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CARDIOVASCULAR DISEASE

# Socio-economic distribution of cardiovascular risk factors and knowledge in rural India

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**Background** To investigate the prevalence, screening and knowledge of cardiovascular risk factors (CVRFs) by socio-economic position (SEP) in rural India.

**Methods** An age- and sex-stratified random sample of 4535 adults was recruited from rural Andhra Pradesh and a questionnaire was administered to assess prevalence, screening and knowledge of CVRFs and record recent attempts to modify behaviour. Education, income and occupation were used to measure SEP.

**Results** Lower fruit intake and higher tobacco and alcohol use were found in those with lower SEP. Overweight, physical inactivity, diabetes, hypertension, family history of cardiovascular disease (CVD) and previous CVD (men only) were greater in higher SEP participants. Lower SEP participants had less blood pressure, glucose or cholesterol screening and less knowledge of nine CVRFs. Regardless of SEP, participants knowledgeable of the harms of a CVRF were more likely to have attempted to modify behaviour. For example, knowledge of benefits of smoking cessation was associated with an increased odds ratio (OR) for attempting to quit: in educated participants—OR 3.67, 95% confidence interval (CI) 2.10–6.42; in participants with no education—OR 3.98, 95% CI 2.27–6.97.

**Conclusions** Some biological CVRFs were worse in higher SEP participants while some behavioural risk factors were worse in lower SEP participants. Lower SEP participants had less CVRF screening and knowledge of CVRFs. Those with knowledge of CVRFs were more likely to make healthy behavioural changes. Our findings suggest equipping rural Indians with knowledge about CVRFs may ameliorate projected future increases in CVD.

**Keywords** Cardiovascular diseases, socio-economic status, risk factors, risk reduction behaviour, India

# Introduction

When cardiovascular disease (CVD) was first recognized as a major cause of death during the 20th century in 'developed' regions like Europe and the USA, it was found to be most common among the affluent sections of society. Over time, prevalence transitioned down the social scale to become higher among people of lower socio-economic position (SEP).[1] In 'developing' world populations, those of higher socio-economic position are currently thought to be at highest risk of CVD.[2] However, there is some evidence that a transition, similar to developed regions, is already occurring,[3,4] as recent studies from urban India indicate that cardiovascular risk factors (CVRFs) such as tobacco use, obesity and hypertension is increasing in those of lower SEP.[5–8]

In rural India, where ~70% of India's population live, recent studies indicate that CVDs are now the leading cause of death[9,10] and CVRF levels are higher than previously assumed in some regions.[11–13] Health care is generally worse in rural compared with urban India, and studies of other health conditions have shown that the poorest in rural areas are worst off.[14] A shift in CVRFs to the more disadvantaged in rural India would therefore present a major health care challenge. One recent study of 1983 rural individuals reported that CVRFs such as smoking were higher in the most socio-economically disadvantaged.[15]

In high-income countries, higher SEP is generally associated with better knowledge of health risks.[16] As knowledge about unhealthy behaviours is one of the precursors to positive behavioural modification,[17,18] if those of lowest socio-economic position in rural India are less aware of potential risks, they may be more susceptible to adverse lifestyle behaviours and subsequent CVD.

The objective of this analysis was, in a rural Indian population, to examine the socio-economic distribution of: (i) CVRFs (smoking, diabetes, hypertension, overweight, physical inactivity, low fruit intake, alcohol use, established and family histories of CVD); (ii) rates of screening for risk factors [blood pressure (BP), blood glucose and cholesterol]; and (iii) knowledge of key behaviours that influence cardiovascular health (lose weight, quit smoking, increase exercise, eat more fish, drink less alcohol, reduce fat in meals, reduce salt in meals, eat more fresh fruit, eat more green leafy vegetables). The analysis then sought to explore the hypothesis that greater knowledge of key behaviours which influence cardiovascular health was associated with protective lifestyle behaviour regardless of SEP.

# Methods

The study was conducted as part of the Andhra Pradesh Rural Health Initiative (APHRI) whose members and details are listed in acknowledgements. The study was approved by the Ethics Committees of the CARE Hospital, Hyderabad in India and the University of Sydney in Australia. All participants provided informed consent and the study was performed in accordance with the Declaration of Helsinki and subsequent amendments.

## Recruitment of study population

This study was conducted in 2005 in 20 villages in the rural East and West Godavari regions of Andhra Pradesh, the fifth largest state of India, having 73% of its total population (of approximately 76 million) residing in rural areas. The proportion living in rural areas is similar to other states of India and the Godavari regions have a predominantly agrarian economy with few factories. The major town in the area, Bhimavaram, has a train station that connects it to Hyderabad, though taking ~10 h travel time. The 20 villages were stratified by population size, distance from the rural centre and region to obtain a representative sample of villages of the area. The villages were all participating in a rural development initiative run by the Byrraju Foundation, a local non-governmental organization and collaborator in APRHI. They were sampled from a list of 88 villages from the East and West Godavari regions for which the community leaders of the villages had consented to participate and the Byrraju Foundation had complete population listings. Six villages were from East Godavari, 14 villages from West Godavari and the mean distance from a large town was ~20 km. The survey sample for each village was a stratified random sample of roughly equal number of individuals from eight groups defined by age (30–39, 40–49, 50–59, >60 years) and sex. A roughly equal total sample was drawn from each of the 20 villages. Using this method of sampling and weighted survey data analysis enabled precise estimation of overall CVRF levels, and by age–sex group for the population living in the 20 villages. A simple random sample would not have allowed calculation of precise estimates for older age groups because the bulk of the population of India is <40 years of age[19] and thus would have resulted in fewer individuals from older age groups. The average household size was four, and as a sample of 200 individuals was sampled from each village, the chances of two or more individuals being randomly sampled from a household was low. Of the 6985 individuals invited, 5627 were still living in the villages, of whom 4535 (81%) agreed to take part and provided informed consent.[20]

## Study variables

For each individual who consented to participate, trained study staff administered a structured questionnaire (see Supplementary Appendix 1 available as Supplementary data at *IJE* online)[20] and a fasting finger-prick glucose test using B-Braun USV meters

