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Assessment of Cardiovascular Disease Risk among Qatari Patients with Type 2 Diabetes Mellitus, Attending Primary Health Care Centers, 2014

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Abstract:

Background:

The accumulated knowledge on the development of cardiovascular disease in diabetic patients due to clustering and synergistic interaction of multiple risk factors leads to the establishment of cardiovascular disease 10-year risk prediction tools. The management of patients based on their total risk prediction is an effective way to reduce disease burden. The behavior of such tools varies based on population and their risk profile.

Objective:

To estimate the total 10-year cardiovascular disease risk using General Framingham Risk Prediction Score and World Health Organization /International Society for Hypertension (WHO/ISH) Risk Prediction Chart on Qatari diabetic patients.

Methods:

Cross-sectional design was used. A total of 532 Qatari diabetic patients attending primary healthcare were enrolled. Data were collected using an interview administered questionnaire, anthropometric & blood pressure measurement, and medical records. The total 10-year cardiovascular disease risk was assessed using the WHO/ISH risk prediction chart and Framingham score.

Results:

The former categorized (81.6%) of participants as low risk and only (3.8%) as in high and very high risk. While the later categorized (12.2%) of participants as low risk and (57.6%) as in high and very high risk. No agreement between both tools in assessment of cardiovascular disease risk (κ = - 0.019, *p*-value = 0.216). All risk factors used by both tools illustrated a statistically significant relation with risk categories, except 'anti-hypertensive medications intake' in the Framingham score.

Conclusion:

Encouraging assessment of patients based on total risk rather than single risk factor and further study of total risk prediction can help to establish a national tool for Qatar.

Keywords: Cardiovascular disease, 10-Year risk prediction tools, General framingham risk prediction score, Type 2 diabetes mellitus, WHO/ISH, Qatar.

1. INTRODUCTION

Patients with Type 2 Diabetes Mellitus (DM) are at 2 to 4 folds increased risk of developing Cardiovascular Disease (CVD) compared with matched sex and age patients without

type 2 DM [1, 2]. Furthermore, CVD accounts for (80%) of all deaths in diabetic patients.

Both type 2 DM and CVD are growing epidemic of huge global concern as their magnitude is substantially increasing and will continue in the future, as far as population`s age increases and exposure to the related risk factors continues [3].

In Qatar, the leading cause of mortality in adults over the

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last decade was CVD. This mortality is owing to the prevalent risk factors associated with a tremendous change in lifestyle. Based on the current data, about two-thirds of Qatari adult populations live with three or more risk factors related to CVD. Besides, the prevalence of type 2 DM is about (17%), which is among the highest prevalence in the world [4].

The synergistic and multiplicative interactions between different risk factors of CVD in type 2 diabetic patients were well described. This knowledge led to the development of multivariable risk prediction tools incorporating these risk factors, which have been simplified for use in the Primary Health Care (PHC) setting [5, 6]. Such prediction tools define the risk factors as well as identify high-risk individuals, evaluate potential targets of therapy, and enhance cost-effective implementation of treatment. Many risk prediction tools for assessing the CVD risk have been described. The joint WHO/International Society of Hypertension (WHO/ISH) risk prediction charts and The General Framingham Risk Profile (GFRP) score for primary care are among the common tools used to assess 10-years total CVD risk. They use different age categories and risk factor profiles [7 - 9]. In Qatar, there are marked efforts at the level of PHC to reduce the burden of type 2 DM and subsequent CVD. Recently, there is an integration of Non-Communicable Disease (NCD) clinics that are responsible for both the preventive and some curative aspects of CVD as well as the management of other NCDs. However, attention needs to be toward identifying the high-risk groups as a total risk rather than the management of a single risk factor. Early prediction of the risk will subsequently reduce CVD burden in the long term. It is best of available knowledge that this is the first study to categorize CVD risk among Qatari patients with Type 2 DM using two known distinct prediction models at the PHC level.

2. AIMS AND OBJECTIVE

Estimating the CVD risk among Qatari patients with Type 2 DM will assist in the development of evidence-based recommendations. That assists clinicians in early identification of risk and deciding for primary prevention of CVD, subsequently reducing the burden of CVD and contributing to improving quality of service provision as well as the quality of life to Qatari patients with type 2 DM. The current cross-sectional study objectives were; 1. To estimate the total 10-year CVD risk among Qatari patients with type 2 DM attending PHC centers 2014 using WHO/ISH CVD risk prediction chart and GFRP score. 2. To compare total 10-year CVD risk among Qatari patients with type 2 DM between WHO/ISH CVD risk prediction chart and GFRP score.

3. METHODS

3.1. Study Settings and Design

The study was carried out as a cross-sectional study and conducted in NCD clinics as well as general walk-in clinics at the PHC centers in Qatar during 2014. There were 21 PHC centers under the Primary Health Care Corporation (PHCC), where each health center has its own well defined geographic and population catchment area. They are the first line of contact with the community, and through them, all-compreh-

ensive PHC programs are implemented.

