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Jumping the gun: the problematic discourse on socioeconomic status and cardiovascular health in India

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There has been an increased focus on non-communicable diseases (NCDs) in India, especially on cardiovascular diseases and associated risk factors. In this essay, we scrutinize the prevailing narrative that cardiovascular risk factors (CVRF) and cardiovascular disease (CVD) are no longer confined to the economically advantaged groups but are an increasing burden among the poor in India. We conducted a comprehensive review of studies reporting the association between socioeconomic status (SES) and CVRF, CVD, and CVD-related mortality in India. With the exception of smoking and low fruit and vegetable intake, the studies clearly suggest that CVRF/CVD is more prevalent among high SES groups in India than among the low SES groups. Although CVD-related mortality rates appear to be higher among the lower SES groups, the proportion of deaths from CVD-related causes was found to be greatest among higher SES groups. The studies on SES and CVRF/CVD also reveal a substantial discrepancy between the data presented and the authors' interpretations and conclusions, along with an unsubstantiated claim that a reversal in the positive SES-CVRF/CVD association has occurred or is occurring in India. We conclude our essay by emphasizing the need to prioritize public health policies that are focused on the health concerns of the majority of the Indian population. Resource allocation in the context of efforts to make health care in India free and universal should reflect the proportional burden of disease on different population groups if it is not to entrench inequity.

Keywords Cardiovascular risk factors, cardiovascular disease, cardiovascular mortality, socioeconomic status, non-communicable diseases, India

Introduction

Non-communicable diseases are emerging as a key focus in the discussions of health issues in many developing countries,[1–3] including India.[1] Sentiments underlying statements such as 'NCDs pose a global threat and require a global response',[2] or '[NCDs] cause and entrench poverty and are a threat to human, social, economic development',[2] are becoming increasingly common. Although there is much to be appreciated about the concerted effort to put NCDs on the national and global public policy agendas, the prevailing narrative ignores and at times distorts the empirical realities of NCDs, specifically with regard to their association with socioeconomic status (SES). Further, even though NCDs represent a wide array

of diseases, writings on NCDs tend to be largely equated with coronary heart disease (CHD), diabetes, cardiovascular diseases and associated risk factors in general. The cardiovascular bias within the narrative of NCDs is especially striking in India.[4] A cursory search suggested that 63% of all papers related to NCDs in India were related to cardiovascular health (Box 1).

In this essay, we review the studies reporting the socioeconomic patterning of cardiovascular risk factors (CVRF), cardiovascular disease (CVD) and CVD-related mortality in India. Drawing upon the epidemiological transition model,[5] a majority of studies as well as editorials on this subject posit that CVRF/CVD are no longer confined to the advantaged groups but are an increasing burden among the poor. If true, this facilitates a compelling case to include CVDs into the core agenda of the Indian health policy which otherwise continues to be focused, and rightly so, on maternal and child health, and infectious diseases.[6] However, if it turns out that, at least at the current time, the burden of CVRF/CVD is largely concentrated among those who are socioeconomically advantaged, then an increasingly vocal advocacy for CVDs threatens shifting the policy discussion from health concerns that afflict a majority of Indians—three-fourths of Indians still live on less than $2/day[7]—to a far smaller and substantially well-off minority. We start the essay by summarizing the literature on SES and cardiovascular health in India. We then discuss four problematic tendencies in the reporting of the empirical research on SES and CVRF/CVD. Finally, we conclude by outlining the implications of a distorted narrative on SES and cardiovascular health, especially in the context of the efforts to make health care free and universal in India.

Box 1 Search criteria

NCDs

A cursory search of the MEDLINE database using the search terms, 'Neoplasms', 'Cardiovascular Diseases', 'Wounds and Injuries', 'Hypertension', 'Diabetes Mellitus', 'Obesity', 'Pulmonary Disease, Chronic Obstructive', 'Respiratory Tract Diseases', 'Schizophrenia or Psychotic Disorders', 'Mental Disorders or Depressive Disorder' and 'India' since 1980 yielded 1920 papers, of which 1205 (62.8%) were related to cardiovascular health.

Systematic review

We systematically searched the MEDLINE database for articles on socioeconomic status and cardiovascular disease/risk factor using the following keyword terms and MeSH headings: 'socioeconomic factors', 'social class', 'education' and 'cardiovascular diseases', 'cholesterol, High-density lipoprotein (HDL) or cholesterol, Low-density lipoprotein (LDL)', 'hypertension', 'obesity', 'body mass index', 'diabetes mellitus', 'diet', 'physical activity', 'tobacco', and 'cardiovascular diseases/mortality'. We supplemented the electronic search by searching reference lists of identified studies and authors' personal collections. Search results were limited to studies that reported original research.

Socioeconomic status and cardiovascular health in India: A literature review

We identified 70 published studies that assessed the association of markers of SES with CVRF/CVD ($n = 67$) and CVD-related mortality ($n = 3$) in India. Studies were identified through electronic searches of the MEDLINE database covering the period from January 1980 to December 2012; studies prior to this period have distinctly indicated a positive association between markers of SES and CHD in India.[8,9] We focused our search on CVD and risk factors that have previously been related to CVD (Box 1).[10] We also identified an article that reviewed the burden of cardiovascular disease in the Indian subcontinent, which, however, did not have any focus on SES.[11]

In Supplementary Tables 1 and 2, available as Supplementary data at *IJE* online, we list studies showing a positive or negative association between SES and CVRF/CVD, respectively, along with information on study setting, sample size, SES marker, outcome and the reported estimate. For the purposes of the review and analysis, however, we used additional inclusion/exclusion criteria. In instances where there were multiple publications based on the same data source, we retained only the most recent study. We also excluded studies by Dr R.B. Singh,[12–17] since there is controversy regarding the validity of the data used in these studies[18,19] even though none of the publications have been formally retracted by the journals where they appeared. It is possible that residual overlap in the data between published studies may remain, although it is unlikely to be quantitatively or qualitatively important for the summaries presented below.

Among studies retained for review ($n = 53$), 85% were cross-sectional and the data reported in these studies were collected between 1969 and 2009. Of these, 48 (91%) were conducted in a single location or region within India and only 5 studies (9%) reported data that were national. A majority (60%) of studies employed a sampling procedure that was broadly representative of the selected area. Studies included men or women (or both) and age groups generally focused on young to older-age adults (20–69 years). Measures of association between SES (defined as education, household income, occupation, household asset/standard of living index, or a

composite of two or more measures), CVD and seven major associated risk factors (smoking, diet, physical inactivity, blood pressure, diabetes, lipids and obesity) reported in these studies were then systematically summarized. Many studies reported multiple SES and CVRF/CVD associations, for example between income and systolic blood pressure as well as education and obesity.

SES and cardiovascular risk factors and diseases

A total of 353 associations from the 53 studies were analysed. Of the analysed SES-CVRF/CVD associations, 217/353 (61%) were found to be positive, indicating higher levels of risk factors observed among higher SES groups compared with lower SES groups. Positive SES-CVRF associations were overwhelmingly observed for obesity (91%, $n = 70$ associations), diabetes (88%, $n = 40$), adverse lipid profile (69%, $n = 73$), hypertension (66%, $n = 61$) and physical inactivity (83%, $n = 12$) (Figure 1). In addition to risk factors, five studies reported on associations between SES and CVD as an outcome. Of these associations, 11/21 (52%) were found to be positive.

