Prediction of 10-Year Risk of Cardiovascular Disease among Diabetic Patients in Bangladesh

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Abstract

Background: *Diabetic populations and people from developing countries have a higher risk of developing CVD than the general population. Bangladesh, a rapidly developing country, faces progressive urbanization and the adoption of a westernized lifestyle, factors which contribute to the rising burden of cardiovascular disease.* ***Objective:*** *To predict the risk of developing cardiovascular diseases among diabetic patients in Bangladesh.* ***Materials and method:*** *This cross sectional study was done among the diabetic patients attending the outpatient department of MARKS Medical College &Hospital, Dhaka, Bangladesh from February 2018 to July 2018. Patients suffering from any cardiovascular disease were excluded from the study. The purpose of the study was explained and informed written consent was obtained from each subject who volunteered for the study. Data was collected with a pre tested structured questionnaire. Cardiovascular risk was assessed based on Framingham scoring, calculated by using online calculator and expressed as percentages. Based on the total risk score calculated, subjects were categorized to be at high (≥20%), intermediate (10-19%), and low (<10%) risk of cardiovascular disease. Data analysis was done in SPSS software version 16.* ***Result:*** *Among the diabetic patients, 32.62% are in high and 22.64% are in intermediate risk category based on Framingham scoring system for developing cardiovascular disease. A statistically significant association was found between cardiovascular risk and factors like gender, occupational status, smoking and hypertension.* ***Conclusion:*** *This study reveals that the diabetic populations are at higher risk of developing cardiovascular diseases. Hence awareness about the risk should be created and appropriate intervention at early stages should be implemented at primary health care level.*

Keywords: *Diabetes; Cardiovascular risk factors; Framingham Risk Score.*

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Introduction

Cardiovascular disease (CVD) is a major public health problem throughout the world. It is the number one cause of morbidity and mortality world-wide. The common modifiable risk factors identified are unhealthy diet, physical inactivity, tobacco use, high blood pressure and blood glucose, abnormal blood lipids, and being overweight.[1] The International Diabetes Federation (IDF) estimates that worldwide, 415 million people have diabetes, 91% of whom have type 2 diabetes mellitus (T2DM).[2] People with diabetes comprise 8.8% of the world's population, and IDF predicts that the number of cases of diabetes will rise to 642 million by 2040.[2] Cardiovascular disease (CVD) is a major cause of death and disability among people with

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diabetes.[2,3] Adults with diabetes historically have a higher prevalence rate of CVD than adults without diabetes[4], and the risk of CVD increases continuously with rising fasting plasma glucose levels, even before reaching levels sufficient for a diabetes diagnosis.[5] Type 2 diabetes mellitus (T2DM) reduces life expectancy by as much as 10 years, and the main cause of death for patients with T2DM is CVD.[2,3] Furthermore, people with T2DM are disproportionately affected by CVD compared with non-diabetic subjects.[6] Haffner et al.[6] reported higher prevalence of death rates due to cardiovascular causes over a 7-year period in patients with T2DM when compared to persons without T2DM. In the Framingham Heart Study, Fox et al.[7] reported that, along with the increasing T2DM prevalence, the attributable risk of CVD due to T2DM increased from 5.4% in the period 1952-1974 to 8.7% in the period 1975-1998. In a longitudinal study of 881 patients with T2DM over 10 years, van Hateren et al.[8] indicated that the hazard ratio for death due to CVD was constantly increasing each year. Thus, an increasing burden of diabetes will likely be followed by an increasing burden of CVD. In general, developing nations continue to be relatively ill-equipped to handle this burden, and, coupled with poor literacy rates and a lack of awareness regarding disease-related symptoms and associated risk factors, the result is worse disease outcomes.[9] This is reflected in the rising rates of CVD-related hospital admissions and mortality among younger subjects, which in turn inflates disability-adjusted life-years.[10,11] As of 2013, 31% of all deaths were from CVD, with 80% occurring in low and middle-income countries. The burden of CVD, especially the coronary artery disease (CAD) is increasing at a greater rate in South Asia than in any other region globally. The economic impact of different types of CVD is enormous. CVD is probably the most important cause of mortality and morbidity in Bangladesh. In 2014, non-communicable diseases represented 59% of the total deaths; CVD was the single-most important contributor, being responsible for 17% of the country's deaths.[12] According to the Health Bulletin 2015, CVD and stroke together was the topmost cause of death in Upazila, District and Medical College Hospitals, and was responsible for 17.78%, 21.83% and 16.32% deaths respectively in 2014.[13] The increased focus on adequately treating patients with both CVD and T2DM is essential as there is higher prevalence of CVD and its risk factors among patients with T2DM. This information is needed to disseminate to healthcare providers, healthcare policy decision-makers, and health economic analysts. Although data on the prevalence of coronary disease risk factors in developing countries are limited, the prevalence observed is alarming. Risk stratification is therefore central to the management of heart disease. We conducted a cross sectional observational study to evaluate the prevalence of cardiovascular disease risk factors among the diabetic Bangladeshi population and to predict the 10-year risk of cardiovascular disease events, defined as myocardial infarction or coronary death.