(Melsungen, Germany). All individuals had a brief physical examination that included two sitting measurements of BP using an Omron M2 manual inflation monitor and measurements of weight, height, waist and hip circumference with participants wearing light clothing without shoes. A team of five health workers were assigned to taking measurements (BP, waist, height and weight). The first measurement was taken after a period of at least 5 min of rest. A fasting venous blood sample was sought from every fourth individual rendering a sub-sample of 1086 participants from which the lipid profile was measured. Frozen samples were transferred to a central internationally accredited laboratory in the CARE hospital, Hyderabad, India, where analyses were performed using a Beckman Coulter Synchron Cx9 Clinical system ALX analyser. The coronary heart disease (CHD) risk for each participant was calculated using a locally recalibrated Framingham equation for the sub-sample of participants in whom lipids were measured.[21]

Information on three socio-economic variables (education, income and occupation) was collected by self-report. For each participant the highest level of education completed was recorded from the categories: higher education (diploma/technical/university); secondary school (to grade 12); primary school (to grade 6) or no formal schooling. Household income was recorded in Indian rupees for an average month. For seasonal workers, interviewers were trained to assist in calculating an average monthly income based on the last 12 months income. Participants were asked their current occupation and interviewers categorized this based on the standard Indian classification system[22] with the assistance of a prompt card (see Supplementary Appendix 2 available as Supplementary data at *IJE* online) into the following groups: skilled manual workers, unskilled manual workers, owner of business or farm, office worker/non-professional, professional, housewife or unemployed/retired. We then defined 'Educated' as those who had attended primary school, secondary school or higher education and 'No education' as those reporting no formal schooling. In analysing occupation, we excluded housewife as we hypothesized that this category would not adequately describe SEP based on previous literature,[5] and unemployed/retired as the way the question was administered did not allow these two categories to be differentiated. Less than 10% of the study population were unemployed/retired. Thus, we also dichotomized occupation into 'skilled occupation', defined as those with an occupation of skilled manual worker or owner of business/farmer office worker/non-professional or professional and 'unskilled occupation' as those who were unskilled manual worker, as again approximately half the sample were unskilled, and the remaining categories of skilled manual workers, owner of business or farm and office worker/non-professional were relatively homogenous in terms of literacy. Income was examined by thirds (high: $\geqslant$2000 rupees; medium: 1200–1999 rupees; poor: 0–1199 rupees).

Information on behavioural CVRFs was ascertained through a questionnaire (see Supplementary Appendix 1 available as Supplementary data at *IJE* online). Current smokers were defined as those that smoked regularly on most days for at least a year, and ex-smokers as those who had stopped smoking for at least 1 year. Low fruit intake was defined as fruit consumed on one day or less a week. Physical inactivity was defined as a report of 'almost none' in response to a question about physical activity during working hours and outside of work. Alcohol use was defined as those who reported at least one drink on one or more days of the week.

Information on biological CVRFs was ascertained through questionnaire, physical examination and blood testing. Hypertension was defined according to Joint National Committee on Prevention, Detection, Evaluation and Treatment of High BP guidelines[23] as mean systolic BP $\geqslant$140 mmHg, and/or mean diastolic BP $\geqslant$90 mmHg, or known hypertension (diagnosed by a doctor) on BP lowering prescription medication. Overweight was defined as a body mass index (BMI) of $\geqslant$25 and underweight as a BMI of $<$18.5.[24] Diabetes was defined as fasting blood glucose $\geqslant$7 mmol/l ($\geqslant$126 mg/dl)[25] or on self-report.

Established CVD was defined as self-reported doctor-diagnosed heart attack, stroke or angina and family history of CVD as a first degree relative having had a heart attack or stroke (according to the knowledge of the study participant) before the age of 60 years.

In addition, all participants were asked whether they had had their BP, blood glucose or cholesterol checked in the last 12 months. Knowledge of nine key behaviours (lose weight, quit smoking, increase exercise, eat more fish, drink less alcohol, reduce fat in meals, reduce salt in meals, eat more fresh fruit, eat more green leafy vegetables) that reduce the risk of CVD was assessed in the questionnaire by asking participants to respond 'yes', 'no' or 'unsure' as to whether a change in each behaviour could prevent a heart attack or stroke. We analysed 'no' and 'unsure' together. Participants were also asked if they had taken action to beneficially modify any of these nine behaviours in the previous 12 months, as 'yes' or 'no'.

## Statistical analysis

(i) Prevalence of CVRFs, screening of risk factors and knowledge about key behaviours that reduce the risk of CVD, by SEP.

We analysed, in turn, prevalence of risk factors, screening of risk factors and knowledge about key behaviours that reduce the risk of CVD, by the three markers of SEP (education, occupation and income). Data are expressed as percentages for categorical variables and means and standard deviations

(SDs) for continuous measures, which were all normally distributed. Differences between socio-economic groups were tested using chi-squared tests for categorical variables or *t*-tests for continuous variables and *t*-tests for trend were used to examine patterns across income categories. Levels of risk factor, screening and knowledge are presented unadjusted; however, comparisons across socio-economic groups are all adjusted for age and sex.

(ii) Influence of SEP and knowledge of key behaviours that reduce the risk of CVD on attempt to modify behaviour.

For further analyses, we chose educational level as the SEP variable, as there was considerable co-linearity between the three socio-economic variables and educational level is a widely used measure of SEP. The association between educational level and an attempt to modify a CVRF in the last 12 months was examined in logistic regression models adjusted for age and sex, in those with that specific risk factor. The association between knowledge about a risk factor and an attempt to modify that risk factor in the past 12 months was examined in logistic regression models adjusted for age and sex, in those with that specific risk factor. These analyses were carried out for smoking cessation, weight loss, increase in exercise, eating more fruit and drinking less alcohol. Effect sizes were measured as odds ratios (ORs), with 95% confidence intervals (CIs).

(iii) Influence of both SEP and knowledge on attempt to modify behaviour.

