Original Article

Cardiovascular Risk Profiling Using the Globorisk Calculator among Noncommunicable Disease Patients Attending Primary Health Centers of a Tertiary Care Teaching Hospital in South India: A Cross-Sectional Analytical Study

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Abstract

Background: Cardiovascular diseases (CVDs) account for over three-quarters of all deaths taking place in developing nations. **Objective:** The present study aims to stratify noncommunicable disease (NCD) patients using the Globorisk chart for predicting their 10-year risk of a major (fatal or nonfatal) CVD event and to estimate the level of agreement between this country-specific chart and the existing World Health Organization (WHO)/International Society of Hypertension (ISH) risk strata. **Methods:** A record-based cross-sectional analytical study was conducted in 2018 among adults attending the NCD clinic of one rural and one urban primary health center in Puducherry. Laboratory and office risk calculators of the Globorisk chart were used to calculate the risk. **Results:** The median age (interquartile range (IQR)) of the 760 study participants was 58 (50–65) years. When calculated using the Globorisk prediction chart, 22.1% (n = 168) of the participants had a <10% risk for any CVD event in the next 10 years, whereas the same risk was found in 71.1% (n = 540) by using the WHO/ISH risk chart. There was no agreement found between the two risk charts (k = 0.0174; *P*-value = 0.26). **Conclusion:** The Globorisk chart was found to identify more patients as belonging to the higher risk category as compared to WHO/ISH charts.

Keywords: Cardiovascular diseases, Globorisk, noncommunicable diseases

Introduction

Accounting for over three-quarters of all deaths taking place in low- and middle-income countries (LMIC), cardiovascular diseases (CVDs) rank among the top global causes of death.[1] The figures for CVD burden in India are more challenging because of early-onset and high case fatality rates.[2] Since the 1960s with the Framingham heart study, risk factors for the development of CVDs have been given much importance in clinical practice. The following decades showed us the effects of risk multiplication and multiple risk factors contributing to the same disease, which led to the development of risk assessment and risk reduction approaches for the control of CVDs.[3] In order to estimate a person's risk of a fatal or nonfatal cardiovascular event during a specific period based on their level of risk factors, various prediction models (or risk scores) have been developed and are currently available within the health system.

The World Health Organization/International Society of Hypertension (WHO/ISH) risk prediction charts predict the 10-year risk for fatal or nonfatal cardiovascular events based on the age, gender, systolic blood pressure (SBP), smoking status, diabetic status, and blood cholesterol levels.[4] The WHO/ISH risk chart is available at 14 WHO epidemiological sub-region levels only, as the data and evidence at the country level were lacking. The relatively new Globorisk chart,

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developed by a team of collaborators under the Harvard School of Public Health, predicts the risk of a fatal or nonfatal cardiovascular event for patients at the country level for all countries in the world using the same parameters of WHO/ISH and also with the person's country of residence using two separate charts, one for laboratory use and another for office use.[5]

There is limited evidence available on the utility of Globorisk charts among the Indian population. So, the present study aims to stratify noncommunicable disease (NCD) patients in the chronic disease clinics functioning in rural and urban primary health centers in South India using this country-specific risk prediction chart for predicting the 10-year risk of a major (fatal or nonfatal) cardiovascular event and to estimate the level of agreement between Globorisk and the existing WHO/ISH risk strata.

Methodology

Study design

A record-based cross-sectional analytical study was conducted at Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER) rural and urban health centers (JIRHC and JIUHC, respectively) for four months (July–October 2018).

Study setting and population

JIRHC caters to a population of around 10,000 spread over four villages with agriculture as the primary occupation, whereas JIUHC caters to a population of about 8000 spread over four wards along with the coastal areas of Puducherry where fishing is the major occupation.

The NCD clinic of these centers is a special clinic conducted on a weekly basis to provide comprehensive healthcare services for NCD patients exclusively by a team that includes the medical officer (MO), postgraduates, undergraduate intern trainees, nursing staff, and public health workers posted under the Department of Preventive and Social Medicine, JIPMER. Healthcare services provided in both centers are similar and include routine medical consultation, laboratory investigations, and the provision of medications for NCDs like diabetes, hypertension, thyroid disorders, bronchial asthma, and epilepsy. On each visit, that is, every month, a clinical including foot examination and blood pressure measurement is conducted for all patients.

