Heliyon 7 (2021) e07728

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Cardiovascular risk assessment among type-2 diabetic subjects in selected areas of Bangladesh: concordance among without cholesterol-based WHO/ISH, Globorisk, and Framingham risk prediction tools

Rajib Mondal [a,b,*], Rani Baroi Ritu [b], Palash Chandra Banik [c]

[a] Department of Public Health, Hamdard University Bangladesh (HUB), Gazaria, Munshiganj, Bangladesh
[b] Department of Public Health and Research, Center for Noncommunicable Diseases Prevention Control Rehabilitation & Research (CeNoR), Dhaka, Bangladesh
[c] Department of Noncommunicable Diseases, Bangladesh University of Health Sciences (BUHS), Dhaka, Bangladesh

ARTICLE INFO

Keywords:
Cardiovascular risk
Diabetic subjects
Concordance
Without cholesterol-based tools
Bangladesh

ABSTRACT

Introduction: Cardiovascular disease (CVD) risk is higher among the subjects with type-2 diabetes mellitus (T2DM) in low- and middle-income countries, like Bangladesh. However, there is no relevant available online published data for this country. We aimed at assessing the 10-year CVD risk among T2DM subjects in selected areas of Bangladesh using the without cholesterol-based joint World Health Organization/International Society of Hypertension (WHO/ISH), Globorisk, and Framingham Risk Score (FRS) risk prediction tools, and also evaluating the concordance among these tools.

Methods and materials: In this paper, we extracted a total of 327 subjects (40–60 years aged) from an observational study with 356 subjects, excluding those with diagnosed CVDs. The subjects were selected conveniently from purposively selected respective diabetic hospitals of Pirojpur and Dinajpur districts. We used the required respective variables of WHO/ISH, Globorisk, and FRS tools to predict CVD risks. The risks were categorized as low (<10%), moderate (10-<20%), high (20-<30%) and very high (≥30%).

Results: Subjects at moderate CVD risk were much higher identified by Globorisk (37.0%) and FRS (38.8%) compared to WHO/ISH (15.3%), and the same scenarios have also been observed for high (13.5%, 19.3% and 2.4%, respectively) and very high (5.5%, 17.4% and 1.8%, respectively) risks. There was fair level of concordance between WHO/ISH and Globorisk (PABAK-OS $k = 0.37$; 95% CI 0.33–0.42; $P < 0.001$), and Globorisk and FRS (PABAK-OS $k = 0.34$; 95% CI 0.30–0.39; $P < 0.001$). And, between WHO/ISH and FRS, it was none to slight level (PABAK-OS $k = 0.09$, 95% CI 0.04–0.14; $P = 0.001$).

Conclusions: A significant proportion of the selected study subjects is at moderate to very high risk of developing CVDs predicted especially by Globorisk and FRS compared to WHO/ISH, indicating low concordance. With and without cholesterol-based studies can answer the problem more clearly.

1. Introduction

Cardiovascular diseases (CVDs) are very common conditions among people with type-2 diabetes mellitus (T2DM) with a higher prevalence (approximately one-third) as well as mortality (approximately half of all deaths) [1]. According to the American Heart Association, diabetic individuals have 2–4 times higher chance to die from heart diseases than that of non-diabetic, and at least 68% of them aged 65 or older die from some form of heart diseases [2].

Along with CVD burden [3, 4], the 10-year predicted risks for CVDs are also higher in low- and middle-income countries (LMICs) than high-income countries (HICs). The high CVD risks are ranged from 1% for South Korean women to 42% for Czech men in HICs, and from 2% in Uganda (men and women) to 13% in Iranian men in LMICs [5]. Particularly in Bangladesh, one-fifth of the rural population [6] and one-fourth of the urban population [7] are at moderate to very high level of CVD risk. Moreover, the CVD risk is invariably high among the T2DM subjects [8]. Among the Omani T2DM subjects, the cholesterol-based Framingham Risk Score (FRS) and joint World Health Organization/International Society of Hypertension (WHO/ISH) 10-year risk prediction tools revealed 20% and 12% of them respectively are at high risk [9]. And, it was 24.1% and 3.2% respectively with the same tools among the Qatari

* Corresponding author.
E-mail address: rajibmondaluday@gmail.com (R. Mondal).

https://doi.org/10.1016/j.heliyon.2021.e07728
Received 2 January 2021; Received in revised form 22 July 2021; Accepted 3 August 2021

T2DM subjects [10]. Among the Sri Lankan T2DM subjects, it was 1.5–2% by WHO/ISH [11, 12], 16.2% by FRS [11], and 4.4–6% by UK Prospective Diabetes Study (UKPDS) risk engine [11, 12] in the same tools. And, in the neighboring country India, 13.8% of their T2DM subjects are at high risk assessed by without cholesterol-based WHO/ISH tool [13]. However, there is no relevant information in Bangladesh reflecting the CVD risk assessment among its diabetic population, based on available online published data.

Meanwhile, a large number of people in Bangladesh, such a LMIC, are suffering from DM, reflecting one in every ten adults [14]. Therefore, no doubt it is highly important to assess the level of CVD risk among this population. This risk estimation will be very much helpful for the clinicians supporting themselves with a guide in the choice of therapeutic and preventive strategies and monitoring the patients [8, 15], and also for the patients motivating themselves to adopt healthy lifestyle measures [15]. Moreover, there is also clear variation persists in the estimated CVD risks by different tools [9, 10, 11, 12, 13]. Under these circumstances, in this highly important paper, we aimed at assessing the 10-year CVD risk among T2DM subjects in selected areas of Bangladesh using the without cholesterol-based WHO/ISH, Globorisk, and FRS risk prediction tools, and also evaluating the concordance among the tools.

