# Place of cardiovascular risk prediction models in South Asians; agreement between Framingham risk score and WHO/ISH risk charts

Chamila Mettananda[1], Nadun Gunasekera[1], Ruth Thampoe[1], Sumudu Madhurangi[1], and Arunasalam Pathmeswaran[1]

[1]University of Kelaniya Faculty of Medicine

June 26, 2020

**Abstract**

Introduction and Objectives There are no cardiovascular risk prediction models developed in South Asian cohorts. Therefore, different risk models not validated in South Asians are being used. We aimed to compare cardiovascular risk predictions of Framingham risk score (FRS) and World health organization/International society of hypertension (WHO/ISH) charts for agreement in a sample of South Asians. Methods 10-year cardiovascular risk predictions of patients without previous cardiovascular diseases attending a non-communicable disease clinic were calculated using FRS (with BMI and with cholesterol) and WHO/ISH charts (with and without cholesterol). Patients were categorized into low(<20% ) and high([?]20%) cardiovascular risk groups on risk predictions. Agreement in risk categorisation with different prediction models was compared using Cohen's kappa coefficient($\varkappa$). Results 169 patients (females 130(81.1%)) mean age 65 ±6.9 years were studied. 80(47.3%), 62(36.7%), 18(10.7%), and 16(9.5%) were predicted high-risk by FRS BMI-based, FRS cholesterol-based, WHO/ISH without-cholesterol and WHO/ISH with-cholesterol models, respectively. Agreement between the two FRS models ($\varkappa$ = 0.736, p<0.0001) and the two WHO/ISH models ($\varkappa$ = 0.804, p<0.0001) in stratifying patients into high and low-risk groups, were "good". However, the agreements between, FRS BMI-based and WHO/ISH without-cholesterol models ($\varkappa$ = 0.234, p<0.0001) and FRS cholesterol-based and WHO/ISH with-cholesterol models ($\varkappa$ = 0.306, p<0.0001) were only "fair". Conclusion Cardiovascular risk predictions of FRS were higher than WHO/ISH charts and the agreement in risk stratification was not satisfactory in Sri Lankans. Therefore, different cardiovascular risk prediction models should not be used interchangeably in the follow-up of South Asians.

**What is already known about this topic?**

Framingham score predicts 10-year cardiovascular risk in White Caucasians. WHO/ISH charts were made to risk predict patients of different WHO Region. Asians have different genetics and high prevalence of cardiovascular diseases than white Caucasians. However, there are no risk prediction models developed in South Asians. Therefore, different risk prediction models are being used for risk stratification of South Asians living worldwide.

**What does this article add?'**

We compared risk predictions of Framingham score and WHO/ISH risk charts for agreement in risk prediction of Sri Lankan and found that it is not satisfactory.

Therefore, different cardiovascular risk prediction models should not be used interchangeably in the follow-up of South Asians.

**Introduction and Objectives**

One-fourth of the world's population is in South Asia[1] and South Asian migrants are found worldwide. Cardiovascular diseases (CVD) are the commonest cause of death globally and three-quarters of CVD deaths take place in low- and middle-income countries [2]. Prevention of CVD is the most cost-effective especially for developing countries like South Asian countries. A total risk-based approach is recommended for CVD prevention[3]. Cardiovascular (CV) risk prediction is an essential entity in this approach. However, there are no CV risk prediction models developed in South Asians or South-East Asians. Therefore, different risk models developed in white Caucasians; e.g. Framingham risk scores (FRS)[4] or developed by modelling approach; e.g. World health organization/International society of hypertension (WHO/ISH) risk charts [5]; are being used to risk predict South Asians. Both the standard models (FRS with- with-cholesterol and WHO/ISH charts with-cholesterol)and the low-information models made up without cholesterol values in equation ( FRS with-BMI and WHO/ISH without-cholesterol) are being used depending on the availability of recourses. However, the best risk score in risk prediction of South Asians is not known. Only a very few studies have looked into this question and the literature is inconclusive and also the available studies are difficult to be compared [6].