Study participants

Records of adults aged between 40 and 79 years attending the NCD clinic of JIRHC and JIUHC in the study period were included in the study. Patients with severe disease states like established CVDs (angina pectoris, coronary heart disease, myocardial infarction, transient ischemic attacks, cerebrovascular disease, peripheral vascular disease, or after coronary revascularization or carotid endarterectomy), mean SBP (>180 mmHg), total blood cholesterol (TC) ≥345 mg/dL, or renal impairment are excluded from the study.

Study tools

The Globorisk chart employed both the laboratory and office risk calculators to determine the 10-year risk of a fatal or nonfatal cardiovascular event.[6] These calculators used various variables such as country, age, gender, smoking status, SBP, TC, and the presence of diabetes mellitus in the laboratory-based version. However, the office version included age, gender, SBP, smoking status, and BMI. For 36 patients with missing cholesterol values, the BMI was utilized to calculate the risk using the office chart.

The calculation of risk based on the WHO/ISH cardiovascular risk prediction charts was conducted using the whoishRisk package for R software.[7] In the WHO laboratory-based model, cardiovascular risk was determined based on factors such as age, sex, smoking status, diabetes status, SBP, and cholesterol levels (measured in mmol/L). On the other hand, the non-laboratory-based model of WHO replaced cholesterol and diabetes with BMI. Risk assessment was based on age, sex, smoking status, SBP, and BMI. The CVD risk within the WHO models is determined across 21 regions as defined by the Global Burden of Disease (GBD).

Study procedure and statistical analysis

Each patient in the NCD clinic has a comprehensive case record issued by the Medical Records Department (MRD) with a unique family folder number, which is updated during every visit by the health workers. Records of the patients are maintained at the center, both as case records and in the hospital information system (HIS) in MS-Excel. Records of around 898 patients receiving treatment from January 1, 2017 to June 30, 2018 were reviewed during the study period. The last recorded values within 3 months were considered for the assessment of cardiovascular risk. The updated data were analyzed using STATA 14 software (manufactured by StataCorp LP, College Station, Texas, USA). Age, SBP, and TC were expressed as median (interquartile range (IQR)). Categorical variables such as gender, tobacco, diabetes, and cardiovascular risk events were expressed as percentages. Diabetes status was determined based on the criteria outlined in the Guidelines for Management of Type 2 Diabetes issued by the Indian Council of Medical Research.[8] SBP and TC were further categorized based on NCEP (ATP III criteria) and Joint National Committee-7 (JNC-7) guidelines.[9,10] Behavioral habits and anthropometric and blood pressure measurements were measured based on the WHO STEPS questionnaire.[11] All current smokers and those who quit smoking in the last year are considered as smokers. The WHO Asia-Pacific guideline was used to classify body mass index.[12]

The risk scores calculated were categorized into five strata for the WHO/ISH chart: <10%, 10%–<20%, 20%–<30%, 30%–<40%, and ≥40%; and seven strata for the Globorisk chart: <5%, 5–9%, 10–19%, 20–29%, 30–39%, 40–49%, and ≥50%, respectively.[13] Globorisk categories were further clubbed for comparison with WHO/ISH. SBP <100 mm Hg and TC <4 mmol/l were considered in the lowermost strata

while calculated in the WHO/ISH chart. Globally, there is no standard cutoff decided on stratifying the population into high-risk and low-risk categories for CVD events using both the models.[6,14] Based on the available literature, CVD risk events were categorized into low-risk models using a cutoff of <10% and high-risk models using a cutoff of >20% and >30%. The level of agreement between the two risk prediction methods was determined by weighted kappa.[15] A *P*-value <0.05 was considered to be statistically significant. We followed the Strengthening and Reporting of Observational Studies in Epidemiology (STROBE) checklist to report our study findings.

Results

Out of all the registered 456 patients in JIRHC and the 442 in JIUHC, records of 362 (79%) and 398 (90%) patients, respectively, were included in the study.

The data presented in Table 1 indicates that the median age of the study participants was 58 (50–65) years, and more than two-thirds of them were females (70%). In the study, population diabetes was higher in rural areas (59%). The median SBP and TC were 130 (120–140) mm Hg and 168 (145–196), respectively. Three-fourths of the patients had their SBP (72%) and TC (77%) within normal limits.

Figures 1 and 2 illustrate that the prevalence of individuals in the high-risk category (30 and above) was notably elevated when utilizing Globorisk compared to the WHO/ISH risk chart (15.3% versus 6.5%).