A new indicator variable comprising both educational level and knowledge about a CVRF was established—those with no formal education and no knowledge was the reference group, with three other groups representing those with no formal education but with knowledge, those who were educated but having no knowledge, and those who were educated with knowledge. In age- and sex-adjusted logistic regression models, we examined this variable against the outcome of an attempt to modify either smoking (in current smokers) or weight (in those who were overweight) in the last 12 months. These were plotted alongside the two-level variables (educational level, knowledge) examined in section ii. Thus, our three logistic regression models adjusted for age and sex were:

(a) association between educational level and an attempt to modify that risk factor in the past 12 months;
(b) association between knowledge about a risk factor and an attempt to modify that risk factor in the past 12 months; and
(c) association between educational level/knowledge and an attempt to modify that risk factor in the past 12 months.

All statistical analyses were carried out using STATA 11.0.

## Ethical approval

The study was approved by the Ethics Committees of the CARE Hospital, Hyderabad in India, and the University of Sydney in Australia.

# Results

Among the 4535 participants, the mean age was 49.4 (SD 13.6), and 51.4% were women. Table 1 describes the socio-economic characteristics of the study sample by sex. Men were more likely to be literate than women, and, concordantly, more likely to have had some formal education. Unskilled manual labourers made up 68.1% of men and 37.4% of women. Data fields were >99% complete for all descriptive and socio-economic variables.

## Disease risk factors by SEP

Those with no education were more likely to be current smokers compared with those with some education, in both men and women (Table 2). Among the participants, 57.7% of men with no formal education smoked compared with 39.5% of educated men and while the pattern was similar in women, fewer of them smoked. A higher educational level in men was associated with a higher prevalence of diabetes, hypertension, overweight, physical inactivity, family history of CVD, established history of CVD, higher fruit intake and lower alcohol intake. In women, a higher educational level was associated with a higher prevalence of overweight, physical inactivity, family history of CVD, higher fruit intake and lower

**Table 1** Characteristics of study sample from rural Andhra Pradesh, India ($n = 4535$)

| Characteristic | Men N (%) | Women N (%) |
|---|---|---|
| Mean age (SD) | 50.7 (13.6) | 48.1 (13.5) |
| Illiterate, *n* (%) | 1164 (52.8) | 921 (39.5) |
| **Highest level of education completed** | | |
| No formal schooling | 895 (40.6) | 1255 (53.9) |
| Primary school | 750 (34.0) | 806 (34.6) |
| Secondary school | 447 (20.3) | 241 (10.4) |
| Graduate or post-graduate studies | 114 (5.2) | 27 (1.2) |
| **Employment** | | |
| Unemployed or retired | 266 (12.1) | 153 (6.6) |
| Housewife | 5 (0.2) | 1216 (52.2) |
| Skilled manual worker | 148 (6.7) | 51 (2.2) |
| Unskilled manual worker | 1501 (68.0) | 872 (37.4) |
| Owner of business/ non-professional | 175 (7.9) | 21 (0.9) |
| Professional | 72 (3.3) | 12 (0.5) |

