Original Article

Estimation of cardiovascular risk in a rural population of Lucknow district using WHO/ISH risk prediction charts

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Abstract

Context: Cardiovascular diseases (CVDs) are the number one cause of death globally, with low- and middle-income countries being affected disproportionately. By 2020, it is projected that there will be 25 million deaths from CVD worldwide, 19 million of which would be from middle- and low-income countries. **Aims:** The aim of this study was to estimate the 10-year risk of cardiovascular events among adults aged ≥40 years in a rural population of Lucknow district using the World Health Organization (WHO)/International Society of Hypertension (ISH) risk prediction charts for SEAR-D region. **Settings and Design:** This was a community based cross-sectional study, conducted from September 2017 to August 2018, in the rural areas of Lucknow district. **Methods and Material:** This study was conducted on 397 subjects aged ≥40 years. The two sets of the WHO/ISH risk prediction charts, with and without cholesterol, for WHO SEAR-D region were used in the study. Statistical analysis used: SPSS, version 23 was used for data analysis. **Results:** Using the risk assessment tools, with and without cholesterol, 78.5 and 76.8%, respectively, of the study population were in the 10-year cardiovascular risk category of <10% risk, while 11.2 and 10.4%, respectively, were in the category of ≥20% risk. Risk categories were found to be concordant in 86.3% of the population. **Conclusions:** The WHO/ISH risk prediction charts can be used at low-cost resource setting as a tool to predict CVD risk among asymptomatic individuals, thus, helping in early detection and prevention of CVDs in resource-scarce settings.

Keywords: Cardiovascular disease, noncommunicable disease, risk prediction, rural population, WHO/ISH risk prediction charts

Introduction

Cardiovascular disease (CVD) is the number one cause of death globally, with low- and middle-income countries being affected disproportionately and overburdening of the public health infrastructure leading to escalating direct/indirect healthcare costs throughout the world.[1-4] The increase in CVD in India is projected to be one of the greatest of any country in the world[3,5] and is expected to be the largest cause of death and disability in the country by 2020.

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.[1-5,6-10] The World Health Organization (WHO) and the International Society of Hypertension (ISH) have formulated CVD risk prediction charts for use in different sections of the globe using the best available mortality and risk factor data.[10,11] The chart is a cost-effective tool to stratify the

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entire population using a risk score and thus presents a 10-year risk of major cardiovascular outcome and would be a useful tool to counsel patients to modify their lifestyles or comply with their medicines.[11]

Very few such studies have been undertaken in India, with most of the studies being conducted in Southern India. There is still a lot to be explored in this context in North India and especially the rural areas, which have been largely neglected. In the present study, an effort is being made to assess the prevalence of CVS risk parameters and to estimate the cardiovascular risk among adults aged >40 years, using the WHO/ISH CVD risk prediction charts in a rural area of Lucknow.

Subjects and Methods

This was a community based cross-sectional study, conducted from September 2017 to August 2018, under the Rural Health Training Centre, Sarojini Nagar, which is the field practice area of the Department of Community Medicine, K.G.M.U. Lucknow. The study participants were adults aged ≥40 years of age without any history of CVD. A multistage random sampling was used to recruit individuals for the study.

Sample size

The sample size was calculated by using the formula for estimation of proportion for one sample situation. To detect prevalence of 6.8% of moderate (10–20%) CVD risk population, as determined by a previous study conducted in South India,[12] the minimum sample size required was 397 with allowable error of 3.5%, and a design effect of 2.

Sampling method

Rural Lucknow is divided into eight blocks, out of which one block (Sarojini Nagar) was selected purposively. List of all the subcenters under PHC, Sarojini Nagar, was collected, and out of the nine subcenters, three subcenters were selected randomly [Figure 1]. In the three selected subcenters, there were 14 villages. In the third stage, three villages were selected using random sampling and a minimum of 133 individuals ≥40 years of age were taken from each village to complete the sample size of 397 in the present study. The list of households in those three villages was collected, and every second household was selected. One individual from the selected household, irrespective of gender, was included in the study on fulfilling the eligibility criteria. Eligible criteria were ≥40 years of age, without any history of CVD. Eligible participants who did not give consent were excluded from the study.