Negative associations (higher SES groups reporting lower prevalence of CVRF) were observed most consistently for smoking/tobacco use (87%, $n = 68$ associations). It should be noted, however, that SES patterns varied by type of tobacco use, with lower SES groups more likely to smoke 'bidis' (locally manufactured hand-rolled cigarettes which contain unprocessed tobacco) whereas manufactured cigarettes were more commonly smoked among higher SES groups and white-collar workers.[20,21] This pattern was also confirmed in a recent nationally representative survey of tobacco use among all adults over the age of 15 years in India.[22] Bidi smoking demonstrated a strong inverse gradient with education: the age-adjusted prevalence in men was 30.8% (95% CI: 29.6–32.2) among the least educated and 8.8% (95% CI: 8.4–9.3) among those with secondary or higher education, whereas cigarette smoking was 8.6% (95% CI: 7.9–9.4) among illiterate men and this increased to 13.1% (95% CI: 12.5–13.6) for those with a secondary or higher level of education.[23]

In the two studies that examined the associations between SES and poor diet, both reported a negative association (100%, $n = 8$ associations). The findings on the relationship between SES and diet, however, must be interpreted cautiously. Of the two studies identified,[24,25] both were conducted in (or only reported data from) rural areas, and one was based on a non-random sample.[25] Both studies also used a relatively simple self-reported measure of diet quality (low fruit and vegetable intake). Importantly, these findings were not consistent with other objectively measured risk factors (e.g. elevated lipids or body mass index) reported in the same studies, which suggests a less favourable overall dietary pattern among higher SES groups.[24,25] It has also been shown that higher income groups in India consume a diet containing 32% of energy from fat compared with consumption of a diet containing 17% of energy from fat in lower-income groups.[26] Further, according to the 2004–05 Indian National Sample Survey data, 80% of rural households had a *per capita* calorie consumption of below 2400 calories, suggesting lower calorie intake among a majority of rural Indians,[27] with the *per capita* calorie consumption for the lowest SES quartile being 1624 (~800 lower than the recommended 2400) as opposed to a consumption of 2521 calories for the top SES quartile.[27]

SES and cardiovascular mortality

An obvious limitation of focusing only on SES patterning in CVRF/CVD might be that, whereas the economically advantaged groups may have a higher burden of morbidity, the mortality burden might be higher among the economically disadvantaged groups. Our search for studies examining the association between SES and cardiovascular mortality in India yielded three returns,[28–30] and we excluded the study by Singh and colleagues[30] for reasons described earlier.

Pednekar and colleagues report the association between levels of educational attainment and cardiovascular mortality in the city of Mumbai ($n = 148\,173$; 13 261 deaths),[29] and concluded that a negative association for CVD mortality exists for men, but not for women. Meanwhile, their data shows the following. Among men, the age-adjusted rates of CVD were lower among those college-educated at 450 (per 100 000) but not dramatically different among those who were illiterate (471). Further, the age-adjusted rates of CVD were 654 for primary-, 618 for middle- or 518 for secondary-educated persons; i.e. higher than those observed for illiterates. Among women, the pattern was even less clear as the authors of the study acknowledge: age-adjusted rates of CVD mortality declined from 429 to 267 among illiterates and those with middle-school education before increasing to 426 among those with secondary education, and then falling again for those with college education. In short, in this large study one cannot observe a robust SES gradient even when one considers CVD-related mortality.

Drawing on the data presented in the study by Pednekar and colleagues,[29] Figure 2 shows the age-adjusted death rate (right-hand side) and the proportion of deaths (left-hand side) attributable to each of the causes [CVD, ischaemic heart disease (IHD), stroke] of the total deaths, by categories of educational status for men and women. The study by Pednekar and colleagues largely focuses on the SES differences in the age-adjusted death rate, as is typical of most epidemiological studies. We additionally present (shown by bars) the fraction deaths due to CVD/IHD/stroke out of all causes of deaths by

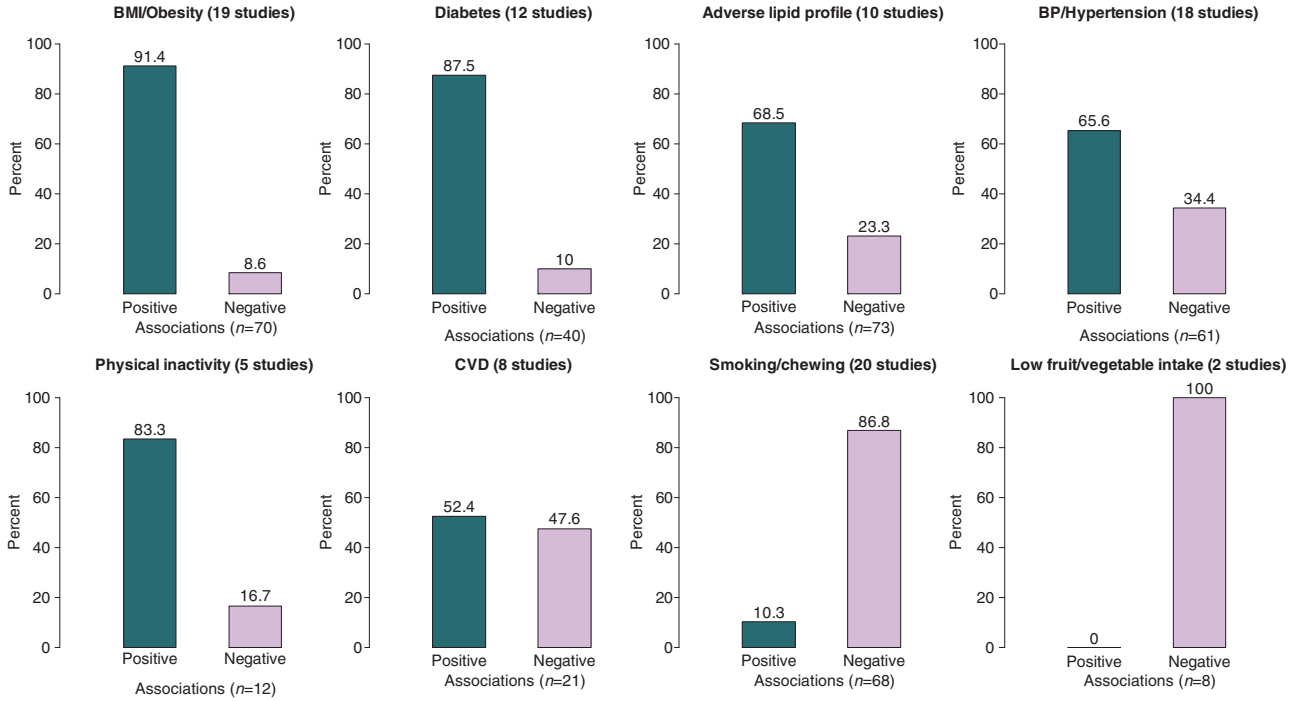

Figure 1 Direction of socioeconomic status (SES) and cardiovascular disease/risk factors associations ($n = 353$) extracted from 53 studies conducted in India. SES-cardiovascular disease/risk factors (CVD/RF) associations for smoking, low fruit/vegetable intake, impaired glucose tolerance (IGT)/diabetes, blood pressure (BP)/hypertension, adverse lipid profile and body mass index (BMI)/obesity derived from 53 studies conducted in India between 1969 and 2009. Percentage of associations that are positive or negative indicated for each risk factor by height of bars. Measures of SES included education, household income, occupation, household asset/standard of living index, or a composite of two or more measures. The SES-CVD/RF relationship was found to be positive (i.e. higher SES groups had increased levels of the risk factor compared with lower SES groups) in a majority of the associations for BMI/obesity, IGT/diabetes, adverse lipid profile and BP/hypertension. Negative associations (i.e. higher SES groups had a reduction in the risk factor compared with lower SES groups) were observed consistently for smoking/tobacco use. In addition, in two studies from rural areas, higher SES groups had lower prevalence of poor diets (diets low in fruits and vegetables) compared with lower SES groups. Plot for CVD includes one study which reported CVD mortality