**Table 2** Risk factor distribution by education, occupation and income

| | **Education**[a] | | | **Occupation**[b] | | | **Income**[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Educated | No education | *P*-value | Skilled | Unskilled | *P*-value | High | Middle | Low | ***P*-trend** |
| **Men** | | | | | | | | | | |
| *N* | 1311 | 895 | – | 434 | 1501 | – | 912 | 717 | 577 | – |
| Mean age (SD) | 50.2 (13.6) | 51.5 (13.5) | 0.022 | 47.4 (12.0) | 48.7 (12.5) | 0.058 | 50.8 (13.2) | 47.5 (12.6) | 54.6 (14.5) | <0.001 |
| Current smoker | 518 (39.5) | 516 (57.7) | <0.001 | 148 (34.1) | 770 (51.3) | <0.001 | 381 (41.8) | 355 (49.5) | 298 (51.7) | <0.001 |
| Diabetes | 255 (20.1) | 106 (12.4) | <0.001 | 102 (24.1) | 186 (12.9) | <0.001 | 186 (21.2) | 84 (12.2) | 91 (16.2) | <0.001 |
| Hypertension | 417 (31.8) | 250 (27.9) | 0.005 | 149 (34.3) | 371 (24.7) | <0.001 | 294 (32.2) | 169 (23.4) | 204 (35.4) | 0.352 |
| Overweight | 310 (23.7) | 95 (10.6) | <0.001 | 152 (35.0) | 203 (13.5) | <0.001 | 231 (25.3) | 105 (14.6) | 69 (12.0) | <0.001 |
| Underweight | 269 (20.6) | 300 (33.5) | <0.001 | 53 (12.2) | 435 (29.0) | <0.001 | 159 (17.5) | 197 (27.5) | 213 (36.9) | <0.001 |
| Physical inactivity | 435 (33.2) | 208 (23.2) | <0.001 | 201 (46.3) | 185 (12.3) | <0.001 | 311 (34.1) | 153 (21.4) | 176 (30.5) | <0.001 |
| Low fruit intake | 491 (37.4) | 501 (55.6) | <0.001 | 135 (31.1) | 717 (47.8) | <0.001 | 328 (36.0) | 348 (48.5) | 316 (54.8) | <0.001 |
| Family history of CVD | 226 (17.2) | 114 (12.7) | 0.006 | 94 (21.7) | 210 (14.0) | <0.001 | 157 (17.2) | 106 (14.8) | 77 (13.3) | 0.065 |
| Prior history of CVD | 126 (9.6) | 56 (6.3) | 0.002 | 34 (7.8) | 95 (6.3) | 0.151 | 95 (10.4) | 41 (5.7) | 46 (8.0) | 0.005 |
| Alcohol use | 334 (25.5) | 329 (36.8) | <0.001 | 103 (23.7) | 523 (34.8) | <0.001 | 240 (26.3) | 246 (34.3) | 177 (30.7) | 0.005 |
| SBP (mmHg mean, SD) | 127 (20) | 126 (21) | 0.013 | 127 (19) | 124 (20) | 0.001 | 127 (19) | 123 (19) | 130 (23) | 0.414 |
| BMI (mean, SD) | 22.2 (3.9) | 20.6 (3.4) | <0.001 | 23.5 (4.0) | 21.0 (3.5) | <0.001 | 22.5 (3.9) | 21.1 (3.7) | 20.5 (3.4) | <0.001 |
| Waist (cm mean, SD) | 82.7 (11.5) | 78.0 (10.3) | <0.001 | 86.5 (11.2) | 79.0 (10.5) | <0.001 | 83.6 (11.6) | 79.4 (10.5) | 78.1 (10.7) | <0.001 |
| *N* | 328 | 204 | | 109 | 370 | | 223 | 170 | 139 | |
| Total cholesterol (mmol, SD) | 4.6 (1.2) | 4.4 (1.1) | 0.171 | 4.7 (1.2) | 4.5 (1.2) | 0.094 | 4.4 (1.3) | 4.5 (1.2) | 4.4 (1.3) | 0.019 |
| LDL-cholesterol (mmol, SD) | 2.8 (0.9) | 2.7 (0.9) | 0.166 | 2.9 (0.9) | 2.8 (0.8) | 0.065 | 2.9 (0.9) | 2.7 (0.8) | 2.7 (0.9) | 0.012 |
| HDL-cholesterol (mmol, SD) | 1.1 (0.3) | 1.2 (0.3) | 0.002 | 1.0 (0.3) | 1.1 (0.3) | 0.024 | 1.1 (0.3) | 1.1 (0.3) | 1.1 (0.4) | 0.567 |
| Triglycerides (mmol, SD) | 1.6 (1.4) | 1.3 (1.0) | 0.009 | 1.7 (1.1) | 1.5 (1.3) | 0.057 | 1.6 (1.1) | 1.5 (1.6) | 1.4 (1.1) | 0.058 |
| Framingham risk score (%) | 13.1 | 11.9 | 0.014 | 11.7 | 10.7 | 0.044 | 13.6 | 9.6 | 14.9 | 0.384 |
| Framingham risk category | | | | | | | | | | |
| High (>20% CHD risk in 10 years) | 66 (20.2) | 33 (16.3) | 0.730 | 18 (16.5) | 52 (14.1) | 0.101 | 48 (21.6) | 17 (10.0) | 34 (24.6) | 0.286 |
| Medium (10–20% CHD risk) | 74 (22.6) | 61 (30.1) | | 27 (24.8) | 91 (24.7) | | 60 (27.0) | 35 (20.6) | 40 (28.9) | |
| Low (<10% CHD risk) | 187 (57.2) | 109 (53.7) | | 64 (58.7) | 226 (61.3) | | 114 (51.4) | 118 (69.4) | (46.4) | |
| **Women** | | | | | | | | | | |
| *N* | 1074 | 1255 | – | 88 | 872 | – | 945 | 550 | 834 | – |
| Mean age (SD) | 45.9 (13.0) | 49.9 (13.7) | <0.001 | 42.6 (11.5) | 43.2 (11.1) | 0.644 | 46.8 (12.8) | 45.4 (13.5) | 51.3 (13.6) | <0.001 |

(continued)

**Table 2** Continued

| | Education[a] | | | Occupation[b] | | | Income[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Educated | No education | *P*-value | Skilled | Unskilled | *P*-value | High | Middle | Low | ***P*-trend** |
| Current smoker | 13 (1.2) | 107 (8.5) | <0.001 | 1 (1.1) | 62 (7.1) | 0.059 | 40 (4.2) | 21 (3.8) | 59 (7.1) | 0.101 |
| Diabetes | 138 (13.1) | 156 (12.8) | 0.258 | 11 (12.9) | 65 (7.7) | 0.075 | 138 (15.0) | 57 (10.7) | 99 (12.1) | 0.005 |
| Hypertension | 313 (29.1) | 373 (29.7) | 0.009 | 15 (7.1) | 149 (17.1) | 0.932 | 269 (28.5) | 151 (27.5) | 266 (31.9) | 0.165 |
| Overweight | 354 (33.0) | 255 (20.3) | <0.001 | 27 (30.7) | 147 (16.9) | 0.002 | 300 (31.8) | 138 (25.1) | 171 (20.5) | <0.001 |
| Underweight | 189 (17.6) | 386 (30.8) | <0.001 | 12 (13.6) | 268 (30.7) | 0.001 | 163 (17.3) | 138 (25.1) | 274 (32.9) | <0.001 |
| Physical inactivity | 662 (61.6) | 619 (49.3) | <0.001 | 45 (51.4) | 106 (12.2) | <0.001 | 541 (57.3) | 277 (50.4) | 453 (54.3) | <0.001 |
| Low fruit intake | 466 (43.4) | 712 (56.7) | <0.001 | 44 (50.0) | 483 (55.4) | 0.344 | 410 (43.4) | 274 (49.8) | 494 (59.2) | <0.001 |
| Family history of CVD | 209 (19.5) | 117 (9.3) | <0.001 | 17 (19.3) | 95 (10.9) | 0.021 | 141 (14.9) | 69 (12.6) | 116 (13.9) | 0.456 |
| Prior history of CVD | 70 (6.5) | 75 (6.0) | 0.227 | 6 (6.8) | 36 (4.1) | 0.236 | 48 (5.1) | 34 (6.2) | 63 (7.6) | 0.128 |
| Alcohol use | 5 (0.5) | 22 (1.8) | 0.014 | 2 (2.3) | 20 (2.3) | 0.997 | 13 (1.4) | 5 (0.9) | 9 (1.1) | 0.350 |
| SBP (mmHg mean,SD) | 122 (20) | 124 (22) | 0.095 | 119 (21) | 116 (19) | 0.057 | 122 (20) | 120 (21) | 125 (24) | 0.257 |
| BMI (mean, SD) | 23.3 (4.5) | 21.6 (4.5) | <0.001 | 23.3 (3.8) | 21.3 (4.0) | <0.001 | 23.2 (4.6) | 22.2 (4.5) | 21.5 (4.5) | <0.001 |
| Waist (cm mean, SD) | 76.9 (10.6) | 74.9 (11.1) | <0.001 | 76.2 (9.9) | 73.3 (10.4) | 0.009 | 77.5 (10.6) | 75.2 (10.9) | 74.4 (11.0) | <0.001 |
| *N* | 248 | 306 | | 18 | 199 | | 238 | 132 | 184 | |
| Total cholesterol (mmol, SD) | 4.9 (1.3) | 4.9 (1.1) | 0.522 | 5.5 (1.3) | 4.8 (1.0) | 0.011 | 5.0 (1.1) | 5.0 (1.1) | 4.7 (1.2) | 0.033 |
| LDL-cholesterol (mmol, SD) | 3.1 (0.9) | 3.1 (0.8) | 0.817 | 3.5 (1.0) | 3.1 (0.8) | 0.052 | 3.2 (0.8) | 3.2 (0.9) | 3.0 (0.9) | 0.022 |
| HDL-cholesterol (mmol, SD) | 1.2 (0.3) | 1.2 (0.3) | 0.713 | 1.3 (0.2) | 1.2 (0.3) | 0.179 | 1.2 (0.3) | 1.2 (0.3) | 1.2 (0.3) | 0.263 |
| Triglycerides (mmol, SD) | 1.4 (0.9) | 1.3 (0.9) | 0.191 | 1.7 (2.4) | 1.2 (0.6) | 0.018 | 1.4 (1.1) | 1.4 (0.7) | 1.3 (0.7) | 0.180 |
| Framingham risk score (%) | 4.2 | 5.0 | 0.955 | 3.6 | 3.2 | 0.391 | 4.3 | 4.2 | 5.3 | 0.279 |
| Framingham risk category | | | | | | | | | | |
| High (>20% CHD risk in 10 years) | 3 (1.2) | 4 (1.3) | 0.783 | 0 | 2 (1.0) | 0.291 | 3 (1.3) | 0 | 4 (2.2) | 0.128 |
| Medium (10–20% CHD risk) | 22 (9.0) | 36 (11.8) | | 2 (11.8) | 10 (5.1) | | 19 (8.2) | 14 (10.6) | 25 (13.6) | |
| Low (<10% CHD risk) | 220 (89.8) | 264 (86.8) | | 15 (88.2) | 185 (93.9) | | 211 (90.6) | 118 (89.4) | 155 (84.2) | |