2. Methods and materials

2.1. Study design, population, and sampling

This study was derived from a Master's Thesis work which was an observational study conducted in 2017 among T2DM subjects in Alhaz Asmat Ali Khan Diabetic Hospital, Pirojpur, and Dinajpur Diabetic Hospital, Dinajpur attending the outpatient departments. Both of the hospitals are affiliated with the 'Diabetic Association of Bangladesh (BADAS)'. Pirojpur district is located in the southern and Dinajpur district is in the northern part of Bangladesh. The hospitals were selected purposively, and the registered diabetic subjects of these hospitals were selected conveniently who visited the outdoors during the data collection period. The subjects who were 40–60 years aged and had diabetes for at least 3 years were recruited in the study [16]. In this paper, we extracted 327 samples from the total of 356 in the main Thesis work excluding those who had any diagnosed CVDs. The extracted samples satisfied the minimum required sample size for this study considering the 13.8% prevalence of high CVD risk (assessed by without cholesterol-based WHO/ISH tool likely this study) among diabetic subjects in neighboring country India [13] using $n = z^2pq/d^2$ formula for a cross-sectional study.

2.2. Research instruments and techniques

We extracted socio-demographic information (sex, age, education, occupation, family income) and relevant risk factors (smoking, hypertension, and overweight/obesity) from the main thesis report. Subjects were asked about their socio-demographic and history of smoking and hypertension-related information. On spot blood pressure measured by qualified doctors and anthropometric height-weight measurement-related information were taken from diabetic record book of the respective subjects. Few new hypertensive cases were identified using systolic blood pressure (SBP) and diastolic blood pressure (DBP), and overweight/obesity was identified from body mass index (BMI) classification calculated using height and weight. Standard guidelines from WHO were followed to identify new hypertensive cases and to calculate as well as classify BMI. Further details of the methods were described in the main report [16].

2.3. Main outcome measure

Our main outcome measure was the prediction of 10-year CVD (including coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, heart failure) risk [17].

2.4. The use of CVD risk prediction tools

The risks were assessed using the without cholesterol-based WHO/ISH, Globorisk, and FRS CVD risk prediction tools.

2.5. WHO/ISH CVD risk prediction charts

These charts predict 10-year risk of a fatal or nonfatal major CVD event such as myocardial infarction or stroke among healthy individuals (who have not yet a history of heart attack or stroke) aged between 40-79 years for 14 WHO epidemiological sub-regions. It uses the following information of an individual-age, sex, SBP, smoking status, total blood cholesterol and presence or absence of DM to predict CVD risk. There are two sets of charts-one set can be used in the settings where blood cholesterol can be measured, and the other set is for that where cholesterol cannot be measured. In our study we used the without cholesterol for DM version using the chart SEAR-D where Bangladesh belongs to [18].

2.6. Globorisk CVD risk prediction charts

Globorisk is the first risk score to predict CVD risk of heart attack or stroke in healthy individuals aged between 40-74 years for all countries of the world. It uses the following information of an individual-country of residence, age, sex, smoking status, diabetes, SBP and total cholesterol to predict 10-year CVD risk. When the diabetes or total cholesterol test is not available, it is recommended to use the office-based version of the Globorisk tool which is based on BMI instead. In our study we used its office-based version for the Bangladesh chart [19].

2.7. Framingham Risk Score (FRS) tool

The FRS predicts a 10-year risk for the development of CVDs, including coronary death, myocardial infarction, coronary insufficiency, angina, ischemic stroke, hemorrhagic stroke, transient ischemic attack, peripheral artery disease, heart failure in healthy individuals aged between 30-74 years. It uses the following information of an individual-age, sex, treated or untreated SBP, smoking status, total blood cholesterol, HDL cholesterol, and presence or absence of DM. Here, when the cholesterol tests are not available, it is recommended to use the BMI-based version of the FRS tool [17].

2.8. Risk stratification and categorization

In our study, we categorized the 10-year fatal or nonfatal CVD risks by following 4 ways: low risk when it is $<10\%$, moderate risk when ranged from 10-$<20\%$, high risk when ranged from 20-$<30\%$, and very high risk when $\geq 30\%$ [20].

2.9. Data processing and statistical procedure

We used Statistical Package for the Social Sciences (SPSS) software version-21 for the data processing and analysis. Descriptive statistics were done to illustrate the socio-demographic information and CVD risk categories identified by the tools, and expressed as frequencies, percentages, means, standard deviations (SD), medians, and interquartile ranges.