Table 1: Sociodemographic profile of study participants (*n*=760)

Characteristics	Rural *n*=362 (%)	Urban *n*=398 (%)	Total *n*=760
Age group (years)			
40–49	80 (22.1)	88 (22.1)	168 (22.1)
50–59	113 (31.2)	138 (34.7)	251 (33.1)
60–69	118 (32.6)	109 (27.4)	227 (29.8)
70–79	51 (14.1)	63 (15.8)	114 (15.0)
Gender			
Male	122 (33.7)	108 (27.1)	230 (30.2)
Female	240 (66.3)	290 (72.9)	530 (69.8)
Tobacco consumption			
Yes	31 (8.6)	27 (6.8)	58 (7.6)
No	331 (91.4)	371 (93.2)	702 (92.4)
Diabetes present			
Yes	214 (59.1)	200 (50.3)	414 (54.4)
No	148 (40.8)	198 (49.8)	346 (45.6)
SBP (in mm Hg)			
< 140	250 (69.1)	295 (74.1)	545 (71.7)
≥ 140	112 (30.9)	103 (25.9)	215 (28.2)
Total cholesterol (in mg/dL)*	(*n*=342)	(*n*=382)	724
Satisfactory (<200)	286 (83.6)	268 (70.2)	554 (76.5)
Unsatisfactory (≥200)	56 (16.4)	114 (29.8)	170 (23.4)

*36 values (4.7%) are missing; SBP=systolic blood pressure

The agreement between the WHO/ISH chart and the Globorisk chart in various risk categories: <10%, 10 to <20%, 20 to <30%, 30 to <40%, and >40% is depicted in Table 2. Specifically, it indicates agreement percentages of 22%, 39%, 25%, 3%, and 0%, respectively. The strata were weighted by 1, 0.94, 0.75, 0.44, and 0, respectively, for the calculation of weighted kappa. There was no agreement found (k = 0.0174), and the finding was not statistically significant. (*P*-value = 0.26).

The stratification of the population into low-risk groups using a cutoff of <10% and high-risk groups for CVD events using a cutoff of >20% and 30% is illustrated in Table 3. In the low-risk model, more than half (53%) of the individuals having hypertension were categorized by WHO/ISH as having the lowest CVD risk category (risk <10%) compared to less than a quarter (19%) based on Globorisk. Ideally, both should have been as low as possible, considering uncontrolled hypertension is a risk for a CVD event. Similarly, more than half (58.2%) of the known diabetic individuals were categorized by WHO/ISH as the lowest CVD risk category (risk <10%) compared to less than a quarter (23%) based on Globorisk. In the high-risk model, when 20% is taken as the cutoff, it is found that 22% of the diabetic patients had a risk of a CVD event according to WHO/ISH compared to 38% based on Globorisk.

Discussion

This study aims to stratify the NCD patients using the Globorisk chart for predicting the 10-year risk of a major (fatal or nonfatal) cardiovascular event in two different populations, that is, urban and rural. In our study, nearly one-fourth (22%) of the patients belong to the strata with <10% risk for CVD events in the next 10 years in both service areas by using the Globorisk chart. This study is unique in obtaining the above result because other studies have revealed a variable level of prevalence of CVD risk for <10% using other risk prediction charts (viz., Nigeria 86%, Cuba 89.7%, Iran 93.9%, Pakistan

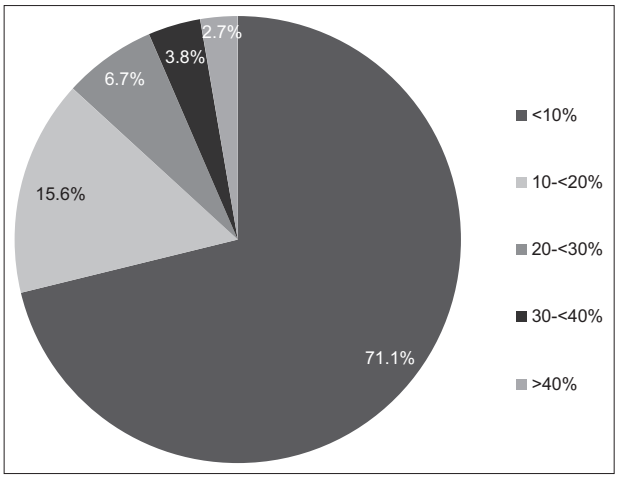

Figure 1: Distribution of study participants based on WHO/ISH risk categories (N = 760); WHO/ISH = World Health Organization/International Society of Hypertension