*P*-values are age-adjusted; values are numbers, and those in parentheses are percentages unless otherwise stated.

[a]We defined some education as those who had attended any level of education from primary school, through secondary school up to higher education (e.g. Diploma/Technical/University studies).

[b]We defined a skilled occupation as a skilled manual worker or owner of business/farm or office worker/non-professional or professional. Unskilled was defined as those who came under the unskilled manual worker section in the question, which accounted for 68.1% of men and 37.4% of women. We excluded housewife and unemployed/retired.

[c]We analysed income by thirds (high: ⩾2000 rupees; medium: 1200–1999 rupees; poor: 0–1199 rupees).

LDL: low-density lipoprotein; HDL: high-density lipoprotein.

alcohol intake. Women were overall much less likely to drink alcohol than men. BMI and waist circumference were greater in those of a higher educational level for both sexes. The patterns were broadly similar when occupation was used as a marker of SEP. Patterns by income revealed that poorer men smoked more, but had less diabetes, less overweight, were more physically active and were less likely to have a family or established history of CVD compared with richer men. Similar patterns were seen in women for diabetes, overweight and BMI, suggesting socio-economic differences in dietary patterns, but not for smoking with its low prevalence in women across all social groups.

In the sub-sample of 1086 participants with blood assays, a higher educational level or occupation in men was associated with no difference in low-density lipoprotein-cholesterol, higher triglycerides and lower high-density lipoprotein-cholesterol concentrations. When considering Framingham CHD risk, men of higher SEP (in terms of education level and occupation) had higher risk than those of lower SEP.

## Screening of risk factors by SEP

Participants of lower SEP had lower rates of BP, blood glucose and cholesterol screening (Table 3), and this was consistent for men and women. Rates of BP and glucose screening were generally high in this study sample as the Byrraju Foundation had recently conducted BP and diabetes screening programs in these villages.

## Knowledge about key behaviours that reduce the risk of CVD by SEP

Individuals of lower SEP had poorer knowledge of the lifestyle factors that influence cardiovascular risk. They were less likely to know that weight loss, smoking cessation, exercise, eating fish, less alcohol, reduced fat, reduced salt and more fruit and vegetables in the diet may prevent heart attack or stroke (Table 4). Again, we observed this pattern in both men and women, though overall levels of knowledge were lower in women than men.

## Influence of SEP and knowledge of key behaviours that reduce the risk of CVD on attempt to modify behaviour

In age- and sex-adjusted models, and in those with the risk factor, those who were educated were: (i) more likely to attempt to lose weight (OR: 2.57; 95% CI 1.85–3.57 in those with BMI ⩾ 25); (ii) more likely to attempt to increase physical activity (OR: 3.66; 95% CI 2.67–5.01 in those who were physically inactive); (iii) more likely to attempt to increase fruit intake (OR: 1.28; 95% CI 1.02–1.61 in those on less fruit); and (iv) more likely to attempt to decrease their alcohol intake (OR: 1.40; 95% CI 1.00–1.94 in