Cohen's kappa statistics were done to measure the inter-rater reliability as the levels of agreement among the tools used in this study [21, 22]. However, the Cohen's kappa is highly influenced by several potential factors, mainly the prevalence effect, bias effect, and unbalanced marginal totals effect that may show as paradox kappa coefficient. To overcome this limitation of Cohen's kappa, we used prevalence-adjusted and

bias-adjusted kappa for ordinal scale (PABAK-OS) statistics after reporting Goodman-Kruskal Gamma (γ) and Kendall's Tau-b (τ_b). As the risk categories of our tools are in ordinal scale, here, the PABAK-OS also overcame the main limitation of simple prevalence-adjusted and bias-adjusted kappa (PABAK) for its suitability towards nominal scales only, which is not sensitive to the ordinal scales [23, 24, 25]. The Goodman-Kruskal Gamma and Kendall's Tau-b is also appropriate to use concordance measures of association in ordinal scaled categories eliminating or reducing the bias and error effects [26, 27]. The Gamma and Tau-b coefficients have the same value range $-1 \leq \gamma/\tau_b \leq 1$, whereas -1 indicates 100% negative association or perfect inversion, $+1$ indicates 100% positive association or perfect agreement, and 0 indicates no association between two raters [27]. However, the final concordance (levels of agreement) among the tools were determined by PABAK-OS coefficients (k). In this study, the PABAK-OS were calculated from an online calculator namely Single Case Research [28]. The levels of statistical significance were considered when $P < 0.05$ in all cases. And, the levels of agreement were interpreted as no agreement (when $k \leq 0$), none to slight (when k 0.01–0.20), fair (when k 0.21–0.40), moderate (when k 0.41–0.60), substantial (when k 0.61–0.80), and almost perfect agreement (when k 0.81–1.00) according to Landis and Koch's approach [29]. Moreover, bivariate analyses such as Chi-square tests and Fisher's Exact tests were done to insight the relationship between socio-demographic factors and CVD risk categories considering statistical significance at $P < 0.05$.

2.10. Ethical statements

The thesis work was conducted in accordance with the Declaration of Helsinki and the guideline of the Bangladesh Medical and Research Council (BMRC). Ethical clearance for the thesis work was taken from the Ethical Review Committee (ERC) of Bangladesh University of Health Sciences (Identification no. BUHS/BIO/EA/17/82). The purpose of the study and the rights of the respondents were described to them. Both verbal and written informed consents were taken from each respondent prior to data collection.

3. Results

3.1. Socio-demographic information

Men and women were in almost equal proportion. The mean ± SD age of the respondents was 50.8 ± 7.0 years, and two-fifths were in their last quarter of the considered age range of this study. The highest proportions of them read up to primary school level (39.4%) and were homemakers (45.9%). Their mean ± SD of monthly family income was 30,554 ± 11,718 Taka (Bangladeshi currency), details in Table 1.

3.2. Risk factors-related information

We found 15.0% of our respondents as a smoker. Jointly, more than one-third were overweight and obese. Respondents were suffering from diabetes mellitus for 7.0 ± 4.5 years. A high proportion (52.0%) had been found to have hypertension, among them a vast majority (92.4%) was on taking medication to control that. The median systolic blood pressure of the respondents was found above the normal range (Table 2).

3.3. Prevalence of CVD risk categories identified by the tools

We found, the majority of the respondents were at low CVD risk identified by both WHO/ISH and Globorisk tools, unlike at moderate risk identified by FRS. Much higher proportions were at moderate risk identified by Globorisk (37.0%) and FRS (38.8%) compared to WHO/ISH (15.3%), and also the same scenarios have been observed for high (13.5%, 19.3% and 2.4%, respectively) and very high (5.5%, 17.4% and 1.8%, respectively) CVD risks. However, higher proportions of

Table 1. Socio-demographic information of the respondents ($n = 327$).

Variables	Number	Percentage (95% CI)
Sex		
Men	162	49.5 (44.1–54.9)
Women	165	50.5 (45.1–55.9)
Age (in years)		
40-44	75	22.9 (18.3–27.5)
45-49	46	14.1 (10.3–17.9)
50-54	76	23.2 (18.6–27.8)
55-60	130	39.8 (34.5–45.1)
Mean ± SD (Interquartile range)	50.8 ± 7.0 (45–57)	
Level of education		
Illiterate	41	12.5 (8.9–16.1)
Up to primary school	129	39.4 (34.1–44.7)
Up to SSC	69	21.1 (16.7–25.5)
HSC and above	88	26.9 (22.1–31.7)
Occupation		
Employed	63	19.3 (15.0–23.6)
Business	69	21.1 (16.7–25.5)
Homemaker	150	45.9 (40.5–51.3)
Others	45	13.8 (10.1–17.5)
Monthly family income (in BDT)		
Less than 30,000	135	41.3 (36.0–46.6)
30,000 and above	192	58.7 (53.4–64.0)
Mean ± SD (Median; Interquartile range)	30,554 ± 11,718 (30,000; 20,000–35,000)	

CI = Confidence interval; SD = Standard deviation; SSC = Secondary School Certificate; HSC = Higher Secondary School Certificate; BDT = Bangladeshi Taka (currency).

Table 2. Risk factors-related information of the respondents ($n = 327$).

Variables	Number	Percentage (95% CI)
Smoking		
Yes	49	15.0 (11.1–18.9)
No	278	85.0 (81.1–88.9)
Duration of smoking, $n = 49$		
Mean ± SD (Interquartile range)	29.4 ± 9.0 (25–35)	
Overweight and obesity status		
Normal weight (BMI <25.0 kg/m^2)	210	64.2 (59.0–69.4)
Overweight (BMI 25.0–29.9 kg/m^2)	94	28.7 (23.8–33.6)
Obese (BMI ≥30.0 kg/m^2)	23	7.0 (4.2–9.8)
Duration of diabetes mellitus		
<7 years	194	59.3 (54.0–64.6)
≥7 years	133	40.7 (35.4–46.0)
Mean ± SD (Interquartile range)	7.0 ± 4.5 (3–10)	
History of hypertension		
Yes	170	52.0 (46.6–57.4)
No	157	48.0 (42.6–53.4)
Duration of hypertension, $n = 170$		
Mean ± SD (Interquartile range)	7.0 ± 5.1 (3–10)	
Taking medicine for hypertension, $n = 170$		
Yes	157	92.4 (88.4–96.4)
No	13	7.6 (3.6–11.6)
Systolic blood pressure (in mm of Hg.)		
Mean ± SD (median)	127 ± 11 (125)	
Diastolic blood pressure (in mm of Hg.)		
Mean ± SD (median)	82 ± 7 (80)	

CI = Confidence interval; SD = Standard deviation; BMI = Body mass index.