Data collection

The people who agreed to take part in the study were informed one day in advance to maintain an overnight fast of minimum 8 h till their fasting blood glucose level was measured. After obtaining the written informed consent, study participants were interviewed face-to-face using a semistructured questionnaire, which was pretested on a group of 30 individuals before its utilization.

The participants were subjected to anthropometric measurements (i.e., height and weight): assessment of blood pressure and blood sugar (both fasting and post prandial) and laboratory investigations (total serum cholesterol). Weight was calculated using an EQUAL digital weighing scale with 180 kg capacity and with accuracy to 100 gm, and height was measured using a stadiometer. Blood pressure was measured using Omron HEM-7120 Automatic Blood Pressure Monitor with two different sized cuffs – one medium and one large size. Accu-Chek active blood glucose meter kit was used to measure blood glucose. A 5-ml disposable, sterile, hypodermic needle was used to collect blood samples for serum total cholesterol investigation, which was then transferred from the syringe into a labeled sterile plain vacutainer vial. The vial was then transferred into a sample transport box to the Department of Pathology at King George's Medical University for evaluation of the total serum cholesterol level. A total of 205 samples of blood, out of the total study population of 397, were taken for the estimation of total serum cholesterol.

The WHO/ISH cardiovascular risk prediction charts for the South-East Asian region were used to assess the cardiovascular risk among the study participants.[11] The predictor variables for the risk prediction were age, gender, smoking, blood pressure, coexistence of diabetes, and serum cholesterol level. The WHO has categorized 10-year CVD risk into five levels: <10%, 10 to <20%, 20 to <30%, 30 to <40%, and ≥40% risk [Figure 2], which we clubbed to three levels for our study, viz. <10%, 10–20%, and ≥20%, respectively.

Definition

Hypertension = SBP >140 mmHg and/or DBP >90 mmHg as recommended by Joint National Committee-VII.[13]

Diabetics = FBS ≥126 mg/dl and/or PPBS ≥200 mg/dl.[11]

High cholesterol = Total serum cholesterol level ≥200 mg/dl.[11]

Smokers = All current smokers and those who used any tobacco product (cigarettes, bidis, chewing tobacco, or snuff) on a regular basis for at least the previous 1 year before the assessment.[14]

Alcohol users = Alcohol use referred to the intake of any form of alcohol in the past 12 months and were further subcategorized depending on the amount of alcohol consumed[15]

Overweight = BMI >23 kg/m^2. BMI calculated using Quetlet's Index formula.[16]

Data analysis

SPSS, version 23 (SPSS-23, IBM, Chicago, USA) was used for data analysis. Chi-square test was used to test association between