3.2. Study Population

Qatari type 2 DM patients attended the selected PHC centers during the data collection period from July to November 2014 and meeting the eligibility criteria. Inclusion criteria were; male & female Qatari patients with type 2 DM and age 40-74 years. The selection of this age range was on our knowledge about the specific age used with each tool. While exclusion criteria were, patients developed any CVD event before the start of the study and patients who refused to participate.

3.3. Sample Size and Sampling Technique

Sample size was calculated by the following equation [8]:

$$n = Z2 \times P (1-P) / e2.$$

Where; n= required sample size and Z= the probability value associated with the confidence level, which equals to 1.96.

The P= the prevalence of CVD risk, which is 0.26 based on a study carried out in Oman in (2010) at PHC level [9]; e = desired margin of error set to be 0.05, the significance level set at < 0.05 and confidence level of 95%. Calculation came out to be 532 patients after inflated by 20% for compensation of non-response and design effect of 1.5, and the study period con-tinued until the calculated sample was completed. A simple cluster technique with a proportionate allocation of the calcu-lated sample size used. Where a list of these health centers was obtained from the authorized person at PHCC, including locality and registered Qatari patients with type 2 DM in NCD clinics during the previous year. Simple random sampling was conducted to select six health centers out of the 21. A cluster sampling technique conducted in which the primary health centers considered clusters or primary sampling units. Within each selected health center, all eligible patients were included in the study. The estimated sample size was distributed proportionately among the six randomly selected health centers according to the size of registered Qatari patients with type 2 DM in NCD clinics within each of these centers.

3.4. Research Instruments

Arabic version interview administered questionnaire was developed by the researcher and involving three sections; Socio-demographic characteristics of; age, gender, education level, marital status, and occupation. Personal medical history of; duration of diabetes, presence of hypertension, and history of taking antihypertensive medications. Cardiovascular disease includes; coronary heart disease, cerebrovascular disease, peripheral arterial disease, and heart failure [10]. Content and face validity of the questionnaire was ensured. The researcher developed it by using a literature review and consultation of experts in fields of community medicine, epidemiology, diabetology, and cardiovascular disease specialists.

In addition to the questionnaire, blood pressure as well as anthropometric measurements to calculate Body Mass Index (BMI). Data extraction sheet utilizing the medical records to acquire information about recent HbA_1C % and total serum cholesterol level.

The WHO/ISH CVD risk prediction chart and the GFRP score to determine and calculate 10-years total CVD risk. The World Health Organization defined the "Total CVD risk" as a probability of subjects experiencing a CVD event over a given period and determined by the combined effect of CVD risk factors, which commonly coexist and act multiplicatively. The WHO/ISH CVD risk prediction chart for Eastern Mediterranean Sub-region B, where Qatar belongs, was used. The CVD risk determined by the color-coded hard copy chart for all eligible patients. Once data about the following risk factors were available; smoking or non-smoking, gender, age, systolic blood pressure in (mmHg), and total blood cholesterol in mmol/l. The chart indicates the CVD risk by a percentage, which is also represented by colors. Simultaneously, the CVD risk was calculated by using the electronic GFRP score, which is an Excel® sheet-based calculator. The researcher entered the following risk factors for all eligible patients; sex, age in years, systolic blood pressure in (mmHg), either on antihypertensive or not, smoking or non-smoking, and BMI. The calculator gave the probability as a percentage automatically.

The researcher was responsible for determining and calculating CVD risk by both tools for all eligible patients. After determining and calculating CVD risk by using the two tools, patients categorized into four categories based on the management recommendations [7]:

- Low risk (<10%): Patients in this category were at low risk, and low risk does not mean "no" risk.
- Moderate risk (10% to <20%): Patients in this category were at moderate risk of fatal or nonfatal cardiovascular events.
- High risk (20% to <30%): Patients in this category were at high risk of fatal or nonfatal cardiovascular events and risked lowering medications recommended.
- Very high risk (≥30%): Patients in this category were at a very high risk of fatal or nonfatal cardiovascular events and risked lowering medications recommended.

3.5. Research Approach

After obtaining the administrative and ethical required Institutional Review Board (IRB) approvals. Arabic speaking nurses were assigned to assist in data collection. The researcher explained to assigned nurses the aim of the study, data collection process, and answered their inquiries. Inside the selected health centers, eligible patients were invited to participate voluntarily after a detailed explanation of the study`s aim, future benefits, and process of data collection. All eligible patients were asked to sign informed consent, which was approved by the IRB committee.

