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Cardiovascular risk factors and impending 10-year risk of fatal or non-fatal cardiovascular disease events among an urban population in Tamil Nadu state in South India - A community based cross-sectional study

Uma Priyadharsini Thulasimani[1], Kalidas Ponnusamy[2], Usha Devarasu[3], Kokila Kolandasamy[4], Siva Paramasivam Mahendran[5]

[1]Senior Assistant Professor, [2]Professor and Head, [3,5]Assistant Professor, [4]Associate Professor, Department of Community Medicine, Coimbatore Medical College, Coimbatore, Tamil Nadu, India

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ABSTRACT

Background: Coronary heart disease, peripheral arterial disease, cerebrovascular disease, congenital and rheumatic heart illnesses are among the heart and blood vessel disorders classified as cardiovascular diseases (CVDs). Sudden premature cardiovascular deaths among apparently healthy population can be well prevented by the early recognition of cardiovascular risk factors using validated cardiovascular risk prediction tools. **Aims and Objectives:** The World Health Organization/international society of hypertension (WHO/ISH) Risk Prediction Charts was utilized to estimate the upcoming 10-year risk of CVD events, and the study's objectives were to identify the risk factors for high CVD risk among urban residents aged ≥40–79 years in Tamil Nadu State, South India. **Materials and Methods:** A total of 350 participants were selected for a community-based cross-sectional study using a two-stage selection technique. A pretested questionnaire, anthropometry and laboratory research were used to acquire the required data. Finding the relationship between the risk factors and high CVD risk among the subjects was done using both univariate and multivariate regression analysis. **Results:** Mean age of subjects was 55.6 years. Hypertensives and diabetics were 35.4% and 27.4%, respectively. An alarming 75.1% subjects were either overweight or obese. The WHO/ISH chart categorized 20.9% subjects with >10% risk of impending CVDs. Risk factors which independently influenced high cardiovascular risk were "being unmarried" (adjusted odds ratio [aOR] 31.76; 95% CI; P=0.009), "positive family history" (aOR 4.13; P=0.017), "Sedentary Occupation" (aOR 3.18; P=0.036), and "alcohol usage" (aOR 3.03; 95% CI [1.06–10.27]; P=0.039). **Conclusion:** The study has identified that more than one-fifth of the subjects were under the >10% CVD risk category thereby underscoring the immediate need for inclusion of CVD risk scoring tools in routine screening programs in all levels of health care settings as an effective health promotion strategy in curtailing the escalating incidence of CVDs events worldwide.

Key words: Cardiovascular diseases; Risk factors; Urban population; Cardiovascular risk score

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INTRODUCTION

Coronary heart disease, peripheral arterial disease, cerebrovascular disease, congenital, and rheumatic heart illnesses are among the heart and blood vessel disorders classified as cardiovascular diseases (CVDs).[1] The World Health Organization states that CVDs due to non-communicable diseases account for 38% of deaths

Address for Correspondence:
Dr. Kokila Kolandasamy, Associate Professor, Department of Community Medicine, Coimbatore Medical College, Coimbatore - 641 018, Tamil Nadu, India. **Mobile:** +91-9003604918. **E-mail:** kokilak@gmail.com

worldwide out of the total 17 million premature deaths in 2019. Every fourth premature cardiac mortality results from myocardial infarction or stroke, which continues to be the largest cause of lost disability-adjusted life years globally.[2,3] In the current rising trend of early age onset CVDs, the concept of predicting an individual's impending CVDs risk using risk scores have gained recent emphasis in the detection of CVDs at subclinical stages. The conventional biochemical markers and invasive laboratory investigations for diagnosing CVDs are still not easily accessible and affordable to the entire population in many developing countries. This method of CVD risk prediction is especially well suited to health-care environments with constrained resources where it becomes crucial to save the most lives at the lowest cost.