**Table 3** Prevalence of self-reported BP, blood glucose and cholesterol checks by education, occupation and income

| | **Education** | | | **Occupation** | | | **Income** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Educated | No education | P-value | Skilled | Unskilled | *P*-value | High | Middle | Low | ***P*-trend** |
| **Men** | | | | | | | | | | |
| *N* | 1311 | 895 | – | 434 | 1501 | – | 912 | 717 | 577 | – |
| BP checked ever | 848 (64.7) | 530 (59.2) | 0.009 | 289 (66.6) | 857 (57.1) | <0.001 | 616 (67.5) | 420 (58.6) | 342 (59.3) | <0.001 |
| BGL checked ever | 559 (42.6) | 327 (36.5) | 0.004 | 206 (47.5) | 518 (34.5) | <0.001 | 422 (46.3) | 259 (36.1) | 205 (35.5) | <0.001 |
| Cholesterol check ever | 127 (9.7) | 17 (1.9) | <0.001 | 54 (12.4) | 63 (4.2) | <0.001 | 90 (9.9) | 35 (4.9) | 19 (3.3) | <0.001 |
| **Women** | | | | | | | | | | |
| *N* | 1074 | 1255 | – | 88 | 872 | – | 945 | 550 | 834 | – |
| BP checked ever | 864 (80.5) | 884 (70.5) | <0.001 | 66 (75.0) | 552 (63.3) | 0.029 | 739 (78.3) | 399 (72.6) | 610 (73.1) | 0.011 |
| BGL checked ever | 436 (40.6) | 430 (34.3) | 0.002 | 31 (35.2) | 222 (25.5) | 0.047 | 394 (41.7) | 189 (34.4) | 283 (33.9) | 0.001 |
| Cholesterol check ever | 67 (6.2) | 36 (2.9) | <0.001 | 4 (4.6) | 21 (2.4) | 0.230 | 58 (6.1) | 24 (4.4) | 21 (2.5) | <0.001 |

*P*-values are age-adjusted; values are numbers, and those in parentheses are percentages.
BSL: blood glucose level.

**Table 4** Knowledge about key behaviours that reduce the risk of CVD: those who correctly answered whether a given action would prevent heart attack or stroke

| | Education | | | Occupation | | | Income | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Educated | No education | *P*-value | Skilled | Unskilled | *P*-value | High | Middle | Low | ***P*-trend** |
| **Men** | | | | | | | | | | |
| *N* | 1311 | 895 | – | 434 | 1501 | – | 912 | 717 | 577 | – |
| Lose weight | 772 (58.9) | 349 (39.9) | <0.001 | 284 (65.4) | 717 (47.8) | <0.001 | 547 (60.0) | 356 (49.7) | 218 (37.8) | <0.001 |
| Quit smoking | 892 (68.0) | 437 (48.8) | <0.001 | 310 (71.4) | 870 (58.0) | <0.001 | 630 (69.1) | 418 (58.3) | 281 (48.7) | <0.001 |
| Increase exercise | 779 (59.4) | 308 (34.4) | <0.001 | 289 (66.6) | 673 (44.84) | <0.001 | 525 (57.6) | 339 (47.3) | 223 (38.7) | <0.001 |
| Eat more fish | 398 (30.4) | 182 (20.3) | <0.001 | 143 (33.0) | 367 (24.5) | <0.001 | 304 (33.3) | 173 (24.1) | 103 (17.9) | <0.001 |
| Drink less alcohol | 725 (55.3) | 395 (44.1) | <0.001 | 256 (59.0) | 749 (49.9) | 0.001 | 532 (58.3) | 340 (47.4) | 248 (43.0) | <0.001 |
| Reduce fat in meals | 878 (67.0) | 390 (45.6) | <0.001 | 316 (72.8) | 809 (53.9) | <0.001 | 603 (66.1) | 404 (56.4) | 261 (45.2) | <0.001 |
| Reduce salt in meals | 808 (61.6) | 405 (45.3) | <0.001 | 287 (66.1) | 781 (52.0) | <0.001 | 561 (61.5) | 383 (53.4) | 269 (46.6) | <0.001 |
| Eat more fresh fruit | 841 (64.2) | 441 (49.3) | <0.001 | 286 (65.9) | 852 (56.8) | 0.001 | 591 (64.8) | 414 (56.7) | 277 (48.0) | <0.001 |
| Eat more green leafy vegetables | 909 (69.3) | 478 (53.4) | <0.001 | 317 (73.0) | 916 (61.0) | <0.001 | 644 (70.6) | 450 (62.8) | 293 (50.8) | <0.001 |
| **Women** | | | | | | | | | | |
| *N* | 1074 | 1255 | – | 88 | 872 | – | 945 | 550 | 834 | – |
| Lose weight | 569 (53.0) | 407 (32.4) | <0.001 | 46 (52.3) | 287 (32.9) | <0.001 | 476 (50.4) | 236 (42.9) | 264 (31.7) | <0.001 |
| Quit smoking | 594 (55.3) | 491 (39.0) | <0.001 | 48 (54.6) | 355 (40.7) | 0.014 | 533 (56.4) | 246 (44.7) | 306 (36.7) | <0.001 |
| Increase exercise | 534 (49.7) | 329 (26.2) | <0.001 | 44 (50.0) | 249 (28.6) | <0.001 | 435 (46.0) | 194 (35.3) | 234 (28.1) | <0.001 |
| Eat more fish | 261 (24.3) | 201 (16.0) | <0.001 | 22 (25.0) | 124 (14.2) | 0.009 | 235 (24.9) | 107 (19.5) | 120 (14.4) | <0.001 |
| Drink less alcohol | 490 (45.6) | 386 (30.8) | <0.001 | 42 (47.7) | 283 (32.5) | 0.005 | 431 (45.6) | 205 (37.3) | 240 (28.8) | <0.001 |
| Reduce fat in meals | 689 (64.2) | 504 (40.2) | <0.001 | 61 (69.3) | 350 (40.1) | <0.001 | 568 (60.1) | 290 (52.7) | 335 (40.2) | <0.001 |
| Reduce salt in meals | 651 (60.6) | 566 (45.1) | <0.001 | 54 (61.4) | 369 (42.3) | 0.001 | 572 (60.5) | 287 (52.2) | 358 (42.9) | <0.001 |
| Eat more fresh fruit | 669 (62.3) | 607 (48.4) | <0.001 | 59 (67.1) | 418 (47.9) | 0.001 | 586 (62.0) | 314 (57.1) | 376 (45.1) | <0.001 |
| Eat more green leafy vegetables | 728 (67.8) | 639 (50.9) | <0.001 | 63 (71.6) | 447 (51.3) | <0.001 | 624 (66.0) | 337 (61.3) | 406 (48.7) | <0.001 |

*P*-values adjusted for age; values are numbers, and those in parentheses are percentages.