The researcher and assigned nurses interviewed patients before their visit to the treating physician in a vital signs assessment room, where also vital signs, including blood pressure and anthropometric measurements, were measured. Standardized methods for measurements were used, including blood pressure, weight, and height, as recommended by PHCC guidelines. Electronic medical records were accessed to record HbA_1C % and total serum cholesterol level for every patient. All accomplished questionnaires were reviewed to ensure completeness and consistency. The CVD risk for each patient was communicated to both the treating physician for further management and patients for awareness. Patients' confidentiality and privacy were assured through the study.

3.6. Data Management

The researcher entered all collected data from completed questionnaires into an-Excel® sheet daily, and later all data were exported to a "Statistical Package of Social Science" version 20.0 (SPSS®) software database for analysis [11]. Different questions included in the interview questionnaires were coded and entered regularly.

The following analysis was done; descriptive statistics: frequency tables, proportions, figures such as bar, mean, and standard deviation were used as appropriate. Also, analytic statistics, including; *Chi*-square test, was used to assess differences between two or more categorical variables of the different risk factors and CVD risk in both tools. Kappa (κ) level of agreement was used to assess the degree of agreement between the WHO/ISH risk prediction chart and the GFRP score. An alpha (p) value of ≤ 0.05 was used as the cut-off level of significance.

4. RESULTS

Five hundred thirty-two (532) Qatari patients with type 2 DM met the eligibility criteria and approached to participate in the study voluntarily during the period from the first of July till the end of November 2014.

4.1. Background Characteristics of the Study Participants

The most common age group was (50- 49) years with (40.6%), with a mean age of (56.06 ± 8.16 Standard Deviation (SD)). Almost two-thirds of them were females (66.7%). Elementary school was the most frequent educational level encountered among the patients (34.0%). The vast majority of patients were married (86.5%), and being a housewife was found to be in more than half of the total sample (54.0%). A *Chi*-square test was carried out to assess the statistically significant relationship between socio-demographic factors and each CVD risk tool. The following variables were statistically significant in both tools; age, gender, occupation. The marital status was statistically significant in only the GFRP score. While the education level has no statistical significance with CVD risk in both tools, as shown in Table **1**.

4.2. Medical Characteristics of the Study Participants

Regarding the medical characteristics of the studied patients, it was found the following; after applying the standard methodology for blood pressure measurement, (21.4%) had systolic hypertension. According to Clinical Guidelines for Management of Hypertension in the Eastern Mediterranean Region Office (EMRO), Systolic blood pressure of ≥140 mmHg was considered as systolic hypertension [12]. Furthermore, smokers were only (4.1%) of the participants. Participants were divided into five groups based on five years duration of type 2 DM occurrence. Almost (29%) of the participants had type 2 DM between 5 years and less than ten years. Around (98.7%) of them used antihypertensive

medications. By using the WHO definition of Body Mass Index (BMI), only (6%) of patients were found to be within the normal range, one fourth were in the overweight and as high as (69%) of patients were obese [13]. Type 2 DM glycemic control is determined by the HbA₁C (%) level, which measures it over the past three months. The target was to keep the level ≤ 7.0% as per PHC guidelines [14]. More than two thirds (65%) of the participants were uncontrolled (HbA₁C level > 7.0%). Total, serum cholesterol was measured and classified as desirable, borderline, and high according to the PHCC clinical guidelines [15]. Around (82.0%) of the participants were within the normal range, as in Table **2** .

4.3. Analytic Statistics

Chi-square test was used to assess the relationship between different categorical risk factors and CVD risk in the WHO /ISH chart and GFRP score. Where the following variables, the presence of hypertension from history, current tobacco use, duration of type 2 DM, BMI, and systolic hypertension by measurements, where 140 mmHg was the cut off value, were statistically significant in both tools. On the other hand, serum cholesterol was statistically significant in only the WHO/ISH chart, while HbA₁C (%) showed no statistical significance in both models.

Further analysis was conducted to determine the CVD risk percentage by both tools among participants. Where all the risk factor profile for each patient was bulged in each tool to determine the CVD risk category. Then the distribution of each

CVD risk was compared as a percentage. The WHO/ISH CVD risk prediction chart categorized (81.6%) of the studied patients as being of low risk (*i.e.*, the 10-years total CVD Risk is estimated to be less than 10%), while those estimated to be in low risk were only (12.2%) of the studied sample by the GFRP score. In contrast, patients classified to be in a very high risk (≥ 30%) were seen more frequently using the GFRP score, *i.e.*, 178 cases representing (33.5%) of the study sample compared to 3 patients (0.6%) of the study sample using the WHO/ISH CVD risk prediction chart. Those patients classified as moderate and high risk (10% to <20% and 20% to <30%) constitute most of the sample (54.4%) by GFRP score, compared to only (17.8%) using WHO/ISH CVD risk pre-diction chart. Comparison between the total 10-year CVD risk using the two tools; the difference was statistically significant (χ^2 = 149.18, *p*-value = 0.000). The total 10-year CVD risk estimation by the two tools is illustrated in, as shown in Fig. (**1**).