Table 2: Comparison of risk stratification in the study population using WHO/ISH and Globorisk charts (*n*=760)*

Globorisk	WHO/ISH Risk Chart					
	<10%	10% to 20%	20% to 30%	30% to 40%	>=40%	Total
<10%	119 (22)	23 (19)	13 (25)	7 (24)	6 (29)	168 (22)
10% to 20%	222 (41)	46 (39)	19 (37)	9 (31)	6 (29)	302 (40)
20% to 30%	123 (23)	27 (23)	13 (25)	8 (28)	4 (19)	175 (23)
30% to 40%	51 (9)	16 (13)	5 (10)	1 (3)	5 (24)	78 (10)
>=40%	25 (5)	7 (6)	1 (2)	4 (14)	0	37 (5)
Total	540	119	51	29	21	760

WHO/ISH=World Health Organization/International Society of Hypertension

Table 3: Characteristics of study participants using low-risk (<10%) and high-risk models (>20% and>30%) based on WHO/ISH and Globorisk prediction charts (*n*=760)

Characteristics	*n*	Low-risk model		High-risk model			
		Risk cutoff <10% *n* (%)		Risk cutoff >20% *n* (%)		Risk cutoff >30% *n* (%)	
		WHO/ISH	Globorisk	WHO/ISH	Globorisk	WHO/ISH	Globorisk
Age >60 years	282	124 (43.9)	68 (24.1)	77 (27.3)	114 (40.4)	37 (13.1)	49 (17.3)
Female	530	367 (69.2)	123 (23.2)	78 (14.7)	213 (40.1)	39 (7.3)	90 (16.9)
Tobacco present	58	27 (46.5)	14 (24.1)	19 (32.7)	26 (44.8)	14 (24.1)	12 (20.7)
Diabetes present	414	241 (58.2)	96 (23.1)	91 (21.9)	159 (38.4)	45 (10.8)	63 (15.2)
SBP >140 (in mm Hg)	215	114 (53.0)	41 (19.0)	59 (27.4)	91 (42.3)	37 (17.2)	43 (20.0)
Total cholesterol ≥200 (in mg/dL)*	170	81 (47.6)	43 (25.2)	44 (25.8)	62 (36.4)	23 (13.5)	23 (13.5)

*36 values (4.7%) are missing; SBP=systolic blood pressure; WHO/ISH=World Health Organization/International Society of Hypertension

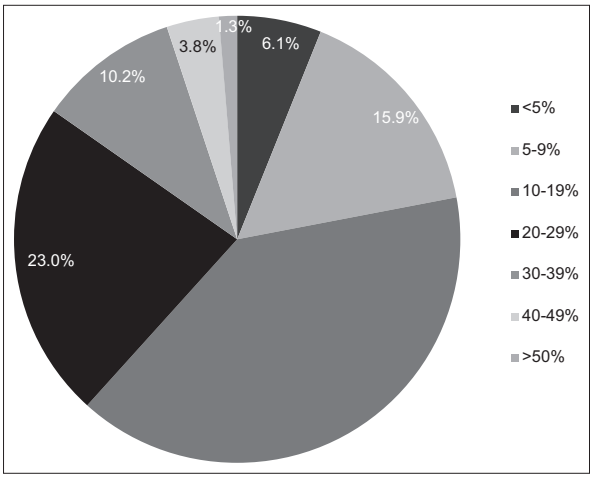

Figure 2: Distribution of study participants based on different Globorisk categories (N = 760)

79.2%, Georgia 83.1%, Sri Lanka 94.9%, Nepal 87.2%, and China 96.1%).[13]

WHO/ISH charts have identified a higher proportion of patients belonging to the low-risk category than the Globorisk chart in predicting CVD risk. The majority (71%) of patients were categorized as having <10% risk, while the same risk was attributed to only 22% of the patients by Globorisk.[16-18]

The percentage of agreement was found to be very low in each category of risk into which the patients were divided – the highest being for the 10–<20% category for which there was 39% agreement, and the least being for ≥40% category, for which it was 0%. The weighted kappa statistic was used to measure the degree of deviation on an ordered scale and to take into account the effect of chance. However, it was found that there was no level of agreement between the two risk assessment tools.

