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Original Article

Prevalence of coronary heart disease in rural and urban Vellore: A repeat cross-sectional survey☆

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ABSTRACT

Background: With the increase of cardiovascular risk factors in India, the prevalence of coronary heart disease (CHD) is also expected to rise. A cross-sectional study in 2010–2012 assessed the prevalence and risk factors for CHD in urban and rural Vellore, Tamil Nadu. The secondary objectives were to compare the current prevalence with the prevalence of CHD in the same areas in 1991–1994.

Methods: A cross-sectional survey was carried out among adults aged 30–64 years to determine the prevalence of CHD (previously diagnosed disease, symptoms detected using Rose angina questionnaire, or ischemic changes on electrocardiography). The study used the WHO STEPS method in addition to the Rose angina questionnaire and resting electrocardiography and was conducted in nine clusters of a rural block in Vellore district and 48 wards of Vellore town. The results were compared with a similar study in the same area in 1991–1994.

Results: The prevalence of CHD was 3.4% (95% CI: 1.6–5.2%) among rural men, 7.4% (95% CI: 4.7–10.1%) among rural women, 7.3% (95% CI: 5.7–8.9%) among urban men, and 13.4% (95% CI: 11.2–15.6%) among urban women in 2010–2012. The age-adjusted prevalence in rural women tripled and in urban women doubled, with only a slight increase among males, between 1991–1994 and 2010–2012.

Conclusions: The large increase in prevalence of CHD, among both pre- and post-menopausal females, suggests the need for further confirmatory studies and interventions for prevention in both rural and urban areas.

1. Introduction

Risk factors for coronary heart disease (CHD), such as diabetes, hypertension, dyslipidemia, and obesity, are on the rise in developing countries such as India.[1–4] Non-communicable diseases are now the major cause of death in India, with cardiovascular diseases being the dominant cause.[5] With CHD in south Asia and the Middle East affecting a younger age group than elsewhere,[6] it is necessary to study the trend of

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prevalence of this condition to promote measures for prevention and decreasing mortality. Recent studies of prevalence of CHD in India conducted using the Rose questionnaire and electrocardiography in Chennai, Rajasthan, Kerala, Uttar Pradesh, Srinagar, and Delhi among others show increasing prevalence of CHD countrywide,[7–13] with mortality data showing higher mortality due to CHD in South India.[14]

This repeat cross-sectional study documents the changes in prevalence of CHD in a rural block and a town in Tamil Nadu, south India, from 1994 to 2012 and also estimates the association of CHD with its risk factors.

2. Methods

A cross-sectional study was conducted in 1991–1994 in 20 urban clusters of Vellore town and 23 clusters of a rural block in Vellore district, selected by probability proportional to size, to assess the prevalence of CHD and its risk factors among all adults aged 30–60 years in the selected clusters. A repeat survey was done using the WHO STEPS method[15] in 48 out of 60 urban wards (selected consecutively according to ward numbers) and nine randomly selected clusters of the 23 rural clusters surveyed earlier, between June 2010 and December 2012. While all individuals in the eligible age group were invited for the survey in the rural clusters, one street was randomly selected among the 48 urban clusters.[16]

Trained field workers and social workers collected history for socio-demographic and behavioral risk factors through house-to-house interviews. Medical history was obtained by physicians or trained research nurses along with physical and biochemical measurements obtained at clinics set up in the study villages/wards. Further details of the methodology used in the surveys including quality control of biochemical tests have been described in earlier publications.[16,17]

Risk factors included diabetes (fasting venous blood sugar of 126 mg% or more or on medication), blood pressure ≥140/90 mmHg (average of two readings, obtained using an automated apparatus OMRON) or on medication, total cholesterol ≥190 mg% or on medication, triglycerides ≥ 150 mg%, low HDL (<40 mg% in males and <50 mg% in females), and physical activity (low, moderate, and vigorous) defined according to the guidelines for analysis of WHO STEPS surveys.[15] Abdominal obesity was defined as waist circumference ≥80 cm in females and ≥90 cm in males,[18] overweight as BMI 25–29 kg/m^2, and obesity as ≥30 kg/m^2. Fruit and vegetable intake was measured as number of servings per day (1 serving = 80 g).[15] Clustering of risk factors was defined as combination of current daily smoking, less than five daily fruits and vegetable servings, low physical activity, overweight (BMI ≥ 25 kg/m^2), and blood pressure ≥140/90 mmHg or on medication, according to the STEPS guidelines.[15]