Additional statistical assessment was calculated using Cohen's Kappa test (κ), which measures quantitatively the ma-gnitude of over-all level of agreement or matching between dif-ferent CVD risk categories as predicted by the two tools [16].

Landis and Koch characterized values (< 0) as indicating no agreement, values (0 - 0.20) as slight agreement, (0.21 - 0.40) as fair, (0.41 - 0.60) as moderate, (0.61 - 0.80) as subs-tantial, and (0.81 − 1) as almost perfect agreement [16]. The current study showed that there was no agreement (κ = - 0.019, *p*-value 0.216) between the two tools, as seen in Table **3**.

Table 1. Distribution of the Socio-demographic characteristics of qatari patients with type 2 dm, primary health care centers, 2014. (N = 532).

WHO/ISH Chart		GFRP score		Frequency (%)	Variable
P-value	χ^2	*P*-value	χ^2	-	-
<0.000*	407.5	<0.000*	312.3	Age	
-				128 (24.0)	40 - 49
				216 (40.6)	50 - 59
				158 (29.7)	60 - 69
				30 (5.7)	≥ 70
0.034*	8.7	<0.000*	121.9	Gender	
-				177 (33.3)	Male
				355 (66.7)	Female
0.061	272	0.055	16.6	Educational Level	
-				169 (31.8)	Illiterate
				181 (34.0)	Elementary School
				85 (16.0)	Secondary school
				97 (18.2)	University and above
0.879	2.4	0.016*	15.600	Marital Status	
-				17 (3.2)	Single
				460 (86.5)	Married
				55 (10.3)	Divorced or Widowed
<0.000*	35.1	<0.000*	78.657	Occupation	
-				287 (54.0)	Housewife
				121 (22.7)	Retired
				117 (22.0)	Professional / Clerk / Admin
				7 (1.3)	Others

Table 2. The medical characteristics of the studied qatari patients with type 2 dm, primary health care centers, 2014. (N = 532).

Variable	Frequency (%)	GFRP score		WHO/ISH Chart	
		χ^2	*P*-value	X^2	*P*-value
Systolic Hypertension (mmHg)	114 (21.4)	140.1	<0.000*	107.2	<0.000*
Current Smoker	22 (4.1)	24.9	<0.000*	14.8	0.002*
Duration of Type 2 DM (years)	-	28.3	0.005*	28.6	0.004*
<5 5- <10 10- <15 15- <20 ≥20	81 (15.2) 154 (28.9) 145 (27.3) 76 (14.3) 76 (14.3)	-	-	-	-
Taking antihypertensive medication (n=387)	382 (98.7)	3.195	0.363	0.263	0.967
BMI (Kg/m²)	-	13.0	0.043*	25.1	<0.000*
Normal Overweight Obese	32 (6) 133 (25) 367 (69)	-	-	-	-
Glycemic Control (**HbA₁C (%)** > 7.0%)	346 (65)	0.8	0.861	0.281	0.964
Serum Cholesterol (mmol/L)	-	5.4	0.497	19.6	0.003*
Desirable Borderline High	436 (82.0) 76 (14.2) 20 (3.8)	-	-	-	-

There was a trend in the CVD risk prediction for both tools; older the age, the more the risk. Where in the GFRP score, it was found that the younger the age, the lower is the CVD risk, as most of patients belonging to the youngest age group (40- 49y), were calculated as being in a mild to moderate risk, while most of those (≥ 70) years were within the very high-risk category, and the relationship was statistically significant (χ^2 = 312.273, *p*=0.000). Similarly, the WHO/ISH CVD risk prediction chart showed that all of those belong to youngest age group were in the low-risk category, while the oldest age group were either moderate, high or very high risk and the relation was also statistically significant (χ^2 = 407.5, *p* = 0.000) as seen in Table **4**.

The WHO/ISH CVD risk prediction chart categorized almost three quarters (75.1%) of the male patients compared to most of the female patients (84.8%) as low risk while it classified only (1.1%) of male patients compared to (0.2%) of females as the very high-risk category. On the other hand, the GFRP score classified (2.3%) of male patients in comparison to (17.2%) of female patients as low risk. Whereas, it categorized more than two thirds (64.4%) of the male patients compared to (18%) of female patients as very high risk, as seen in Fig. (**2**). The relation between gender and the CVD risk prediction using the GFRP score was statistically significant (χ^2 = 121.952, *p* = 0.000). Similarly, the WHO/ISH CVD risk prediction chart showed a difference in risk by gender that was also statistically significant (χ^2 = 8.687, *p*= 0.034) as shown in Fig. (**2**).