South Asians have a high risk of CVD compared to other Asians and white Caucasians [7]. They have a different CVD profile; high risk of CVD than Whites in the UK [8,9] and America[10], a rising trend of CVDs despite CVDs having a declining trend in the west [11], more strokes than coronary heart diseases and CVDs at younger ages[12,13]. Furthermore, they have different genetics and have high prevalences of vascular risk factors like diabetes mellitus and metabolic syndrome than white Caucasians [14-17]. Therefore, the risk prediction models developed of Western cohorts might not be accurately predicting CV-risk of South Asians.

Therefore, we compared 10-year general-cardiovascular risk predictions of four commonly used models in South Asians; Framingham BMI-based, Framingham cholesterol-based, WHO/ISH with-cholesterol and WHO/ISH without-cholesterol for agreement in a sample of Sri Lankans without prior CVDs.

Methods

All consecutive adults attending a non-communicable disease clinic at the Faculty of Medicine, University of Kelaniya, Sri Lanka were screened in 2019 over one year. Patients with vascular risk factors and having complete data to calculate CV-risk scores but without a past history of CVD were enrolled in this study. Data on vascular risk factors were collected using an interviewer-administered questionnaire and referring clinic records. Height and weight were measured at the clinic. Two blood pressure measurements were done in the left arm 5 minutes apart in seated position with a mercury sphygmomanometer. 10-year CV-risk predictions of all participants were calculated using four models; FRS BMI-based, FRS cholesterol-based, WHO/ISH charts without and with-cholesterol. 10-year risk predictions of developing a fatal or non-fatal CVD were calculated using the formulas; Framingham 10-year general CVD risk [18] and WHO/ISH charts meant for South-East Asian Region- B (SEAR- B) [19]. FRS was calculated using age, systolic blood pressure (SBP), antihypertensive use, current smoking status, diabetes status, and body mass index (BMI) or total cholesterol (TC) and high-density lipoprotein (HDL) level. WHO/ISH risk predictions were calculated using age, SBP, current smoking status, diabetes status and additionally with total cholesterol for WHO/ISH with-cholesterol estimate. BMI was calculated with weight and height. The mean of the two blood pressure measurements made at the clinic was used as the SBP. The most recent recorded TC and HDL values within the previous year were used in risk calculations. All current smokers and those who quit smoking less than 1 year before the assessment were considered current smokers. Persons with self-reported diabetes mellitus cross-checked with medical records or taking insulin or oral hypoglycaemic drugs were considered as having diabetes mellitus according to the World Health Organization, criteria[20]. People with self-reported hypertension cross-checked with medical records, physician-diagnosed hypertension, or taking antihypertensive medications were defined as hypertension, according to the Joint National Committee (JNC) VII criteria[21]. Past history of hyperlipidaemia was defined as someone with physician-diagnosed hyperlipidaemia in medical records on the National Cholesterol Education Program III criteria[22]. Patients were categorised into two risk groups using risk estimates; low risk (<20% ) and high risk ([?] 20%) risk.

IBM SPSS statistics version 22.0 was used for analysis. Continuous variables were reported as means with

standard deviation (SD) or 95% confidence intervals, and categorical variables were reported as percentages. The significance level was set at p <0.05. Mean Framingham risks of BMI-based and cholesterol-based models were compared using the paired sample Students t-test. Risk predictions of the models were compared for agreement across risk categories with Cohen's kappa coefficient ($\kappa$ ). The strength of agreement was interpreted as,$\kappa$ : [?] 0.20 = poor, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = good and 0.81–1.00 = very good [23-25].

Ethics approval was obtained from the Ethics Review Committee, Faculty of Medicine, University of Kelaniya, Sri Lanka. Informed consent of all the patients was obtained.

**Results**

169 patients without previous CVDs; 130(81.1%) females, mean 65 ±6.9 years (range 47-78 years) were studied. Baseline characteristics, risk factors, and medication use of the sample are shown in Table 1. Of the total population, 56.2% were 65 years or older. The majority, 98.8% were Singhalese. Risk factor distribution among the study participants was, hypertension 66.9%, hyperlipidemia 89.9%, diabetes mellitus 46.7%, smoking 2.4%, and obesity 8.3%. Patients were on medications; antihypertensives 65.7%, lipid-lowering medications 89.9%, anti-diabetic medications 46.2%, and antiplatelet medications 15.5% among the total population. Men in comparison to women were older ( 68 ± 4.79 and 64 ± 7.03 years, p <0.0001 respectively), smoked more (12.5%, 0.0%, p <0.0001) and were less likely to be on lipid-lowering medications (77.4%, 92.7%, p=0.019).