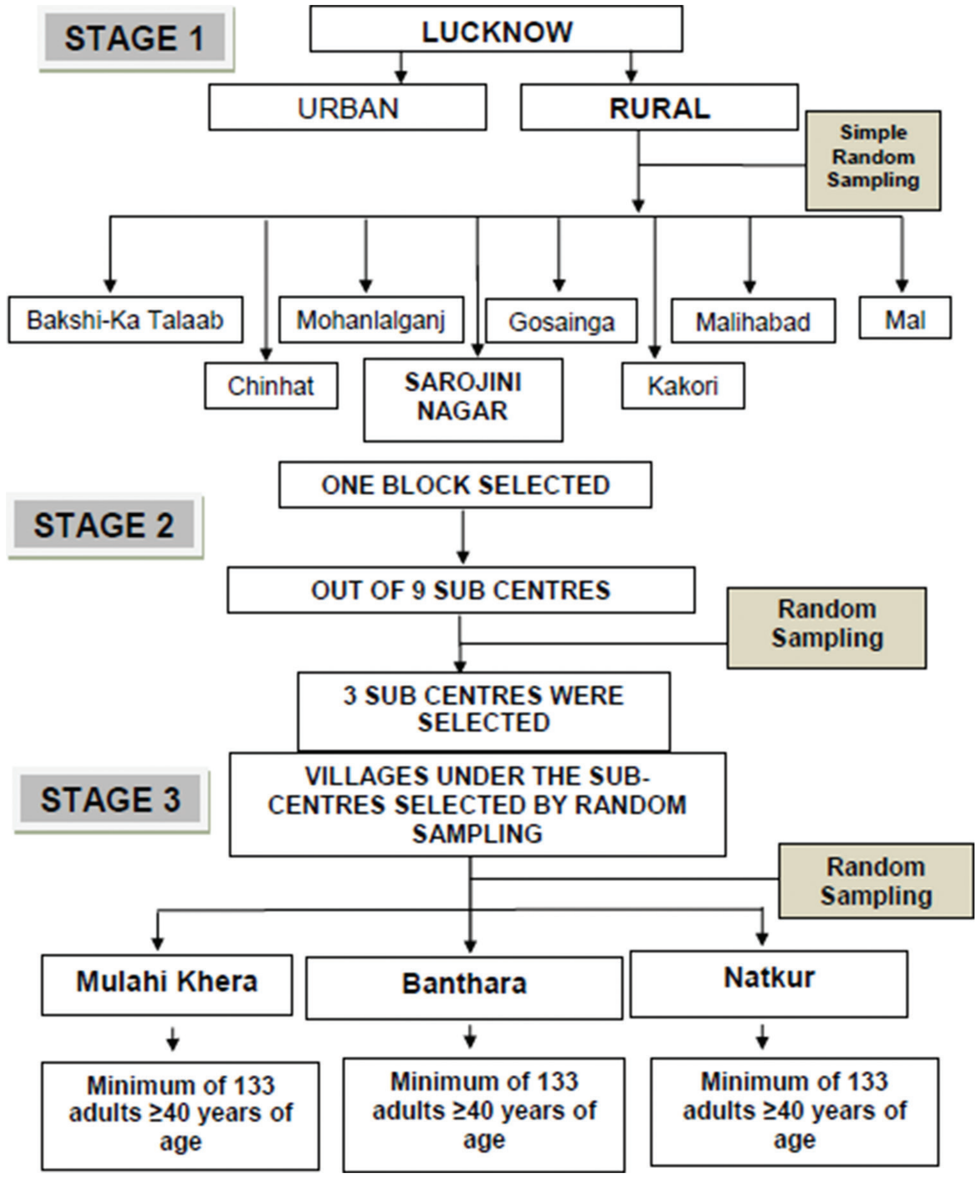

Figure 1: Sampling technique

categorical variables and concordance between the two prediction charts was calculated for different risk levels, using the chart with cholesterol as a reference. A "*P*" value of less than 0.05 was considered statistically significant.

Ethical consideration

Owing to ethical considerations, permission was obtained from the Institutional Ethics committee approval was obtained on 23/02/2018 from the institutional ethics committee of the King George's medical University UP, Lucknow, before commencing the study.

Results

Among the total 397 study participants, maximum (72.8%) were females and a majority (45.8%) of the total population were in the age group of 40–49 years. About half (47.1%) of the study population belonged to the OBC category, and more than half (56.4%) of the total population were found to have no formal education. Majority (82.7%) of the female participants were housewives, while most (64.8%) of the males were self-employed. About two-third (66.2%) of the study population had a nuclear family and about half (47.9%) belonged to the lower socio-economic status [Table 1].

The overall prevalence of hypertension was found to be 34.0% in the study population with a slightly higher prevalence among females (34.9%) than in males (32.40%). Almost similar prevalence of diabetes mellitus was seen in males (15.7%) and females (15.6%) with an overall prevalence of 15.6%. Prevalence of high cholesterol was more among males (18.0%) than in females (16.7%) with an overall prevalence of 17.1%. Smokers and alcohol users consisted of 9.3 and 7.1%, respectively, of the total study population and all of the smokers and alcohol users were males [Figure 3].