Cardiovascular risk is described as "the likelihood that a person will have a CVDs event, such as a myocardial infarction or stroke, over a specified time period, such as 10 years.[4] To prevent CVDs in the first place, the World Health Organization recommends a "Total CVD Risk Assessment Approach" which takes into account all the major risk factors in an individual compared to the traditional "vertical approach" which involves treating single risk factors like diabetes and hypertension based on predefined standard guidelines.[5] An individual may have a higher overall risk of CVD than an individual with one marginally elevated risk factor if they have many mildly elevated risk factors. In most of the developing countries and particularly in India, urbanization as a double-edged sword has created a more conducive environment for lifestyle diseases, resulting in a rapid hike in CVD incidence in urban areas. Despite successful structured preventive health systems in the country, the number of people with undiagnosed, untreated cardiovascular risk factors are on the rise in urban populations.[6] Furthermore, there is yet a dearth of research on the concept of CVDs risk prediction, especially in the urban areas of South India. This study utilizes the World Health Organization/international society of hypertension (WHO/ISH) risk prediction table to evaluate the risk of cardiovascular deaths or nonfatal events over a 10-year period among the urban population of Coimbatore district in the state of Tamil Nadu located in South India.

To stratify the total CVD disease risk in people aged 40–79 years who do not yet have established coronary heart disease, atherosclerotic diseases, or stroke, the WHO/ISH have developed epidemiological sub region-based CVD Risk prediction charts (Figure 1). These charts take into account risk factor variables of age, gender, systolic blood pressure in mm Hg, presence or absence of diabetes mellitus total serum cholesterol in mmol/L, and current smoking status. These charts are evidence-based methods for identifying people at high risk for CVDs who should start taking aspirin, lipid-lowering medications antihypertensives and counseling for behavior change.[5]

Aims and objectives

The aim of the study was to use the SEAR-D region's risk prediction charts from the World Health Organization and International Society of Hypertension, to estimate cardiovascular risk factors and the impending 10-year risk of fatal or nonfatal cardiovascular events among subjects aged 40–79 years in an urban population of Coimbatore district in South India and to identify the variables impacting High CVDs Risk in South Indian urban participants between the ages of 40 and 79.

MATERIALS AND METHODS

This is a community based cross-sectional study done among subjects aged ≥40–79 years during May 2021–November 2021 in an urban area of Coimbatore district in Tamil Nadu, South India.

The formula for estimating sample size for proportions was used to determine the sample size. $n=Z^2 P (1-P)/d^2$.

To detect a prevalence of 28% of High CVD risk (≥20% CVD risk), as established by a prior, comparable investigation carried out in Central India,[7] using a margin of error 5% (d) and confidence interval set at 95% (Z=1.96), 310 people made up the estimated sample size. The minimal sample size needed for the study was 341 and was rounded off to 350 because a 10% non-response rate was anticipated.

The sample population for the study was obtained by two stage sampling method. The primary unit of sampling was the health subcenters (HSC) of Singanallur Urban Health Centre, which is the field practicing area. In the first stage, out of five HSCs, three were randomly selected by lottery method. In the second stage, 126 households from the first HSC, 113 from second and 111 from third HSC were selected by probability proportionate to size method and the individual houses were selected by systematic random sampling method. Anyone between the ages of 40 and 79 were eligible to participate in the study. From each household the oldest person whose age within the above-mentioned age group was selected during the time of survey. If In case of more than one eligible person in any house, any one person was randomly selected. If the selected households did not have respondent or if the house was locked next household was selected. The process continued till the desired samples from each HSCs were achieved.