Materials and method

Study design and patient population

The present cross-sectional study included 340 diabetic patients (110 males and 230 females) aged 30-73 years who were outpatients of MARKS Medical College & Hospital, Dhaka, Bangladesh. The study was done for a period of six months from February 2018 to July 2018. The subjects were known case of diabetes. Patients suffering from any cardiovascular disease were excluded from the study. The purpose of the study was explained to all the subjects prior to data collection. Informed written consent was obtained from each subject who volunteered for the study.

Study objective and endpoints

The objective of the study was to estimate cardiovascular risk at ten years by Framingham cardiovascular risk assessing calculator. Demographic variables and cardiovascular risk factors, including hypertension, dyslipidemia, diabetes, smoking, were recorded during the interview and examination. Data were collected by means of a structured questionnaire.

Socio-demographic data included data on age, gender, educational level (illiterate, primary school, secondary school and graduation), occupational status (service holders, businessman, housewife and others; including retired persons, farmer, etc.), monthly income in Bangladeshi taka (BDT); upper (≥100000 BDT), middle (50000-<100000 BDT) and low (<50000 BDT). Subjects who were currently smoking or had quit less than one year previously were classified as smokers. Non-smokers were classified as those who had never smoked or who had quit more than one year previously. In our study, the subject was considered hypertensive if discovered hypertensive during assessment or was diagnosed as hypertensive by a physician or taking medications for hypertension. Diabetes was considered to be present if the subject was on treatment with insulin or oral hypoglycemic agents or had been diagnosed as diabetic by a physician.

Standing height was measured to the nearest 0.1 centimeter with fixed stadiometer. Body weight was measured in kilograms with a weighing scale to the nearest 0.5 kilogram. Body mass index (BMI) was derived by dividing the body weight by the height squared (kg/m^2). Blood pressure, systolic (SBP) as well as diastolic (DBP), was recorded using an aneroid sphygmomanometer and stethoscope. The patients were classified on the basis of body mass index (BMI) using WHO classification.[14] Dyslipidemia was defined by the presence of more than one abnormal serum lipid concentration or if the subject was on treatment with statins or other lipid lowering medications or had been diagnosed by a physician. The patients were referred to a laboratory where intravenous blood was drawn by trained technician after a fasting period of at least 8 hours to estimate the value of fasting glucose (FG), total cholesterol (TC), and high density lipoprotein (HDL).