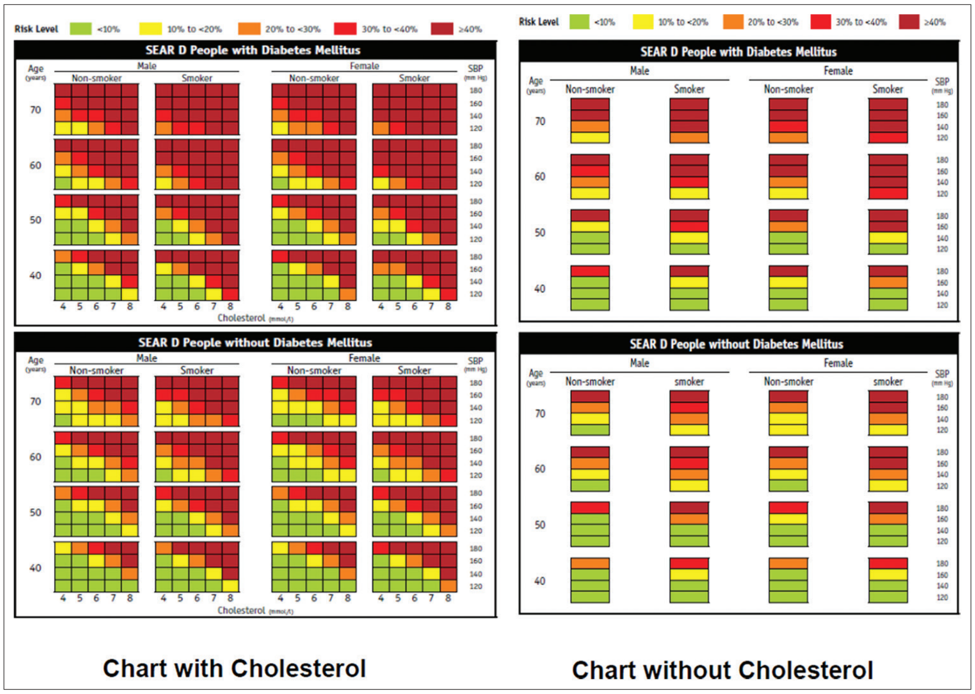

Figure 2: WHO/ISH CVD risk prediction charts for SEAR-D

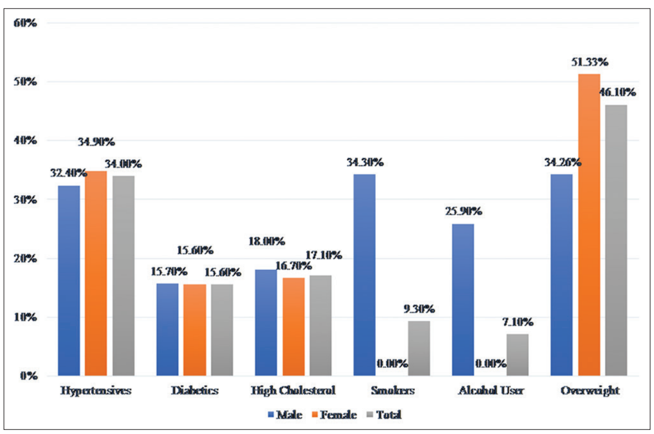

Figure 3: Distribution of CVD risk factors among the study population

Mean age of the total study population was 51.6 (±9.3) years with an overall mean BMI of 22.8 (±4.5) kg/m^2. The mean systolic and diastolic blood pressure of the total population was 127.2 (±20.1) and 79.7 (±11.9) mm of Hg, respectively. The overall mean fasting and post prandial blood sugar levels of the study population was 109 (±41.5) and 143.7 (±58.3) mg/dl, respectively, with almost similar values in both the sexes. The mean serum total cholesterol was found to be higher among females than in males with an overall mean total serum cholesterol level of 163.6 (±35.3) mg/d [Table 2].

WHO/ISH CVD risk prediction charts, with and without cholesterol, were used to predict CVD risk in the study population. The risk of CVD was found to be almost similar with both the charts with maximum of the study participants being in the low-risk (<10%) category. No statistical difference was found between the two charts used to predict CVD risk on applying two sample z-test for comparison of proportion of two samples [Figure 4].

