International Journal of General Medicine

Dovepress

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ORIGINAL RESEARCH

# Risk Assessment for Cardiovascular Disease Using the Framingham Risk Score and Globorisk Score Among Newly Diagnosed Metabolic Syndrome Patients

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**Purpose:** The presence of metabolic syndrome (MetS) is linked to an increased risk of cardiovascular disease (CVD) development. In this study, CVD risk was calculated among individuals with newly diagnosed MetS using the Framingham Risk Score (FRS) and Globorisk Score. The FRS and Globorisk score are particularly relevant in predicting CVD risk as these scores include key MetS-related risk factors like blood pressure, cholesterol levels, and age.

**Patients and Methods:** A community-based cross-sectional study was conducted at various sites in Karachi, Pakistan, from February 2022 to August 2022. Newly diagnosed cases of MetS with no physical disability, known illness, and not taking any regular medication were recruited. MetS was defined based on the definition of International Diabetes Federation. The major outcome was 10-year risk for CVD using the FRS and Globorisk Score.

**Results:** Of 304 patients, 59.2% were classified as low risk according to FRS, while 20.4% were classified as moderate and high risk each. Using the Globorisk score, 44.6% of 224 patients were classified as low risk, 34.4% as moderate risk, and 21.0% as high risk. A moderate positive correlation was observed between the two CVD risk scores (r = 0.651, 95% CI 0.58–0.71). Both risk scores have reported age, gender, and current smokers as significant risk factors in predicting CVD in 10-years ($P < 0.05$).

**Conclusion:** The outcome of both CVD risk scores predicted moderate-to-high risk of CVD in 10-years in almost half of the newly diagnosed patients with MetS. In particular, the risk of development of CVD in 10-years in newly diagnosed MetS is higher with increasing age, in male gender, and current smokers.

**Keywords:** cardiometabolic syndrome, diabetes, hypertension, obesity, dyslipidemia, cardiac events

## Introduction

Metabolic syndrome (MetS) is a prevalent global health concern, as evidenced by numerous studies linking it to cardiovascular disease (CVD).[1–4] Developing countries, in particular, bear a significant burden of morbidity and mortality related to CVD, with reports indicating that up to 75% of non-communicable disease-related mortality can be attributed to CVD.[5,6]

Studies have indicated that the presence of MetS is associated with a significantly elevated risk of developing CVD, with a 50–60% increased risk compared to individuals without MetS.[7] Furthermore, additional research has shown

Received: 20 June 2023
Accepted: 18 August 2023
Published: 20 September 2023

a substantially greater risk of CVD development in individuals with MetS, with reported two to five-fold increases in risk.[8,9]

Early detection of MetS is paramount significant as it can identify individuals who are at risk of developing CVD thus avoiding adverse cardiovascular outcomes.[10] Many algorithms that estimate risk of development of CVD in individuals with MetS have been validated so far.[2–4]

Although the criteria for prediction of CVD risk in individuals with MetS display some discrepancies, however, data collected from large prospective population-based studies, like the Framingham offspring study,[11] Botnia study,[12] Kuopio Ischemic heart Disease study,[13] Italian study,[14] and Atherosclerosis Risk in Communities study,[15] provide sufficient evidence in support of MetS hypothesis which states that MetS greatly increases risk of CVD associated morbidity and mortality in these individuals.[12,16]

Evidence has revealed that globally, CVD is the leading cause of death, and around 80–86% of these deaths occur in low- and middle-income countries.[17,18] Most South Asian countries, including Pakistan, are identified to have a higher risk of cardiometabolic diseases as compared to other part of the globe.[19,20] Although numerous studies have been conducted regarding the risk factors of CVD, to our knowledge, there is a dearth of studies available from Pakistan that estimate the CVD risk among patients with MetS. As our study focuses specifically on newly diagnosed MetS patients, the Framingham Risk Score (FRS) and Globorisk score are particularly relevant. These scoring systems encompass risk factors that are commonly associated with MetS, such as blood pressure, cholesterol levels, and age, making them well suited for our study population. Moreover, one of the reasons for using Globorisk score is its ability to evaluate country-specific CVD risk. Thus, the current study assessed the risk of developing CVD events over 10 years using two widely used predictive scores, namely the FRS and Globorisk Score. As far as we know, this study is one of the first in Pakistan to perform an in-depth estimation of the risk of CVD among patients with newly diagnosed MetS.

## Materials and Methods

This study is a part of a large community-based cross-sectional survey that was conducted primarily to assess the prevalence and associated risk factors of MetS among apparently healthy adult population of Karachi, Pakistan. The survey was carried out in various areas of Karachi from February 2022 to August 2022. Approval was obtained for this study from the human ethics committee of Dow University of Health Sciences (IRB-2332/DUHS/Approval/2021/670).

### Sample Population

The inclusion criteria for this research study were individuals aged 30–74 years who were recently diagnosed with MetS. All these individuals were asymptomatic and perceived themselves as healthy prior to this screening survey. Any individual with major physical disability, known illness, and taking any regular medication was excluded. Moreover, pregnant or lactating women were also excluded from the study.