Since there is no standard cutoff for stratifying populations into high-risk and low-risk categories for CVD events.[6,14] CVD risk events were categorized into low-risk models using a cutoff of <10% and high-risk models using a cutoff of >20% and >30%. In the low-risk model, participants who had aged more than 60 years, females, with tobacco intake, diabetics, uncontrolled hypertensive, and unsatisfactory cholesterol levels were higher in WHO/ISH risk as compared to the Globorisk prediction chart, whereas in the high-risk model, the above findings were comparatively lesser in the WHO/ISH chart. This shows that the WHO/ISH chart underestimates the real cardiac risk.[19] This could be due to many reasons. WHO/ISH chart is WHO region-specific, whereas Globorisk measures country-specific risk charts for predicting individuals' 10-year risk of cardiovascular disease. It is unable to adequately recognize high-risk individuals – morbid obesity, sedentary lifestyle, and family history of NCDs – hence labeling them as low cardiac risk based on the six predefined parameters. Also, the antihypertensive and statin therapies alter the SBP and the TC misclassifying the risk categories.

The Globorisk prediction tool identified more patients as belonging to the high-risk category for a CVD event.[5]

Moreover, 15% of the patients were assessed to have ≥30% risk by Globorisk against 7% as per the WHO/ISH charts. Similarly, 38% of the patients were assessed to have ≥20% risk by Globorisk against 13% as per the WHO/ISH charts. This demonstrates that Globorisk has the potential to become one of the best global parameters for CVD risk estimation. Given the rise of NCDs in LMIC, further calibration, validation, and economic studies may be needed to assess the cost-effectiveness of risk prediction by this tool in such settings.[20]

WHO/ISH charts have been recommended in LMIC.[21] The biggest advantage is its simplicity and the option of cholesterol.[22] However, as found in repeated studies regarding its inaccuracy, it will lead to undermining the risk and categorizing high-risk people into the low CVD group in LMIC.[14,16,23,24] This will further contribute to more resources being spent in resource-constraint settings, and yet high-risk people will be missed increasing the economic and health burden for all.

Risk-based prevention of CVD is a major strategy proposed by national and international guidelines.[6] CVDs can be prevented either by the total risk approach, that is, using simple time-saving prediction charts for screening the masses, or by a single risk approach, that is, by screening a single parameter like BP or TC. In LMIC, the former is preferred.[25,26] For this reason, proper policies need to be framed by the government. However, there is still no universal consensus on the threshold level (>30% vs. 20%) that is required to make a decision for treatment, and hence further studies need to be done using the Globorisk prediction chart.

Conclusion

Globorisk's identification of a higher number of high-risk patients for CVD suggests its potential as a reliable global measure for assessing CVD risk. With the increasing incidence of NCDs in LMIC, additional research is essential to assess the cost-effectiveness of using this tool for risk prediction in these settings.

Ethical approval

The Jawaharlal Institute of Postgraduate Medical Education and Research Institutional Ethics Committee approved the study.

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Nil.

Conflicts of interest

There are no conflicts of interest to declare.

