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Original Article

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

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Abstract

Background: World Health Organization/International Society of Hypertension (WHO/ISH) charts have been employed to predict the risk of cardiovascular outcome in heterogeneous settings. The aim of this research is to assess the prevalence of Cardiovascular Disease (CVD) risk factors and to estimate the cardiovascular risk among adults aged >40 years, utilizing the risk charts alone, and by the addition of other parameters.

Methods: A cross-sectional study was performed in two of the villages availing health services of a medical college. Overall 570 subjects completed the assessment. The desired information was obtained using a pre-tested questionnaire and participants were also subjected to anthropometric measurements and laboratory investigations. The WHO/ISH risk prediction charts for the South-East Asian region was used to assess the cardiovascular risk among the study participants.

Results: The study covered 570 adults aged above 40 years. The mean age of the subjects was 54.2 (±11.1) years and 53.3% subjects were women. Seventeen percent of the participants had moderate to high risk for the occurrence of cardiovascular events by using WHO/ISH risk prediction charts. In addition, CVD risk factors like smoking, alcohol, low High-Density Lipoprotein (HDL) cholesterol were found in 32%, 53%, 56.3%, and 61.5% study participants, respectively.

Conclusion: Categorizing people as low (<10%)/moderate (10%-20%)/high (>20%) risk is one of the crucial steps to mitigate the magnitude of cardiovascular fatal/non-fatal outcome. This cross-sectional study indicates that there is a high burden of CVD risk in the rural Pondicherry as assessed by WHO/ISH risk prediction charts. Use of WHO/ISH charts is easy and inexpensive screening tool in predicting the cardiovascular event.

Keywords: Cardiovascular Disease (CVD), Hypertension, Smoking, Non-Communicable Disease (NCD), South India

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Key Messages

Implications for policy makers

- The result of this study can be utilized by the policy-makers to universally incorporate the use of World Health Organization/International Society of Hypertension (WHO/ISH) Cardiovascular Disease (CVD) risk charts in predicting the risk of any fatal outcome.
- The policy-makers can plan and fund more studies on a major scale in their local settings, in order to approximate the probability of risk in the local population.

Implications for public

It has been well documented that the use of the total Cardiovascular Disease (CVD) risk approach can significantly minimize the involved expenditure in contrast to the use of individual risk parameters. As these risk charts are graphical and easy to understand, the general population can be explained about their individual risk, and hence motivated to adopt necessary preventive measures to delay any untoward outcome.

Background

For many years, diseases of infectious origin are the leading cause accounting for mortality, especially in resource-constraint settings (1). However, in the past few decades owing to urbanization/globalization, increased life expectancy, and adoption of harmful lifestyles, Non-Communicable Diseases (NCDs), especially Cardiovascular Disease (CVD) has emerged as one of the leading cause of morbidity, early death, overburdening of the public health infrastructure, and escalating direct/indirect healthcare costs throughout the world (2–4).

CVD results secondary to the abnormalities in the

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cardiovascular system, and includes a wide spectrum of disorders (5). Despite the reduction in the incidence of Coronary Heart Disease (CHD) in developed nations, the scenario in developing nations poses a serious challenge (6). CVD generally results from the interplay of a wide range of genetic, socio-economic, individual, physician-related, environmental factors, and healthcare delivery system-related factors (2,3,5–12). These risk factors have been targeted in separate high-risk groups and in community settings and encouraging results have been obtained (13,14).

In view of the interplay of multiple factors in the etiology of CVDs, it will be wrong to adopt a single risk factor for predicting cardiovascular risk (2–11,15). In fact, the best approach will be to adopt a particular risk chart which considers a maximum number of all probable determinants so that the contribution of each of the risk factors can be ascertained in different regions (15–17). The total risk approach was initially implemented in the developed nations and subsequently they have been employed in other parts of the world after adjustments (16–18). The World Health Organization (WHO) and the International Society of Hypertension (ISH) have formulated CVS risk prediction charts for use in different sections of the globe using the best available mortality and risk factor data (15,19). The proposed chart is a cost-effective tool to stratify the entire population using a risk score and thus presents a ten-year risk of major cardiovascular outcome in 14 of the WHO epidemiological sub-regions. Hence, it is a useful tool to counsel patients to modify their lifestyles or comply with their medicines (19). We have adopted WHO/ISH cardiovascular risk prediction charts in the current study and not the General Framingham Risk Profile (GFRP) because of the augmentation of risk in wide group of population (20,21). The WHO/ISH charts are designed to aid the clinicians in implementing timely preventive measures to improve the life expectancy, quality of life of the risk groups and reduction in the burdening of the health system (4,13,19).