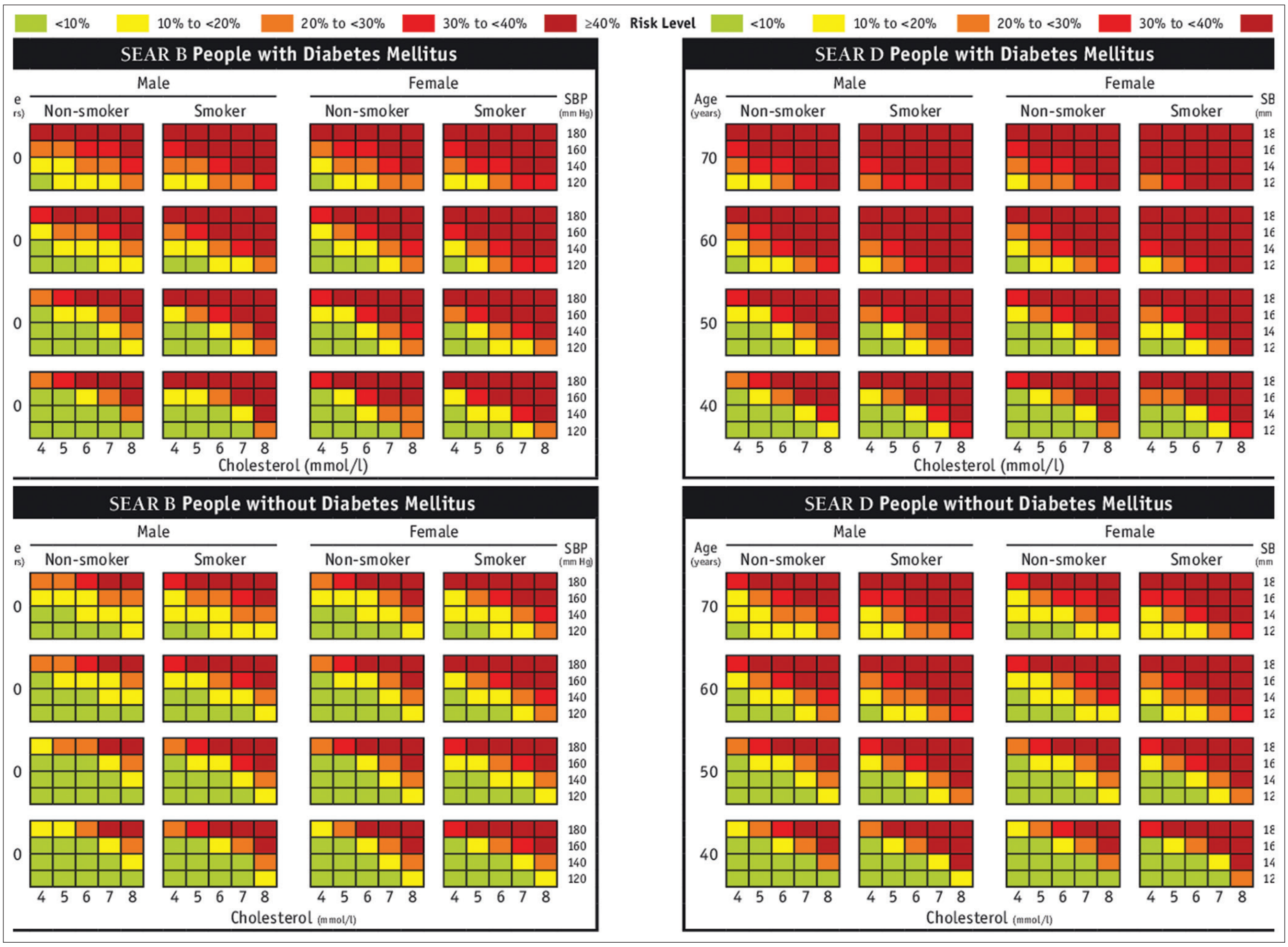

Figure 1: The World Health Organization/international society of hypertension risk prediction charts

To gather data on the respondents' sociodemographic traits, prior histories of hypertension, diabetes, heart disease, smoking, drinking and physical activity, a semi-structured, pilot tested, and validated questionnaire were employed. The subsequent clinical examination comprised taking measurements of the patient's height, weight, blood pressure and glucose levels in the blood and plasma, as well as collecting blood samples for biochemical testing. Two blood pressure readings were measured 10 min apart by a calibrated Sphygmomanometer in sitting, outstretched arm position in both arms and the mean was taken as the final reading. After a 12-h overnight fast, 5 mL of fasting blood samples were taken to calculate the serum cholesterol and fasting glucose levels. The WHO/ISH CVD risk prediction chart's color-coded risk categories of green (10%), (yellow) 10–20%, orange (20–30%), red (30–40%), and deep red (40%) were applied individually to each study subject to estimate the 10-year risk of suffering a fatal or nonfatal cardiovascular event.