Table 1 **Baseline characteristics of the study population**

Comparison of risk factors used in the calculation of Framingham and WHO/ISH scores and mean FRS of men and women are shown in Table 2. There was no significant difference in the history of diabetes mellitus, use of anti-hypertensive medications, and measured risk factors like BMI, SBP, TC and HDL levels between men and women. The two groups were only different from age and smoking status. However, the mean FRS of men were significantly higher than that of females with both BMI-based (male 28.94 ± 3.17, female 17.10 ±8,62) and cholesterol-based (male 26.47 ± 4.99, female 13.86 ± 8.25) models.

Table 2 **CV-risk factors used in risk calculations and mean Framingham risk scores by sex**

Patients were categorised into low(<20% ) and high(≥20%) CV-risk groups on risk predictions (Table 3). 80(47.3%), 62 (36.7%), 18 (10.7%), 16 (9.5%), of the participants were predicted high risk by FRS BMI-based, FRS cholesterol-based, WHO/ISH without-cholesterol and WHO/ISH with-cholesterol models, respectively. Agreement between different risk models in categorizing patients into low and high-risk groups was studied using Cohen's kappa statistics (Table 3).

Table 3 **10-year CV-Risk stratification of the sample with different risk models and inter-rater agreement**

The two versions of FRS models; BMI-based and cholesterol-based were in good agreement in stratifying patients into high and low-risk groups, $\varkappa = 0.736$, p<0.0001. Similarly, the two versions of WHO/ISH models without-cholesterol and with-cholesterol were also in good agreement in stratifying patients into high and low-risk groups; $\varkappa = 0.804$, p<0.0001. However, the agreement between, FRS BMI-based model and WHO/ISH without-cholesterol model in stratifying patients into high and low-risk groups was fair; $\varkappa = 0.234$, p<0.0001 and FRS BMI-based risk estimates were higher than WHO/ISH without-cholesterol estimates. Furthermore, the agreement between, FRS cholesterol-based model and WHO/ISH with-cholesterol model in stratifying patients into high and low-risk groups was also fair; $\varkappa = 0.306$, p<0.0001 and FRS cholesterol-based risk estimates were higher than WHO/ISH with-cholesterol estimates.

**Discussion**

This is the first study comparing 10-year cardiovascular risk predictions of Framingham and WHO/ISH risk models for agreement among Sri Lankans and adds to the limited literature from South Asia and South-East Asian Region (SEAR) – B. We observed that FRS and WHO/ISH (SEAR-B) models were not in good

agreement in predicting high-risk patients. Therefore, the FRS and WHO/ISH risk charts should not be used interchangeably in risk stratification of individual patients during follow-ups and the same risk model should be used in serial follow-ups of individual patients of South Asia and South-East Asian Region(SEAR).

Furthermore, we observed that the low information risk models, which do not need cholesterol values in risk estimation (e.g. FRS with BMI-and WHO/ISH without-cholesterol) were, good in agreement with standard risk models using cholesterol values (e.g. FRS with-cholesterol and WHO/ISH with-cholesterol) in risk stratification of Sri Lankans into low and high-risk groups. This was also observed in a study of South Asians living in Canada (except in men aged 60-74 years) where they compared FRS BMI-based and cholesterol-based models [26]. Therefore, the low information models can be used in the risk stratification of patients in poor resource settings where laboratory facilities are space to measurer cholesterol levels among Sri Lankans and South Asians. However, the dissimilarities reported need be interpreted cautiously as FRS predicts the risk of all fatal and non-fatal CVDs including coronary, cerebrovascular, and peripheral arterial disease and heart failure while WHO/ISH score predicts only fatal and non-fatal myocardial infarctions and strokes and therefore the two tools are not directly comparable.