The present study was conducted to assess the prevalence of CVS risk parameters and to estimate the cardiovascular risk among adults aged >40 years, using the WHO/ISH risk charts alone, and with the addition of other parameters.

Methods

A cross-sectional study was performed from November 2011 to January 2012. As per the report of the Census 2011, the Union territory of Pondicherry has a total population of 1.25 million (22).

Study population

Of the three villages under the rural health centre, two villages – Ramanathapuram (population 2,165) and Pillaiyarkuppam (population 2,412) were chosen purposively for the study as they were closer to the centre, and they would facilitate collecting fasting blood samples in the early mornings. The sample size was estimated using OpenEpi version 2.3.10. To detect the prevalence of 5.8% of diabetes (CVD risk factor with the lowest prevalence) with 2% absolute precision, minimum sample needed was 525 (23). Taking into consideration a non-response rate of 25%, it was decided to study 705 subjects. The study sample included persons above 40 years (N= 1,279) of age and cluster sampling method was used. Pilot study showed that if individual subjects were chosen by random or systematic random sampling method, there was dissatisfaction among the people who were left out in the community. Hence, instead of individual subjects, streets were considered as the units of sampling. Thus, four out of nine streets were selected from each village randomly using lots.

Inclusion and exclusion criteria

From the houses of the selected streets, all participants aged more than 40 years (n=705) were invited to take part in the study. Subjects unavailable during home visits on three separate days (n=128) and those who did not wish to participate in the study (n=7) were excluded. In addition, those individuals with confirmed atherosclerotic CVD were excluded from the study. In total, 570 subjects participated in the assessment.

Study tool

After obtaining the verbal informed consent, study participants were interviewed face-to-face using a semi-structured questionnaire. The questionnaire was pre-tested on a group of 30 individuals before its utilization. Also, each of the participants were subjected to anthropometric measurements (i.e. height, weight, and waist circumference); assessment of blood pressure, and laboratory investigations (lipid profile, estimation of fasting and postprandial blood glucose). Lipid profile was measured using fasting blood samples of the study subjects with the help of an Olympus AU400 auto analyzer while glucometer was used for the blood glucose measurement. The set cut-off values for lipid profile were as follows, total cholesterol <200 mg/dl, triglycerides <150 mg/dl, Low-Density Lipoprotein (LDL) <130 mg/dl and High-Density Lipoprotein (HDL) >40 mg/dl for males and >50 mg/dl for females (24). The WHO/ISH cardiovascular risk prediction charts for the South-East Asian region was used to assess the cardiovascular risk among the study participants (19). The predictor variables for the risk prediction were age, gender, smoking, blood pressure, coexistence of diabetes, and serum cholesterol level.

Operational definitions

Education status was categorized as no schooling and attended school (25). For the categorization of the work status (viz. employed and unemployed) guidelines of Census 2001, recommended by the Government of India were utilized (26). BG Prasad modified classification was employed for classifying the study population as per their socio-economic status (27). Physical activity was categorized based on the total Metabolic Equivalents/week (MET/week) as physically inactive (<600 MET/week) and physically active (≥600 MET/week) (28). Smoking was defined as the use of any smoke form of tobacco product in the last six months (29). Alcohol use was defined as consumption of any type of alcohol in the last one year (29). These were further classified as abstainers (never consumed alcohol in past 12 months), grade 1 (<39.9 gm/day), grade 2 (40 to 59.99 gm/day) and grade 3 (>60 gm/day) (30). Study participants were classified as diabetics based on the guidelines proposed by Indian Council of Medical Research (ICMR) [fasting blood sugar (>125 mg/dL) and/or postprandial blood sugar (>200 mg/dL)] (30,31). Furthermore, those individuals who were under treatment with oral hypoglycemic agents/insulin were also labeled as diabetic irrespective of their blood glucose status. Subjects were diagnosed to be hypertensive (if systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg or taking antihypertensive medication).

Height was recorded in standing position with subject's shoes and socks removed prior to measurement. The subject was asked to stand straight on a plane floor so that his heels, buttock and shoulder are in contact with vertical wall. The heels were placed together so that the medial malleoli touch each other. Subject was asked to relax his shoulder and to keep hands and arm loose and relaxed with palm facing medially. The head was positioned in the Frankfrut plane. The height was measured in centimeters with the help of a measuring tape (32).