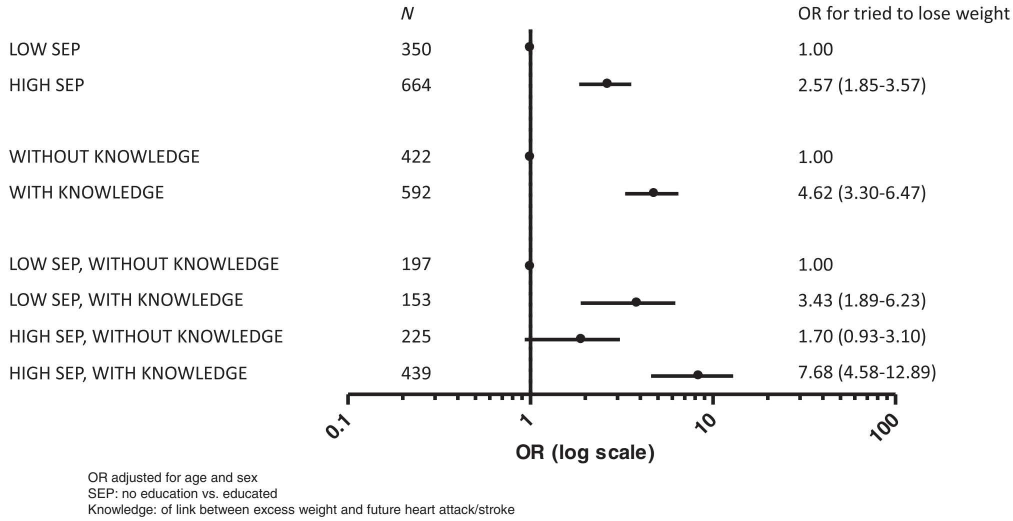


**Figure 1** ORs (95% CIs) for attempt to lose weight by SEP and knowledge, in those with BMI $\geqslant$ 25. OR adjusted for age and sex. SEP, no education vs eduated, knowledge of link between excess weight and future heart attack/stroke

those who drank alcohol)—in the past 12 months compared with those with no education. Educational level was not, however, a significant predictor of an attempt to quit smoking (OR: 1.26; 95% CI 0.88–1.80 in current smokers).

In age- and sex-adjusted models, and in those with the risk factor, those that had specific knowledge of the benefit of modifying that risk factor were: (i) more likely to attempt to lose weight (OR: 4.62; 95% CI 3.30–6.47); (ii) more likely to attempt to increase physical activity (OR: 6.08; 95% CI 4.50–8.22); (iii) more likely to attempt to increase fruit intake (OR: 4.14; 95% CI 3.20–5.36); (iv) more likely to attempt to decrease their alcohol intake (OR: 1.65; 95% CI 1.18–2.30); and (v) more likely to attempt to quit smoking (OR: 3.13; 95% CI 2.09–4.71)—compared with those without knowledge.

### Influence of both SEP and knowledge on the beneficial modification of behaviour

Knowledge of the benefit of weight loss, in those who were overweight, was associated with an increased odds of attempting to lose weight in both those with no formal education (OR: 3.43; 95% CI 1.89–6.23) and in participants who were educated [(OR: 7.68; 95% CI 4.58–12.89), Figure 1]. Similarly, knowledge of the benefits of smoking cessation, in current smokers, was associated with increased odds of attempting to quit smoking in both those with no formal education (OR: 3.98; 95% CI 2.27–6.97) and in participants who were educated [(OR: 3.67; 95% CI 2.10–6.42), Figure 2].

## Discussion

This study finds that in this rural Indian population undergoing epidemiological transition, CVRF levels were variably associated with SEP. Those of lower SEP had higher rates of behavioural risk factors, including smoking, alcohol and lower fruit intake, while those of higher SEP had higher levels of biological risk factors, including hypertension (men only), diabetes and overweight. Individuals of higher SEP were more likely to have had CVRF screening and were better informed about CVRFs. Both education and knowledge of CVRFs were associated with positive attempts to change behaviours. Importantly, knowledge of CVRFs remained associated with positive behavioural change in the socio-economically disadvantaged.

### Comparison with previous research

The socio-economic distribution of CVRF profiles here is consistent with findings from another recent study of rural individuals,[15] an older study of three villages in rural Rajasthan,[26] and findings among those of lower SEP in an urban setting.[27] We, however, sought to go beyond simply describing the socio-economic distribution of risk factor prevalence. In a representative sample of individuals from this rural region, we demonstrate socio-economic inequities in the knowledge of behaviours that might pertain to future CVD and socio-economic inequities in receipt of CVRF screening. We also analysed rarely available data from these rural settings of the socio-economic distribution of attempts at behavioural modification.

### Importance of the study findings

The fact that smokers with knowledge of the adverse effects of smoking were more likely to have attempted quitting, regardless of SEP, suggests that interventions which improve knowledge of health risks may have substantial potential to improve health behaviours. In these settings, interventions which improve