Ranawaka et al. [27] studied cardiovascular risk estimates of a Sri Lankan community, in 2007 and observed 8.2% prevalence of high-risk patients using the WHO/ISH model in a cohort of patients with and without previous CVDs. We studied a cohort of Sri Lankans without previous CVDs in 2019 and observed 9.5% of them being at high-risk the with WHO/ISH(-with cholesterol) model. Therefore, our findings seem consistent with previous literature. Ranawaka et al. compared risk predictions of WHO/ISH, National Cholesterol Education Program - Adult Treatment Panel III (NCEP-ATP III) and Systematic Coronary Risk Evaluation (SCORE) models and observed a difference between the predictions of the three models; 8.2%, 25.4%, and 11.8% respectively being categorised as high risk. NCEP-ATP III model, which is a derivative of FRS, predicted 25.4% of the Sri Lankan being at high risk, compared to 8.4% predictions with WHO/ISH model, which was much higher than the prediction of NCEP-ATP III model. We also observed that the predictions of FRS were higher than that of WHO/ISH models.

Results of other Asian studies comparing of Framingham score and WHO/ISH charts also reports the two being different but the literature on best risk estimates for South Asians is not consistent. Several studies identified WHO/ISH score underestimating the risk of Asians compared to FRS [28-30]. It was reported that The FRS and SCORE-high models, but not the WHO/ISH model can be used to identify high cardiovascular risk in Malaysians [28]. The same was reported by a few other Asian studies of Cambodia, Mongolia, Malaysia, and Jamaica [31,32]. Few Indian studies reported the FRS CV risk assessment model has performed the best to identify patients at high CVD risk while WHO and ASCVD calculators were the worst [29,30,33]. In contrast, Asia Pacific Cohort Studies Collaboration observed that FRS overestimated CV-risk in Chinese but was adequately predictive when it was recalibrated using contemporary data. However, this study did not assess CV-risk with WHO/ISH r charts[12]. Further to that, some reported that the Framingham and British scores underestimate CVD risk in Asian Indians and the need for developing specific models for them [34].

CV-risk assessment should be based ideally on data of epidemiological risk factors appropriate to the population to which it is applied to[35]. WHO/ISH charts were developed using extrapolated data on CV risk factors in different geographical regions but have not been systematically validated prospectively in most populations and therefore may perform poorly [5]. Framingham score may not be reflecting CV-risk of Asians accurately due to several reasons. Framingham risk score was developed using data of Americans in an era when the CVD risk was very high in the USA but was less in Asia[18]. It does not take into account some important risk factors relevant to Asians like abdominal obesity, physical inactivity, and family history of premature CVD, which are currently increasing in prevalence among Asians. The differential effect of ethnic groups, environments, and genes on the risk of CVD could also play a part[36,37]. Also, Asians are relatively younger when they develop CVDs compared to white Caucasians [12,13] while "age" is a very strong risk factor in the Framingham model. Therefore, FRS may underestimate mate CV-risk of young Asian patients. Therefore, the best model to risk stratify South Asians is still a query.

After all, a screening tool should be able to detect all patients at high-risk without missing high-risk patients

while having an acceptable false positive detection rate. The prevalence of high-risk patients according to WHO/ISH (SEAR – B) model is much lower than that with the FRS model and therefore, maybe a lot of high-risk patients fromSEAR – B region are not getting adequate primary prevention measures, due to being risk-stratified with WHO/ISH (SEAR – B) model. We cannot be certain until a new model is developed of a cohort of South Asians or the existing risk scores are validated in them.

Our study has many strengths. This is a very thorough study with complete data. We used only the patients who did not have any previous CVDs. We have calculated risk predictions of a given patient using 4 models and compared them in pairs and therefore there is no selection bias. However, there are a few limitations of our study as well. This is not a random sample of Sri Lanka and is of a high-risk population and therefore, the rates of risk factors prevalence and mean risk scores of this cohort may not be generalizable Sri Lanka. However, the conclusion that "FRS and WHO/ISH charts are only in satisfactory agreement in the prediction of high-risks Sri Lankans " is generalizable, as we arrived at this conclusion by comparing risk scores within each patient, nullifying any selection bias.

**Conclusion**

The agreement between CV-risk predictions of Framingham score and WHO/ISH charts was not satisfactory in Sri Lankans. However, the two versions (standard and low information models) of the Framingham score were in good agreement. Similarly, the two versions of the WHO/ISH charts (standard and low information models) were also in good agreement.

Therefore, in the absence of a specific or validated risk model for South Asians, using the same risk model in serial risk calculations of individual patients would be the best.