Operational definitions

- Subjects who met the criteria for hypertension were those whose systolic or diastolic blood pressure was >140 mm Hg, or who were currently taking an antihypertensive medication.[5]
- A survey-measured fasting blood glucose level of 110 mg/dL (whole blood) or 126 mg/dL (blood plasma) or a measured blood sugar level below these thresholds but a report of using insulin or oral hypoglycemic medications at the time of the survey was considered to be diabetes.[5]
- According to the World Health Organization's Asian Pacific Classification of body mass index (BMI), participants 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) before their body mass method (BMI) was computed using Quetelet's index.[8]
- Smokers are defined as all current smokers and tobacco users, including those who gave up smoking less than a year before to the study.[5]
- Alcohol users were those who had consumed alcohol in any form within the past 12 months.[9]
- A first-degree relative developing CVDs before the age of 55 for males and 65 for women in the family was considered to have a family history of CVD.[10]

- Regular exercise was defined as 75–150 min per week of vigorous level aerobic physical activity, or at least 150–300 min per week of moderate intensity aerobic physical activity.[11]

Statistical analysis

Microsoft Excel was used to enter the data acquired, and SPSS software version 23.0 for Windows was used to analyze it (SPSS Inc., Chicago, IL, USA). For each variable, frequency distributions and percentages were calculated. The relationship between sociodemographic and lifestyle characteristics and the dependent variable was examined using the Chi-square test (High CVDs risk). The multivariate regression analysis of the statistically relevant factors from the univariate analysis was then used to generate the adjusted odds ratio (aOR). P<0.05 was regarded as statistically significant.

RESULTS

According to the WHO/ISH risk prediction chart, a total of 350 patients were examined for a 10-year risk of fatal or nonfatal cardiovascular events. Among the participants, 190 (54.3%) were female and 160 (45.7%) were male. Mean age of the subjects was 55.6 years. 78% of the subjects were educated up to or below secondary school level and majority (98%) were married. About 86% of subjects hailed from a nuclear family and 23.4% subjects were sedentary by occupation. Majority (77.1%) belonged to the lower and lower middle class as per the Modified BG Prasad's Classification (Table 1).

Table 2 shows the distribution of cardiovascular risk factors among the study population. About 35.4% subjects were hypertensive and 27.4% were diabetic. About 21.4% of them had both hypertension and diabetes. About 9.1% of subjects had hypercholesteremia. With majority of them (94.9%) having no regular exercise, 28% of them were overweight, and 47.1% were obese thus accounting for an alarming 75.1% of subjects above the normal BMI category. About 13.4% of the subjects were smokers and 17.7% of study subjects were alcohol users. A positive family history of CVD was present in 11.7% of the subjects.

WHO/ISH risk prediction chart-based CVD risk stratification

The WHO/ISH CVD risk prediction chart was applied on 350 study subjects. Each subject was made to visualize their own CVD risk category in the color-coded charts. It was observed that although 79.1% (n=277) of study subjects had <10% risk of fatal or non-fatal cardiovascular events in the next 10 years, 14.6% (n=51) had 10–20% risk of CVD, 3.4% (n=12) had 20% to 30% risk, 2.3% (n=8) subjects had risk of 30–40% risk, and 0.6% (n=2) of subjects had risk more than 40% (Figure 2).

Table 1: Socio demographic profile of the study subjects

Variables	Category	Frequency (n=350)	Percentage
Age group in years	40–49	115	32.9
	50–59	113	32.3
	60–69	100	28.6
	≥70	22	6.3
Gender	Male	160	45.7
	Female	190	54.3
Marital Status	Not married/separated/widowed	8	2.3
	Married	342	97.7
Education	Secondary school and below	273	78.0
	Graduate	77	22.0
Occupation	Sedentary	82	23.4
	Non sedentary	268	76.6
Family type	Nuclear	301	86.0
	Joint	49	14.0
Socioeconomic status (based on per capita monthly income)	Upper and upper middle class	80	22.9
	Lower middle and lower class	270	77.1