Framingham scoring method and assumptions

The Framingham Risk Score is a gender-specific algorithm used to estimate the 10-year cardiovascular risk of an individual. The Framingham risk score was first developed based on data obtained from the Framingham Heart Study, to estimate the 10-year risk of developing coronary heart disease.[15] The Framingham risk score is one of a number of scoring systems used to determine an individual's chances of developing cardiovascular disease are available online. We used version of the Framingham Risk Score that was published in 2008. The publishing body is the ATP III, i.e. the Adult Treatment Panel III, an expert panel of the National Heart, Lung, and Blood Institute, which is part of the National Institutes of Health (NIH), USA.[16] To calculate the total risk score by using online calculator need to enter the appropriate value according to the patient’s age, sex, HDL-C, total cholesterol, systolic blood pressure, whether the patient being treated for high blood pressure or not, and if they smoke or have diabetes. Cardiovascular risk scoring systems give an estimate of the probability that a person will develop cardiovascular disease within a specified amount of time, usually 10 to 30 years.[17] Because they give an indication of the risk of developing cardiovascular disease, they also indicate who is most likely to benefit from prevention. For this reason, cardiovascular risk scores are used to determine who should be offered preventive drugs such as drugs to lower blood pressure and drugs to lower cholesterol levels.[15] Framingham Risk Score is calculated by using online calculator and expressed as percentages. Based on the total risk score calculated, subjects were categorized to be at high (≥20%), intermediate (10-19%), and low (<10%) risk of cardiovascular disease.[18,19] This online assessment tool is intended as a clinical practice aid for use by experienced healthcare professionals. Results obtained from this tool should not be used alone as a guide for patient care. A more useful metric is to consider the effects of treatment. If a group of 100 persons all have a 20% ten-year risk of cardiovascular disease it means that we should expect that 20 of these 100 individuals will develop cardiovascular disease (coronary heart disease) in the next 10 years and eighty of them will not develop cardiovascular disease in the next 10 years. If they were to take a combination of treatments (for example drugs to lower cholesterol levels plus drugs to lower blood pressure and to control diabetes) that would reduce their risk of cardiovascular disease by half it means that 10 of these 100 individuals should be expected to develop cardiovascular disease in the next 10 years and 90 of them should not be expected to develop cardiovascular disease. If that was the case then 10 of these individuals would have avoided cardiovascular disease by taking treatment for 10 years; 10 would get cardiovascular disease whether or not they took treatment; and 80 would not have got cardiovascular disease whether or not they took treatment. Because risk scores such as the Framingham Risk Score give an indication of the likely benefits of prevention, they are useful for both the individual patient and for the clinician in helping decide whether lifestyle modification and preventive medical treatment, and for patient education, by identifying men and women at increased risk for future cardiovascular events.[20]

Statistical analysis

Continuous variables are reported as means and standard deviations (SD). Categorical data are reported as frequencies and percentages. For continuous variables, the two-sample t-test was carried out, while for categorical variables, the chi-square test was applied. Analysis was carried out using Statistical Package for Social Science (SPSS) software version 16. A p-value less than 0.05 was considered statistically significant, unless specified other wise.

Results

Demographic and clinical characteristics

A total of 340 diabetic patients were included. Among them, 110(32.4%) were male and 230(67.6%) were female. The mean age of the respondent was 47.58±9.01 (Mean±SD) years. Maximum age was 73 years and minimum age was 30 years. Males were significantly taller (male vs. female: 1.63±6.46 vs. 1.54±4.59 meter) and heavier (male vs. female: 68.37±9.86 vs. 61.26±8.58 kg) than females ($p<0.001$). But female had higher BMI (kg/m^2) as compared tto males (25.92±3.74 vs. 25.50± 3.19); ($p=0.30$). The cardio-metabolic risk factors, SBP (male vs. female: 128.18±1.41 vs. 125.96 ±1.59 mmHg; $p=0.21$), fasting blood glucose (Male vs. Female: 7.65±1.69 vs. 7.59±1.63 mmol/L; $p=0.75$), and total cholesterol (male vs. female: 5.33±1.47 vs. 4.89±1.28 mmol/L; were higher among males than females. But HDL cholesterol was slightly higher in females than male (male vs. female: 0.98±0.15 vs. 0.99±0.16 mmol/L; $p=0.49$). (Table I)

Table I: Descriptive value for anthropometric, clinical characteristics & Framingham cardiovascular risk score of diabetic patients

Variables		Total Mean ± SD	Male Mean ± SD	Female Mean ± SD	p-value
Age(Years)		47.58 ± 9.01	51.01 ± 1.04	45.94 ± 7.74	.000
Weight (Kg)		63.56 ± 9.60	68.37 ± 9.86	61.26 ± 8.58	.000
Height (meter)		1.57 ± 7.02	1.63 ± 6.46	1.54 ± 4.59	.000
BMI (kg/m^2)		25.79 ± 3.57	25.50 ± 3.19	25.92 ± 3.74	0.30
Blood pressure (mm Hg)	SBP	126.68 ± 1.54	128.18 ± 1.41	125.96 ± 1.59	0.21
	DBP	80.21 ± 8.73	80.45 ± 9.20	80.10 ± 8.52	0.73
Total Cholesterol (mmol/L)		5.03 ± 1.36	5.33 ± 1.47	4.89 ± 1.28	.005
HDL(mmol/L)		0.99 ± 0.16	0.98 ± 0.15	0.99 ± 0.16	0.49
FBS(mmol/L)		7.65±1.69	7.59 ± 1.63	7.61 ± 1.64	0.75
Framingham Score		14.41 ± 1.07	21.84 ± 1.03	10.86 ± 9.04	.000

NB: BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure;
HDL: High Density Lipoprotein;
FBS: Fasting Blood Sugar. $p<0.05$=significant.