On predicting CVD risk using charts with cholesterol, majority (80.3 and 77.8%, respectively) of the males and females were in the low-risk (<10%) categories followed by 14.8% of males in high (≥20%) risk and 12.5% of females in the moderate (10–20%) CVD risk categories. On age-wise distribution, the risk of CVD increased with increasing age with more than half (66.7%) of the study participants aged ≥70 years in high (≥20%) CVD risk category. Almost half (48.7%) of the hypertensives and about a quarter (25.9%) of the diabetics had high (≥20%) CVD risk. Gender, age groups, hypertension status, diabetes status, and BMI were found to have a statistically significant association (p-value < 0.05) with the different CVD risk categories [Table 3].

When prediction charts without cholesterol were used, more males (14.8%) had high (≥20%) CVD risk than females (8.7%) and the risk of CVD increased with increasing age. Almost one-third (35.2%) of the hypertensives, less than one-fourth (22.6%) of the diabetics and about half (51.2%) of the study participants with BMI ≥23 kg/m^2 had high (≥20%) CVD risk. In total, 8.1% of the smokers and 14.3% of the alcohol users were in high (≥20%) CVD risk category. Age groups, hypertension status, diabetes status, BMI, tobacco use, and alcohol use were found to have a statistically significant association (p-value <0.05) with the different CVD risk categories [Table 4].

Concordance between WHO/ISH CVD risk charts, with and without cholesterol, was calculated for the different risk levels assuming the chart with cholesterol as reference (i.e., if CVD risk

Table 1: Socio-demographic profile of the study participants

Characteristics	Males *n* =108 *n* (%)	Females *n*=289 *n* (%)	Total *n*=397 *n* (%)
Age (in completed years)			
40-49	49 (45.4)	133 (46.0)	182 (45.8)
50-59	21 (19.4)	85 (29.4)	106 (26.7)
60-69	25 (23.1)	60 (20.8)	85 (21.4)
≥70	13 (12.0)	11 (3.8)	24 (6.0)
Marital Status			
Married	103 (95.4)	248 (85.8)	351 (88.4)
Widowed	5 (4.6)	41 (14.2)	46 (11.6)
Religion			
Hindu	103 (95.4)	286 (98.9)	389 (98.0)
Muslim	5 (4.6)	3 (1.1)	8 (2.0)
Category			
Unreserved	28 (25.9)	71 (24.6)	99 (24.9)
Other backward class	55 (50.9)	132 (45.7)	187 (47.1)
SC/ST	25 (23.1)	86 (29.8)	111 (28.0)
Education level			
No formal schooling	40 (37.0)	184 (63.7)	224 (56.4)
Primary school completed	28 (25.9)	62 (21.5)	90 (22.7)
High school completed	21 (19.4)	37 (12.8)	58 (14.6)
College/University completed	19 (17.6)	6 (2.1)	25 (6.3)
Employment status			
Government employee	8 (7.4)	14 (4.8)	22 (5.5)
Nongovernment employee	12 (11.1)	4 (1.4)	16 (4.0)
Self-employed	70 (64.8)	28 (9.7)	98 (24.7)
Housewife	0 (0.0)	239 (82.7)	239 (60.2)
Retired	18 (16.7)	3 (1.04)	22 (5.5)
Type of family			
Nuclear family	75 (69.4)	188 (65.1)	261 (66.2)
Joint family	33 (28.6)	101 (34.9)	134 (33.8)
Socioeconomic status			
Upper	14 (13.0)	16 (5.5)	30 (7.6)
Upper middle	5 (4.6)	29 (10.0)	33 (8.3)
Middle	23 (21.3)	40 (13.8)	64 (16.1)
Lower middle	16 (14.8)	63 (21.8)	80 (20.2)
Lower	50 (46.3)	141 (48.8)	190 (47.9)

Table 2: Mean and standard deviation (SD) of different CVD risk factors among the study participants