educational categories. We show that whereas the death rates were lower among the college-educated from CVD (though there is no evidence for a clear gradient), the percentage of deaths from CVD and IHD was greater among higher education groups for both men and women. The information on CHD/IHD deaths as a proportion of all deaths is important as it can lead to the entrenchment of the inverse care law,[31] since if state resources are concentrated on such conditions they will, proportionally, have greater benefit for the health of the better-off. Stroke mortality showed a more consistent negative socioeconomic gradient, in line with evidence that stroke, in particular haemorrhagic stroke, shows an association with deprivation in early life.[32]

The second study by Mohan and colleagues was also a prospective study from rural Tamil Nadu ($n = 120\,000$; 3832 deaths), and the authors report on the broad category of 'circulatory' causes of death. CVD-related mortality was lower among those with high SES.[28] In the study by Mohan and colleagues, determination of cause of death was by verbal autopsy which relies on the accurate reporting of signs and symptoms of the deceased by their relatives or household members and is unable to reliably differentiate sub-types within the broad category of circulatory/cardiovascular mortality and could have blurred the distinction between causes with common symptoms and signs.[33,34] Circulatory/cardiovascular deaths will include those from infectious causes related to poverty, such as rheumatic heart disease, as well as a range of infectious and non-infectious cardiomyopathies, whereas IHD is clearly the focus of concerns regarding the cardiovascular risk factors, including obesity, that are the focus of the contemporary discourse on NCDs in low- and middle-income countries.

The problematic narrative

The prevailing discourse on cardiovascular health in India does not reflect the empirical reality whereby, with the exception of smoking, cardiovascular risk

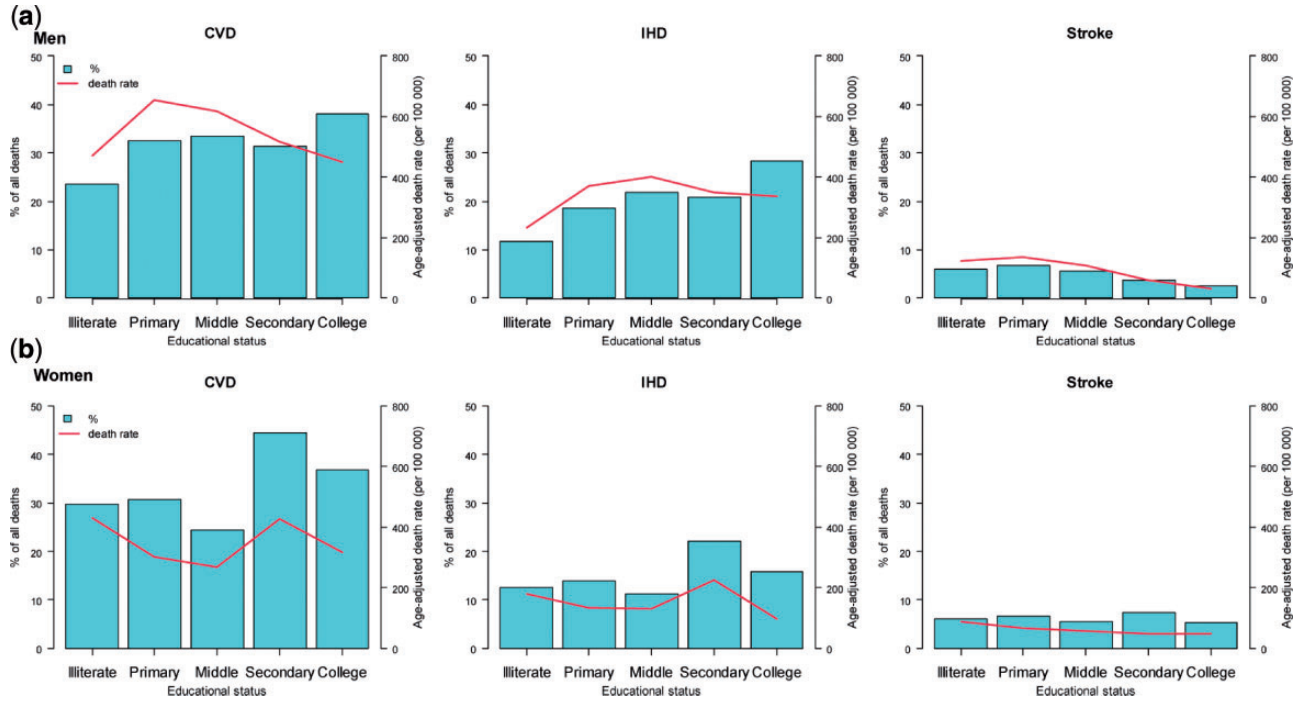

Figure 2 Percentage of deaths (left hand y-axis) and age-adjusted death rate (right hand y-axis) from CVD, IHD and stroke according to educational status among 88 658 men aged ⩾35 years in Mumbai, India between 1997–2003. Data are from Pednekar (2011)[29]

factors such as obesity, diabetes, elevated lipids and hypertension are substantially more prevalent among the higher SES groups. Even the patterning of cardiovascular mortality does not seem to suggest a robust SES gradient, and it seems clear that IHD deaths occur disproportionately among the more economically advantaged groups. We identify and discuss four problematic aspects of the current narrative on cardiovascular health in India.

Discrepancy between data and interpretation

Many of the empirical studies reviewed either downplay the positive association between SES and CVRF/CVD, or state conclusions that are often discordant with their own results.[35,36] We highlight here a few of such discrepancies.

Exploring the association between educational status and CVRF in Jaipur, India,[37] Gupta and colleagues concluded that, 'Urban Indian subjects with low and middle educational status have greater cardiovascular disease risk than the highly educated'.[37] [p. 409] Yet, their results showed that body mass index (BMI), obesity, truncal obesity, hypertension, high cholesterol, metabolic syndrome and diabetes had a greater prevalence among those with higher educational status.[37] Only smoking, short height, total cholesterol and low High-density lipoprotein (HDL) cholesterol appeared to be at a somewhat increased prevalence among low- and middle-educational groups, with smoking being the most striking of these.[37]

In another study, Gupta and colleagues concluded that a 'Significant increase in coronary risk factors – obesity, diabetes, low-density lipoprotein (LDL) and low HDL cholesterol, and triglycerides [has been] seen in this urban Indian population over a seven year period'[38] without any explicit reference to the SES patterning of risk factors. A closer examination of the study's findings reveals that over the study period, physical activity decreased for men and women in the high SES group; obesity increased among the high SES group in men; truncal obesity and hypertension increased more in high SES men and women.[38]