Distribution of socio-demographic and clinical parameters among male and female subjects was shown in Table II. The analysis reveals that female were more obese than male (60% vs. 58.18%). But male were more overweight than female (23.63% vs. 18.69%); (p=0.52). Most of the female were housewife (72.60%). Whereas most of the male were service holder (53.63%); (p<0.001). Most of the male (50.90%) and female (58.26%) patients came from middle socio-economic status (p=0.28). History of dyslipidemia was more among male than female (52.72% vs. 47.82%; p=0.39). Male subjects had a higher prevalence of smoking (50% vs. 0.43%; p<0.001) and hypertension than female subjects (male vs. female: 62.72% vs. 60.86%; p=0.74). (Table II)

Table II: Distribution of socio-demographic & clinical parameters among male and female subjects

Variables		Male N (%)	Female N (%)	» Value	df	p-value
BMI (kg/m^2)	Normal weight	20 (18.18)	49(21.30)	1.29	2	0.52
	Over Weight	26 (23.63)	43(18.69)			
	Obese	64 (58.18)	138 (60.0)			
Smoker	Yes	55 (50.0)	1 (0.43)	1.32	1	.000
	No	55 (50.0)	229 (99.56)			
Occupation	Service holder	59 (53.63)	26 (11.30)	1.72	3	.000
	Businessman	21 (19.09)	2 (8.69)			
	House wife	0 (0.0)	167 (72.60)			
	Others	30 (27.27)	35 (15.21)			
Socio-economic Status	Upper	41 (37.27)	66 (28.69)	2.54	2	0.28
	Middle	56 (50.90)	134 (58.26)			
	Low	13 (11.81)	30 (13.04)			
Post Menopausal	Yes		113 (49.13)	3.40	2	.000
	No		117 (50.86)			
Treated Hypertension	Yes	69 (62.72)	140 (60.86)	0.108	1	0.74
	No	41 (37.27)	90 (39.13)			
History of Dyslipidemia	Yes	58 (52.72)	110 (47.82)	0.715	1	0.39
	No	52 (47.27)	120 (52.17)			

Pearson chi-square = » value; df: degree of freedom; p<0.05=significant.

Framingham cardiovascular risk score among Bangladeshi adults

The overall estimated Framingham cardiovascular risk score for the present population was 14.41±1.07 (Mean±SD) as shown in Table I. The estimated 10-year cardiovascular risk score was significantly higher among males than females (male vs. female: 21.84±1.03 vs. 10.86±9.04); (p<0.001). High risk was found in 32.62% patients (male vs. female: 58.18% vs. 20.43%), intermediate risk was in 22.64% patients (male vs. female: 17.27% vs. 25.21%), and low risk was in 44.70% patients (male vs. female: 24.54% vs. 54.34%); (p<0.001). (Table III)

Table III: Sex-wise distribution of diabetic patients in different categories of Framingham cardiovascular risk scores

Variables		Total N (%)	Male N (%)	Female N (%)	» Value	df	p-value
Framingham Risk Score	Low (<10%)	152 (44.70)	27 (24.54)	125 (54.34)	49.33	2	.000
	Intermediate	77 (22.64)	19 (17.27)	58 (25.21)			
	High (>20%)	111 (32.62)	64 (58.18)	47 (20.43)			

Pearson chi-square = » value; df: degree of freedom; p<0.05=significant.