**Acknowledgments**

We acknowledge all the study participants of this study.

Funding - none

References

1. Worldometers. Southern Asia Population. 2020; https://www.worldometers.info/world-population/southern-asia-population/. Accessed 30.052020.

2. WHO. Cardiovascular diseases (CVDs). 2017; https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds). Accessed 28.05.2020, 2020.

3. Mendis S, Lindholm LH, Anderson SG, et al. Total cardiovascular risk approach to improve efficiency of cardiovascular prevention in resource constrain settings. *Journal of clinical epidemiology.*2011;64(12):1451-1462.

4. Framingham heart study - cardiovascular-disease-10-year-risk. 2016; https://framinghamheartstudy.org/fhs-risk-functions/cardiovascular-disease-10-year-risk/.

5. WHO. World Health organization/International Society of Hypertension risk prediction charts for 14 WHO epidemiological sub-regions In: WHO; 2007. Accessed 16.04.2020.

6. Gopal DP, Usher-Smith JA. Cardiovascular risk models for South Asian populations: a systematic review. *Int J Public Health.*2016;61(5):525-534.

7. Volgman Annabelle S, Palaniappan Latha S, Aggarwal Neelum T, et al. Atherosclerotic Cardiovascular Disease in South Asians in the United States: Epidemiology, Risk Factors, and Treatments: A Scientific Statement From the American Heart Association. *Circulation.*2018;138(1):e1-e34.

8. Cappuccio FP, Oakeshott P, Strazzullo P, Kerry SM. Application of Framingham risk estimates to ethnic minorities in United Kingdom and implications for primary prevention of heart disease in general practice: cross sectional population based study. *BMJ.*2002;325(7375):1271.

9. Bellary S, O'Hare JP, Raymond NT, et al. Premature cardiovascular events and mortality in south Asians with type 2 diabetes in the United Kingdom Asian Diabetes Study - effect of ethnicity on risk. *Curr Med Res Opin.* 2010;26(8):1873-1879.

10. Enas EA, Garg A, Davidson MA, Nair VM, Huet BA, Yusuf S. Coronary heart disease and its risk factors in first-generation immigrant Asian Indians to the United States of America. *Indian Heart J.*1996;48(4):343-353.

11. Gaziano TA, Bitton A, Anand S, Abrahams-Gessel S, Murphy A. Growing Epidemic of Coronary Heart Disease in Low- and Middle-Income Countries.*Current problems in cardiology.* 2010;35(2):72-115.

12. Barzi F, Patel A, Gu D, et al. Cardiovascular risk prediction tools for populations in Asia. *Journal of epidemiology and community health.* 2007;61(2):115-121.

13. Ueshima H, Sekikawa A, Miura K, et al. Cardiovascular disease and risk factors in Asia: a selected review. *Circulation.*2008;118(25):2702-2709.

14. Ranasinghe P, Mathangasinghe Y, Jayawardena R, Hills AP, Misra A. Prevalence and trends of metabolic syndrome among adults in the asia-pacific region: a systematic review. *BMC Public Health.*2017;17(1):101.

15. Pan WH, Yeh WT, Weng LC. Epidemiology of metabolic syndrome in Asia.*Asia Pacific journal of clinical nutrition.* 2008;17 Suppl 1:37-42.

16. Nanditha A, Ma RCW, Ramachandran A, et al. Diabetes in Asia and the Pacific: Implications for the Global Epidemic. *Diabetes Care.*2016;39(3):472-485.

17. Ramachandran A, Snehalatha C, Shetty AS, Nanditha A. Trends in prevalence of diabetes in Asian countries. *World J Diabetes.*2012;3(6):110-117.

18. D'Agostino RB, Sr., Vasan RS, Pencina MJ, et al. General cardiovascular risk profile for use in primary care: the Framingham Heart Study. *Circulation.* 2008;117(6):743-753.

19. Mendis S, Lindholm LH, Mancia G, 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(8):1578-1582.

20. WHO/IDF. *Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia : report of a WHO/IDF consultation.* Geneva: WHO; 2006.

21. Chobanian AV, Bakris GL, Black HR, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: The JNC 7 report. *Journal of the American Medical Association* 2003;289(19):2560-2571.