Reddy and colleagues have gone further, stating there is a 'growing vulnerability of lower socioeconomic groups to CHD',[39] despite observing a positive SES-cardiovascular disease risk factor association for BMI, overweight, total cholesterol and triglycerides among men. This study, meanwhile, found a negative socioeconomic gradient for smoking, hypertension and diabetes among women. It should be noted the sample used in this study was solely based on employees working in large industries and their families.[40] According to a recent estimate, the combined labour force across all sizes of public and private manufacturing is about 6 million,[41] which makes up for less than 2% of the Indian population. Further, the levels of illiteracy in India (26% in the 2011

census)[42] are more than double those of the illiteracy proportion observed in the sample used in the above study.[40] With regard to 'growing vulnerability', the study by Reddy and colleagues does not present any data on CVRF by SES for more than one point in time, although a study by Gupta and colleagues found practically no change in the prevalence of obesity, truncal obesity or hypertension among the lowest SES group over a period of 7 years from 1995 to 2002.[38]

Kinra and colleagues, with an objective 'to investigate the sociodemographic patterning of non-communicable disease risk factors in rural India',[25] found a positive association between SES and CVRF/CVD factors related to diabetes, adverse lipid profile, hypertension and overweight.[25] Yet, the paper concluded, 'The prevalence of most risk factors was generally high across a range of sociodemographic groups in this sample of rural villagers in India; in particular, the prevalence of tobacco use in men and obesity in women was striking . . . [t]hese data highlight the need for careful monitoring and control of non-communicable disease risk factors in rural areas of India'.[25] With no statement on the direction of patterning in the conclusion, readers could be grossly misled.

Similarly, in a study of male slum residents in Kolkata, Chakraborty and colleagues concluded 'Both monthly family income and house type had a significant impact on BMI'.[43] They failed, however, to state the positive direction of this relationship (mean BMI was 19.5 kg/m^2; 4% were overweight in the low SES group, compared with BMI of 21.1 and 13.8% overweight in the high SES group).

Rastogi and colleagues report a case-control study of 1050 individuals conducted in two urban centres in India (New Delhi and Bangalore).[44] The results of this study indicated that those with no education had a relative risk (RR) of 2.5 with the 95% confidence interval ranging from 1.0 to 4.1 for heart attack, compared with those with 'highest level' of education. Using income as a marker of SES, their data also showed an RR of 1.6 for those earning less than 3000 rupees compared with households earning >10 000 rupees (in 1999), with 95% confidence intervals ranging from 0.9 to 3.0. If we apply the conventional statistical significance standards, we would have to interpret both the reported associations as being statistically null. However, the authors choose to interpret these findings as supporting their substantive hypothesis. Moreover, the study does not present any data on SES 'gradient', and only shows the difference between two extreme SES categories. Further, the study design is cross-sectional and therefore no assessment of 'reversal' in patterning can be made.

There appears to be an emerging interest in examining whether the SES of individuals is related to their decision to participate in screening for CVD risk, or to their knowledge and practice of behaviours that lower CVD risk.[24] Zaman and colleagues report that individuals with lower SES had lower levels of participation in cardiovascular risk screening as well as less awareness of the cardioprotective effects of several health-related behaviours.[24] However, concluding that individuals with lower SES have a higher risk of cardiovascular diseases because of these lower rates of screening or lesser knowledge of CVRF and CVD is deeply misleading. The lower prevalence of screening or knowledge among lower SES groups could be observed simply because the risk factor is also less of a concern in this group. This is clearly evident in their study where Zaman and colleagues found that lower SES was associated with lower levels of overweight, physical inactivity, diabetes, hypertension, family history of CVD and a history of previous CVD (in men).[24]

In summary, discrepancy between data and interpretation in scientific papers appears to reflect a bias towards a particular conclusion, with a resistance to altering the preferred interpretation in light of subsequent contrary evidence.[45,46]

The 'reversal' of the positive SES-cardiovascular risk factor/disease association: has anyone seen it?

The SES-cardiovascular health narrative in India appears to be implicitly motivated from the idea that the association between SES and CVRF/CVD factors is initially positive (as is currently observed for India) and then over the course of a 'demographic and epidemiologic transition' reverses to being negative.[24,37,39,47] In a recent editorial,[48] Reddy cited a single empirical study[44] as evidence that 'the social gradient [in CVD] is now reversing' in India, even though there appear to be considerable concerns regarding drawing such inferences from this study, as described in the previous section. The idea for the 'reversal' or 'crossover' hypothesis is drawn from experiences of Western, industrialized societies. We screened the citations in the studies reviewed in Supplementary Tables 1 and 2 (available as Supplementary data at *IJE* online) and identified two journal articles[49,50] that were cited by authors[24,37,47,51] as providing evidence for a reversal of the positive SES-CVRF/CVD association in developed societies. We additionally found an article examining the reversal in the SES-cholesterol association in the US,[52] as well as a book chapter in which one of us reviewed the historical evidence on whether a SES crossover in CVD occurred in the West.[53] So, is there robust empirical support for an SES crossover or reversal hypothesis in CVRF/CVD in developed countries?

In a much cited paper comparing age-specific mortality rates across social classes (as defined by the Registrar General) in England and Wales, Marmot and colleagues reported that among men aged 55–64 years, the ratio of heart disease mortality in classes I and II (higher SES) to that in classes IV and V (lower) changed from 1.2 in 1949–53 to 0.9 in

1970–72.[49] Similar patterns were observed for men in the 35–44 and 45–54 age groups. The ratio decreased over time among women, even though women of classes I and II had lower heart disease mortality rates than women in classes IV and V in every age category and at every time point.[49]

Two points need to be made regarding this study before drawing inferences regarding the possible 'crossover'. First, it is important to consider that changing diagnostic practice, that would differ by socioeconomic groups due to characteristics of the professionals predominantly serving them at these times, and level of patient investigation, are important factors that could influence these apparent trends.[53] Second, the evidence is based on shifting patterns of CHD mortality not morbidity. With respect to current considerations of the evolving CHD pattern in India, representative data from the USA show a positive association between income and serum cholesterol and fasting low-density lipoprotein (LDL) in 1976–80 which shifted to a negative association in 1999–2004.[52] The greater diffusion in the use of statins among the more affluent is likely the key explanation to the reversal in the SES-LDL relationship which is now observed in the USA.[52]

Marmot and colleagues also analysed dietary intake of sugar, milk, eggs, butter, cheese, wholemeal bread, margarine, fruit and vegetables from 1951 to 1971 by income group, and found that greater quantities of wholemeal bread, and lower quantities of sugar and margarine, were consumed in the higher-income groups than among persons in the lower-income group and this difference grew larger over time.[49] Consumption of the other foods was greater in the high-income group between 1951 and 1971. The study, however, did show a progressive decrease in the proportion of smokers in the higher-income group as a ratio of the proportion of smokers in the lower-income group, between 1952 and 1971; the ratio among men decreased from ~1.25 in 1951 to ~0.80 in 1971, and the corresponding figures from women were about 1.0 to 0.75.[49] Interestingly, the authors concluded that 'Whereas in 1931 and 1951 heart disease was more common in men of social classes I and II, by 1961 it was more common in men of classes IV and V',[49] even though the study examined mortality and not prevalence of heart disease.

It is important, however, to recognize that CVD morbidity and risk factors are very different from CVD mortality. Whereas the time period when the CVD mortality gradient in the UK apparently reversed is likely to have preceded the era when effective medical treatments emerged, it is possible to observe an inverse SES gradient in mortality with little reversal in morbidity or risk factors in more recent times, including in contemporary India.