5. DISCUSSION

In the current study; despite of known highly prevalent CVD risk factors among Qatari patients with type 2 DM, the WHO/ISH CVD risk prediction chart showed that the majority of patients (81.6%) were drawn together in the 'low risk' category, while less than (4%) were grouped collectively in the 'high' and the 'very high' risk categories. Unlike the picture seen by using the GFRP score, where only (12.2%) of patients were calculated to be at the 'low risk' category, and more than half of them (57.6%) were in the 'high' and 'very high' risk categories. Such a contradiction between the two tools was confirmed on analysis, and the difference was statistically significant using the chi-square test (χ^2 = 149.18, *p*-value = 0.000). Furthermore, when using Cohen's Kappa test, it yielded (κ = - 0.019, *p*-value = 0.216), and "no agreement" was what the analysis concluded, being less than zero. Quite similar behavior of the two tools was reported in Malaysia by Selvarajah and his colleagues in (2013), they applied the two tools over a five-year cohort study among the general population, out of which (17.1%) were with type 2 DM. Most of their patients (89%) were categorized as 'low risk' using the WHO/ISH CVD risk prediction chart, and (48%) by the GFRP Score (which was higher than found in the current study). Furthermore, WHO/ISH risk prediction chart only recognized (3%) of their patients in the 'high' and 'very high' risk categories, compared to less than one fourth (23%) by GFRP score [17].

The trend of the WHO/ISH risk prediction chart to categorize the majority of patients as being 'low risk' was also noticeable in a study carried out by Tulloch-Reid and his colleagues in Jamaica during (2007-2008). Where; CVD risk was assessed by using data from the "Jamaica health and lifestyle survey" among the general population, in which type 2 DM prevalence was around (16%). The 'low risk' category was in (89.6%) of the sample, and only (2.4%) were at a 'very high' risk category [18].

Similar results were also seen in a multi-nation study conducted in (Nigeria, Iran, China, Pakistan, Georgia, Nepal, Cuba, and Sri Lanka) among their general population in (2011). Where; a large fraction (90.0 - 98.9%) of the study participants were categorized in the 'low risk' and 'moderate risk' categories, while only (0.2 - 4.8%) were in the 'high-risk' categories [19].
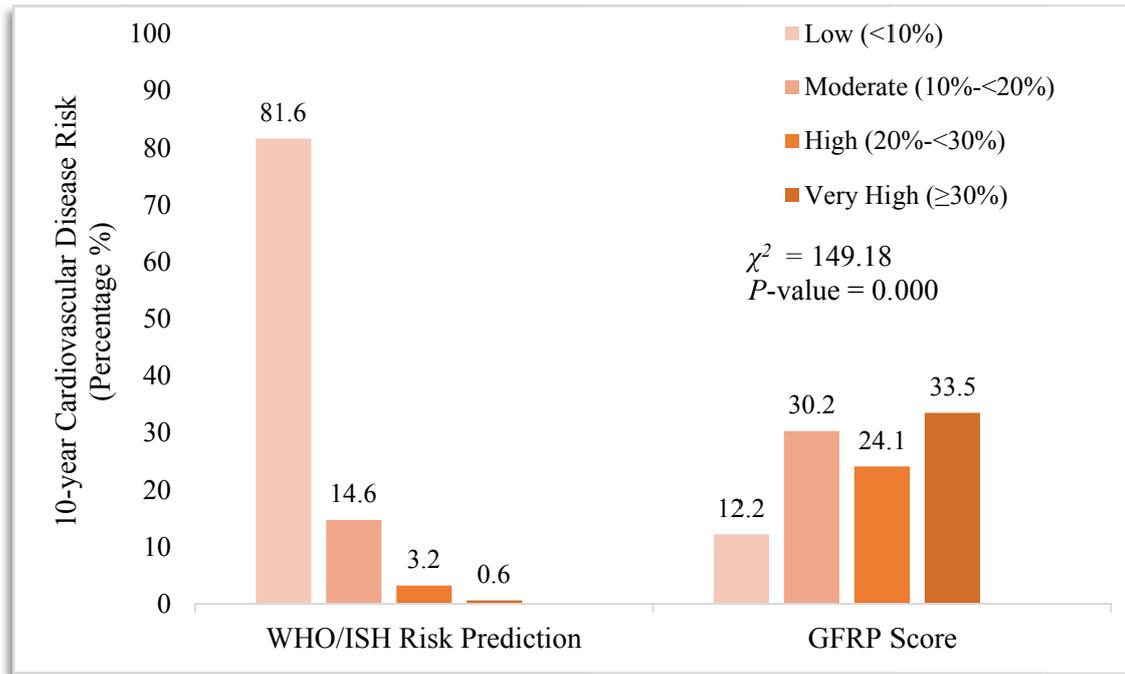
Fig. (1). Comparison of the total 10-year cardiovascular disease risk estimation using the WHO/ISH CVD risk prediction chart and the GFRP score among Qatari patients with type 2 diabetes, Primary Health Care Centers, 2014. (N = 532).
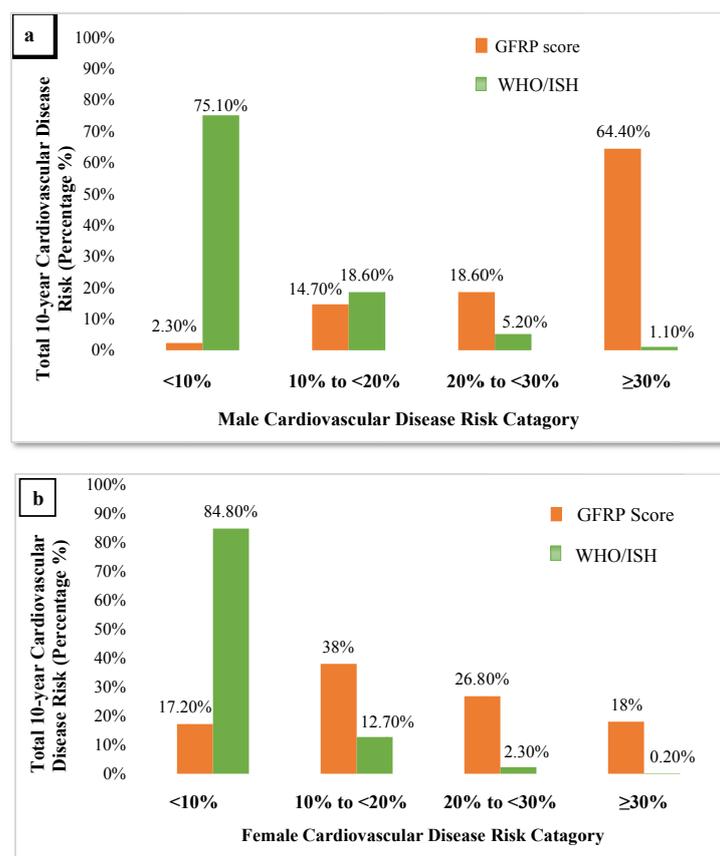
Fig. (2). Comparison of the total 10-years cardiovascular disease risk between the WHO/ISH CVD risk prediction chart and the GFRP score among male and female Qatari patients with type 2 diabetes; (**a**) for males and (**b**) for females, Primary Health Care Centers, 2014. (Males n = 177, Females n = 355).