Variables	Male		Female		Overall	
	Mean	SD	Mean	SD	Mean	SD
Age (Years)	53.6	10.6	50.9	8.7	51.6	9.3
BMI (kg/m2)*	21.3	3.7	23.3	4.7	22.8	4.5
Systolic blood pressure (mmHg)	126.4	23.1	128.2	18.9	127.7	20.1
Diastolic blood pressure (mmHg)	79.5	13.3	79.8	11.4	79.7	11.9
Fasting blood glucose (mg/dl)	109.8	44.2	109.6	40.5	109.7	41.5
Post prandial blood glucose (mg/dl)	147.5	66.8	142.3	54.8	143.7	58.3
Total cholesterol (mg/dl)	158.1	43.1	166.0	31.4	163.6	35.3

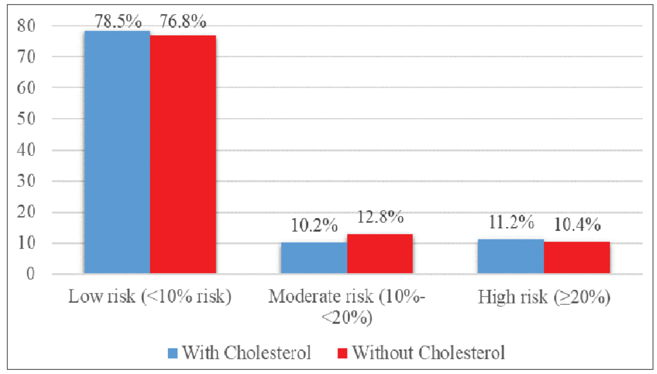

Figure 4: Estimated CVD risk among the study population

was classified higher without cholesterol, we described it as an overestimate; if lower, underestimate). Without cholesterol, CVD risk was overestimated in 11.7% and underestimated in 2.0%. Of the 29 individuals with nonconcordant CVD risk estimates, 85.7% (25/28) were overestimates; 47914.3% (4/28) belonged to low and moderate CVD risk categories [Table 5].

Discussion

On estimating the CVD risk using WHO/ISH risk prediction charts, with and without cholesterol, almost similar trend was observed with both the charts with more than three-fourth of the study participants having low (<10%) risk of CVD. Previous studies done by Balaji *et al.* (2018),[17] Patil *et al.* (2017),[18] Ghorpade *et al.* (2015),[12] and Shrivastava *et al.* (2015)[19] documented similar results with majority of the patients falling under low-risk (<10%) category for CVDs.

On age-wise distribution of CVD risk with cholesterol, it was seen that maximum (91.0%) of the study participants with low (<10%) CVD risk were in the age group of 40–49 years and majority (66.7%) of the study participants with high (≥20%) CVD risk were in the age group of 60–69 years of age and on using CVD risk prediction chart without cholesterol; similar trend was observed with majority (94.5%) of the study participants with low (<10%) CVD risk in the age group of 40–49 years and majority (43.9%) of the study participants with high (≥20%) CVD risk in the age group of 60–69 years of age. Mutthunarayanan *et al.* (2015)[20] and Dhungana *et al.* (2015)[21] observed similar results in their studies with majority of the study participants having <10% CVD risk in the age group of 40–49 years of age, while out of the study participants with ≥20% risk, maximum were in the age group of ≥60 years of age.

About a quarter (25.9% when using charts with cholesterol and 22.6% using charts without cholesterol) of the diabetics had high (≥20%) CVD risk, while majority of the diabetics had low (<10%) risk of CVD. In contrast to this, Shrivastava *et al.* (2015)[19] documented in their study that maximum (36.2%) of the diabetics had high (≥20%) CVD. This disparity might be because of differing socio-demographic profile, family history of CVD risk factors, and dietary habits among the study participants.

Table 3: Association of socio-demographic factors with CVD risk categories (Using WHO/ISH CVD risk prediction charts, with cholesterol)