Table 2: Distribution of cardiovascular risk factors among the study subjects

Variables	Category	Frequency	Percentage
Comorbidity	Diabetes	96	27.4
	Hypertension	124	35.4
	Hypertension and diabetes	75	21.4
	Hypercholesterolemia	32	9.1
Physical activity	No regular physical exercise	332	94.9
	Regular exercise	18	5.1
Family history	Positive family history	41	11.7
	No family history	309	88.3
BMI	Overweight and obesity	263	75.1
	Normal	87	24.9
Personal habits	Smokers	47	13.4
	Alcoholics	62	17.7
Family history	Positive family history	41	11.7
	No family history	309	88.3

BMI: Body mass index

Factors influencing high CVDs risk

Univariate analysis

Based on the World health Organization's HEARTS technical package for CVD management in primary health care,[4] the risk groups were categorized into high cardiovascular risk (≥20% risk) and low to moderate cardiovascular risk (<20% risk). All the socio-demographic and the lifestyle factors except those risk factors inherent in the WHO/ISH chart were further subjected to univariate analysis with high CVDs risk as the dependent variable. The univariate analysis showed that education up to or below secondary school level (P=0.006), sedentary type of occupation (P<0.001), alcohol usage (P<0.001), positive family history (P<0.001), and unmarried marital status (P<0.001), were found to be factors significantly associated with high CVD risk (Table 3).

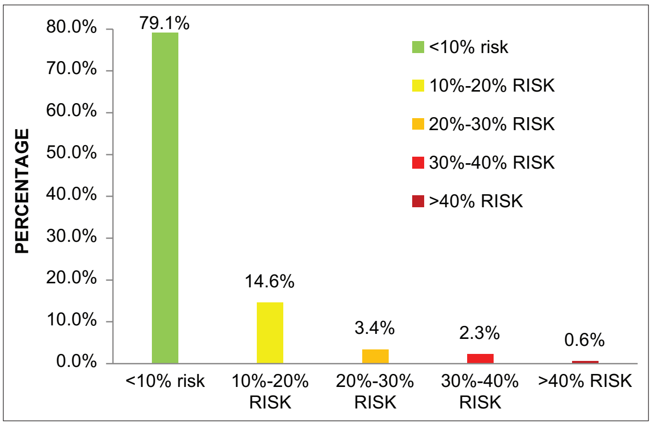

Figure 2: Cardiovascular risk stratification based on World Health Organization/international society of hypertension risk prediction chart

Multivariate regression analysis

The parameters which were significantly associated with high CVD risk in univariate analysis were further subjected to multiple logistic regression model (Table 4). After adjusting for covariates, the factor with the highest aOR which independently influenced high cardiovascular risk was being unmarried (aOR 31.76; 95% CI [2.33–432.4]; P=0.009) followed by positive family history (aOR 4.13; 95% CI [1.28–13.31]; P=0.017), sedentary occupation (aOR 3.18; 95% CI [1.08–9.40]; P=0.036), and alcohol usage (aOR 3.03; 95% CI [1.06–10.27]; P=0.039).

DISCUSSION

Although there exists previous research on risk factors of CVDs in India, CVD risk prediction studies done on an apparently healthy population based on standardized prediction tools are minimal. Our study aims to predict and stratify the CVD risk of an urban population in South India using the WHO/ISH risk prediction charts. Being community based, it offers to capture the impact of inequalities in social and local environmental factors, cultural and ethnic factors apart from the behavioral risk factors contributing to CVD mortality unlike hospital-based studies. Our study has revealed that more than

Table 3: Associations between sociodemographic and lifestyle factors with high cardiovascular disease risk