CHD was defined as previously diagnosed CHD (verified by medical records where available), symptoms detected by the Rose angina questionnaire,[19] or electrocardiographic (ECG) changes suggestive of ischemia. The ECGs were taken using the BPL Cardiart 6208 View electrocardiograph, which also provided automated Minnesota codes, reassessed by a cardiologist unaware of the patient's clinical history, using the American Heart Association/American College of Cardiology Foundation/Heart Rhythm Society recommended criteria for abnormalities in Q, ST, and T waves.[20,21] In the earlier survey, ECG changes suggestive of ischemia were also assessed by trained cardiologists, using the "Minnesota Code 1982" criteria for ischemia using a standard 12-lead electrocardiogram.[22]

2.1. *Statistical methods*

As the first survey was done among adults aged 30–60 years and the second among those aged 30–64 years, the comparison of results is restricted to the population aged 30–60 years in both surveys. Age standardization was done using the Census of India 2001 data to enable comparison of rates. For the repeat survey (2010–2012), 95% confidence intervals were calculated using adjustment for cluster design.[23] Chi-square tests were used to compare proportions and adjusted odds ratios were calculated for risk factors for CHD using binary logistic regression.

3. Results

In 2010–2012, out of 3121 persons aged 30–64 years in the urban area and 4537 in the rural area, 2397 (77%) and 3799 (83%) were interviewed respectively, as part of the study.

The interviewed population was similar to the general population of the district in literacy, religion, and occupational pattern.

The prevalence of CHD among rural males was 3.4% (95% CI: 1.6–5.2%) and 7.4% (95% CI: 4.7–10.1%) among rural females (Table 1). The prevalence among urban males was 7.3% (95% CI: 5.7–8.9%) and 13.4% (95% CI: 11.2–15.6%) among urban females.

While the prevalence of previously diagnosed CHD was higher among men as compared to women, women had higher rates of ECG evidence of ischemia as well as symptoms of angina (Table 1). As compared to rural participants, rates of previously diagnosed CHD, ECG changes, and symptoms were two to three times higher among urban participants. Majority (95%) of the participants who were diagnosed to have ischemic changes on ECG were asymptomatic (117/123).

The rates of CHD among pre- and post-menopausal women (amenorrhoea for 12 months due to natural menopause) are shown in Table 2. Both pre- and post-menopausal women had higher rates of abnormal ECGs as well as symptoms of angina as compared to men, although previously known disease was lowest in pre-menopausal women.

In the earlier survey (1991–1994), 4693 rural and 2649 urban participants were examined, which constituted 71% and 75% of the eligible population aged 30–60 years in the study area. Comparison of the age-adjusted prevalence rates of CHD between the two surveys showed a significant increase in the rates of CHD among females aged 30–60 years in both the rural and urban areas, with only a small rise in prevalence rates among urban males (Table 3). Age-specific rates showed that CHD among women below 50 years increased between the two surveys whereas there was no change in age-specific prevalence rates among males (Table 4).

Female sex, urban residence, lower education, past history of smoking, low daily intake of fruits and vegetables, family history of premature heart disease, and diabetes mellitus were

Table 1 – Prevalence of coronary heart disease in the study population in 2010–2012.