Risk Factor	Risk categories			*P*
	Low risk (<10% risk)	Moderate risk (10%-<20%)	High risk (≥20%)	
Gender				
Male	49 (80.3)	3 (4.9)	9 (14.8)	**0.005***
Female	112 (77.8)	18 (12.5)	14 (9.7)	
Age groups (in years)				
40-49	91 (91.0)	4 (4.0)	5 (5.0)	**<0.001***
50-59	46 (85.2)	6 (11.1)	2 (3.7)	
60-69	22 (48.9)	11 (24.4)	12 (26.7)	
≥70	2 (33.3)	0 (0.0)	4 (66.7)	
Hypertension status				
Hypertensive	12 (30.8)	8 (20.5)	19 (48.7)	**<0.001***
Normotensive	149 (89.8)	13 (7.8)	4 (2.4)	
Diabetes status				
Diabetic	16 (59.3)	4 (14.8)	7 (25.9)	**0.017***
Nondiabetic	145 (81.5)	17 (9.6)	16 (9.0)	
Serum total cholesterol level				
High cholesterol	26 (74.3)	2 (5.7)	7 (20.0)	0.146
Normal	135 (79.4)	19 (11.2)	16 (9.4)	
BMI (kg/m^2)				
<23	93 (82.3)	13 (11.5)	7 (6.2)	**0.039***
≥23	68 (73.9)	8 (8.7)	16 (17.4)	
Tobacco use				
Smokers	15 (93.8)	1 (6.3)	0 (0.0)	0.256
Nonsmokers	146 (77.2)	20 (10.6)	23 (11.2)	
Alcohol intake				
Yes	14 (87.5)	2 (12.5)	0 (0.0)	0.331
No	147 (77.8)	19 (10.1)	23 (11.2)	

Table 4: Association of socio-demographic factors with CVD risk categories (Using WHO/ISH CVD risk prediction charts, without cholesterol)

Risk Factor	Risk categories			*P*
	Low risk (<10% risk)	Moderate risk (10%-<20%)	High risk (≥20%)	
Gender				
Male	80 (74.1)	12 (11.1)	16 (14.8)	0.183
Female	225 (77.9)	39 (13.5)	25 (8.7)	
Age groups (in years)				
40-49	172 (94.5)	4 (2.2)	6 (3.3)	**<0.001***
50-59	89 (84.0)	12 (11.3)	5 (4.7)	
60-69	38 (44.7)	29 (34.1)	18 (21.2)	
≥70	6 (25.0)	6 (25.0)	12 (50.0)	
Hypertension status				
Hypertensive	48 (45.7)	20 (19.0)	37 (35.2)	**<0.001***
Normotensive	257 (88.0)	31 (10.6)	4 (1.4)	
Diabetes status				
Diabetic	38 (61.3)	10 (16.1)	14 (22.6)	**0.001***
Nondiabetic	267 (79.7)	41 (12.2)	27 (8.1)	
BMI (kg/m^2)				
<23	157 (51.5)	37 (72.5)	20 (48.8)	**0.016***
≥23	148 (48.5)	14 (27.5)	21 (51.2)	
Tobacco use				
Smokers	24 (64.9)	10 (27.0)	3 (8.1)	**0.025***
Nonsmokers	281 (78.1)	41 (11.4)	38 (10.6)	
Alcohol use				
Yes	16 (57.1)	8 (28.6)	4 (14.3)	**0.020***
No	289 (78.3)	43 (11.7)	37 (10.0)	

Table 5: Concordance of WHO/ISH CVD risk prediction charts, with and without cholesterol

CVD risk predicted	Without cholesterol			Total
With cholesterol	Low risk (<10% risk)	Moderate risk (10%-<20%)	High risk (≥20%)	
Low risk (<10% risk)	157	11	1	169
Moderate risk (10-20%)	4	10	12	26
High risk (>20%)	0	0	10	10
Total	161	19	25	**205**

Concordance: 86.3% (177/205); nonconcordance: 13.7% (28/205); overestimate: 11.7% (24/205); underestimate: 2.0% (4/205)

Majority (93.8 and 64.9% for with and without cholesterol charts, respectively) of the smokers had low (<10%) risk of CVD irrespective of the type of risk prediction charts used. None of the smokers had high (≥20%) CVD risk when risk was estimated using risk prediction chart with cholesterol, while 8.1% of the smokers were found to have high (≥20%) CVD risk on using the charts without cholesterol. Balaji *et al.* (2018)[17] reported similar findings where 50.8% of the smokers had low risk of CVD while only 16.1% were in the high-risk category, while Ghorpade *et al.* (2015)[12] observed that 58.6% of the smokers had moderate risk of CVD and 34.6% had high risk of CVD.