Table 3. Distribution of 10-years total cardiovascular disease risk among qatari patients with type 2 diabetes by the WHO/ISH chart and the GFRP score, primary health care centers, 2014. (N = 532).

-	GFRP Score CVD Risk (%)				-		
WHO/ISH CVD Risk (%)	<10%	10%- < 20%	20%- < 30%	≥ 30%	Total	κ Kappa	p value
<10%	64	157	119	94	434 (81.6%)	-0.019	
10%- < 20%	1	4	7	66	78 (14.7%)		
20%- < 30%			2	15	17 (3.2%)		0.216
≥ 30%				3	3 (0.6%)		
Total	65 (12.2%)	161 (30.3%)	128 (24.1%)	178 (33.5%)	532 (100%)		

Table 4. Distribution of the total 10-year cardiovascular disease risk using the who/ish cvd risk prediction chart and the gfrp score among qatari patients with type 2 diabetes in relation to the age, primary health care centers, 2014. (N = 532).

WHO/ISH Chart					
Age	CVD Risk <10%	CVD Risk 10% to < 20%	CVD Risk 20% to < 30%	CVD Risk ≥ 30%	Total
40 – 49	128 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	128
50 – 59	212 (98.1%)	4 (1.9%)	0 (0.0%)	0 (0.0%)	216
60 – 69	94 (59.5%)	61 (38.6%)	3 (1.9%)	0 (0.0%)	158
> 70	0 (0.0%)	13 (43.3%)	14 (46.7%)	3 (10.0%)	30
Total	434 (81.6%)	78 (14.6%)	17 (3.2%)	3 (0.6%)	532 (100%)
GFRP Score					
Age	CVD Risk <10%	CVD Risk 10% to < 20%	CVD Risk 20% to < 30%	CVD Risk ≥ 30%	Total
40 – 49	51 (39.8%)	60 (46.9%)	12 (9.4%)	5 (3.9%)	128
50 – 59	13 (6.0%)	86 (39.8%)	75 (34.7%)	42 (19.5%)	216
60 – 69	1 (1.5%)	15 (9.5%)	40 (25.3%)	102 (64.7%)	158
> 70	0 (0.0%)	0 (0.0%)	1 (3.3%)	29 (96.7%)	30
Total	65 (12.2%)	161 (30.2%)	128 (24.1%)	178 (33.5%)	532 (100%)

The noted tendency of WHO/ISH risk prediction chart to categorize patients toward the 'low risk' category in the current study, as well as in other studies, could be explained by the methodology used during its development. Where; it was developed on a foundation of a hypothetical cohort, using estimates of risk factor prevalence in various regions. The calculation of the total risk of CVD events was based on incidence rates estimated from other WHO studies. Moreover, the main factor influencing the CVD risk prediction using the WHO/ISH chart is the age. In the studies of Selvarajah and Tulloch-Reid, the age group of (40-49) years accounted for (49.7%) and (45%) of the studied samples, respectively. While in the current study, the same age group accounts for only (24%) followed by the (50-59) year group accounting for (40%).