22. Executive Summary of The 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). *Journal of the American Medical Association.*2001;285(19):2486-2497.

23. Sim J, Wright CC. The Kappa Statistic in Reliability Studies: Use, Interpretation, and Sample Size Requirements. *Physical Therapy.*2005;85(3):257-268.

24. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics.* 1977;33(1):159-174.

25. Altman DG. *Practical statistics for medical research.* London: Chapman and Hall; 1991.

26. Jones CA, Ross L, Surani N, Dharamshi N, Karmali K. Framingham ten-year general cardiovascular disease risk: agreement between BMI-based and cholesterol-based estimates in a South Asian convenience sample. *PLoS One.* 2015;10(3):e0119183-e0119183.

27. Ranawaka U, Wijekoon N, Pathmeswaran P, et al. Risk estimates of cardiovascular diseases in a Sri Lankan community. *The Ceylon medical journal.* 2016;61:11.

28. Selvarajah S, Kaur G, Haniff J, et al. Comparison of the Framingham Risk Score, SCORE and WHO/ISH cardiovascular risk prediction models in an Asian population. *International Journal of Cardiology.*2014;176(1):211-218.

29. Bansal M, Kasliwal RR, Trehan N. Relationship between different cardiovascular risk scores and measures of subclinical atherosclerosis in an Indian population. *Indian Heart Journal.*2015;67(4):332-340.

30. Bansal M, Kasliwal RR, Trehan N. Comparative accuracy of different risk scores in assessing cardiovascular risk in Indians: A study in patients with first myocardial infarction. *Indian Heart Journal.*2014;66(6):580-586.

31. 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(1):539.

32. Tulloch-Reid MK, Younger NO, Ferguson TS, 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.*2013;8(6):e66625.

33. Garg NM, Subrat K., Kapoor A, Tewari S, Kumar S, Khanna R, Goel PK. Comparison of different cardiovascular risk score calculators for cardiovascular risk prediction and guideline recommended statin uses.*Indian Heart Journal.* 2017;69(4):458-463.

34. Kanjilal S, Rao VS, Mukherjee M, et al. Application of cardiovascular disease risk prediction models and the relevance of novel biomarkers to risk stratification in Asian Indians. *Vasc Health Risk Manag.* 2008;4(1):199-211.

35. Smith Sidney C, Jackson R, Pearson Thomas A, et al. Principles for National and Regional Guidelines on Cardiovascular Disease Prevention.*Circulation.* 2004;109(25):3112-3121.

36. D'Agostino RB, Sr, Grundy S, Sullivan LM, Wilson P, for the CHDRPG. Validation of the framingham coronary heart disease prediction scores: Results of a multiple ethnic groups investigation. *Journal of the American Medical Association.* 2001;286(2):180-187.

37. Marrugat J, D'Agostino R, Sullivan L, et al. An adaptation of the Framingham coronary heart disease risk function to European Mediterranean areas. *Journal of epidemiology and community health.* 2003;57(8):634-638.

**Tables**

Table 1 Baseline characteristics of the study participants

| | Male | Female | Total | P* |
|---|---|---|---|---|
| | n=32 | n=137 | n=169 | |
| Age, y, mean (SD) | 68.06(4.79) | 63.68(7.03) | 65 ± 6.9 | <0.0001 |
| Age [?] 60 y, n (%) | 30(93.8) | 94(68.6) | 124(73.4) | 0.003 |
| **Level of education**+, n (%) | | | | 0.059 |
| Up to grade 5 | 0(0.0) | 6(5.1) | 6 (4.1) | |
| Up to grade 8 | 10(33.3) | 55(46.6) | 65 (43.9) | |
| Up to grade 10 | 12(40.0) | 47(39.8) | 59 (39.9) | |
| Up to grade 12 | 6(20.0) | 8(6.8) | 14 (9.5) | |