### Risk Scores

Metabolic syndrome was defined based on the definition of International Diabetes Federation (IDF).[21] FRS was evaluated using factors like age, gender, total cholesterol, high-density lipoprotein (HDL), systolic blood pressure (SBP), anti-hypertensive treatment, smoker, and diabetes. Ten-year FRS of <10% was classified as low, 10–20% as intermediate, and >20% as high risk.[22] Globorisk score also predicts ten year risk of heart attack or stroke in healthy individuals.[2] The variables included are country name (Pakistan), age, gender, smoker, diabetes, blood pressure, and cholesterol. The Globorisk tool has no categorical risk classification as other existing cardiovascular risk classification system. However, the current study categorized the risk as low (<10%), moderate (10–19.9%), high (20–29.9%) and very high (≥30%) as described in study by Barua et al.[23]

### Data Collection Procedure

A pre-structured questionnaire was used for the purpose of the collection of the data. Detailed information was collected regarding the sociodemographic and clinical characteristics of the individuals. All information required for the assessment of FRS and Globorisk Score was calculated. All participants provided informed consent prior to enrollment.

## Data Analysis Plan

Statistical analysis was performed using STATA 17. The normality of the data was assessed using Shapiro–Wilk test. The mean along with the standard deviation (SD) was reported for quantitative variables. Frequency and percentages were calculated for qualitative variables. The One-Way ANOVA test was applied to see the mean difference of quantitative predictor variables with FRS and Globorisk Score. Moreover, a chi-square test was applied to see the association of outcome, ie, 10-year CVD risks using both risk scores with predicting factors. The $P$ of $\leq 0.05$ was considered significant. Pearson's correlation test along with the Kappa statistics was also applied to see the relationship and inter-rater agreement between FRS and Globorisk scores. Moreover, the proportion of agreement between the two scores was also explored.

# Results

During a seven-month survey from February 2022 to August 2022, a total of 1065 apparently healthy individuals underwent MetS screening, with 343 individuals testing positive. Since the FRS was developed for individuals aged 30–74 years, 39 patients aged <30 years were excluded from the study for 10-year CVD risk assessment using FRS. Similarly, as Globorisk was developed for individuals aged between 40 and 80 years, 119 patients aged <40 years were excluded from the study for 10-year CVD risk assessment using Globorisk Score. The inclusion of patients in this study is depicted in Figure 1, which shows a flowchart of the study's patient selection process.

The study participants included in FRS had a mean (SD) age of 46.60 (9.97) years, while those included in the Globorisk score had a mean (SD) age of 50.74 (8.15) years. Of the patients in FRS, 183 (60.2%) were male, while 135 (60.3%) were male in Globorisk score. Among the participants, only 74 (24.3%) in FRS were current smokers, while 60 (26.8%) in Globorisk score were current smokers (Table 1).

The 10-year CVD risk classification of FRS showed that out of 304 patients, 180 (59.2%) were observed to have low risk according to FRS, whereas moderate and high risks were observed in 62 (20.4%) each. Meanwhile, the 10-year CVD

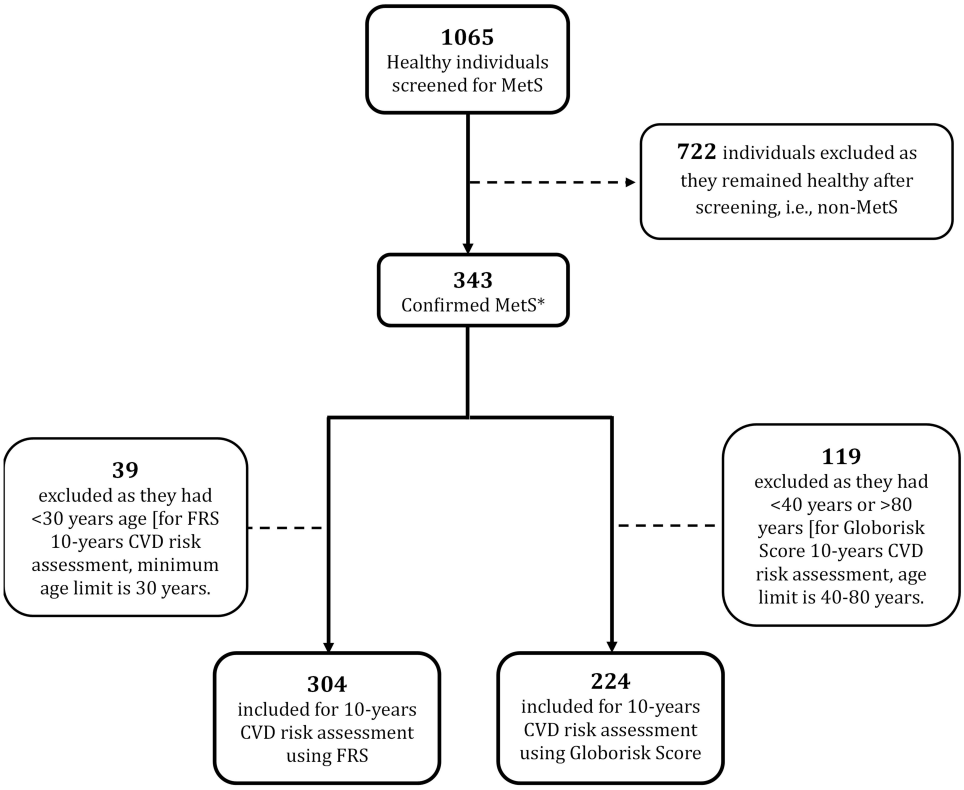


**Figure 1** Flowchart showing inclusion of patients for 10-year CVD risk assessment using FRS and Globorisk scores. *MetS was confirmed using the definition of IDF.