Age in years	Pre-existing CHD		Newly diagnosed by positive ECG		Newly diagnosed by symptoms (among ECG negative)		Prevalence of CHD (pre-existing/symptoms/ECG positive), %	
	Males	Females	Males	Females	Males	Females	Males	Females
Rural								
30–34	0/198	0/308	0/187	5/298	3/187	10/292	3/187 (1.6)	15/297 (5.1)
35–39	1/233	0/343	1/222	1/334	5/220	14/333	7/223 (3.1)	15/334 (4.5)
40–44	2/223	0/325	1/203	4/317	3/201	14/311	6/204 (2.9)	18/315 (5.7)
45–49	0/254	2/290	3/242	2/280	1/239	15/278	4/242 (1.7)	19/282 (6.7)
50–54	3/223	2/256	0/210	4/250	2/210	13/246	5/213 (2.3)	19/252 (7.5)
55–59	2/172	2/218	2/163	7/207	5/161	20/200	9/165 (5.5)	29/209 (13.9)
60–64	4/192	3/203	4/181	8/191	6/178	13/183	14/186 (7.5)	24/194 (12.4)
Total (%)	12/1497 (0.80)	9/1949 (0.46)	11/1410 (0.78)	31/1878 (1.65)	25/1397 (1.79)	99/1843 (5.37)	48/1420[a] (3.38)	139/1883[a] (7.38)
Urban								
30–34	1/119	0/180	1/109	8/175	2/108	11/167	4/110 (3.6)	19/175 (10.9)
35–39	0/140	0/245	1/130	11/231	4/129	11/220	5/130 (3.8)	22/231 (9.5)
40–44	4/153	1/182	1/136	10/172	1/135	15/162	6/140 (4.3)	26/173 (15.0)
45–49	6/149	0/188	2/135	17/182	3/133	15/165	11/141 (7.8)	32/182 (17.6)
50–54	2/109	0/133	3/103	9/127	3/100	6/118	8/105 (7.6)	15/127 (11.8)
55–59	9/87	4/114	0/74	4/106	2/74	7/102	11/83 (13.3)	15/110 (13.6)
60–64	4/97	9/120	8/84	6/106	1/76	5/100	13/88 (14.8)	20/115 (17.4)
Total (%)	26/854 (0.30)	14/1162 (1.20)	16/771 (2.08)	65/1099 (5.91)	16/755 (2.12)	70/1034 (6.77)	58/797[a] (7.28)	149/1113[a] (13.39)

[a] Denominator excludes those without prior CHD with either ECG or symptoms missing.

found to be significantly associated with CHD (Table 5). However, low physical activity was less likely to be associated with CHD (Table 5). There was also a small, although statistically insignificant, association between elevated total cholesterol and CHD.

Clustering of common risk factors also showed a positive relationship with prevalence of CHD (Table 5).

4. Discussion

Repeat cross-sectional surveys are useful to monitor trends of non-communicable diseases and there is an ongoing need for periodic surveys to document trends of CHD, in order to assess interventions and plan prevention. The strength of this study is the availability of population-based data for comparison of rates of CHD measured in the same urban and rural locations and age group about 20 years apart, using similar methodology. The educational status of the population in this area improved considerably in this period with the proportion having studied beyond middle school (8th standard) increasing from 15% to 33% in the rural area and 28% to 50% in the urban area.[17] The improvement in socioeconomic status has also led to environmental, dietary, and other lifestyle changes in this part of Tamil Nadu, as seen all over the country.

The prevalence of previously diagnosed disease was higher in males although newly detected symptoms and ECG abnormalities were higher in females. This pattern was similar to other population-based studies worldwide that show this pattern, although admission and mortality rates due to myocardial infarction in hospital-based studies are higher in males.[24] A systematic review of studies from India also showed little increase in prevalence rates of ECG-diagnosed CHD among men while finding significant increases in women.[25] A study in urban Delhi, which followed the same methodology as the current study from Vellore, also showed increase in CHD prevalence in women but not in men,[13] with higher rates for CHD in urban Delhi as compared to urban Vellore, probably reflecting the differences in socio-economic status in the two populations.

Table 2 – Comparison of CHD among men, pre- and post-menopausal women in 2010–2012.