Another study by Marmot and colleagues,[50] cited by several papers, shows that SES was inversely associated with CHD mortality, smoking, physical inactivity, overweight (BMI>27), high post-prandial blood glucose and high systolic blood pressure; and positively associated with high plasma cholesterol and height.[50] However, the study does not provide any empirical evidence showing a reversal of the positive association between SES and CVRF/CVD.

An editorial by Reddy and Yusuf[4] was also cited[51,54] to support the reversal in the positive association between SES and cardiovascular disease and associated risk factors in the West, even though the editorial itself does not provide any citations or empirical support for this claim.

Finally, a comprehensive review of studies with objective measures of CHD,[53] (available as Supplementary data at *IJE* online) as opposed to reported diagnoses or death certification, showed little evidence of a reversal in socioeconomic gradient in the West. Thus, the generally accepted change in patterning of CVRF may be over-confidently asserted. At the same time, explanations for potential reversal in CVD mortality may be due to real changes in incidence attributable to changes in risk factor prevalence or to effective treatments or due to artefacts of diagnostic fashion, death certification and coding. In Box 2 we present an example of how the assertion of a reversal in the SES-obesity/overweight association—both within India, and across a wider spectrum of low- and middle-income countries, as well as in the Western countries—is unduly exaggerated.

There is evidence for a reversal hypothesis in the West for smoking. Besides the study by Marmot and colleagues,[49] a study from Norway reported a greater decrease in the prevalence of smoking among high-income men (75% in 1955 to 28% in 1990) compared with low-income men (from 60% in 1955 to 48% in 1990).[55]

At the same time, smoking patterns in India appeared to be inversely associated with SES well before India experienced an epidemiological transition. One might argue that the 'Preston effect',[56] i.e. the transmission of knowledge and norms from developed countries that had already experienced the transition to less developed countries,[20,57] could explain the inverse association between SES and smoking in India. However, the distinctly positive association between SES and cigarette smoking does not support this interpretation, especially since norms and knowledge are more likely to be transmitted first to urban, middle-class populations. It is exactly this group in India who are more likely to smoke cigarettes compared with rural, poor populations who are more likely to smoke bidis. Furthermore, long-standing sociological explanations such as informal social control as well as stigma associated with smoking especially among the higher SES group is more likely to explain the inverse gradient in overall smoking as opposed to the one posited by epidemiological transition models of knowledge and behavioural changes.

Box 2 Socioeconomic status (SES) and body mass index

The current cross-sectional SES patterning of obesity in the developed countries is not as straightforward as sometimes stated. Some of the most recent data on obesity and SES in the USA showed little evidence of a gradient by income or education for men.[95] Moreover, obesity levels increased almost equally at all income and educational levels over the past two decades.[95] Similar patterns have also been observed in the UK. In a thorough review of this association, McLaren concluded that the general observation that a greater proportion of studies from high-income countries show a negative association masks the nuances in the SES-obesity association by sex and indicator of SES.[96] For instance, the predominant finding for men was 'that of non-significance and curvilinearity'.[96] The negative pattern appeared more consistent for women, but as McLaren notes, the finding was not as common (63% of all studies) as was observed by Sobal and Stunkard[97] in a previous review conducted in 1989.[96] In short, the idea of an inverse gradient, at least for overweight/obesity, even in the context of developed countries appears to be somewhat oversimplified. Overweight is a generalized epidemic in high-income countries, with its socioeconomic patterning arguably not highly meaningful from a clinical standpoint.

To illustrate this further, we present some key findings from the World Health Survey, which was conducted in countries at all levels of economic development in 2002–03.[98] The age-adjusted association between adult BMI and household wealth was positive in 58 of 66 (88%) countries for men and 46 of 66 (70%) countries for women (Figure 3). Notably, even among high-income countries ($n = 16$), 11 showed a positive association between SES and BMI in men and 10 in women. In India, and other low- to middle-income countries, the association between SES and obesity is consistently positive in the World Health Survey as well as in the Demographic and Health Surveys.[69,76,99–101]

In light of this, one needs to question the importance of testing the hypothesis that at a certain level of a country's economic development the association between SES and obesity will cross over. This idea has particularly gained attention since Monteiro and colleagues suggested that the SES-obesity association crosses over from positive to inverse at *per capita* income levels of US$2500.[102] India, with its purchasing power parity adjusted *per capita* income of US$1488.50 is yet to reach this supposed crossover point. Also, there is a six-fold difference in the *per capita* income between Indian states, and there is absolutely no suggestion that India is anywhere close to experiencing a reversal in the SES-obesity/overweight association.[76] If anything, lowest SES groups in India had a substantially increased risk of being underweight and a decreased risk of being overweight with increasing state *per capita* income (Figure 4).

We examined the SES crossover in body mass index by levels of country's *per capita* income using the latest DHS data from 54 countries. We found that the wealth gradient in BMI/overweight was less marked or the richest quartile has lower levels of BMI/overweight than the poorest quartile ($P = 0.062$) only in countries with a *per capita* gross domestic product (pc-GDP) of US$5500.[101] Indeed, the second- and third-richest wealth quartiles were consistently more likely to be overweight than the poorest quartile even at pc-GDP above US$5500.[101]

In World Health Survey data that also include high-income countries, a 1-unit higher logarithm of *per capita* gross domestic product (pcGDP) was associated with a 0.69 (CI%: 0.48–0.90) unit higher BMI. This relationship was consistent at all levels of household wealth, except for the richest quintile for whom the pcGDP-BMI relationship was still positive but considerably weaker than for the lower wealth quintiles (Figure 5). However, at higher levels of pcGDP (>$8000) the 95% CI around the mean BMI for the richest quintile considerably overlapped that of the other quintiles (Figure 5).

In summary, the notion that the film of history from the now richest part of the world is rewound and then rolled forward in India is untenable, and needs to be critically re-considered. Further, any potential reversal of SES gradient in the West may be more specific to certain diseases/causes (e.g. ICD among men[58]) instead of a universal gradient reversal. The particularities of each situation need to be examined, rather than scenarios imposed.[59,60] For a reversal in the SES-CVRF/CVD gradient to occur in India, several factors—such as cheap availability of calorie-dense food (and food in general), dramatic shifts in occupational patterns from an agrarian to a service economy, high SES groups cutting down or shifting their dietary patterns, or economic growth spilling over to the low SES groups and improving their incomes in a substantial manner—have to be present and dominant. There is currently little evidence for such changes occurring in India. On the contrary, inflation in food commodities has become a critical concern,[61] economic growth has been remarkably uneven and concentrated among a small

minority[62] and more than half of the workforce in India is still engaged in labour-intensive agriculture activities.[63] According to the latest available World Bank poverty estimates, over 40% of the Indian population were living on less than $1.25 per day,[64] and 76% were estimated to be living on less than $2 per day.[7]

Interpreting the data and narrative on CVRF/CVD within this larger reality of the Indian population, one cannot miss the remarkable congruence between what Dr Samuel Black observed in 18th-century Ireland, when he outlined conditions that would make an individual 'liable' to or 'exempt' from susceptibility to angina pectoris, and what appears to be the current case in 21st-century India (Box 3).[65] The only difference is that in Black's day CHD was probably responsible for a much lower proportion of mortality than it is causing in India today, as this was well before the rise of the disease. This is not to deny that a reversal in the socioeconomic gradient of CHD might occur at some stage in India, although it is possibly starting at a greater positive gradient for some risk factors than existed in high-income countries during the rise of CHD. Importantly, to consider that this may happen is different from announcing that it has already occurred.