**Table 1** Characteristics of the Patients Included in Framingham Risk Score and Globorisk Score

| | Patients Included for FRS (n=304) | Patients Included for Globorisk Score (n=224) | p-value |
|---|---|---|---|
| | n (%) | | |
| **Age** | | | |
| ≤40 years | 104 (34.2) | 24 (10.7) | <0.001 |
| 41–50 years | 107 (35.2) | 107 (47.8) | |
| >50 years | 93 (30.6) | 93 (41.5) | |
| **Gender** | | | |
| Male | 183 (60.2) | 135 (60.3) | 0.987 |
| Female | 121 (39.8) | 89 (39.7) | |
| **IDF Risk Factors** | | | |
| 3 | 209 (68.8) | 150 (67.0) | 0.756 |
| 4 | 78 (25.7) | 58 (25.9) | |
| 5 | 17 (5.6) | 16 (7.1) | |
| **Smoker** | | | |
| Current Smoker | 74 (24.3) | 60 (26.8) | 0.686 |
| Ex-Smoker | 25 (8.2) | 21 (9.4) | |
| Non-Smoker | 205 (67.4) | 143 (63.8) | |
| **Areca Nut Use** | | | |
| Yes | 61 (20.1) | 43 (19.2) | 0.804 |
| No | 243 (79.9) | 181 (80.8) | |
| **Chew Tobacco** | | | |
| Yes | 44 (14.5) | 34 (15.2) | 0.822 |
| No | 260 (85.5) | 190 (84.8) | |
| **Currently working** | | | |
| Yes | 196 (64.5) | 135 (60.3) | 0.323 |
| No | 108 (35.5) | 89 (39.7) | |
| **HTN** | | | |
| Yes | 225 (74.0) | 172 (76.8) | 0.466 |
| No | 79 (26.0) | 52 (23.2) | |
| **High FBP** | | | |
| Yes | 122 (40.1) | 101 (45.1) | 0.254 |
| No | 182 (59.9) | 123 (54.9) | |
| **Low HDL** | | | |
| Yes | 142 (46.7) | 104 (46.4) | 0.949 |
| No | 162 (53.3) | 120 (53.6) | |

**Abbreviations**: FBP, Fasting Blood Plasma; FRS, Framingham Risk Score; HDL, High-Density Lipoprotein; HTN, Hypertension; IDF, International Diabetes Federation.

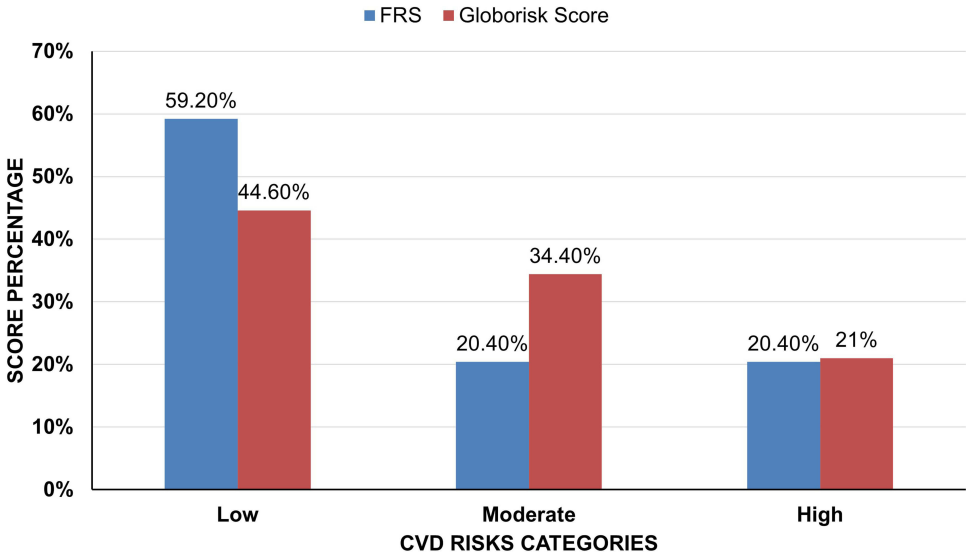


**Figure 2** The 10-year CVD risk classification using Framingham and Globorisk Score.

risk classification according to Globorisk score showed that of 224 patients, low CVD risk was observed in 100 (44.6%), moderate in 77 (34.4%), and high risk in 47 (21.0%) patients, as shown in Figure 2.

Table 2 shows the agreement and correlation between the FRS and Globorisk score. The results indicate that the two CVD risk scores had moderate agreement and positive correlation. Specifically, the agreement between the FRS and Globorisk score was 67.85% (Kappa 0.501), indicating moderate agreement. Furthermore, a moderate positive correlation was observed between the two CVD risk scores (r = 0.651, 95% CI 0.58–0.71).