	Pre-existing CHD (%)		Newly diagnosed by positive ECG (%)		Newly diagnosed by symptoms (among ECG negative), %		Prevalence of CHD (pre-existing/symptoms/ECG positive),[a] %	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Men	12/1497 (0.8)	26/854 (3)	11/1410 (0.78)	16/771 (2.08)	25/1397 (1.8)	16/755 (2.1)	48/1420 (3.38)	58/797 (7.3)
Pre-menopausal women	0/1122 (0)	1/708 (0.1)	12/1087 (1.1)	38/675 (5.6)	46/1072 (4.3)	44/637 (6.9)	58/1084 (5.4)	83/676 (12.3)
Post-menopausal women	8/691 (1.2)	13/381 (3.4)	18/657 (2.7)	25/354 (7.1)	45/638 (7.1)	20/329 (6.1)	71/664 (10.7)	58/367 (15.8)

[a] Denominator excludes those without prior CHD with either ECG or symptoms missing.

Table 3 – Comparison of coronary heart disease in 1991–1994 and 2010–2012 (30–60 years).

Sex	Year of study	Positive ECG (%, 95% CI)		Pre-existing CHD or symptoms or ECG positive (%, 95% CI)*		Age adjusted rates of CHD (pre-existing or symptoms or ECG positive)	
		Rural	Urban	Rural	Urban	Rural	Urban
Males	1991–1994	31/2059 (1.51, 0.97–2.05)	43/1149 (3.74, 2.62–4.86)	62/2059 (3.01, 2.27–3.70)	68/1149 (5.92, 4.53–7.31)	2.75 (2.05–3.45)	4.63 (3.51–5.75)
	2010–2012	8/1289 (0.62, 0.18–1.06)	16/726 (2.20, 1.11–3.29)	36/1285 (2.80, 1.88–3.72)	48/727 (6.60, 4.76–8.44)	2.58 (1.72–3.44)	5.79 (4.27–7.31)
Females	1991–1994	40/2634 (1.52, 1.04–1.99)	63/1500 (4.2, 3.16–5.24)	66/2634 (2.51, 1.91–3.10)	90/1500 (6.00, 4.80–7.20)	2.39 (1.80–2.98)	5.48 (4.32–6.63)
	2010–2012	27/1761 (1.53, 0.95–2.11)	65/1034 (6.29, 4.78–7.80)	123/1756 (7.00*, 5.78–8.22)	134/1033 (12.97*, 10.91–15.09)	6.33 (5.19–7.47)	12.69 (10.62–14.78)

* p value <0.001 for chi-square comparing rates in 1991 and 2010.
** Adjusted to 2001 Census of India 30–60 years.

Possible explanations for the higher prevalence of angina in females may include gender differences in health perceptions or differential health-seeking behavior or that these symptoms in females may not always indicate severe disease. However, this is a phenomenon that warrants further exploration.[24] However, as there is evidence that positive symptoms with the Rose questionnaire indicate higher mortality from heart diseases among women, these symptoms warrant confirmatory tests and intervention. Overall, in our study, the proportion of participants who were found to have CHD was higher using the Rose questionnaire than using ECG criteria, similar to the findings in Trivandrum[7] and Moradabad[8] but not in Rajasthan,[9] possibly reflecting differences in population characteristics, such as educational status and health-seeking behavior. Interesting, those who had objective evidence of ischemia on ECG were mostly asymptomatic, proving that silent episodes of ischemia are also going unrecognized.

While the prevalence rates of CHD rates among rural males showed no change in the 20-year period, the rates in urban males rose marginally and the rates in females rose to more than twice the previous rates, with an increase in premature CHD. With a high rise in risk factors such as overweight and physical inactivity among females,[17] the rise in prevalence of CHD among them is expected. Rural males have been protected due to their higher activity levels and lower body mass indices. However, the lack of a significant rise of CHD rates in males was surprising, as risk factors such as diabetes and hypertension have increased in the same population.[17] A possible explanation may be the fact that in 1991–1994 around 40% of males were smokers whereas in the current study only 25% were smokers. As smoking is a strong predictor of CHD, reduction in smoking may have stemmed the rise in CHD rates that would have been expected with the rise in other cardiovascular risk factors. Also with a reduction in smoking, diabetes would be the risk factor to be targeted next to reduce the incidence of CHD.