On using the WHO/ISH CVD risk prediction charts with cholesterol, the majority (48.7%) of hypertensives were in the high-risk (≥20%) category, while on using the same charts without cholesterol, it was observed that the majority (45.7%) were in the low-risk (<10%) category. Balaji *et al.* (2018)[17] in their study observed similar trend with the maximum (26.0%) prevalence of hypertension being among the low-risk (<10%) group of study participants, while Ghorpade *et al.* (2015)[12] found that the prevalence of hypertension was maximum (86.2%) among the high-risk (≥20%) groups.

It was observed that the mean BMI increased with increasing risk of CVD with maximum mean BMI of 25.1 (±5.0) kg/m^2 in the high-risk (>20%) group category. BMI was found to be significantly associated with the risk categories on predicting the CVD risk using charts with cholesterol. A similar trend was seen in a previous study by Ghorpade *et al.* (2015)[12] in which they observed that the maximum mean BMI of 41.4 (±12.9) kg/m^2 was in the high-risk (>20%) group category. When the WHO/ISH CVD risk prediction charts without cholesterol were used, the least mean BMI of 21.2 (±4.3) kg/m^2 was seen in the moderate (10–20%) risk group category and the highest mean BMI of 23.2 (±4.8) kg/m^2 was observed among the study participants with high (>20%) risk of CVD. In a previous study by Balaji *et al.* (2018),[17] it was seen that BMI had an increasing trend with increasing risk of CVD in the study participants with 22.4 (±3.1) kg/m^2 in the low-risk group and 23.1 (±2.6) kg/m^2 in the high-risk category, while Muthunarayanan *et al.* (2015)[20] in their study observed that majority (44.4%) of the participants had a BMI of >25 kg/m^2. These disparities in BMI observations in the present study and the previous studies might be because of the differences in the composition of the study population and food habits of the study participants owing to the geographical differences.

In the present study, an overall good concordance (86.3%) between WHO/ISH CVD risk charts, with and without cholesterol was observed. Of the 29 individuals with nonconcordant CVD risk estimates, 85.7% (25/28) were overestimates; 14.3% (4/28) belonged to low and moderate CVD risk categories. Similar results were observed by Nordet *et al.* (2013)[10] in which without information about cholesterol, CVD risk was overestimated in 136 (10.6%) and underestimated in 17 (1.3%). High concordance between the two charts implies that in resource constraint settings, where cholesterol estimation is not possible, the WHO/ISH CVD risk prediction chart without information about cholesterol could be used to estimate the CVD risk. This could prove vital in identifying high-risk people at the primary healthcare level and prevent the progress of disease.

Conclusion

Majority of the study participants in our study had low (<10%) risk of any CVD in the next 10 years. Among the CVD risk factors, the prevalence of hypertension was 34.0%, prevalence of diabetes was 15.6%, and prevalence of high cholesterol was 17.1%. Smokers and alcohol users consisted of 9.3 and 7.1%, respectively, of the total study population. Good concordance between the two WHO/ISH risk prediction charts was observed in the present study.

The WHO/ISH CVD risk chart could help as a tool to assess and categorize the population according to the different CVD risk categories, which in turn would help in giving more care and counseling for those at high risk by means of a regular follow-up, thus helping in the prevention of fatal and nonfatal CVDs at the primary care level in resource-scarce settings.

Orientation of primary care physicians and other healthcare workers regarding screening for risk factors from time to time and also to incorporate the use of WHO/ISH CVD risk prediction charts for prediction of CVDs could prove vital in preventing CVDs in low-income settings.

Limitations

Majority (72.8%) of the participants of the study were female as it was difficult to convince the male population during the early hours in the rural areas to take part in the study. Hence, the generalizability of the study is limited.

A follow-up study of the study participants could have given a better perspective of the prediction of CVD risk using the WHO/ISH risk prediction chart.

Strengths

This is the only study done in North India estimating the CVD risk in a rural population and exploring the concordance between the two WHO/ISH CVD risk prediction charts.

We were able to detect diabetes and hypertension in many study participants who were unaware of their disease status.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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