The study found significant differences in various parameters among different 10-year risk categories of FRS and Globorisk scores. For FRS, a significant increase in risk from low to high was observed with respect to the mean age (P <

**Table 2** Correlation Analysis and Agreement Between the Framingham Risk Score and GloboRisk Score

| Variables | n | Pearson's Correlation | | | Agreement | Kappa (SE) |
|---|---|---|---|---|---|---|
| | | r (95% CI) | *P*-value | Comment | | |
| **Total** | 224 | 0.651 (0.58–0.71) | <0.001 | Moderate | 67.85% | 0.501 (0.047) |
| **Age** | | | | | | |
| ≤40 years | 24 | 0.676 (0.37–0.85) | <0.001 | Moderate | 83.33% | 0.500 (0.212) |
| 41–50 years | 107 | 0.784 (0.70–0.85) | <0.001 | Strong | 77.57% | 0.568 (0.072) |
| >50 years | 93 | 0.379 (0.19–0.54) | <0.001 | Weak | 52.69% | 0.263 (0.073) |
| **Gender** | | | | | | |
| Male | 135 | 0.793 (0.72–0.85) | <0.001 | Strong | 65.92% | 0.495 (0.059) |
| Female | 89 | 0.353 (0.16–0.52) | 0.001 | Moderate | 65.93% | 0.303 (0.086) |
| **IDF Risk Factors** | | | | | | |
| 3 | 150 | 0.601 (0.49–0.69) | <0.001 | Moderate | 66.67% | 0.463 (0.058) |
| 4 | 58 | 0.764 (0.63–0.85) | <0.001 | Strong | 74.14% | 0.611 (0.085) |

(*Continued*)

**Table 2** (Continued).

| Variables | n | Pearson's Correlation | | | Agreement | Kappa (SE) |
|---|---|---|---|---|---|---|
| | | r (95% CI) | *P*-value | Comment | | |
| 5 | 16 | 0.845 (0.60–0.94) | <0.001 | Strong | 56.25% | 0.356 (0.172) |
| **Smoker** | | | | | | |
| Current Smoker | 60 | 0.634 (0.45–0.76) | <0.001 | Moderate | 66.67% | 0.338 (0.101) |
| Ex-Smoker | 21 | 0.722 (0.42–0.88) | <0.001 | Strong | 57.14% | 0.241 (0.167) |
| Non-Smoker | 143 | 0.363 (0.21–0.50) | <0.001 | Moderate | 69.93% | 0.408 (0.067) |
| **Areca Nut Use** | | | | | | |
| Yes | 43 | 0.567 (0.32–0.74) | <0.001 | Moderate | 65.11% | 0.458 (0.115) |
| No | 181 | 0.675 (0.59–0.75) | <0.001 | Moderate | 68.50% | 0.507 (0.051) |
| **Chew Tobacco** | | | | | | |
| Yes | 34 | 0.724 (0.51–0.85) | <0.001 | Strong | 67.64% | 0.505 (0.122) |
| No | 190 | 0.636 (0.54–0.71) | <0.001 | Moderate | 67.89% | 0.495 (0.051) |
| **Currently working** | | | | | | |
| Yes | 135 | 0.698 (0.60–0.78) | <0.001 | Moderate | 64.41% | 0.510 (0.060) |
| No | 89 | 0.588 (0.43–0.71) | <0.001 | Moderate | 68.53% | 0.454 (0.076) |
| **HTN** | | | | | | |
| Yes | 172 | 0.659 (0.57–0.74) | <0.001 | Moderate | 69.77% | 0.540 (0.052) |
| No | 52 | 0.772 (0.63–0.86) | <0.001 | Strong | 61.54% | 0.356 (0.088) |
| **High FBP** | | | | | | |
| Yes | 101 | 0.752 (0.65–0.83) | <0.001 | Strong | 66.34% | 0.503 (0.067) |
| No | 123 | 0.530 (0.39–0.65) | <0.001 | Moderate | 69.11% | 0.469 (0.067) |
| **Low HDL** | | | | | | |
| Yes | 104 | 0.773 (0.68–0.84) | <0.001 | Strong | 63.46% | 0.444 (0.070) |
| No | 120 | 0.594 (0.46–0.70) | <0.001 | Moderate | 71.67% | 0.556 (0.059) |

0.001), weight ($P < 0.001$), height ($P < 0.001$), waist circumference (WC) ($P < 0.001$), fasting plasma glucose (FPG) ($P < 0.001$), and total cholesterol (TC) (P.008). While for Globorisk score, significant differences were observed in mean age ($P < 0.001$), height (P.002), WC ($P < 0.001$), SBP ($P < 0.001$), and FPG (P.040). These results are presented in Table 3.

Furthermore, the study also found significant associations between the 10-year CVD risk according to FRS and several variables, including gender ($P < 0.001$), smoking status ($P < 0.001$), areca nut use (P.023), chew tobacco (P.009), current working status (P.001), number of MetS components ($P < 0.001$), high FPG ($P < 0.001$), and low HDL (P.007). Similarly, the 10-year CVD risk according to Globorisk score was significantly associated with gender ($P < 0.001$), smoking status ($P < 0.001$), and HTN (P.001). These associations were statistically significant ($Ps < 0.05$) for both risk scores and are summarized in Table 4.