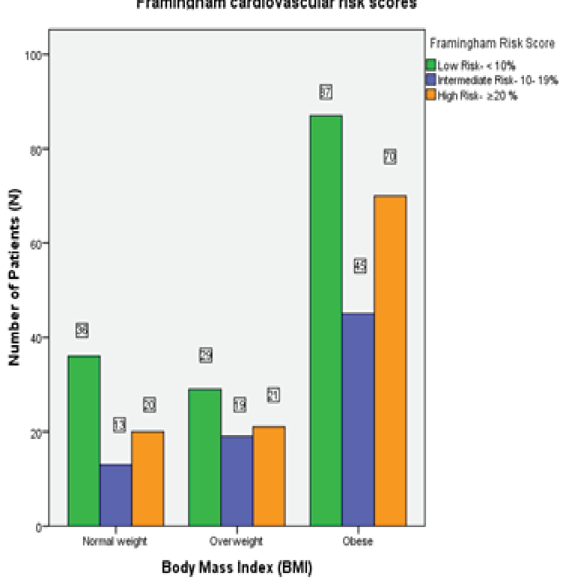
Table IV presents the cross tabulation of socio-demographic and clinical risk factors and Framingham 10-year cardiovascular risk level; that is low, intermediate, and high. Smoking was found to be a significant predictor of cardiovascular risk among the patients, 30.63% of the smoker were at high risk; (p<0.001). Among the postmenopausal women 58.44% and 34.23% were in intermediate risk and high risk group respectively in comparison to 12.98% and 8.1% of the women, who are non-menopausal; (p<0.001). Most of the high risk group (31.53%) were housewife; (p<0.001) and came from middle income status (53.15%); (p=0.28). According to BMI categories, 63.06 % of the obese patients and 18.91% of the overweight patients were at high risk for cardiovascular diseases (CVD) in the next 10 years; (p=0.57). (Fig 1)

Table IV: Cross tabulation of socio-demographic & clinical factors and Framingham 10-year cardiovascular risk level

Variables		Framingham Score Low N (%)	Intermediate N (%)	High N (%)	» Value	df	p-value
Sex	Male	27 (17.76)	19 (24.67)	64 (57.65)	49.33	2	.000
	Female		58 (75.32)	47 (42.34)			
BMI	Normal weight	36 (23.68)	13 (16.88)	20 (18.01)	2.91	4	0.57
(kg/m^2)	Over Weight	29 (19.07)	19 (24.67)	21 (18.91)			
	Obese	87 (57.23)	45 (58.44)	70 (63.06)			
Smoker	Yes	12 (7.89)	10 (12.98)	34 (30.63)	24.98	2	.000
	No	(92.10)	67 (87.01)	77 (69.36)			
Occupation	Service Holder	38 (25.0)	19 (24.67)	28 (25.22)	34.99	6	.000
	Businessman	2 (1.31)	15 (6.49)	16 (14.41)			
	House wife	89 (58.55)	43 (55.84)	35 (31.53)			
	Others	23 (15.13)	10 (12.98)	32 (28.82)			
Socio-economic Status	Upper	47(30.92)	28 (36.36)	32 (28.82)	5.05	4	0.28
	Middle	89(58.55)	42 (54.54)	59 (53.15)			
	Low	16(10.52)	7 (9.09)	20 (18.01)			
Post Menopausal	Yes	30 (19.73)	45 (58.44)	38 (34.23)	1.20	4	0.57
	No	95 (62.5)	13(16.88)	9 (8.10)			
Treated Hypertension	Yes	59 (38.81)	55 (71.42)	95 (85.58)	63.41	2	.000
	No	93 (61.18)	22 (28.57)	16 (14.41)			
History of Dyslipidemia	Yes	70 (46.05)	35 (45.45)	63 (56.75)	3.56	2	0.16
	No	82 (53.94)	42 (54.54)	48 (43.24)			

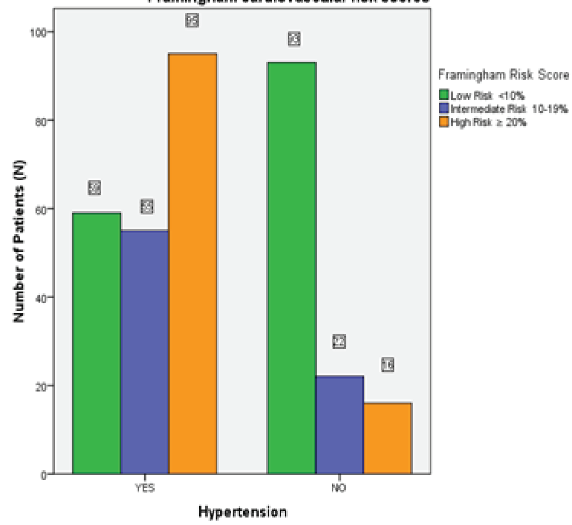
BMI: Body Mass Index; Pearson chi-square = » value; df: degree of freedom; p<0.05=significant

Figure 1: BMI-wise distribution of diabetic patients in different categories of Framingham cardiovascular risk scores



Among the patients who had high probability for the incidence of CVD in the future 10 years, 85.58% of them were hypertensive (p<0.001); (Fig 2) and 56.75% of them had history of dyslipidemia (p=0.16).