Waist circumference was measured at a level midway between the lowest rib and the iliac crest using microtoise tape with sensitivity of 0.1 cm. Subjects with a waist circumference of ≥102 cm (male) and ≥88 cm (females) were said to have abdominal or truncal obesity. Weight was measured using digital weighing machine by United Nations Children's Fund (UNICEF) with sensitivity of 100 g. The subjects were weighed in minimal clothing without shoes. Weight was recorded in kilogram. Before each reading, it was ensured that the equipment was properly placed and checked for zero balance (32).

Blood pressure was measured using a digital blood pressure monitor (Omron, SEM-1, Japan) by using the oscillometric technique as recommended by NCD surveillance of Integrated Disease Surveillance Project (IDSP), Government of India. It was measured in right upper limb in supine position or sitting on a chair with back straight and with arm resting on a table at the level of the heart with appropriate size cuff. The first reading of blood pressure was taken after 5 minutes of rest and the second reading was taken at the end of interview, i.e. after 10 minutes. The second reading was taken as the final reading (33).

Body Mass Index (BMI) was calculated by obtaining the ratio of weight (kg)/height^2 (m) and study subjects were classified as underweight (<18.5 kg/m^2), normal (18.5–22.99 kg/m^2), overweight (23–24.99 kg/m^2) and obese (≥25 kg/m^2) (34).

Statistical analysis

The collected data was entered in Microsoft Excel. Data were analyzed by the SPSS version 16.0 for Windows (SPSS Inc., Chicago, IL, USA). Frequency distributions and percentages were computed for all the variables. The association between various study categorical variables and gender was calculated by using Chi-Square test. All *P*-values were two tailed and significant when values were less than 0.05.

Results

The mean age of the subjects was 54.2 (±11.1) years with 53.3% subjects being women. Table 1 reveals the association between different socio-demographic/study variables and the gender of the study subjects. Most of the study participants, 234 (41%) were from the age group of 40–49 years, followed by 178 (31.2%) of the 50–59 years. The higher proportion of women did not attend the school and were non-worker as compared to the men (*P*=0.001). One-third of the subjects were obese with no gender preponderance. In addition, abdominal obesity was present in 114 (37.5%) women compared to 76 (28.6%) men, *P*=0.024.

Table 2 demonstrates the distribution of CVD risk based on the employment of distinctive characteristics in combination. Using chart alone, 86.0% subjects were predicted to have a

Table 1. Characteristics of study participants

Study variables	Women (%)	Men (%)	*P*-value
Total	304 (53.3)	266 (46.7)	-
Age in years			0.521
40–49	125 (41.1)	109 (41.0)	
50–59	100 (32.9)	78 (29.3)	
60–69	46 (15.1)	52 (19.5)	
>69	33 (10.9)	27 (10.2)	
Educational status			<0.001
No schooling	184 (60.5)	63 (23.7)	
Attended school	120 (39.5)	203 (76.3)	
Occupational status			<0.001
Non-workers	148 (48.7)	55 (20.7)	
Worker	156 (51.3)	211 (79.3)	
Per capita income			0.867
≤3100 INR (≤ US$49.3)	280 (92.1)	246 (92.5)	
>3100 INR (> US$49.3)	24 (7.9)	20 (7.5)	
Physical activity status			0.616
Inactive	30 (9.9)	23 (8.6)	
Active	274 (90.1)	243 (91.4)	
BMI (kg/m^2)			0.616
<23	197 (64.8)	167 (62.8)	
≥23	107 (35.2)	99 (37.2)	
Waist circumference[a] (cm)			0.024
Normal	190 (62.5)	190 (71.4)	
High risk	114 (37.5)	76 (28.6)	
Blood pressure[b] (mm Hg)			0.123
Normal	229 (75.3)	185 (69.5)	
Above normal	75 (24.7)	81 (30.5)	
Diabetes[c]			0.132
Absent	259 (85.2)	214 (80.5)	
Present	45 (14.8)	52 (19.5)	
Total cholesterol (mg/dl)			0.682
Normal (<200 mg/dl)	224 (73.7)	200 (75.2)	
High (>200 mg/dl)	80 (26.3)	66 (24.8)	

BMI= Body Mass Index.
[a] Normal (<102 cm for males and <88 cm for females).
[b] Normal (systolic blood pressure <139 mm Hg and diastolic blood pressure <89 mm Hg).
[c] Present [(fasting blood sugar (>125 mg/dL) and/or postprandial blood sugar (>200 mg/dL)].