**Table 3** Mean Difference of Quantitative Predictors Variables with Framingham Risk Score and Globorisk Score

| Variables | Framingham Risk Score (n=304) | | | P-value | GloboRisk Score (n=224) | | | P-value |
|---|---|---|---|---|---|---|---|---|
| | Low Risk (n=180) | Moderate Risk (n=62) | High Risk (n=62) | | Low Risk (n=100) | Moderate Risk (n=77) | High Risk (n=47) | |
| | Mean ±SD | | | | Mean ±SD | | | |
| Age, years | 42.28 ±8.14 | 47.91 ±7.26 | 57.84 ±7.84 | <0.001 | 45.36 ±4.22 | 51.71 ±6.32 | 60.62 ±7.33 | <0.001 |
| Weight, kg | 74.43 ±12.67 | 78.89 ±13.63 | 82.54 ±13.14 | <0.001 | 161.21 ±10.91 | 162.99 ±10.03 | 165.45 ±10.03 | 0.094 |
| Height, cm | 160.41 ±11.58 | 166.04 ±10.39 | 169.29 ±7.51 | <0.001 | 73.14 ±11.64 | 77.70 ±14.07 | 81.02 ±13.07 | 0.002 |
| BMI, kg/m2 | 28.93 ±4.08 | 28.66 ±4.75 | 28.78 ±4.09 | 0.905 | 28.19 ±3.91 | 29.25 ±4.21 | 29.61 ±4.21 | 0.099 |
| WC, cm | 96.56 ±8.62 | 99.64 ±8.42 | 104.65 ±10.18 | <0.001 | 96.52 ±8.15 | 99.73 ±9.06 | 104.78 ±10.67 | <0.001 |
| SBP, mmhg | 129.48 ±13.95 | 138.67 ±16.95 | 132.23 ±15.74 | <0.001 | 129.14 ±12.94 | 135.33 ±16.89 | 145.43 ±15.47 | <0.001 |
| DBP, mmhg | 84.94 ±10.34 | 88.09 ±10.55 | 86.99 ±10.07 | 0.084 | 85.59 ±10.23 | 87.48 ±10.49 | 87.75 ±9.49 | 0.344 |
| FPG, mg/dl | 94.18 ±13.40 | 102.43 ±17.54 | 107.42 ±15.65 | <0.001 | 97.74 ±15.82 | 101.11 ±17.27 | 104.94 ±15.15 | 0.040 |
| TG, mg/dl | 163.59 ±70.32 | 193.64 ±102.74 | 160.39 ±61.61 | 0.018 | 158.28 ±67.08 | 171.85 ±88.02 | 142.77 ±47.14 | 0.090 |
| HDL, mg/dl | 38.95 ±6.99 | 36.77 ±7.50 | 38.22 ±7.59 | 0.111 | 37.47 ±6.16 | 38.68 ±8.78 | 38.25 ±7.97 | 0.401 |
| TC, mg/dl | 177.27 ±31.68 | 184.40 ±36.89 | 192.22 ±34.78 | 0.008 | 176.75 ±34.66 | 180.97 ±36.27 | 177.36 ±31.99 | 0.708 |



https://doi.org/10.2147/IJGM.S423151

**Table 4** Comparison of Framingham Risk Score and Globorisk Score with Sociodemographic and Clinical Characteristics of Newly Diagnosed Individuals with Metabolic Syndrome