Table 3. Predicted categories of 10-year CVD risks identified by WHO/ISH, Globorisk, and FRS tools among diabetic subjects ($n = 327$).

Predicted categories of 10-year CVD risk	WHO/ISH CVD risk tool	Globorisk CVD risk tool	FRS CVD risk tool
	Number, % (95% CI)	Number, % (95% CI)	Number, % (95% CI)
Low risk (<10%)	263, 80.4 (76.1–84.7)	144, 44.0 (38.6–49.4)	80, 24.6 (19.9–29.3)
Moderate risk (10−<20%)	50, 15.3 (11.4–19.2)	121, 37.0 (31.8–42.2)	127, 38.8 (33.5–44.1)
High risk (20−<30%)	8, 2.4 (0.7–4.1)	44, 13.5 (9.8–17.2)	63, 19.3 (15.0–23.6)
Very high risk (≥30%)	6, 1.8 (0.4–3.2)	18, 5.5 (3.0–8.0)	57, 17.4 (13.3–21.5)

CVD = Cardiovascular diseases; WHO = World Health Organization; ISH = International Society of Hypertension; FRS = Framingham Risk Score; CI = Confidence interval.

respondents at high risk, especially the very high risk were identified by the FRS compared to Globorisk (Table 3).

3.4. Concordance among the tools for identifying CVD risk

We found there were clear discrepancies in identifying the 10-year CVD risks by the tools. Approximately, one-third of the respondents were identified as at low risk by the WHO/ISH, whereas they were identified as at moderate risk by the Globorisk and FRS. Using the PABAK-OS statistics of inter-rater reliability tests, we found improved kappa coefficient values compared to Cohen's kappa coefficient values across all the tools. Based on the PABAK-OS, we found there was a fair level of agreement between WHO/ISH and Globorisk tools ($k = 0.37$, 95% CI 0.33–0.42), and Globorisk and FRS tools ($k = 0.34$, 95% CI 0.30–0.39) for identifying the CVD risk categories among the population, which was statistically significant ($P < 0.001$). Moreover, there was none to a slight level of agreement between WHO/ISH and FRS tools ($k = 0.09$, 95% CI 0.04–0.14), which was also statistically significant ($P = 0.001$), details in Table 4.

3.5. Associations of CVD risk categories with socio-demographic factors

It was observed that there were statistically significant proportional differences of CVD risk categories identified by the tools with different

Table 4. Degrees of agreements among WHO/ISH, Globorisk, and FRS tools for identifying CVD risk among diabetic subjects ($n = 327$).

CVD risk predictor tools			<10%	10−<20%	20−<30%	≥30%	Total	Cohen's κ (*P*-value)	γ (*P*-value)	τ_b (*P*-value)	PABAK-OS (95% CI) (*P*-value)
			Globorisk								
WHO/ISH	<10%	Count (%)	143 (43.7)	102 (31.2)	18 (5.5)	0 (0.0)	263 (80.4)				
		Expected count	115.8	97.3	35.4	14.5	263.0				
	10−<20%	Count (%)	1 (0.3)	18 (5.5)	20 (6.1)	11 (3.4)	50 (15.3)				
		Expected count	22.0	18.5	6.7	2.8	50.0				
	20−<30%	Count (%)	0 (0.0)	1 (0.3)	6 (1.8)	1 (0.3)	8 (2.4)	0.20 (<0.001)	0.93 (<0.001)	0.56 (<0.001)	0.37 (0.33–0.42) (<0.001)
		Expected count	3.5	3.0	1.1	0.4	8.0				
	≥30%	Count (%)	0 (0.0)	0 (0.0)	0 (0.0)	6 (1.8)	6 (1.8)				
		Expected count	2.6	2.2	0.8	0.8	6.0				
	Total	Count (%)	144 (44.0)	121 (37.0)	44 (13.5)	18 (5.5)	327 (100.0)				
		Expected count	144.0	121.0	44.0	18.0	327				
FRS	<10%	Count (%)	77 (23.5)	3 (0.9)	0 (0.0)	0 (0.0)	80 (24.5)				
		Expected count	35.2	29.6	10.8	4.4	80.0				
	10−<20%	Count (%)	62 (19.0)	62 (19.0)	3 (0.9)	0 (0.0)	127 (38.8)				
		Expected count	55.9	47.0	17.1	7.0	127.0				
	20−<30%	Count (%)	5 (1.5)	49 (15.0)	9 (2.8)	0 (0.0)	63 (19.3)	0.31 (<0.001)	0.95 (<0.001)	0.74 (<0.001)	0.34 (0.30–0.39) (<0.001)
		Expected count	27.5	23.3	8.5	3.5	63.0				
	≥30%	Count (%)	0 (0.0)	7 (2.1)	32 (9.8)	18 (5.5)	57 (17.4)				
		Expected count	25.1	21.1	7.7	3.1	57.0				
	Total	Count (%)	144 (44.0)	121 (37.0)	44 (13.5)	18 (5.5)	327 (100.0)				
		Expected count	144.0	121.0	44.0	18.0	327				
			FRS								
WHO/ISH	<10%	Count (%)	80 (24.5)	111 (33.9)	49 (15.0)	23 (7.0)	263 (80.4)				
		Expected count	64.3	102.1	50.7	45.8	263.0				
	10−<20%	Count (%)	0 (0.0)	16 (4.9)	12 (3.7)	22 (6.7)	50 (15.3)				
		Expected count	12.2	19.4	9.6	8.7	50.0				
	20−<30%	Count (%)	0 (0.0)	0 (0.0)	2 (0.6)	6 (1.8)	8 (2.4)	0.07 (0.001)	0.78 (<0.001)	0.42 (<0.001)	0.09 (0.04–0.14) (0.005)
		Expected count	2.0	3.1	1.5	1.4	8.0				
	≥30%	Count (%)	0 (0.0)	0 (0.0)	0 (0.0)	6 (1.8)	6 (1.8)				
		Expected count	1.5	2.3	1.2	1.0	6.0				
	Total	Count (%)	80 (24.5)	127 (38.8)	63 (19.3)	57 (17.4)	327 (100.0)				
		Expected count	80.0	127.0	63.0	57.0	327.0				