Factors	High CVD risk (≥ 20%) n=22		Low to moderate CVD risk (<20%) n=328		P-value/OR/95%CI
	n	%	n	%	
Physical activity					
No regular exercise	21	6.3	311	93.7	1.000*; OR=1.148; (0.146–9.048)
Regular exercise	1	5.6	17	94.4	
BMI					
Overweight/obese	16	6.1	247	93.9	0.787; OR=0.874; (0.331–2.310)
Normal	6	6.9	81	93.1	
Education					
Secondary school and below	22	8.1	251	91.9	0.006*: OR=NA
Graduate	0	0.0	77	100.0	
Occupation					
Sedentary	12	14.6	70	85.4	<0.001; OR=4.423; (1.835–10.661)
Non-sedentary	10	3.7	258	96.3	
SES					
Upper and upper middle class	0	0.0	80	100.0	0.008; OR=NA
Lower middle and lower class	22	8.1	248	91.9	
Alcohol usage					
Alcoholic	14	22.6	48	77.4	<0.001*; OR=10.208; (4.064–25.642)
Non-alcoholic	8	2.8	280	97.2	
Family history					
Positive family history	12	29.3	29	70.7	<0.001*; OR=12.372; (4.922–31.100)
No family history	10	3.2	299	96.8	
Family type					
Nuclear	18	6.0	283	94.0	0.528; OR=0.716; (0.232–2.211)
Joint	4	8.2	45	91.8	
Marital status					
Unmarried	5	62.5	3	37.5	<0.001; OR=31.86; (7.02–144.5)
Married	17	5.0	325	95.0	

Table 4: Multiple logistic regression model using high cardiovascular risk as dependent variable

Category	Variable	Adjusted odds ratio	95% confidence interval		P-value
			Lower limit	Upper limit	
Marital status	Unmarried	31.762	2.333	432.422	0.009
Education	Secondary school and below	62464613.81	0.000	----	0.996
Occupation	Sedentary	3.186	1.080	9.400	0.036
SES	Upper and upper middle	0.000	0.000	-----	0.996
Alcohol usage	Alcoholics	3.303	1.061	10.277	0.039
Family history	Positive family history	4.137	1.286	13.310	0.017

one-fifth of study subjects (20.9%) were unaware of their >10% risk of developing CVD in the next 10 years with their current risk factor profile thereby spotlighting the necessity to lay focus on the 20.9% of subjects as they are the most vulnerable population who warrant the utmost need for deterring them from their accelerating risk for impending CVDs and subclinical atherosclerosis. Similar CVD risk prediction studies in other Asian countries have shown variable levels of high-risk CVD prevalence (Mongolia - 6%,[12] Cambodia - 1.3%,[12] Kenya - 1.7%,[13] Bangladesh - 0.5%[14] and Sri Lanka - 3.1%[15]) due to diverse genetic, epidemiological and socioeconomic settings. A multicentric study by Mendis et al.,[16] among eight low and middle income countries has identified low CVD risk in China (96.1%), Cuba (89.7%), Georgia (83.1%), Iran (93.9%), Pakistan (79.2%), and Nigeria (86.0%). Contrastingly, a study which evaluated three cardiovascular risk assessment tools, namely, the WHO/ISH risk score, Framingham risk score and United Kingdom Prospective Diabetes Study risk engine has found that the WHO/ISH risk score had a negative association (r=−0.07) with subclinical atherosclerosis when compared to the other two risk scores which had positive associations.[17] Therefore, more thorough research is required to confirm the regional risk prediction charts now in use for specific populations at the national and local levels. In spite of commendable preventive health programs on non-communicable diseases in India, the high prevalence of hypertension and diabetes (35.4% and 25.4%) found in our study when compared to national averages may be attributed to the expeditious urbanization process in urban and semi urban areas embracing lifestyle risk factors such as faulty dietary practices, alcohol, tobacco consumption, and physical inactivity. Alarmingly, only a quarter of our study subjects were within the normal BMI category whereas three-fourth of them were either overweight or obese. This may be attributed to the reduced physical activity among the study subjects owing to transformed types of occupational settings, improved access to transportation and better socio-economic conditions in the urban sector studied. The state level prevalence of overweight in Tamil Nadu State in India has also seen an acute rise from 30.6% in the National Family Health Survey 4 (NFHS)[18] to 43.1% in NFHS 5.[19] Overweight and obesity have attained epidemic proportions globally paving way for further increase in lifestyle and CVDs.