| Variables | Framingham Risk Score (n=304) | | | P-value | Globo Risk Score (n=224) | | | P-value |
|---|---|---|---|---|---|---|---|---|
| | Low Risk (n=180) | Moderate Risk (n=62) | High Risk (n=62) | | Low Risk (n=180) | Moderate Risk (n=62) | High Risk (n=62) | |
| | n (%) | | | | n (%) | | | |
| **Age, years** | | | | | | | | |
| ≤40 | 90 (86.5) | 14 (13.5) | 0 (0) | <0.001 | 20 (83.3) | 4 (16.7) | 0 (0) | <0.001 |
| 40–50 | 65 (60.7) | 29 (27.1) | 13 (12.1) | | 69 (64.5) | 33 (30.8) | 5 (4.7) | |
| >50 | 25 (26.9) | 19 (20.4) | 49 (52.7) | | 11 (11.8) | 40 (43.0) | 42 (45.2) | |
| **Gender** | | | | | | | | |
| Male | 70 (38.3) | 52 (28.4) | 61 (33.3) | <0.001 | 44 (32.6) | 55 (40.7) | 36 (26.7) | <0.001 |
| Female | 110 (90.9) | 10 (8.3) | 1 (0.8) | | 56 (62.9) | 22 (24.7) | 11 (12.4) | |
| **Smoking Status** | | | | | | | | |
| Current Smoker | 7 (9.5) | 22 (29.7) | 45 (60.8) | <0.001 | 1 (1.7) | 28 (46.7) | 31 (51.7) | <0.001 |
| Ex-Smoker | 11 (44.0) | 12 (48.0) | 2 (8.0) | | 12 (57.1) | 9 (42.9) | 0 (0) | |
| Non-Smoker | 162 (79.0) | 28 (13.7) | 15 (7.3) | | 87 (60.8) | 40 (28.0) | 16 (11.2) | |
| **Areca Nut** | 32 (52.5) | 20 (32.8) | 9 (14.8) | 0.023 | 17 (39.5) | 17 (39.5) | 9 (20.9) | 0.697 |
| **Chew Tobacco** | 18 (40.9) | 16 (36.4) | 10 (22.7) | 0.009 | 13 (38.2) | 15 (44.1) | 6 (17.6) | 0.430 |
| **Currently working** | 102 (52.0) | 50 (25.5) | 44 (22.4) | 0.001 | 54 (40.0) | 52 (38.5) | 29 (21.5) | 0.185 |
| **IDF Risk Factors** | | | | | | | | |
| 3 | 141 (67.5) | 32 (15.3) | 36 (17.2) | <0.001 | 71 (47.3) | 48 (32.0) | 31 (20.7) | 0.801 |
| 4 | 36 (46.2) | 23 (29.5) | 19 (24.4) | | 23 (39.7) | 23 (39.7) | 12 (20.7) | |
| 5 | 3 (17.6) | 7 (41.2) | 7 (41.2) | | 6 (37.5) | 6 (37.5) | 4 (25.0) | |
| **High WC** | 168 (58.1) | 59 (20.4) | 62 (21.5) | 0.112 | 95 (44.2) | 74 (34.4) | 46 (21.4) | 0.709 |
| **HTN** | 131 (58.2) | 44 (19.6) | 50 (22.2) | 0.395 | 67 (39.0) | 60 (34.9) | 45 (26.2) | 0.001 |
| **High FPG** | 46 (37.7) | 33 (27.0) | 43 (35.2) | <0.001 | 37 (36.6) | 38 (37.6) | 26 (25.7) | 0.074 |
| **Low HDL** | 72 (50.7) | 39 (27.5) | 31 (21.8) | 0.007 | 49 (47.1) | 36 (34.6) | 19 (18.3) | 0.622 |
| **High TG** | 77 (54.2) | 36 (25.4) | 29 (20.4) | 0.115 | 43 (46.2) | 36 (38.7) | 14 (15.1) | 0.163 |

**Notes**: Family history of hypertension, type II diabetes, increased waist circumference, and waist high triglyceride were non-significant in both Framingham risk score and Globorisk score.

## Discussion

The results of the present study indicate that nearly half of the newly diagnosed MetS patients were classified as having moderate to high-risk for developing CVD over a 10-year period using Globorisk whereas FRS predicted one-third of the study population in a moderate-to-high risk for MetS. The finding regarding underestimation of FRS is also reported in studies published previously in individuals with MetS and other diseases.[24–26] There could be several reasons why an individual's risk score would be higher using the Globorisk score compared to the FRS. First, the FRS was developed based on data from a primarily white population in the United States, while the Globorisk score was developed using data

from multiple countries and ethnic groups. It has been observed that South Asians exhibit genetic differences and a higher prevalence of most cardiovascular risk factors at a younger age.[27,28] Second, the Globorisk score includes additional risk factors such as smoking, diabetes, and BMI that are not included in the FRS.[22] If an individual has one or more of these risk factors, their overall risk score would be higher using the Globorisk score.

The results of the current study indicate that the two CVD risk scores had moderate agreement and positive correlation. Specifically, the agreement between the FRS and Globorisk score was 67.85%, indicating moderate agreement. Furthermore, a moderate positive correlation was observed between the two CVD risk scores suggesting that the scores tended to increase or decrease together. These findings suggest that while there is some overlap between the FRS and Globorisk score in identifying patients at risk for CVD, they are not interchangeable and may provide complementary information. Previously published studies have also reported moderate relationship amongst different CVD prediction models.[29,30]

The results of the present study reported that there is a significant association between several demographic and clinical variables and the risk of developing CVD over a 10-year period as determined by the FRS and Globorisk Score. Specifically, the study found that as the mean age, weight, height, WC, SBP, FPG, and TC of patients increased, so did their risk of developing CVD in 10 years. Moreover, male gender, current smokers, areca nut use, chewing of tobacco, no current working, higher number of components of MetS, high FPG, and low HDL are also significantly highly associated with risk of development of 10 years of CVD as predicted by both FRS and Globorisk scores. The variables that were identified as significant predictor variables in the current study have also been found to be significant in previously published studies.[3,4,31] This suggests that these factors may be important predictors of cardiovascular risk and should be closely monitored and managed in individuals with MetS to mitigate the risk of future CVD events. The findings also highlight the importance of early identification and intervention in individuals with MetS who have these risk factors to prevent the development of CVD.

The study has several limitations that need to be acknowledged. First, the study was limited to Karachi and did not consider other provinces in Pakistan, which limits its generalizability to the entire Pakistani population. Furthermore, the cross-sectional design of the study prevented long-term follow-up of patients, and a study with a follow-up period of at least 10 years, including disease reports and incidence, would provide a more comprehensive understanding of the development of CVD in this population. Another limitation is that the risk of CVD was calculated using predictive scores that did not take into account the family history of diabetes and CVD, both of which are strong predictors of long-term CVD risk. Finally, the study was community-based and did not offer counselling to individuals who were classified as having a moderate or high risk of developing CVD, which could have led to missed opportunities for lifestyle modifications and medication compliance.