WHO = World Health Organization; ISH = International Society of Hypertension; FRS = Framingham Risk Score; CVD = Cardiovascular diseases; <10% = Low risk; 10-<20% = Moderate risk; 20-<30% = High risk; ≥30% = Very high risk; γ = Goodman-Kruskal Gamma; τ_b = Kendall's Tau-b; PABAK-OS = Prevalence adjusted and bias adjusted Kappa for ordinal scale; CI = Confidence interval.

Table 5. Associations of 10-year CVD risk categories (identified by WHO/ISH, Globorisk, and FRS tools) with the socio-demographic factors among diabetic subjects (n = 327).

Variables	WHO/ISH 10-year CVD risk categories			Globorisk 10-year CVD risk categories			FRS 10-year CVD risk categories		
	Low, % (95% CI)	Moderate, % (95% CI)	High and very high, % (95% CI)	Low, % (95% CI)	Moderate, % (95% CI)	High and very high, % (95% CI)	Low, % (95% CI)	Moderate, % (95% CI)	High and very high, % (95% CI)
Sex									
Men	77.2 (70.7–83.7)	18.5 (12.5–24.5)	4.3 (1.2–7.4)	25.3 (18.6–32.0)	41.4 (33.8–49.0)	33.3 (26.0–40.6)	11.1 (6.3–15.9)	31.5 (24.3–38.7)	57.4 (49.8–65.0)
Women	83.6 (78.0–89.2)	12.1 (7.1–17.1)	4.2 (1.1–7.3)	62.4 (55.0–69.8)	32.7 (25.5–39.9)	4.8 (1.5–8.1)	37.6 (30.2–45.0)	46.1 (38.5–53.7)	16.4 (10.8–22.0)
P-value		0.289			<0.001*			<0.001*	
Age (in years)									
40-44	97.3 (93.6–101.0)	2.7 (1.0–6.4)	0.0 (0)	92.0 (85.7–98.1)	8.0 (1.9–14.1)	0.0 (0)	65.3 (54.5–76.1)	28.0 (17.8–38.2)	6.7 (1.0–12.4)
45-49	97.8 (93.6–102.0)	0.0 (0)	2.2 (2.0–6.4)	84.8 (74.4–95.2)	10.9 (1.9–19.9)	4.3 (1.6–10.2)	32.6 (19.1–46.1)	54.3 (39.9–68.7)	13.0 (3.3–22.7)
50-54	97.4 (93.8–101.0)	1.3 (1.2–3.8)	1.3 (1.2–3.8)	46.1 (34.9–57.3)	51.3 (40.1–62.5)	2.6 (1.0–6.2)	17.1 (8.6–25.6)	55.3 (44.1–66.5)	27.6 (17.5–37.7)
55-60	54.6 (46.0–63.2)	36.2 (27.9–44.5)	9.2 (4.2–14.2)	0.8 (0.7–2.3)	54.6 (46.0–63.2)	44.6 (36.1–53.1)	2.3 (0.3–4.9)	30.0 (22.1–37.9)	67.7 (59.7–75.7)
P-value		<0.001*			0.873			<0.001*	
Level of education									
Illiterate	68.3 (54.1–82.5)	29.3 (15.4–43.2)	2.4 (2.3–7.1)	29.3 (15.4–43.2)	58.5 (43.4–73.6)	12.2 (2.2–22.2)	17.1 (5.6–28.6)	53.7 (38.4–69.0)	29.3 (15.4–43.2)
Up to primary	82.2 (75.6–88.8)	13.2 (15.9–30.5)	4.7 (1.0–8.4)	45.7 (37.1–54.3)	32.6 (24.5–40.7)	21.7 (14.6–28.8)	26.4 (18.8–34.0)	37.2 (28.9–45.5)	36.4 (28.1–44.7)
Up to SSC	79.7 (70.2–89.2)	15.9 (7.3–24.5)	4.3 (0.5–9.1)	47.8 (36.0–59.6)	33.3 (22.2–44.4)	18.8 (9.6–28.0)	31.9 (20.9–42.9)	30.4 (19.5–41.3)	37.7 (26.3–49.1)
HSC and above	84.1 (76.5–91.7)	11.4 (4.8–18.0)	4.5 (0.2–8.8)	45.5 (35.1–55.9)	36.4 (26.3–46.5)	18.2 (10.1–26.3)	19.3 (11.1–27.5)	40.9 (30.6–51.2)	39.8 (29.6–50.0)
P-value		0.301			0.125			0.222	
Occupation									
Employed	85.7 (77.1–94.3)	11.1 (3.3–18.9)	3.2 (1.1–7.5)	34.9 (23.1–46.7)	47.6 (35.3–59.9)	17.5 (8.1–26.9)	15.9 (6.9–24.9)	42.9 (30.7–55.1)	41.3 (29.1–53.4)
Business	81.2 (72.0–90.4)	14.5 (6.2–22.8)	4.3 (0.5–9.1)	33.3 (22.2–44.4)	36.2 (24.7–47.5)	30.4 (19.5–41.3)	18.8 (9.6–28.0)	27.5 (17.0–38.0)	53.6 (41.8–65.4)
Homemaker	82.0 (75.9–88.1)	13.3 (7.9–18.7)	4.7 (1.3–8.1)	61.3 (53.5–69.1)	33.3 (25.8–40.8)	5.3 (1.7–8.9)	36.0 (28.3–43.7)	47.3 (39.3–55.3)	16.7 (10.7–22.7)
Others	66.7 (52.9–80.5)	28.9 (15.7–42.1)	4.4 (1.6–10.4)	15.6 (5.0–26.2)	35.6 (21.6–49.6)	48.9 (34.3–63.5)	6.7 (0.6–14.0)	22.2 (10.1–34.3)	71.1 (57.9–84.3)
P-value		0.270			<0.001*			<0.001*	
Monthly income (in BDT)									
<30,000	81.5 (74.9–88.1)	14.1 (8.2–20.0)	4.4 (0.9–7.9)	54.1 (45.7–62.5)	33.3 (25.3–41.3)	12.6 (7.0–18.2)	32.6 (24.7–40.5)	43.0 (34.6–51.3)	24.4 (17.2–31.6)
≥30,000	79.7 (74.0–85.4)	16.1 (10.9–21.3)	4.2 (1.4–7.0)	37.0 (30.2–43.8)	39.6 (32.7–46.5)	23.4 (17.4–29.4)	18.8 (13.3–24.3)	35.9 (29.1–42.7)	45.3 (38.3–52.3)
P-value		0.873			0.004*			<0.001*	