Figure 2 : Distribution of hypertensive patients in different categories of Framingham cardiovascular risk scores



Discussion

This study was conducted to assess the cardiovascular risk among diabetic patients visiting outpatient department of a medical college hospital. There are many standard scoring systems to assess the risk. In this study, Framingham risk scoring online calculator was used. Based on the scoring system the study participants who were known diabetic patients were categorized to be of low, intermediate and high risk for developing cardiovascular complications in the next 10 years. This study shows around 32.62% of the study population were at high risk of developing cardiovascular complications. Males showed discernible frequency of adverse cardiovascular risk as compared to the females and had higher risk of developing CVD in the future. Similar findings have been reported by Gomes et al.[21] among Brazilian diabetic population which contradicts with the earlier studies reporting high cardiovascular mortality in women.[22-24] Recent accumulating evidence has demonstrated that diabetes alters estrogen-related protective mechanism and causes pronounced adverse changes in cardiovascular risk factors leading to enhanced atherogenesis in females.[24,25] In our study, cross tabulation showed that 49.13% females were postmenopausal and 50.86% were non-menopausal which contrasts with the high risk for cardiovasculardisease with menopausal women (34.23%) in comparison to non-menopausal women (8.1%).

The other probable explanation for biological sex differences in cardiovascular morbidity risk could be the distinct biological as well as gender-related acculturation and lifestyle differences between males and females.[26] Lifestyle and cultural habits have demonstrated stronger influences on metabolic disorders than those from genetic factors. The gender difference in lifestyle depends on the sex-specific behavior inculcated in an individual by family or society in which they live and it varies with age.[27] In the present study, males were primarily service holder (53.63%) and supplement their livelihood by working in governmental and private sectors while majority of the females (72.60%) were housewife. And 25.22% of the service holders and 31.53% of the housewives had high risk score of developing cardiovascular complications. This study also shows that participants who belong to middle socio-economic status (53.15%) had higher risk of developing cardiovascular complications.

Obesity is a co morbid condition and itself is a modifiable risk factor for developing non-communicable diseases like hypertension, cardiovascular diseases and diabetes mellitus due to poor lifestyle conditions.[28] In this study, 63.06% of obese population had high risk score for developing cardiovascular complications.

Smoking and hypertension have contributed significantly to the high risk of developing cardio-vascular disease (CVD) in the future among the patients; which are already distinguished as risk factors for CVD.[28-30] Our study shows that, 30.63% of the smoker and 85.58% of the hypertensive had high risk score for developing cardiovascular complications.

Primary prevention through improved control of risk factors and therapeutic lifestyle modification (including dietary modification, aerobic exercise, and smoking cessation) is a pioneer strategy advocated by the National Cholesterol Education Program in the Adult Treatment Panel III (ATP III) guidelines.[31] Lifestyle interventions have been effective in the improvement of cardiovascular risk factors and the benefits are proportionally higher among those at high risk for cardiovascular disease.[31] This study shows that 55.26% of the study participants are on intermediate to risk high categories for developing cardiovascular disease which is similar to the study done by Garg et al. who used Framingham Risk Score and showed that 51.9% were on high risk of developing the same.[32]

Limitation

Considering the small sample size and cross-sectional study design, it would not be the generalized findings of the entire population. However, probable reason based on the findings of the present study and the contrasting evidence put forth in the discussion from the previous literature would provide an overview of the scenario. Therefore, there is a need of a comprehensive study design which includes various factors which directly or indirectly influence the disease incidence especially in a country with diverse ethnic population. These findings need to be validated further through various epidemiological study designs, large sample sizes, and inclusion of various other socio-demographic and biological parameters.

Conclusion

Non communicable diseases are at constant rise due to the epidemiological transition and though national health programs are implemented to combat the burden through various interventions, more emphasis on awareness creation for early detection and periodical follow up is vital to prevent the complications. However, the paradox in the prevention of cardiovascular complications of type 2 diabetes is that, at diagnosis, diabetic individuals are already at an amplified risk of CVD. This study shows that 32.62% of the population is at high risk of developing cardiovascular complications based on Framingham scoring. This mounting evidence accentuates the need of intensive management of cardiovascular risk factors among diabetic individuals. And public awareness programs to control these risk factors are warranted.

Conflict of Interests

There is no conflict of interests regarding the publication of this paper.

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