Furthermore, the mainstream of the current study sample (66.7%) were females; most of them are post-menopausal, which is considered as a condition of an underestimated risk. Besides, the majority of current sample patients are under pharmacological treatment against hypertension and hyperlipidemia.

On the contrary; the ability of the GFRP score to calculate more patients as being at the 'high' and 'very high' categories, is mostly due to the comprehensive definition of the CVD risk endpoint which was based on an actual single cohort of white Caucasian Americans from New England – Boston [20].

The picture was quite different in a study conducted by Al-Lawati in Oman (2008) among patients with type 2 DM. Where; the WHO/ISH risk prediction chart showed (55.9%) of the patients in the 'low risk' category, which was lower than the current study, compared to (25.8%) calculated by GFRP score, which was in contrast higher than the finding of the current research. Furthermore, almost one quarter (24.3%) of their patients grouped in the 'very high' risk category by the WHO/ISH risk prediction chart, which was comparatively higher than the present study results. Moreover, the same study from Oman revealed that the proportion of patients in the 'very high' risk category was (22.3%) of patients using the GFRP score [11].

The risk factor profile could explain such an increase in predicted CVD risk among Omani patients with type 2 DM enrolled in that study, where more proportion of the patients (29.6%) were in the older age group (≥ 60 years), and a higher percent were smokers (11%), as well as, the different mean of systolic blood pressure (i.e.130.5 mmHg ± 12.7 SD). Also, the proportion of patients under treatment against hypertension and dyslipidemia was less compared to those in the current study (40% and 42%), respectively. All may contribute to the increased proportion of patients grouped in the 'high risk' and the 'very high' risk categories.

In the current study, the performance of the two risk prediction tools showed clear differences in CVD risk stratification based on age as well as the gender of the studied diabetic patients. The present study confirmed the directly proportional relationship between age progression and the increase in CVD risk that goes with the bio-physiological knowledge about the age-related changes that occur in the cardiovascular system. Framingham heart study was one of the leading CVD risk studies that addressed the effect of age on the prediction of CVD events [21]. The WHO/ISH risk prediction chart confirms the same observation together with multiple other studies, all agreed that the predicted CVD risk increases with age [22]. Baynouna, in her published research, addressed the same finding in a study conducted in the UAE during (2004-2005) [23].

The difference in risk between the two genders using both tools was quite evident in this study. The finding of more males in the 'high' and the 'very high' risk categories was consistent with much research as well as the established medical knowledge. A small portion of males (6.3%) was categorized as in need of the risk lowering medications by the use of the WHO/ISH risk prediction chart. That was consistent with a study done by Otgontuya and his colleagues in Cambodia, Malaysia, and Magnolia during (2010). They used the STEPwise data of the general population in these countries, out of which type 2 DM prevalence was (4.9 - 15.6%) [24]. In comparison, the vast majority of current study males (83%) needed the risk lowering medications by the GFRP score, which was quite similar, as seen by Selvarajah and his colleagues in Malaysia during (2013) [19]. The current study identified (2.5%) of females as requiring the risk lowering medications ($\geq$ 20%) risk by the WHO/ISH risk prediction chart. Such a small percentage was also reported in Cuba in a study carried out in (2008) by Porfi Rio Nordet [20]. On the contrary, in the current study, the GFRP score calculated (44.8%) of females as requiring the risk lowering medications. This was described in only (12%) of the females studied by Selvarajah. It is well documented that males are more at CVD risk than females, especially at premenopausal age, probably due to the protective female hormonal effects of estrogen and more habitual exposure to specific risks by males like the tobacco use.

In addition to diabetes, the two tools shared the following risk factors as an input item for risk prediction: (age, gender, measured systolic blood pressure, and the current tobacco use). All of which illustrated statistically significant relations with the CVD risk categories among type 2 DM patients of the current study by both tools. Moreover, both tools showed a statistically significant relationship between the predicted CVD risk categories and BMI of participants.

While the WHO/ISH risk prediction chart showed a statistically significant relationship between the blood chol-esterol level and the predicted CVD risk categories, but on the other hand, it is not among the input risk factors in the GFRP score, which failed to demonstrate such a statistically significant relation.

Taking into consideration that anti-hypertensive medi-cation intake is one variable used in GFRP score calculation,

and the vast majority of patients in the study (98.7%) were using them. However, the tool failed to illustrate a statistically significant relation between the CVD risk categories and the intake of the anti-hypertensive medication. This is inconsistent with the findings from the Framingham heart study conducted among white Americans [9, 23]. The possible explanation could be related to the non-proportionate influence of other confounders like age, or because this tool was derived from a different population other than Qatari patients with type 2 DM.