Table 2. Risk of CVD with different inclusion criteria for the risk factors

Inclusion criteria	CVD Risk		
	Low (%) (<10%)	Moderate (%) (10%–20%)	High (%) (>20%)
Chart + BP 160/100 + Cholesterol ≥8 mmol/l	473 (83.0)	39 (6.8)	58 (10.2)

CVD= Cardiovascular Disease.

low risk (<10%) of the CVD event in 10 years duration. Only 7 people (4 men and 3 women) had a risk >30%, so to see the stratified prevalence of CVD risk by gender, the cutoff for the high risk was taken as a CVD risk above 20%. The CVD risk was more among males than in females ($P = 0.017$). The prevalence of low, moderate and high CVD risk in the men was 82.7%, 12.8%, and 4.5%, while in the women the prevalence was 88.8%, 5.9%, and 5.3%, respectively. By application of additional criteria for blood pressure and cholesterol, the subjects with low risk were reduced to 83%. However, it was found that 6.8% and 10.2% subjects had moderate (10%–20%) and high risk (>20%) of CVD-related outcome.

The study population showed higher prevalence of obesity (36.1%), abdominal obesity (33.4%), smoking (32.0%), and alcohol usage (53.0%; Table 3). Diet of the most participants was low in calorie, but was high in salt. Similarly, other CVD risk conditions like diabetes (17.0%) and hypertension (27.4%). Of the lipid parameters, a higher proportion of subjects had lower than the recommended HDL level (56.3%) followed by high total cholesterol (25.6%), high LDL (22.5), and high TGL (20.7%).

The prevalence of the risk factors was stratified by the CVD risk (as mild, moderate and high). The risk predictors used to calibrate the CVD risk (viz. smoking, diabetes, hypertension, and high total cholesterol) showed a higher prevalence of a fatal outcome in the next decade, as the CVD risk worsened. It was observed that in the higher CVD risk group, maximum prevalence was of hypertension (86.2%) followed by excessive salt intake (70.7%). For the same group, high prevalence was noted for alcohol use (61.5%) and low HDL (50.0%). In the moderate CVD risk category, almost half of the subjects were tobacco and alcohol users and had a low HDL.

Discussion

It has been well documented that the eventual outcome of myocardial infarction/stroke/death rarely precipitates because of a single potential risk factor, but more often because of the combined effect of several risk factors (35,36). Studies have revealed that the cardiovascular risk evaluation by general practitioners is limited and thus there is immense need to enhance their awareness of the same (12,36).

In the current study, different socio-demographic and biochemical parameters have been assessed to identify their association with the study population. It has been found that level of education, employment status and waist circumference of the study participants was statistically associated with the gender of the study subjects. Findings of an epidemiological study performed in northern India revealed that no gender differences was present with regard to parameters like physical inactivity, central obesity, overweight, and hypertension (9). However, another study done to assess the associations between socio-economic parameter and CVD risk factors among urban and rural South Indians, showed contrasting results, with a significant statistical association being observed with factors like hypertension, deranged lipid profile, abdominal obesity, and parental education status (10). Multiple studies across the world have utilized the WHO/ISH cardiovascular risk prediction charts to estimate the risk in heterogeneous settings (14,37,38). In contrast, findings of a study reflected that the WHO/ISH charts were incorrect to discriminate the risk in Malaysian population (39). The WHO has recommended that in low-resource settings, measures like individual counseling should be made available based on the extent of cardiovascular risk (4,40). In the present study, high risk was found to be 4.9% by utilizing WHO/ISH risk prediction charts. Various studies have revealed a variable level of prevalence of CVD risk using the similar WHO/ISH risk prediction charts in some of the Asian countries (viz. China 1.1%, Iran 1.7%, Sri Lanka 2.2%, Nepal 9.8%, and Pakistan 10.0%) (41,42). A combination of three criteria of a chart, high blood pressure and high serum cholesterol; 10.2% subject had a moderate or high risk of CVD event. It signifies the proportion of the subjects who needs intensive lifestyle interventions and appropriate pharmacological management. The CVD risk was found to be less when compared with the Cambodia (11.2%) and Malaysia (21.5%) (43). In fact, these risk prediction charts have been identified as a key tool in the