Box 3 Dr Samuel Black's categorization of factors related to liability and exemption from angina pectoris

Liable

The male sex

The better ranks of society

The psychologically stressed

Those with an ossific diathesis

Those with an accumulation of fat around the heart

Those with full and plethoric habits who live luxuriously

Those with insufficient exercise

The obese

Exempt

The female sex

The poor

The laborious

Those who use strong exercise

The foot-soldier

The French

Source: Evans (1995)[65]

Language of 'double burden'

Finally, there has been a tendency in the discourse to introduce the idea of a 'double burden', especially to characterize the malnutrition burden such that both underweight and overweight are major concerns, but also more generally to suggest that there is a simultaneous existence of 'diseases of poverty' and 'diseases of affluence' in countries like India.[15] Empirical studies which have identified a 'double burden' of malnutrition status have been ambiguous about the definition of double burden.[66] For instance, a population from Andhra Pradesh where 12% of women were overweight/obese and 37% were underweight was characterized as having a 'double burden'.[67] In another study in Bangladesh, 4.1% of women were overweight/obese and 38.8% were underweight, which was also characterized as evidence of 'double burden'.[68] Put simply, in the absence of a formal definition of double burden, the working definition in the literature appears to be any situation where prevalence of underweight and overweight are non-zero in the population, i.e., virtually every situation imaginable.

The current narrative of double burden misses the empirical fact that, to the extent there is double burden of malnutrition in India, it is across, and not within, different socioeconomic groups.[69] Further, a recent analysis of nationally-representative data from 57 low- to middle-income countries (LMIC), which used a standardized approach to determine the coexistence of underweight and overweight, demonstrated a strong and consistent negative correlation between the prevalence of underweight and overweight among reproductive-age women (and adult men in seven countries) both within and between countries.[70] The findings were also replicated in analyses restricted to low SES groups, suggesting that the hypothesized 'double burden' of underweight and overweight has yet to occur within strata of SES in a majority of LMICs, including India.[69]

Intrauterine exposures and cardiovascular health

Within the context of the discourse on the cardiovascular disease in adulthood,[71] it has been argued, following the Barker hypothesis,[72] that children born to mothers who experienced nutritional insults during pregnancy may be more likely to succumb to obesity, diabetes, cardiovascular disease or other chronic diseases in adulthood.[73] Two key assumptions central to this model are that (i) the children survive the nutritional insults that they are exposed to as foetuses and infants, and (ii) the survivors are exposed to substantial increases in their material standard of living, most effectively in a rapid manner, and are able to access, afford and consume calorie-dense food. Not discounting the intrauterine hypothesis for emergence of cardiovascular disease/risk factors, a more realistic hypothesis for India is likely to be one of

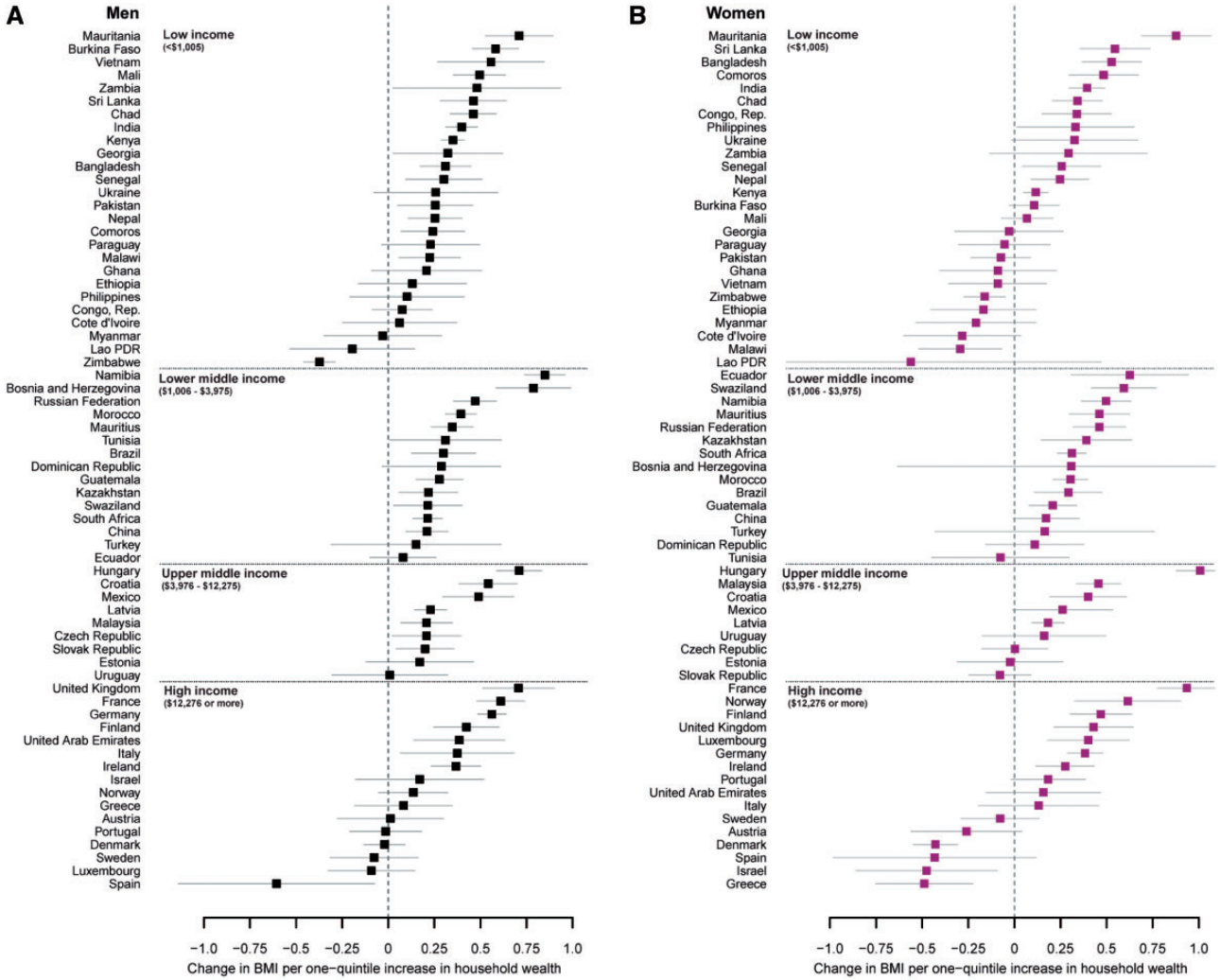

Figure 3 Change in BMI (with 95% confidence intervals) for a one-quintile increase in household wealth across 66 countries in the World Health Survey (2002–03) for men (A) and women (B). Estimates and 95% confidence intervals are from country-specific multilevel linear models adjusted for age and sex. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres and was determined through self-reports of height and weight by survey respondents. Household wealth was measured by an index of asset ownership and the population in each survey was divided along this index into quintiles from poorest to richest. For country income groups, the 2011 World Bank classification has been used[103]

intergenerational chronic growth failure whereby mothers with chronic energy deficiency are more likely to give birth to low-weight infants, who upon survival will experience growth failure in childhood and adolescence, with debilitating mental and physical health consequences leading to poor educational outcomes and lower socioeconomic position and exposure to diseases of poverty.[74] The data on, and SES patterns of, height, weight and body mass index, appear to more strongly support, at least for now, an intergenerational growth failure and deprivation hypothesis, and not one of rapid excess energy intake and consumption.[69,75–80]

