Sharing Statement

Most of the data needed is included in the published article. However, more data is available from the King Saud University Ethics Committee for researchers who meet the criteria for access to confidential data. The ethics committee contact details for data requests are: as.ude.usk@bri. This contact point is completely independent of all researchers.

Institutional Review Board Statement

The approval letter (number 13–3721) of King Saud University – Institutional Review Board (IRB) was sought prior to the study commencement.

Informed Consent Statement

The informed written consent was obtained from each participant before questionnaire completion and blood sample withdrawal. The study was conducted as per the principles expressed by Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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