Family history was an independent risk factor for CHD in our study, as has been seen in the INTERHEART study.[2] While traditionally women have been considered less likely to develop heart disease in the pre-menopausal age, with alarming rise in body mass indices as seen in this population over the last 20 years,[17] the advantage of being a pre-menopausal woman seems to be disappearing. The rates of CHD in this population were higher in women compared to men, irrespective of menopause, although previously known disease was least among pre-menopausal women. As the rates of both ECG abnormalities as well as symptoms were higher in females, it is unlikely that these findings are merely due to different perceptions of heart disease and its symptoms between the genders, although such factors could explain some of the differences in symptom rate between populations. Awareness regarding chest pain, chest pain as part of somatization, and muscle weakness due to vitamin D deficiency could be other reasons why Indian women report chest pain on exertion more than males, which could be explored in future research. Occurrence of CHD in females at a later age than males may be one reason why women are less likely to be hospitalized for CHD, as it may be causing deaths among elderly women, before hospitalization. Predictive

Table 4 – Age specific prevalence rates of coronary heart disease in 1991–1994 and 2010–2012.

Sex	Age group (years)	Age specific rates of CHD (%)					
		Rural			Urban		
		1991–1994	2010–2012	p value (chi-square)	1991–1994	2010–2012	p value (chi-square)
Males	30–34	1.71	1.60	>0.05	0.80	3.64	>0.05
	35–39	1.57	3.14	>0.05	2.86	3.85	>0.05
	40–44	3.36	2.94	>0.05	2.19	4.29	>0.05
	45–49	2.82	1.65	>0.05	6.57	7.80	>0.05
	50–54	4.68	2.35	>0.05	7.44	7.62	>0.05
	55–60	4.65	5.09	>0.05	17.29	13.86	>0.05
	Total[a] (95% CI)	2.75 (2.05–3.45)	2.58 (1.72–3.44)		4.63 (3.51–5.75)	5.79 (4.27–7.31)	
Females	30–34	1.01	5.05	< 0.001	0.74	10.86	<0.001
	35–39	0.91	4.49	0.011	2.42	9.52	<0.001
	40–44	2.99	5.71	>0.05	6.00	15.03	0.004
	45–49	2.76	6.74	0.011	7.35	17.58	0.002
	50–54	5.13	7.54	>0.05	9.84	11.81	>0.05
	55–60	4.45	13.41	<0.001	15.98	13.79	>0.05
	Total[a] (95% CI)	2.39 (1.80–2.98)	6.33 (5.19–7.47)		5.48 (4.32–6.63)	12.69 (10.62–14.78)	

[a] Adjusted to 2001 Census of India 30–60 years.

Table 5 – Risk factors for coronary heart disease: unadjusted and adjusted odds ratios.