| | Male | Female | Total | P* |
|---|---|---|---|---|
| Graduate/ postgraduate | 2 (6.7) | 2(1.7) | 4 (2.7) | |
| **Ethnicity**, n (%) | **Ethnicity**, n (%) | | | 1.000 |
| Sinhalese | 32(100) | 135(98.8) | 167(98.8) | |
| Tamils | 0 (0.0) | 2(1.2) | 2(1.2) | |
| **Past medical history**, n (%) | **Past medical history**, n (%) | **Past medical history**, n (%) | **Past medical history**, n (%) | **Past medical history**, n (%) |
| Hypertension | 25(78.1) | 88(64.2) | 113(66.9) | 0.150 |
| Hyperlipidemia | 25(78.1) | 127(92.7) | 152(89.9) | 0.220 |
| Diabetes mellitus | 20(62.5) | 59(43.1) | 79(46.7) | 0.520 |
| Current smoking | 4(12.5) | 0 (0.0) | 4(2.4) | <0.0001 |
| Obesity (BMI>30) | 2(6.3) | 12(8.8) | 14(8.3) | 1.000 |
| **Premorbid medications,** n (%) : | **Premorbid medications,** n (%) : | **Premorbid medications,** n (%) : | **Premorbid medications,** n (%) : | **Premorbid medications,** n (%) : |
| Anti-hypertensive medications | 24(75.0) | 87(63.5) | 111(65.7) | 0.301 |
| Lipid-lowering medications ++ | 24(77.4) | 127(92.7) | 151(89.9) | 0.019 |
| Anti-diabetic medication | 18(56.3) | 60(43.8) | 78(46.2) | 0.239 |
| Antiplatelet medication § | 3(10.0) | 23(16.8) | 26(15.5) | 0.577 |

* p-value between male and female

Missing data; + 21, ++ 1, § 1

Table 2 **CV-risk factors used in risk calculations and mean Framingham risk predictions by sex**

| Mean(SD) or n(%) | Male | Female | p |
|---|---|---|---|
| Age (years), mean(SD) | 68.06(4.79) | 63.68(7.03) | <0.0001 |
| Diabetes mellitus, n (%) | 20(62.5) | 59(43.1) | 0.520 |
| Current smoking, n (%) | 4(12.5) | 0 (0.0) | <0.0001 |
| On antihypertensive medications, n (%) | 24(75.0) | 87(63.5) | 0.301 |
| BMI (kg/m$^2$), mean(SD) | 24.71(3.85) | 24.86(3.80) | 0.85 |
| Systolic blood pressure (mmHg), mean(SD) | 136.38(22.92) | 131.91(18.81) | 0.25 |
| Total cholesterol (mg/dl), mean(SD) | 174.66(27.41) | 183.79(33.04) | 0.15 |
| High density lipoprotein (mg/dl), mean(SD) | 48.58(9.58) | 53.07(16.64) | 0.145 |
| **FRS (BMI-based), mean(SD)** | 28.94(3.17) | 17.10(8.62) | <0.0001 |
| **FRS (cholesterol-based), mean(SD)** | 26.47(4.99) | 13.86(8.25) | <0.0001 |

FRS=Framingham risk score

Table 3 **10-year CV-Risk stratification of the sample with different risk models and inter-rater agreement**

| | 10-year CV risk | 10-year CV risk | Agreement | Agreement |
|---|---|---|---|---|
| | Low risk (risk <20%) | High risk (risk [?] 20%) | $\kappa$ [a] | P [b] |
| Framingham (BMI-based), n(%) | 89(52.7) | 80(47.3) | 0.736 | <0.0001 |
| Framingham (cholesterol-based), n(%) | 107(63.3) | 62(36.7) | | |
| WHO/ISH (without-cholesterol), n(%) | 151(89.3) | 18(10.7) | 0.804 | <0.0001 |
| WHO/ISH (with-cholesterol), n(%) | 153(90.5) | 16(9.5) | | |
| Framingham (BMI-based), n(%) | 89(52.7) | 80(47.3) | 0.234 | <0.0001 |
| WHO/ISH (without-cholesterol), n(%) | 151(89.3) | 18(10.7) | | |
| Framingham (cholesterol-based), n(%) | 107(63.3) | 62(36.7) | 0.306 | <0.0001 |
| WHO/ISH (with-cholesterol), n(%) | 153(90.5) | 16(9.5) | | |

Cohen's kappa coefficient ($\kappa$ )

**Hosted file**

`Tables_IJCP.docx` available at https://authorea.com/users/337028/articles/462693-place-of-cardiovascular-risk-prediction-models-in-south-asians-agreement-between-framingham-risk-score-and-who-ish-risk-charts