P-values were obtained from Chi-square and Fisher's Exact tests where appropriate; Star (*) mark = Significant association; WHO = World Health Organization; ISH = International Society of Hypertension; FRS = Framingham Risk Score; CVD = Cardiovascular diseases; Low= <10%; Moderate = 10−<20%; High and very high = ≥20%; CI = Confidence interval; SSC = Secondary School Certificate; HSC = Higher Secondary School Certificate; BDT = Bangladeshi Taka (currency).

socio-demographic factors in bivariate analyses, and these varied from the tool-to-tool. The WHO/ISH risk categories were highly associated with age group ($P < 0.001$), unlike the Globorisk risk categories with sex ($P < 0.001$), occupation ($P < 0.001$), and monthly income ($P = 0.004$). And, the FRS risk categories were highly associated with all socio-demographic factors except the level of education (Table 5).

4. Discussion

4.1. The implication of the study

This current paper perhaps is the first reported research work in Bangladesh where the 10-year CVD risk was explored among T2DM subjects using different nonlaboratory-based CVD risk prediction tools and the concordances among these tools were also assessed. We found a noticeable proportion of our study subjects are at moderate to very high risk for developing CVD events in the next 10 years. However, a varying level of concordance was also observed among the different risk predicting tools.

4.2. Variations of the findings in different tools

We found, the proportions of the subjects at moderate risk identified by Globorisk and FRS were more than 2 times higher than that of identified by WHO/ISH. The high-risk proportion was nearly 6 times higher identified by Globorisk and 8 times higher identified by FRS, than that of identified by WHO/ISH. The very high-risk proportion was 3 times higher identified by Globorisk and 10 times higher identified by FRS, than that of identified by WHO/ISH tool. And, although the moderate risks were almost in similar proportion identified by Globorisk and FRS, higher proportions of the high risk (1.5 times higher) and very high risk (3 times higher) were identified by FRS than that of Globorisk tool.