References

1. Narain R, Saxena S, Goyal A. Cardiovascular risk prediction: A comparative study of Framingham and quantum neural network based approach. Patient Prefer Adherence 2016;10:1259-70.
2. Prabhakaran D, Jeemon P, Roy A. Cardiovascular diseases in India: Current epidemiology and future directions. Circulation 2016;133:1605-20.
3. Pletcher MJ, Moran AE. Cardiovascular risk assessment. Med Clin North Am 2017;101:673-88.
4. WHO | WHO/ISH cardiovascular risk prediction charts. WHO. Availablefrom: https://www.who.int/cardiovascular_diseases/guidelinees/Chart_predictions/en/. [Last accessed on 2019 May 04].
5. Hajifathalian K, Ueda P, Lu Y, Woodward M, Ahmadvand A, Aguilar-Salinas CA, *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;3:339-55.
6. 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 - The Lancet Diabetes & Endocrinology [Internet]. Available from: https://www.thelancet.com/journals/landia/article/PIIS2213-8587(17)30015-3/fulltext. [Last accessed on 2019 May 4].
7. Collins D, Lee J, Bobrovitz N, Koshiaris C, Ward A, Heneghan C. whoishRisk – an R package to calculate WHO/ISH cardiovascular risk scores for all epidemiological subregions of the world. F1000Research [Internet] 2017:5. Available from:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5345772/. [Last accessed on 2019 May 12].
8. Guidelines for Management of Type 2 Diabetes | Indian Council of Medical Research | Government of India [Internet]. Available from: https://www.icmr.nic.in/content/guidelines-management-type-2-diabetes. [Last accessed on 2019 May 04].
9. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, *et al*. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA 2003;289:2560-72.
10. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002;106:3143-421.
11. WHO STEPS surveillance manual : the WHO STEPwise approach to chronic disease risk factor surveillance / Noncommunicable Diseases and Mental Health, World Health Organization [Internet]. Available from: https://apps.who.int/iris/handle/10665/43376. [Last accessed on 2019 May 04].
12. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. - PubMed - NCBI [Internet]. Available from: https://www.ncbi.nlm.nih.gov/pubmed/14726171. [Last accessed on 2019 May 04].
13. Mendis S, Lindholm LH, Anderson SG, Alwan A, Koju R, Onwubere BJC, *et al*. Total cardiovascular risk approach to improve efficiency of cardiovascular prevention in resource constrain settings. J Clin Epidemiol 2011;64:1451-62.
14. Selvarajah S, Kaur G, Haniff J, Cheong KC, Hiong TG, van der Graaf Y, *et al*. Comparison of the Framingham Risk Score, SCORE and WHO/ISH cardiovascular risk prediction models in an Asian population. Int J Cardiol 2014;176:211-8.
15. Landis JR, Koch GG. The Measurement of Observer Agreement for Categorical Data. Biometrics 1977;33:159-74.
16. Otgontuya D, Oum S, Buckley BS, Bonita R. Assessment of total cardiovascular risk using WHO/ISH risk prediction charts in three low and middle income countries in Asia. BMC Public Health 2013;13:539.
17. Herath M, Weerarathna T, Umesha D. 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 2015;583.
18. Norhayati M, Amirah SS, Husniati YL. Cardiovascular risk: associated factors, assessment and agreement between WHO/ISH risk prediction chart and Framingham Scoring System among Primary Care Patients in Kelantan, Malaysia. Public Health 2013;5:12.
19. Maldonado S, Lafuente MV, Benjamín M, González Puche E, Dorme G, Longarini D, *et al*. Usefulness of Remote Monitoring of Pediatric Patients with Cardiac Implantable Electronic Devices. Rev Argent Cardiol 2018;86:28-32.

20. Valaulikar R, Ps B, Bhat RA. Assessment of 10-Year Risk of Developing a Major Cardiovascular Event in Type-2 Diabetes Patients Attending a Hospital in Davangere, Karnataka. 2017;8:5.
21. Mendis S, Lindholm LH, Mancia G, Whitworth J, Alderman M, Lim S, *et al*. World Health Organization (WHO) and International Society of Hypertension (ISH) risk prediction charts: assessment of cardiovascular risk for prevention and control of cardiovascular disease in low and middle-income countries. J Hypertens 2007;25:1578-82.
22. Savitharani B, Madhu B, Renuka M, Sridevi, Ashok N. Utilization of who-ish 10-year cvd risk prediction chart as a screening tool among supporting staff of a tertiary care hospital, Mysuru, India. Heart India 2016;4:13.
23. Tulloch-Reid MK, Younger NO, Ferguson TS, Francis DK, Abdulkadri AO, Gordon-Strachan GM, *et al*. Excess Cardiovascular Risk Burden in Jamaican Women Does Not Influence Predicted 10-Year CVD Risk Profiles of Jamaica Adults: An Analysis of the 2007/08 Jamaica Health and Lifestyle Survey. PLoS ONE [Internet] 20138(6). Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3689813/. [Last accessed on 2019 May 05].
24. Nordet P, Mendis S, Dueñas A, de la Noval R, Armas N, de la Noval IL, *et al*. Total cardiovascular risk assessment and management using two prediction tools, with and without blood cholesterol. MEDICC Rev 2013;15:36-40.
25. Ghorpade AG, Shrivastava SR, Kar SS, Sarkar S, Majgi SM, Roy G. Estimation of the cardiovascular risk using World Health Organization/International Society of Hypertension (WHO/ISH) risk prediction charts in a rural population of South India. Int J Health Policy Manag 2015;4:531-6.
26. Fatema K, Zwar NA, Milton AH, Rahman B, Ali L. Application of two versions of the WHO/international society of hypertension absolute cardiovascular risk assessment tools in a rural Bangladeshi population. BMJ Open 2015;5:e008140.