Despite the aforementioned limitations, the study holds significant importance. Our study is the first, to the best of our knowledge, to comprehensively report on the 10-year prediction outcomes of CVD in newly diagnosed MetS patients. Although the study was conducted solely in Karachi, it included participants from diverse ethnic backgrounds and all major areas of the city, thereby increasing the gene pool of the study population and minimizing bias. Furthermore, individuals from all adult age groups were included in the study, which enabled the assessment of CVD risk in different age groups and identification of the age group most vulnerable to developing CVD in the future. The present study has brought to light the group of newly diagnosed MetS patients who are at a heightened risk of developing CVD in the future, underscoring the need for this population to be the focus of future research studies. Finally, a notable strength of this study is the comprehensive reporting of the correlation, inter-rater agreement, and proportion of agreement between the FRS and Globorisk scores in predicting the 10-year risk of CVD. This reporting is essential for evaluating the credibility and consistency of these two scales and for enhancing the accuracy of CVD risk predictions.

In terms of future research, it is recommended that studies similar to the present one be conducted more frequently in several cities and provinces to ensure that the study findings are generalizable to the entire Pakistani population. Additionally, interventions focused on lifestyle modification and counselling should be introduced and the outcomes analyzed through long-term follow-up to assess the effect of such modifications on MetS and its progression to complications, such as CVD.

## Conclusion

In this study, the outcome of both CVD risk scores predicted moderate-to-high risk of CVD in 10 years in almost half of the newly diagnosed patients with MetS. In particular, the risk of development of CVD in 10 years in newly diagnosed MetS is higher with increasing age, in male gender, and current smokers as found in both FRS and Globorisk score. It is strongly recommended that the MetS who are at the old age category, males and smokers should be prioritised for healthy lifestyle counselling to prevent CVD events. They must follow strict compliance with the MetS therapeutic management and lifestyle modifications to reduce cardiovascular risk stratification in future. Moreover, the use of these CVD predicting risk scores in healthcare settings is also strongly recommended for all MetS patients.

## Ethics Statement

The study was conducted in accordance with the Declaration of Helsinki and all procedures were approved by the Ethics Committee of Dow University of Health Sciences (IRB-2332/DUHS/Approval/2021/670). All participants received and signed an informed consent form.

## Acknowledgments

The authors would like to thank the research assistants of Student Taskforce for Education & Public Health (STEP) of Primary Care Diabetes Association (PCDA) Pakistan who contributed by recruiting participants and assistance in data collection and entering of the data. Furthermore, we would like to thank all participants who took part in this study.

## Funding

The study was supported by Sindh Higher Education Commission of Pakistan (Project code 299). In addition, PharmEvo Pakistan partially supported the logistics of this study. Furthermore, the University of Birmingham has provided support by covering the article processing charge for this paper.

## Disclosure

Dr. Kashif Shafique, Mr. Syed Omair Adil and Dr. Fareed Uddin report grants from Sindh Higher Education Commission and PharmEvo Research Forum, during the conduct of the study. The author reports no other conflicts of interest in this work.

## References

1. Saklayen MG. The global epidemic of the metabolic syndrome. *Curr Hypertens Rep*. 2018;20(2):12. doi:10.1007/s11906-018-0812-z
2. Hajifathalian K, Ueda P, Lu Y, et al. A novel risk score to predict cardiovascular disease risk in national populations (Globorisk): a pooled analysis of prospective cohorts and health examination surveys. *Lancet Diabetes Endocrinol*. 2015;3:339–355. doi:10.1016/S2213-8587(15)00081-00089
3. Jahangiry L, Farhangi MA, Rezaei F. Framingham risk score for estimation of 10-years of cardiovascular diseases risk in patients with metabolic syndrome. *J Health Popul Nutr*. 2017;36:36. doi:10.1186/s41043-017-0114-0
4. Farhangi MA, Jahangiry L. Gender difference in the association between Framingham risk score with cardio-metabolic risk factors and psychological distress in patients with metabolic syndrome. *Diabetes Metab Syndr*. 2020;14(2):71–75. doi:10.1016/j.dsx.2019.12.009
5. Gaziano TA. Cardiovascular disease in the developing world and its cost-effective management. *Circulation*. 2005;112(23):3547–3553. doi:10.1161/CIRCULATIONAHA.105.591792
6. Alwan A. *Global Status Report on Noncommunicable Diseases 2010*. Geneva, Switzerland: World Health Organization; 2011.
7. Qiao Q, Gao W, Zhang L, Nyamdorj R, Tuomilehto J. Metabolic syndrome and cardiovascular disease. *Ann Clin Biochem*. 2007;44(3):232–263. doi:10.1258/000456307780480963
8. Huang PL. A comprehensive definition for metabolic syndrome. *Dis Model Mech*. 2009;2(5–6):231–237. doi:10.1242/dmm.001180
9. Wenger NK. Women and coronary heart disease: a century after Herrick understudied, underdiagnosed, and undertreated. *Circulation*. 2012;126(5):604–611. doi:10.1161/CIRCULATIONAHA.111.086892
10. Roth GA, Mensah GA, Johnson CO, et al. Global burden of cardiovascular diseases and risk factors, 1990–2019: update from the GBD 2019 Study. *J Am Coll Cardiol*. 2020;76:2982–3021. Erratum in: *J Am Coll Cardiol*. 2021 Apr 20;77(15):1958–1959. doi:10.1016/j.jacc.2020.11.010
11. Rutter MK, Meigs JB, Sullivan LM, D'Agostino RB Sr, Wilson PW. Insulin resistance, the metabolic syndrome, and incident cardiovascular events in the Framingham Offspring Study. *Diabetes*. 2005;54(11):3252–3257. doi:10.2337/diabetes.54.11.3252
12. Isomaa B, Almgren P, Tuomi T, et al. Cardiovascular morbidity and mortality associated with the metabolic syndrome. *Diabetes Care*. 2001;24:683–689. doi:10.2337/diacare.24.4.683
13. Lakka HM, Laaksonen DE, Lakka TA, et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *JAMA*. 2002;288:2709–2816. doi:10.1001/jama.288.21.2709