4.3. Comparing findings with other studies

We found our study subjects with very less proportions at moderate, high and very high risks compared to the diabetic population of neighboring country India (29.9%, 13.2% and 12.2%, respectively) identified by the same WHO/ISH tool. This variation might be due to the population with higher mean age, higher prevalence of smokers, and higher SBP in the Indian study [13]. However, our study population was reported with higher proportions at moderate, high and very high risks (identified by WHO/ISH and FRS tools) compared to the Sri Lankan diabetic population identified by with cholesterol-based WHO/ISH tool (6.7%, 1.5–1.6% and 1.5–1.9% respectively), and also higher proportion at very high risk (8.8%) although moderate and high risks were almost similar identified by with cholesterol-based FRS tool. This variation might be due to the difference in with and without cholesterol-based tools, disproportionate sex ratio, and lower SBP in Sri Lankan study population [11, 12]. We found our study population with a higher proportion at moderate risk, but lower proportions at high and very high risks (identified by WHO/ISH and FRS tools) compared to the Omani diabetic population identified by both with cholesterol-based WHO/ISH (8%, 12% and 22% respectively) and FRS (32%, 20% and 24% respectively) tools. The higher proportions of high and very high risks in Omani population might be due to the difference in with and without cholesterol-based tools, the higher age and higher SBP among them [9]. Similar proportions of all risk categories (identified by WHO/ISH) have been reported in our study compared to the Qatari diabetic population identified by with cholesterol-based WHO/ISH tool. However, there was a higher proportion of moderate risk but lower proportions of high and very high risks (identified by FRS) in our study compared to the Qataris identified by cholesterol-based FRS (30.2%, 24.1% and 33.5% respectively) tool. This variation might be due to the difference in with and without cholesterol-based tools and higher age among the Qataris [10]. Furthermore, we found similar to higher proportions of our study subjects at moderate to very high risks compared to other national studies among urban, rural, and also postmenopausal women identified by WHO/ISH (with and without cholesterol) and FRS tools [6, 7, 30].

4.4. Extent of the concordance

In terms of the extent of concordance (level of agreement) among the CVD risk predicting tools for identifying the categories of risks based on the PABAK-OS statistics, we found there was a fair level of agreement between WHO/ISH and Globorisk tools, as well as Globorisk and FRS tools. However, when the tools were WHO/ISH and FRS, there was none to a slight level of agreement between these. We assume that the possible reasons for not showing the higher level of concordance among the tools might be due to not using the uniform variables to estimate the risks. There were distinctive variable(s) in particular risk prediction tool(s) which were uncommon in other(s). The development of a tool like FRS based on-as well as its applicability among-the particular racial populations might also be a potential issue in this regard.

4.5. Limitations and strengths

Along with other epidemiological studies, our study also isn't an exception in terms of limitations. Such as, the nonrandomized respondents from purposively selected only two study settings do not represent the generalizability of the whole diabetic population of the country. We had to use the without cholesterol-based tools, whereas the cholesterol measurements were not available for the respondents as the study was a self-funded student work and conducted in low-resourced settings. The use of without cholesterol-based tools might underestimate the CVD risks. FRS might underestimate or overestimate CVD risk among Bangladeshis as a non-US population. Again, the office-based Globorisk tool might also underestimate the CVD risk among diabetic population. Moreover, as this study was carried in the hospital settings, there might be a probable chance for the enrolment of patients with higher complexity of the disease a bit leading to capturing and reflecting a higher CVD risk unlike the given context in population-based or primary care service-based settings. Yet, it has to be taken into consideration that when there is a traceable higher complexity of the disease, the patients from peripheral centers (like our study centers) are usually referred to the central tertiary care 'BIRDEM General Hospital' situated in Dhaka, complying with the referral system of BADAS.

However, our study firstly reports the CVD risk among T2DM subjects in Bangladesh and the concordance among the used risk prediction tools. The findings of this paper will help the policymakers to insight the importance of designing the CVD risk assessment and primary care management guidelines for diabetic subjects in Bangladesh, guiding the clinicians to choose therapeutic and preventive strategies and also the subjects to adopt a healthy lifestyle. Subsequently, the ultimate and combined doctors-patients measures will help to reduce the future CVD burden in this country.

5. Conclusions

A significant proportion of the selected study subjects in Bangladesh is at moderate to very high risk of developing CVDs. Higher proportions of subjects with these risks were predicted especially by FRS and Globorisk tools compared to WHO/ISH, indicating low concordance among these tools. FRS tool appears to be the most useful for CVD risk assessment in T2DM subjects in Bangladesh as it could identify the highest number of subjects at high to very high risk. Concurrent with and without cholesterol-based further large-scale studies can answer the question more clearly.

Declarations

Author contribution statement

Rajib Mondal: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Rani Baroi Ritu: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Palash Chandra Banik: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

We thank all participants of the study. We would also like to acknowledge especially to Prof. Liaquat Ali, Ex-Vice Chancellor, Bangladesh University of Health Sciences (BUHS), Prof. Saidur Rahman Mashreky, Department of Noncommunicable Diseases (BUHS), Dr. Mithila Faruque, Asst. Prof. and Head, Department of Noncommunicable Diseases (BUHS), and the authorities of Alhaz Asmat Ali Khan Diabetic Hospital and Dinajpur Diabetic Hospital who helped for the implementation of the main study.

References

[1] T.R. Einarson, A. Acs, C. Ludwig, et al., Prevalence of cardiovascular disease in type 2 diabetes: a systematic literature review of scientific evidence from across the world in 2007–2017, Cardiovasc. Diabetol. 17 (1) (2018) 83.

[2] American Heart Association, Cardiovascular disease and diabetes, Available from, https://www.heart.org/en/health-topics/diabetes/why-diabetes-matters/cardiovascular-disease–diabetes. (Accessed 15 May 2020).

[3] GBD Collaborators, Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017, Lancet 392 (10159) (2018) 1736–1788.

[4] World Health Organization, Cardiovascular diseases, Available from, https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds). (Accessed 15 May 2020).

[5] P. Ueda, M. Woodward, Y. Lu, et al., Laboratory-based and office-based risk scores and charts to predict 10-year risk of cardiovascular disease in 182 countries: a pooled analysis of prospective cohorts and health surveys, Lancet Diabet. Endocrinol. 5 (3) (2017) 196–213.