The difference in the performance of the WHO/ISH CVD risk prediction chart and GFRP score was evident in this study, which could be related to; the methodology from which each tool developed from, risk factor profile, and the population they derived from. The current study revealed that the WHO/ISH CVD risk prediction chart is toward categorizing more patients toward the low risk, while the GFRP score is accumulating more patients toward the high and very high-risk category. Such behavior was consistent with findings in a number of studies done elsewhere, which necessitate the importance of assessing the tools prior to the clinical adoption.

Study limitations were; inability to demonstrate the temporality between the CVD risk and different risk factors. This was due to the study design as cross-sectional. Insufficient references comparing the behavior of two distinct tools in Arabian Gulf population which share similar risk factor profile.

CONCLUSION

The findings of this study provided evidence that although the two tools of CVD risk prediction deal with almost similar risk factors as an-input, they cannot similarly detect the CVD risk among patients with type 2 diabetes.

The WHO/ISH CVD risk prediction chart aggregated Qatari patients with type 2 DM toward the low-risk category, hence, the proportion of them in need for risk lowering medications were only (3.8%); categorized as in high or very high risk. The GFRP score estimated the fraction of Qatari patients with type 2 DM in need of risk lowering medications as of (57.6%) being categorized as in high or very high risk.

No agreement between the GFRP score and WHO/ISH CVD risk prediction chart in the assessment of the CVD risk among Qatar patients with type 2 DM (κ = - 0.019, *p*-value = 0.216).

All the risk factors used as an-input in both tools illustrated a statistically significant relation with CVD risk categories, except for the 'anti-hypertensive medications intake' input factor used in the GFRP score, raising concerns about some tool inputs and their suitability with Qatari patients with type 2 DM. A statistically significant relation was seen between the total 10-year CVD risk prediction categories using the GFRP score and; the confirmed history of hypertension, level of education, marital status, occupation, duration of type 2 DM, lipid-lowering medication intake, Aspirin intake, and BMI.

A statistically significant relation was seen between the total 10-year CVD risk prediction categories using the WHO /ISH risk prediction chart and; the confirmed history of hypertension, occupation, duration of DM, and BMI.

The trend of increasing the CVD risk categories as the age increases with highly statistically significant relation in both tools. Both tools showed that more males were in the high and very high-risk categories compared to females, where they were more to be toward the low-risk category. Statistically significant relations were illustrated between the CVD risk categories and the gender in both tools. A statistically insignificant relation was between the total 10-year CVD risk prediction categories using both tools and; educational level, antihypertensive medications intake, and HbA$_1$C %.

This study addressed the crucial need for assessing the performance of any CVD risk prediction tool on Qatari patients with type 2 DM comprehensively before its adoption into clinical practice. Such assessment needs a population-based longitudinal study to take into consideration local risk factor profile and ethnicity. Also, evaluating the existing risk prediction tool based on the expected and the observed outcome for the coming ten years for each tool.

Consideration of the GFRP total 10-year CVD risk prediction score in the PHC centers may tend to qualify more type 2 diabetics for preventive pharmaceutical interventions.

Which requires studying further the total 10-year CVD risk prediction outcome in relation to the cost-effectiveness of the relevant interventions at the national level. The study highlighted the importance of overall risk rather than individual risk factor management.

The disagreement between the two tools in categorizing patient's CVD risks emphasises the need for developing Qatar national prediction tool.

LIST OF ABBREVIATIONS

BMI	=	Body Mass Index
CVD	=	Cardiovascular Disease
EMRO	=	Eastern Mediterranean Region Office
GFRP	=	General Framingham Risk Prediction
HbA$_1$C	=	Glycated Hemoglobin A1
IRB	=	Institutional Research Board
NCD	=	Non-Communicable Disease
PHC	=	Primary Health Care
PHCC	=	Primary Health Care Corporation
SD	=	Standard Deviation
SPSS®	=	Statistical Package of Social Science
Type 2 DM	=	Type 2 Diabetes Mellitus
WHO/ISH	=	World Health Organization/International Society of Hypertension

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The Ethical Committee name is Hamad Medical Corporation/ Weill Cornell Medical College in Qatar- Joint Institutional Review Board. With the below details:

JIRB SCH Registration: SCH-JOINT-111

JIRB DHHS Registration: IRB00009413

HMC SCH Assurance: SCH-A-HMC-020

WCMC-Q-SCH Assurance: SCH-WCMC-Q-002

WCMC DHHS Assurance: FWA00000093

IRB number is 14-00052.

HUMAN AND ANIMAL RIGHTS

No Animals were used in this research. All human research procedures were followed in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all the participants.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of the article is available in the [figshare.com] at reference number [10.6084/m9.figshare.11962290].

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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