Further, although nutritional stress during pregnancy may influence cardiovascular health in adulthood, many confounding factors could generate noncausal links between maternal nutritional status and offspring outcomes.[81] One approach to strengthen causal inference in assessments of intrauterine influence is to compare the strength of associations between an exposure among mothers and offspring outcomes and the same exposure among fathers and offspring outcomes. If there were a direct biological effect of intrauterine exposure on offspring health, then the link with offspring health should be considerably stronger for exposure among mothers than for exposure among fathers. If the mother-offspring and father-offspring associations are similar, then it would suggest the absence of a unique intrauterine mechanism generating intergenerational associations.[81] Studies on intergenerational associations of BMI by using such an analytical design have been conducted in developed countries,[81–84] with

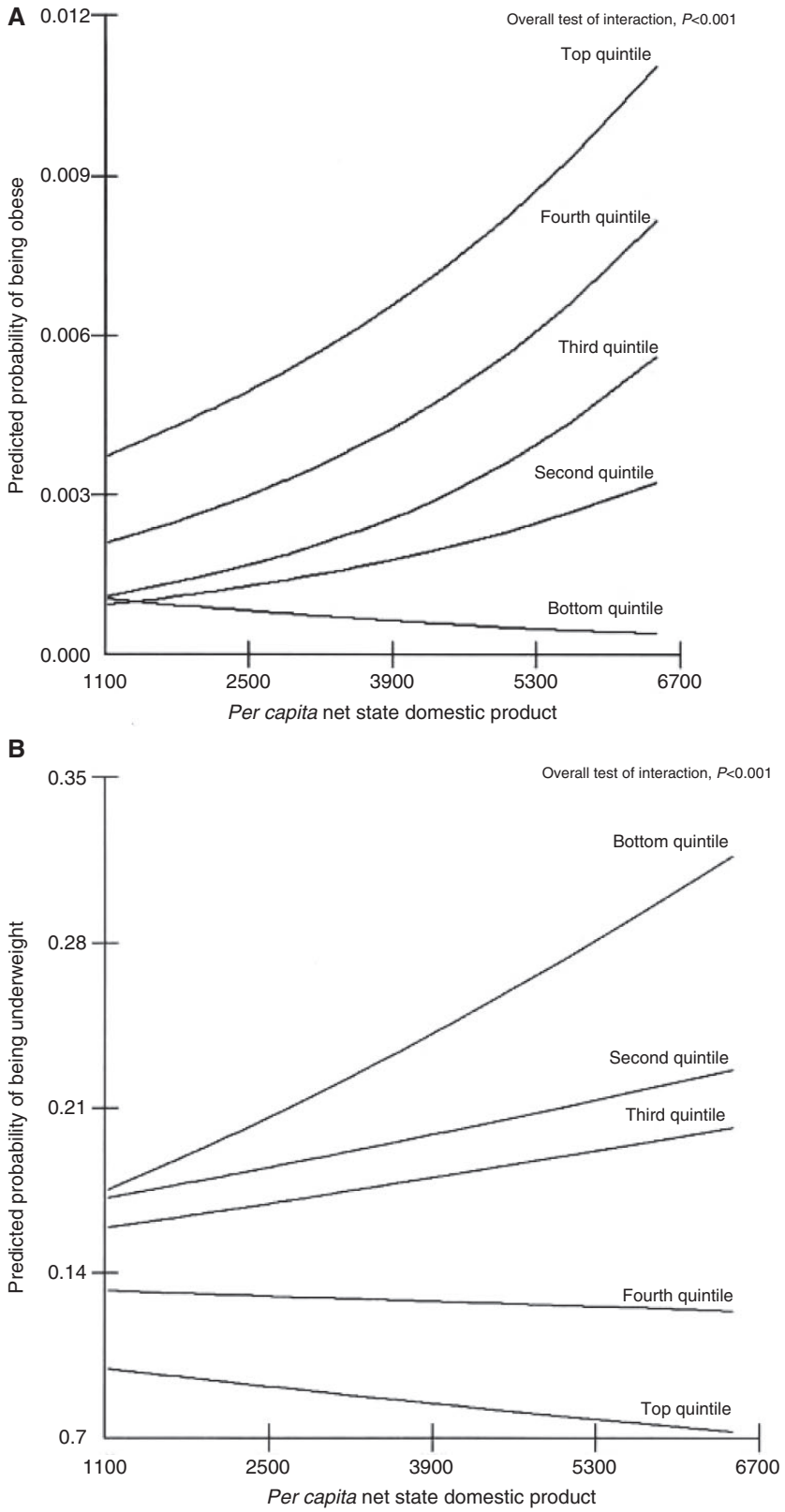

Figure 4 Plots of predicted probabilities of being (A) obese or (B) underweight by *per capita* net state domestic product for quintiles of the household standard-of-living index in India (Source: Subramanian *et al*.[76])

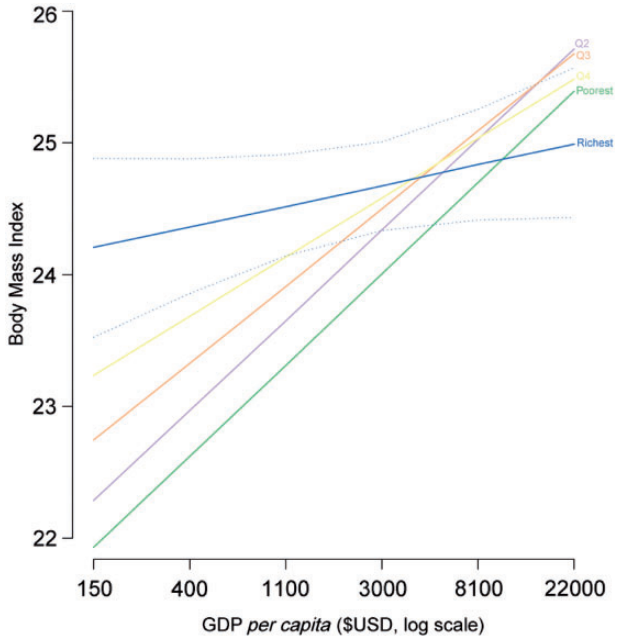

Figure 5 Relationship between body mass index (BMI) and country *per capita* gross domestic product (pc-GDP) by quintiles of household wealth across 65 countries in the 2002-3 World Health Survey; pc-GDP was not available for Myanmar. At the country level, wealth was defined as *per capita* gross domestic product (pc-GDP) converted to (2002) U.dollars.[104] The logarithm of pc-GDP was used. Interaction test $P<0.0001$ based on a 2-tailed Wald test and the chi-square distribution (adjusted for age and sex). Dotted lines indicate 95% confidence interval around the predicted relationship for the richest quintile

adequately powered studies showing that the strength of the association between maternal-offspring BMI is similar to that of paternal-offspring BMI, suggesting that maternal adiposity during pregnancy may not have a specific intrauterine influence on childhood BMI. Meanwhile, results from India suggest that the strength of association between maternal BMI and offspring anthropometric failure was same as that of paternal BMI and offspring anthropometric failure.[80] In short, the current evidence for the developmental or intrauterine origins of cardiovascular disease does not allow for causal interpretation, and well-powered studies using creative analytical strategies are required to scrutinze the 'foetal origins of adult disease' hypothesis. Thus, it would be premature for considerations of adult onset of cardiovascular diseases to focus on nutritional deprivation of mothers and young women in India, although the issue demands further investigation.