[6] K. Fatema, N.A. Zwar, A.H. Milton, et al., Application of two versions of the WHO/international society of hypertension absolute cardiovascular risk assessment tools in a rural Bangladeshi population, BMJ Open 5 (2015), e008140.

[7] M.M. Monower, M.S. Flora, A. Akhter, et al., Framingham risk assessment of coronary heart diseases in selected area of Dhaka city: a cross-sectional study, NHFB 7 (2018) 12–17.

[8] M.C. Bertoluci, V.Z. Rocha, Cardiovascular risk assessment in patients with diabetes, Diabetol. Metab. Syndrome 9 (2017) 25.

[9] J.A. Al-Lawati, M.N. Barakat, N.A. Al-Lawati, et al., Cardiovascular risk assessment in diabetes mellitus: comparison of the general Framingham risk profile versus the World Health Organization/International Society of Hypertension risk prediction charts in Arabs-clinical implications, Angiology 64 (5) (2013) 336–342.

[10] A. Al-yafei, S.O. Osman, N. Selim, et al., Assessment of cardiovascular disease risk among Qatari patients with type 2 diabetes mellitus, attending primary health care centers, 2014, Open Diabetes J. (10) (2020) 1–10.

[11] H.M.M. Herath, T.P. Weerarathna, R.B.A.T. Dulanjalee, et al., Association of risk estimates of three different cardiovascular risk assessment tools with carotid intima media thickness in patients with type 2 diabetes, J. Clin. Diagn. Res. 10 (7) (2016) OC09–OC12.

[12] H.M.M. Herath, T.P. Weerarathna, D. Umesha, Cardiovascular risk assessment in type 2 diabetes mellitus: comparison of the World Health Organization/International Society of Hypertension risk prediction charts versus UK Prospective Diabetes Study risk engine, Vasc. Health Risk Manag. 11 (2015) 583–589.

[13] R. Valaulikar, P.S. Balu, R.A. Bhat, Assessment of 10-year risk of developing a major cardiovascular event in type-2 diabetes patients attending a hospital in Davangere, Karnataka, Natl. J. Community Med. 8 (4) (2017) 193–197.

[14] S. Akter, M.M. Rahman, S.K. Abe, et al., Prevalence of diabetes and prediabetes and their risk factors among Bangladeshi adults: a nationwide survey, Bull. World Health Organ. 92 (3) (2014) 204–213, 213A.

[15] K.G.M. Moons, A.P. Kengne, D.E. Grobbee, et al., Risk prediction models: II. External validation, model updating, and impact assessment, Heart 98 (2012) 691–698.

[16] R. Mondal, Association of Degree of Salinity in Groundwater with Chronic Kidney Disease Among Diabetic Population in Bangladesh, MPH thesis, Bangladesh University of Health Sciences, Dhaka, Bangladesh, 2017. Unpublished work.

[17] Framingham heart study, Available from, https://framinghamheartstudy.org/fhs-risk-functions/cardiovascular-disease-10-year-risk/. (Accessed 13 May 2020).

[18] World Health organization, World Health organization/International Society of Hypertension (WH0/ISH) risk prediction charts for 14 WHO epidemiological sub-regions (charts in colour), Available from, https://www.who.int/ncds/management/WHO_ISH_Risk_Prediction_Charts.pdf?ua=1. (Accessed 10 May 2020).

[19] Globorisk, Available from, http://www.globorisk.org/. (Accessed 11 May 2020).

[20] World Health Organization, Prevention of Cardiovascular Disease: Guidelines for Assessment and Management of Cardiovascular Risk, World Health Organization, Geneva, 2007.

[21] L. Cyr, K. Francis, Measures of clinical agreement for nominal and categorical data: the kappa coefficient, Comput. Biol. Med. 22 (4) (1992) 239–246.

[22] M. McHugh, Inter-rater reliability: the kappa statistic, Biochem. Med. 22 (3) (2012) 276–282.

[23] I. Nurjannah, S.M. Siwi, Guidelines for analysis on measuring interrater reliability of nursing outcome classification, Int. J. Res. Med. Sci. 5 (4) (2017) 1169–1175.

[24] R. Parker, K. Vannest, J. Davis, Inter-rater Reliability for Multi-Category Scales: Problems and a Solution in PABAK-OS, 2011. Unpublished work.

[25] J. Sim, C.C. Wright, The kappa statistic in reliability studies: use, interpretation, and sample size requirements, Phys. Ther. 85 (3) (2005) 257–268.

[26] A.J. Bishara, J.B. Hittner, Reducing bias and error in the correlation coefficient due to nonnormality, Educ. Psychol. Meas. 75 (5) (2015) 785–804.

[27] A. Göktaş, Ö. Işçi, A comparison of the most commonly used measures of association for doubly ordered square contingency tables via simulation, Metodološki zvezki 8 (1) (2011) 17–37.

[28] K.J. Vannest, R.I. Parker, O. Gonen, et al., Single Case Research: Web Based Calculators for SCR Analysis. (Version 2.0), Texas A&M University, College Station, TX, 2016 [Web-based application] Available from, www.singlecaseresearch.org. (Accessed 11 May 2020).

[29] J.R. Landis, G.G. Koch, The measurement of observer agreement for categorical data, Biometrics 33 (1977) 159–174.

[30] L. Barua, M. Faruque, P.C. Banik, et al., Concordance between two versions of world health organization/international society of hypertension risk prediction chart and framingham risk score among postmenopausal women in a rural area of Bangladesh, Indian J. Publ. Health 63 (2) (2019) 101–106.