Risk factor	Categories	% with coronary heart disease	Unadjusted odds ratios (95% CI)	p value	Adjusted odds ratios (95% CI)	p value
Gender	Males	106/2217 (4.8)	0.47 (0.38–0.59)	<0.001	0.41 (0.28–0.59)	<0.001
	Females	288/2996 (9.6)	–		–	
Place	Urban	207/1910 (10.8)	2.02 (1.65–2.49)	<0.001	2.02 (1.58–2.58)	<0.001
	Rural	187/3303 (5.7)	–		–	
Education	≤8 years	275/3148 (8.7)	1.55 (1.93–1.24)	<0.001	1.37 (1.05–1.78)	0.021
	>8 years	119/2044 (5.8)	–		–	
Smoking	Current	26/550 (4.7)	0.59 (0.39–0.88)	0.023	0.79 (0.46–1.37)	0.410
	Former	19/206 (9.2)	1.19 (0.74–1.94)		1.95 (1.10–3.43)	0.022
	Non-smokers	348/4448 (7.8)	–		–	
Alcohol use	Ever users	60/1216 (4.9)	0.57 (0.43–0.76)	<0.001	1.19 (0.78–1.83)	0.405
	Never users	334/3997 (8.4)	–			
Physical activity	Low	194/2571 (7.5)	0.96 (0.73–1.25)	0.912	0.66 (0.49–0.89)	0.007
	Moderate	114/1536 (7.4)	0.94 (0.69–1.26)		0.76 (0.55–1.04)	0.088
	High	83/1055 (7.9)	–		–	
Daily fruit and vegetable intake	<1 serving	203/2323 (8.7)	1.36 (1.11–1.68)	0.003	1.27 (1.01–1.59)	0.040
	≥1 serving	188/2864 (6.6)	–		–	
Family history of heart disease before 60 years	Yes	26/154 (16.9)	2.59 (1.67–3.99)	<0.001	2.46 (1.54–3.94)	<0.001
	No	367/5037 (7.3)	–		–	
BMI (kg/m^2)	≥30	60/561 (10.7)	1.58 (1.17–2.14)	0.009	1.10 (0.76–1.59)	0.608
	25–29.9	109/1501 (7.3)	1.03 (0.82–1.31)		0.86 (0.64–1.17)	0.332
	<25	221/3140 (7.0)	–		–	
Abdominal obesity*	Yes	246/2796 (8.8)	1.53 (1.24–1.90)	<0.001	0.93 (0.68–1.26)	0.619
	No	139/2348 (5.9)	–		–	
Blood pressure ≥ 140/90 mmHg or on medication	Yes	122/1098 (11.1)	1.77 (1.41–2.22)	<0.001	1.26 (0.96–1.65)	0.099
	No	271/4110 (6.6)	–		–	
Fasting sugar 126 ≥ mg% or on medication	Yes	101/765 (13.2)	2.09 (1.64–2.66)	< 0.001	1.47 (1.10–1.95)	0.008
	No	283/4164 (6.8)	–		–	
Total cholesterol ≥ 190 mg% or on medication	Yes	177/1867 (9.5)	1.49 (1.21–1.84)	< 0.001	1.25 (0.99–1.58)	0.060
	No	198/3015 (6.6)	–		–	

Table 5 (*Continued*)

Risk factor	Categories	% with coronary heart disease	Unadjusted odds ratios (95% CI)	*p* value	Adjusted odds ratios (95% CI)	*p* value
Triglycerides ≥ 150 mg%	Yes	110/1308 (8.4)	1.14 (0.90–1.44)	0.266	1.04 (0.80–1.35)	0.757
	No	267/3583 (7.5)	–		–	
Low HDL**	Yes	306/3793 (8.1)	1.29 (0.99–1.70)	0.059	1.04 (0.78–1.39)	0.790
	No	69/1089 (6.3)	–		–	
Clustering of risk factors***	>3	50/469 (10.7)	–	0.010$	–	
	1–3	339/4686 (7.2)	–		–	
	No risk factors	3/44 (6.8)				

* Waist circumference ≥ 90 cm in men, ≥80 cm in women.
** <40 mg% in men, <50 mg% in women.
*** Current daily smoking, less than five daily fruits and vegetable servings, low physical activity, overweight (BMI ≥ 25 kg/m^2), blood pressure ≥ 140/90 mmHg, or on medication.
$ Chi-square for trend.

validity of the Rose questionnaire in India also needs to be studied, as a large proportion of the CHD subjects in this study were symptom positive rather than ECG positive.

Irrespective of the reason for the phenomenon, higher rates of CHD in females and a rising trend of the same in both urban and rural women, along with a rise in risk factors, such as overweight, abdominal obesity, and diabetes, points to the need for targeted education regarding prevention and early detection of CHD among women.

Conflicts of interest

The authors have none to declare.