Our study has revealed significantly high CVDs risk among unmarried/separated subjects in comparison with their married counterparts (aOR 31.76; 95% CI 2.33–432.4; P=0.009). A systematic review and meta-analysis including 34 worldwide studies with more than two million participants has established that being unmarried had 1.42 times higher odds of developing CVDs.[20] A long term prospective study by Ramezankhani et al.,[21] in Iran states that unmarried men had higher rates of hypertension and all-cause mortality (hazard ratio 1.55 and 2.17, respectively) compared to married men. Despite the fact that ample research has been done on the potential benefits of companionship and improved socioeconomic scenarios after marriage, further prospective research is essential to understand the various implications of marriage over cardiovascular health.

The likelihood of high CVDs risk among subjects with sedentary type of occupation was 3.1 times higher than those with non-sedentary type occupation (aOR 3.18; 95% CI 1.08–9.40; P=0.036) in our study. This is in line with a similar study by Lee et al.,[22] in Korea which also reports significantly higher odds of cardiovascular risk among individuals with a sedentary time of >9 h per day. Advancements in technology resulting in long hours of sitting has been causing depletion in occupation related energy expenditure thereby reducing physical activity levels hampering cardiovascular health. An Indian study among bank employees with sedentary working pattern depicted a strong association between decreased physical activity and dyslipidemia (P=0.000).[23]

In our study, the odds of having a high risk of CVDs were 4.1 times greater in subjects with a positive family history of the condition. According to a prospective multicentric study conducted among people of Dutch, South Asian, and African ancestry (Surinamese, Ghanaian, Turkish, and Moroccan origin), having a good family history was linked to a greater prevalence of non-stroke CVDs (OR 2.05; 95% CI [1.65–2.54]).[24] Familial CVDs bestows proband risk through increased susceptibility for atherosclerosis in the vascular system. A prospective study by Parikh et al.,[25] among all Framingham Offspring Study participants followed from 1971 to 2001 has reported that off springs with least 1 parent with premature CVDs had 2.6 times greater risk of cardiovascular events in their lifetime.

In our study, subjects who were alcohol users were 3.303 times more likely to develop high risk of CVD. The previous literature shows evidence that though alcohol seemingly exerts a positive effect initially; it exerts a more negative effect on the endothelial–nitric oxide–generating system causing endothelial dysfunction which is an indicator of impending blood vessel damage and atherosclerosis.[26-28] The currently existing heterogenous results on effects of alcohol on CVDs yield more promising avenues for further extensive research.

Limitations of the study

There are two primary drawbacks to the study. The study excluded CVD risk factors such as central obesity, poor dietary habits such as consuming excessive salt and fatty food consumption. The relatively small sample size, which restricts the generalizability of the conclusions to a larger population is another drawback.

CONCLUSION

Our study has identified that more than one-fifth of the urban population studied had >10% chances of developing a fatal or non-fatal cardiovascular event in the next 10 years which is a crucial cause of concern. The study has reported high prevalence of cardiovascular comorbidities such as hypertension, diabetes, overweight and obesity among the urban population in spite of structured non-communicable disease control programs in the country. This underscores the immediate need for inclusion of CVD risk scoring tools like the WHO/ISH chart in routine screening activities in all levels of health care settings as a health promotion strategy in curtailing the impending rise in CVDs in the population. The study also emphasizes the need to develop more population based relevant risk assessment tools encompassing risk factor variables such as central obesity, stress levels, physical inactivity and high fat diet intake which have been frequently ignored by traditional risk scoring tools.

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Authors' Contributions:
UPT- Concept and design of the study, review of literature, acquisition of data, original draft preparation, preparation of manuscript, statistical analysis, interpretation of results, review and editing, revision of final manuscript; **KP-** Concept and design of the study, interpretation of results; **UD-** Review of literature, acquisition of data, original draft preparation, interpretation of results; **KK-** Review of literature, acquisition of data, preparation of manuscript, statistical analysis, interpretation of results, review and editing, revision of final manuscript; **SPM-** Acquisition of data, statistical analysis, interpretation of results, review and editing

Work attributed to:
Coimbatore Medical College, Coimbatore-641018, Tamil Nadu, India.

Orcid ID:
Uma Priyadharsini Thulasimani - https://orcid.org/0000-0001-5489-7704
Dr. Kokila Kolandasamy - https://orcid.org/0000-0003-0872-441X

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