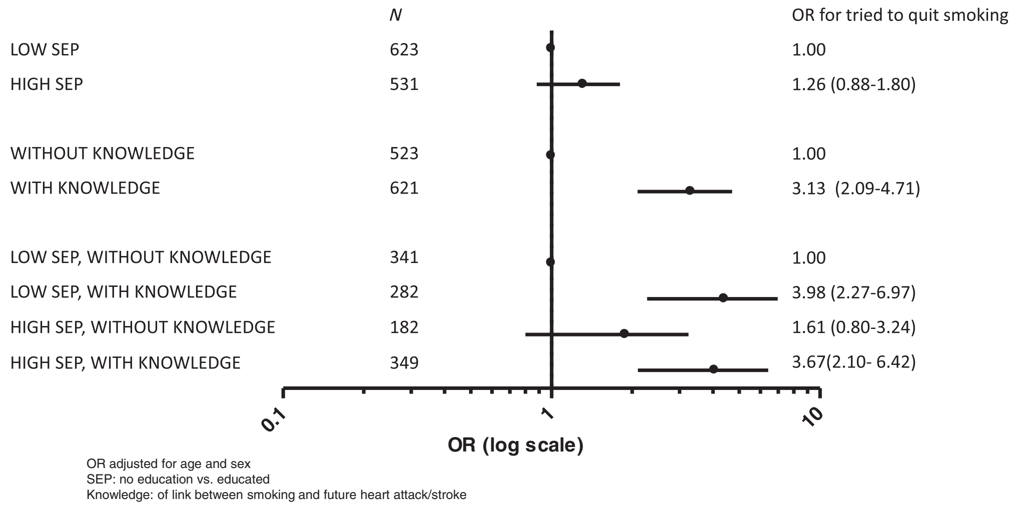


**Figure 2** ORs (95% CIs) for attempt to quit smoking by SEP and knowledge, in current smokers. OR adjusted for age and sex. SEP, no education vs eduated, knowledge of link between excess weight and future heart attack/stroke

knowledge of health risks are highly practicable and may be delivered through similar mechanisms as other health education programmes, such as on HIV and sex education.[28] They also may have particular benefits for those of lower SEP and potential in ameliorating social inequities. While community education interventions have limited efficacy in developed world settings,[29] they have not been tested in developing country settings where general educational levels are very low.[30] While the lower screening rates of CVRFs for those of lower SEP may simply reflect the lower prevalence of these risk factors in these individuals and may be appropriate, strategies are needed to ensure access in accordance with need. Of note, under-nutrition (as evidenced by lower BMI and lower fruit intake) remains a problem of those of lower SEP,[31] and was evident in the current cohort despite residing in a highly fertile region. Also, those of lower SEP consumed more alcohol,[32] perhaps due to increased availability and social stresses. Thus, any policy that seeks to equitably improve the cardiovascular health of all in rural India needs to take into account the specific challenges of tailoring educational messages about cardiovascular risk and behaviour change in a generation in which undernutrition still exists. It should be remembered that the term higher SEP as used in this paper is a relative term, and that this part of India remains relatively poor, with a median income in our study of 2248 Indian rupees a month ($51).

## Strengths and limitations

This study used relatively simple indicators of SEP; more complex measures have been used in India by others, using data covering quality of housing, ownership of land and durable goods.[33] However, our findings were consistent across these simple measures of education, income and occupation, providing reassurance about their likely validity. The dichotomization of educational level (approximately half the sample, 40.6% of men and 53.9% of women, had no formal schooling) reflects the notion that an important marker of socio-economic status in such rural settings is access to any formal education at all at an early age, particularly for girls.[34,35] We acknowledge that income is harder to measure than either education or occupation in such settings due to the informal economy[36] and that asset ownership may be of more utility.[37] The stronger effects with education than with income and occupation may indicate that education is specifically protective. While higher income may improve access to healthier diets and better medical care, it may afford individuals unhealthier lifestyle choices; education, however, potentially equips individuals to make better lifestyle choices whilst also being associated with greater material wealth.[38]

Some measures of risk factors were on the basis of self-report. While many of these (e.g. smoking, medical diagnosis of CVD) have been validated,[39,40] the sensitivity of self-reported behavioural change is lower.[41] That such self-reported measures are themselves biased in terms of socio-economic profile has been largely refuted,[42] but few validated tools are available in these rural Indian settings for the assessment of knowledge—others have used similar questioning techniques to us.[43]

We acknowledge that the cross-sectional design prevents full determination of cause and effect. Asking participants about their knowledge of the benefits of key behaviours and then whether they have attempted to modify the behaviour could lead to reporting biased answers and our findings should be validated in prospective studies and randomized controlled trials. The strengths of the study were its representative sampling methodology, high response rates, comprehensive measures of CVRFs and screening, knowledge and behaviours and largely complete data acquisition. By using the unique resources of the Byrraju Foundation, we were able to get complete population listings that were not available elsewhere, and to hence conduct such a complete study. Though the main drive of the project was to determine socio-economic distribution of risk factors, we acknowledge that overall screening rates for BP and blood glucose level were higher than might be expected for rural India due to the previous work by the Byrraju Foundation, but we present results that still demonstrate a socio-economic distribution. Explaining this would require further work into access to health care, which we have not examined in this paper and was not the remit of the study design.

## Conclusion

The study has shown that those of lower SEP had more adverse levels of the behavioural risk factors of smoking, alcohol and low fruit intake, while those of higher SEP had more adverse levels of hypertension, diabetes and overweight. However those of lower SEP had poorer knowledge of CVRFs and were less likely to have received risk factor screening and are therefore particularly ill-prepared to manage the consequences of a projected CVD epidemic. The finding that those with knowledge of CVRFs were more likely to make healthy behavioural changes regardless of their education level may indicate a potential important benefit of specific education on preventive behaviours. Such CVRF education could be built into CVD prevention programs in this and other rural Indian communities. The efficacy and cost-effectiveness of such community-level programs would be worthy of further evaluation using adequately powered randomized and controlled study designs.

## Supplementary Data

Supplementary Data are available at *IJE* online.

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**Conflict of interest:** All authors declare that the answer to the questions on your competing interest form are all no and therefore have nothing to declare. All authors declare no support from any organization for the submitted work other than the funding grant; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

**KEY MESSAGES**

- In rural Andhra Pradesh, India, those of lower SEP had higher rates of behavioural risk factors—smoking, alcohol and lower fruit intake—whereas those of higher SEP had higher levels of biological risk factors—hypertension (men only), diabetes and overweight.
- Individuals of higher SEP were more likely to have received CVRF screening and had better knowledge of the risk factors for CVD.
- Knowledge of the harms of a risk factor was associated with positive attempts to modify that risk factor, regardless of SEP.
- While there are limitations to the analyses, our findings suggest equipping rural Indians with information about CVD risk may decrease inequities and may ameliorate potential increases in CVD that are projected in coming years.



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