14. Trevisan M, Liu J, Bahsas FB, Menotti A. Syndrome X and mortality: a population-based study. Risk Factor and Life Expectancy Research Group. *Am J Epidemiol*. 1998;148:958–966. doi:10.1093/oxfordjournals.aje.a009572
15. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third national health and nutrition examination survey. *JAMA*. 2002;287(3):356–359. doi:10.1001/jama.287.3.356
16. Grundy SM. Does the metabolic syndrome exist? *Diabetes Care*. 2006;29(7):1689–1692. doi:10.2337/dc05-2307
17. Turin TC, Shahana N, Wangchuk LZ, et al. The burden of cardiovascular and cerebrovascular diseases and the conventional risk factors in the South Asian Population. *Glob Heart*. 2013;8:121–130. doi:10.1016/j.gheart.2012.01.001
18. Yusuf S, Rangarajan S, Teo K, et al. Cardiovascular risk and events in 17 low-, middle-, and high-income countries. *N Engl J Med*. 2014;371(9):818–827. doi:10.1056/NEJMoa1311890
19. Wolf RM, Nagpal M, Magge SN. Diabetes and cardiometabolic risk in South Asian youth: a review. *Pediatr Diabetes*. 2021;22(1):52–66. doi:10.1111/pedi.13078
20. Adil SO, Islam MA, Musa KI, Shafique K. Prevalence of metabolic syndrome among apparently healthy adult population in Pakistan: a systematic review and meta-analysis. *Healthcare*. 2023;11(4):531. doi:10.3390/healthcare11040531
21. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009;120:1640–1645. doi:10.1161/CIRCULATIONAHA.109.192644
22. D'Agostino Ralph B, Vasan Ramachandran S, Pencina Michael J, et al. General cardiovascular risk profile for use in primary care. *Circulation*. 2008;117:743–753. doi:10.1161/CIRCULATIONAHA.107.699579
23. Barua L, Banik PC, Islam SM, Faruque M. Application of country-specificGloborisk score to estimate next 10 years risk of cardiovascular diseases and its associated predictors among postmenopausal rural women of Bangladesh: a cross-sectional study in a primary care setting. *Lifestyle Med*. 2021;2(2):e32. doi:10.1002/lim2.32
24. Bansal M, Shrivastava S, Mehrotra R, Agarwal V, Kasliwal RR. Low Framingham risk score despite high prevalence of metabolic syndrome in asymptomatic North-Indian population. *J Assoc Physicians India*. 2009;57:17–22.
25. Barton TJ, Low DA, Bakker EA, et al. Traditional cardiovascular risk factors strongly underestimate the 5-year occurrence of cardiovascular morbidity and mortality in spinal cord injured individuals. *Arch Phys Med Rehabil*. 2021;102(1):27–34. doi:10.1016/j.apmr.2020.07.013
26. Grand M, Díaz A, Bia D. Cardiovascular risk prediction equations underestimate risk in people living with HIV: comparison and cut-point redefinition for 19 cardiovascular risk equations. *Curr HIV Res*. 2022;20:137–151. doi:10.2174/1570162X20666220126124149
27. Pursnani S, Merchant M. South Asian ethnicity as a risk factor for coronary heart disease. *Atherosclerosis*. 2020;315:126–130. doi:10.1016/j.atherosclerosis.2020.10.007
28. Martinez-Amezcua P, Haque W, Khera R, et al. The upcoming epidemic of heart failure in South Asia. *Circ Heart Fail*. 2020;13(10):e007218. doi:10.1161/CIRCHEARTFAILURE.120.007218
29. Mettananda KCD, Gunasekara N, Thampoe R, Madurangi S, Pathmeswaran A. Place of cardiovascular risk prediction models in South Asians; agreement between Framingham risk score and WHO/ISH risk charts. *Int J Clin Pract*. 2021;75:e14190. doi:10.1111/ijcp.14190
30. Mondal R, Ritu RB, Banik PC. 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. *Heliyon*. 2021;7:e07728. doi:10.1016/j.heliyon.2021.e07728
31. Yang W, Ma R, Zhang X, et al. Comparison between metabolic syndrome and the Framingham risk score as predictors of cardiovascular diseases among Kazakhs in Xinjiang. *Sci Rep*. 2018;8(1):16474. doi:10.1038/s41598-018-34587-1