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REFERENCES

1. Anchala R, Kannuri NK, Pant H, et al. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *J Hypertens*. 2014;32:1170–1177.
2. Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. *Indian J Med Res*. 2007;125:217–230.
3. Gupta R, Guptha S, Agrawal A, Kaul V, Gaur K, Gupta VP. Secular trends in cholesterol lipoproteins and triglycerides and prevalence of dyslipidemias in an urban Indian population. *Lipids Health Dis*. 2008;7:40.
4. Ramachandran A, Snehalatha C, Baskar AD, et al. Temporal changes in prevalence of diabetes and impaired glucose tolerance associated with lifestyle transition occurring in the rural population in India. *Diabetologia*. 2004;47:860–865.
5. World Health Organization. *Non communicable diseases country profile*. 2014. Retrieved 18.5.2015.
6. Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937–952.
7. Kutty VR, Balakrishnan KG, Jayasree AK, Thomas J. Prevalence of coronary heart disease in the rural population of Thiruvananthapuram district, Kerala, India. *Int J Cardiol*. 1993;39:59–70.
8. Singh RB, Sharma JP, Rastogi V, et al. Prevalence of coronary artery disease and coronary risk factors in rural and urban populations of north India. *Eur Heart J*. 1997;18:1728–1735.
9. Gupta R, Gupta VP, Sarna M, et al. Prevalence of coronary heart disease and risk factors in an urban Indian population: Jaipur Heart Watch-2. *Indian Heart J*. 2002;54:59–66.
10. Mohan V, Deepa R, Rani SS, Premalatha G. Prevalence of coronary artery disease and its relationship to lipids in a selected population in South India: the Chennai Urban Population Study (CUPS No. 5). *J Am Coll Cardiol*. 2001;38:682–687.
11. Kamili M, Dar I, Ali G, Wazir H, Hussain S. Prevalence of coronary heart disease in Kashmiris. *Indian Heart J*. 2007;59:44–49.
12. Gupta R. Recent trends in coronary heart disease epidemiology in India. *Indian Heart J*. 2008;60:B4–B18.
13. Ajithakumari PP, Roy A, Anand K, et al. Rising prevalence of Coronary Heart Disease (CHD) in urban Delhi, India – results from a repeat cross-sectional study. *Eur Heart J*. 2013;34 (suppl 1). http://dx.doi.org/10.1093/eurheartj/eht308.P2506.
14. Gupta R, Guptha S, Sharma KK, Gupta A, Deedwania P. Regional variations in cardiovascular risk factors in India: India heart watch. *World J Cardiol*. 2012;4:112–120.
15. World Health Organization. STEP wise approach to surveillance. Available from: http://www.who.int/chp/steps/en/.
16. Oommen AM, Abraham VJ, George K, Jose VJ. Prevalence of risk factors for non-communicable diseases in rural and urban Tamil Nadu. *Indian J Med Res*. 2015 [in press].
17. Oommen AM, Abraham VJ, George K, Jose VJ. Rising trend of cardiovascular risk factors between 1991-94 and 2010-12: a repeat cross sectional survey in urban and rural Vellore. *Indian Heart J*. 2015 [in press].
18. World Health Organization. Western Pacific Region. International Association for the study of obesity. The International obesity task force. *The Asia Pacific Perspective: Redefining Obesity and its Treatment*. 2000. Available from: http://www.wpro.who.int/nutrition/documents/docs/Redefiningobesity.pdf?ua=1.
19. Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. *Bull World Health Organ*. 1962;27:645–658.
20. Wagner GS, Macfarlane P, Wellens H, et al. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part VI: acute ischemia/infarction: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee. Council on

Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: endorsed by the International Society for Computerized Electrocardiology. *Circulation*. 2009;119:e262–e270.
21. Rautaharju PM, Surawicz B, Gettes LS. AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: part IV: the ST segment, T and U waves, and the QT interval. A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society Endorsed by the International Society for Computerized Electrocardiology. *J Am Coll Cardiol*. 2009;53:982–991.
22. Prineas R, Henry B, Richard C. *The Minnesota code manual of electrocardiographic findings: standards and procedures for measurement and classification*. Boston: Wright-PSG; 1982.
23. Bennett S, Woods T, Liyanage WM, Smith DL. A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q*. 1991;44:98–106.
24. Hemingway H, Langenberg C, Damant J, Frost C, Pyörälä K, Barrett-Connor E. Prevalence of angina in women versus men: a systematic review and meta-analysis of international variations across 31 countries. *Circulation*. 2008;117:1526–1536.
25. Ahmad N, Bhopal R. Is coronary heart disease rising in India? A systematic review based on ECG defined coronary heart disease. *Heart*. 2005;91:719–725.