Table 3. Prevalence of NCD risk factors in the CVD risk groups

Risk factors	CVD risk			Total
	Mild (%) (<10%)	Moderate (%) (10%-20%)	High (%) (>20%)	
Total (n)	473	39	58	570
Physical inactivity	7.6 (5.5-10.3)	15.4 (6.5-29.3)	19.0 (10.4-30.6)	9.3 (7.1-11.9)
BMI (≥23 kg/m^2)	35.9 (31.7-40.3)	30.8 (17.9-46.4)	41.4 (29.3-54.3)	36.1 (32.3-40.2)
Abdominal obesity	32.6 (28.5-36.9)	33.3 (20.0-49.1)	39.7 (27.7-52.6)	33.4 (29.6-37.3)
Smoking	28.0 (22.2-34.3)	58.6 (40.3-75.3)	34.6 (18.4-54.1)	32.0 (26.6-37.7)
Tobacco chewing	22.8 (19.2-26.8)	48.7 (33.4-64.2)	20.7 (11.7-32.5)	24.4 (21.0-28.0)
Alcohol usage	52.1 (45.4-58.8)	51.7 (33.8-69.3)	61.5 (42.1-78.6)	53.0 (47.0-59.0)
High calorie intake	4.1 (2.5-6.1)	5.1 (0.9-16.0)	5.3 (1.3-13.4)	4.3 (2.8-6.1)
High salt intake	62.1 (57.7-66.5)	41.0 (26.5-56.9)	70.7 (58.1-81.3)	61.5 (57.5-65.5)
Hypertension	18.6 (15.3-22.3)	46.2 (31.1-61.8)	86.2 (75.5-93.4)	27.4 (23.8-31.1)
Diabetes	13.7 (10.9-17.1)	28.2 (15.8-43.7)	36.2 (24.6-49.1)	17.0 (14.1-20.3)
Total cholesterol (mg/dl)	22.6 (19.0-26.6)	41.0 (26.5-56.9)	39.7 (27.7-52.6)	25.6 (22.2-29.3)
High triglyceride (mg/dl)	19.2 (15.9-23.0)	17.9 (8.2-32.3)	34.5 (23.1-47.4)	20.7 (17.5-24.2)
High LDL (mg/dl)	20.1 (16.7-23.9)	30.8 (17.9-46.4)	36.2 (24.6-49.1)	22.5 (19.2-26.0)
Low HDL (mg/dl)	57.7 (53.2-62.1)	48.7 (33.4-64.2)	50.0 (37.3-62.7)	56.3 (52.2-60.4)

NCD= Non-communicable disease; CVD= Cardiovascular Disease; BMI= Body Mass Index; LDL= Low-Density Lipoprotein; HDL= High-Density Lipoprotein.

successful implementation of the NCD action plan (44).

In the current study, high salt intake (62.1%), tobacco chewing (48.7%), and alcohol use (51.7%) were recorded as the risk factors with maximum prevalence in the mild and moderate risk groups, respectively. While in the high-risk group, prevalence was higher for low HDL (50.0%), alcohol usage (61.5%), high salt intake (70.7%), and hypertension (86.2%). In a study done among the sedentary workers in an Indian city, the major risk factors for CHD were elevated triglycerides, hypertension, and high levels of serum total cholesterol (45). The probable reason for such results is because of the sedentary lifestyle and higher prevalence of central obesity among them (42).

These findings point that although WHO/ISH risk charts are a handy and simple tool for CVD risk prediction, but may underestimate the CVD risk burden. The CVD risk factors relevant to the Asian context like obesity, abdominal obesity, family history of CVDs, tobacco chewing, high salt intake, and NCD treatment status are not part of the current risk prediction chart. It is the need of the hour to develop a comprehensive risk prediction chart for Asian population including these risk factors. Finally, it is also recommended to assess the treatment outcome based on the total CVD risk as estimated by the WHO/ISH risk charts.

As the present study was conducted in two of the villages of rural Pondicherry (viz. sample size being small) and thus findings of the study cannot be generalized to the other populations.

Conclusion

Categorizing people as low (<10%) / moderate (10%–20%) / high (>20%) risk is one of the crucial steps to mitigate the magnitude of cardiovascular fatal/non-fatal outcome. This cross-sectional study indicates that there is significant burden of CVD risk in the rural Pondicherry as assessed by WHO/ISH risk prediction charts.

Ethical issues

The ethical committee of Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry approved the present study. Verbal informed consent was obtained from all study participants before interviewing them and utmost care was taken to maintain privacy and confidentiality.

Competing interests

Authors declare that they have no competing interests.

Authors' contributions

AGG conceived about the study design and collected the data. SRS searched for the review of literature and wrote the initial draft of the manuscript. SSK, SS, and SMM reviewed the manuscript for mistakes and modified the initial draft. GR supervised the overall process and epidemiologic interpretation of the information. All authors approved the final version of the manuscript.

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