Concluding remarks

Our scope in this essay was restricted to drawing observations with regard to the narrative of socioeconomic patterning on cardiovascular health in India. Whether the observations made regarding India also apply to other low- and middle-income countries, about which similar well-meaning rhetoric is being generated, needs to be investigated. The critical review of the discourse on the association between SES and cardiovascular health has four salient findings.

First, with the exception of smoking, cardiovascular diseases and risk factors such as obesity, diabetes, elevated lipids and hypertension are in general more prevalent among the higher SES groups in India. Even the patterning of cardiovascular mortality does not seem to suggest a robust negative SES gradient, and it seems clear that IHD deaths occur disproportionately among the more economically advantaged groups.

Second, the empirical literature appears to reflect a strong bias to a particular interpretation despite what the evidence reveals, with a considerable eagerness either to declare that cardiovascular disease and associated risk factors are a generalized burden in India, or to incorrectly assert that these disproportionately affect the poor in India. The haste to declare that cardiovascular diseases and associated risk factors in India disproportionately burden the poor might help garner immediate attention in public policy discussion. It may also be seen as a necessary component of successful action in a situation where some commentators suggest that 'advocacy on non-communicable diseases has been described by young people as dull and uninspiring, lacking an emphasis on social justice or inequality and missing a sense of outrage and urgency against continued inaction'.[85] In the current scenario, however, a disproportionate focus on cardiovascular risks will lead to increasing inequality through unwittingly shifting limited resources from the health concerns of the poor to health concerns of the middle-class and rich in India. It is important to stress that such a focus is indeed one that would lead to an anti-poor shift, particularly as India appears to be at least willing to consider proposals for universal access to free health care.[86] With respect to CHD, the most important inequality disadvantaging the poor is in relation to treatment rather than incidence of disease,[87] which adds emphasis to this concern.

Third, anticipating the association between SES and cardiovascular health from the lens of the Western 'reversal' or 'crossover' in socioeconomic gradient is problematic since neither is it grounded in an extensive evidence base from the West nor are the macro socioeconomic realities afflicting the majority of the Indian population supportive of such a reversal or crossover in the near future.

Finally, it would be premature to motivate a focus on cardiovascular disease burden based on the intrauterine hypothesis even though there is an extremely high prevalence of maternal undernutrition in India. The vicious cycle of growth failure among children and persistent levels of poverty, and the similarity in the strength of the association between mother-

offspring and father-offspring on anthropometric failure, suggest that the importance of the Barker hypothesis may be exaggerated.

We hasten to add that this essay does not intend to downplay the significance of the rising burden of CVD, CVRF and CVD mortality. According to the recently released Global Burden of Disease report, in South Asia (i.e. Afghanistan, Bangladesh, Bhutan, India, Nepal and Pakistan),[88] the proportion of mortality from cardiovascular and circulatory diseases increased from 12% to 20% between 1990 and 2010, and diabetes/endocrine disorders increased from 3% to 5% over the same period (calculated from http://healthmetricsandevaluation.org/gbd/visualizations/regional, last accessed 7 January 2012).[89] It is obvious that some of this burden will also inevitably fall on the poor in India. The critique here exclusively relates to the distributive aspects of the burden, and at this point the evidence that it is generalized or that the poor (who constitute the overwhelming majority in India) are disproportionately burdened might be premature.

Further, the inferences drawn in this essay are also restricted to socioeconomic patterning of cardiovascular health and not for the entire array of the NCDs. Of course, as mentioned earlier, more than 60% of all studies under the rubric of NCDs appear to cardiovascular related, ignoring other important burdens such as cancer, injuries, respiratory illness and mental health, all of which may have considerably different socioeconomic patterning. Moreover, the notion that in countries like India cancers are as a group non-communicable is a counterintuitive concept, since Human papillomavirus (HPV)-related cervical cancer, hepatitis B-related liver cancer, *Helicobacter-pylori*-related stomach cancer and probably HPV-related head and neck cancer etc., constitute a major component of total cancer incidence and mortality and are clearly communicable. Yet, it is not an exaggeration to state that in recent narratives, after introducing the NCD categorization, much of the focus is shifted to behavioural factors related to coronary heart disease, diabetes, hypertension and smoking-related cancers, with strategies clearly related to those being proposed for 'immediate priority and interventions'.[90] Specifically, we argue that in the context of India, broad categories of diseases such as the use of the umbrella term of 'NCDs'—with substantial heterogeneities in their patterning—can be deeply misleading and distort priorities, and a targeted disease-specific approach might be more equitable.

It is worth learning from the discourse on the extent and prevalence of HIV in India that occurred over the last decade. Similar to the assertion that we now frequently encounter about alarming levels of CVD burden in India, at the start of the 21st century India was described as the epicentre of the global HIV/AIDS epidemic with the virus apparently moving from concentrated high risk groups to the general population.[91] It was estimated that, in 2002, 5.7 million people were living with HIV in India, and it was projected to reach almost 25 million by 2010.[91] In 2006, India dramatically increased its investment in enhancing and improving collection of national data on HIV and its risk factors.[92] This included a much wider sampling of clinics, and importantly included a national household survey (the third National Family Health Survey),[93] and together the data sources went well beyond the typical sentinel surveillance sites that were the only source of data for estimating prevalence.[94] Following this, the estimate of individuals living with HIV infection was downwardly revised to 2.5 million (i.e. reduced by 56%) with a national prevalence of 0.36%.[92] Importantly, and this offers lessons for tackling CVD burden in India, the downward revision did not trigger complacency. Rather, India now had a robust evidence base to continue with the targeted approach to better understand and control the epidemic.[92]

A principal factor that made a difference to the discourse and policy to address HIV in India was investment in good data collected through rigorous and up-to-date scientific procedures followed by an unbiased and public analysis and scrutiny of the data.[92] Thus, an overarching and immediate need is for India to ensure a similar investment in surveillance and monitoring of all major diseases and risk factors, and especially cardiovascular-related conditions. As we observed, more than 90% of the studies showing prevalence of cardiovascular disease or related risk were based on data from one town/city or handful of villages in a district, with an overwhelmingly pro-urban bias. Yet, such studies often provide the sole basis for describing the burden of CVD and associated risk factors for all of India.[11] It is also important that surveillance efforts are not focused simply on reporting and documenting overall prevalence but also include critical socioeconomic and geographical data so that appropriate determination of the size and location of key population groups can be made with an eye towards possible interventions. The least India can and should do, building on its traditional strengths in conducting censuses successfully, is to develop a systematic and rigorous framework for coordinated data collection and making these data available on a timely basis for public scrutiny. Well-intentioned but incorrect interpretations of data or editorials cannot be the basis for scientific inquiries on a question that has considerable implications for the poor of India.

In summary, it is true that risk factors for CVD are no longer confined to high-income countries. However, with the exception of smoking, they are consistently more heavily concentrated among high-income individuals within low- and middle-income countries, and most certainly within India. It is therefore important to prioritize public health policies that are focused on the health concerns of the majority of the Indian

population, especially the more than three-fourths who live on less than $2/day. Resource allocation in the context of efforts to make health care in India free and universal should reflect the proportional burden of disease on different population groups if it is not to entrench health inequities.

Supplementary Data

Supplementary data are available at *IJE* online.

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Contributions

S.V.S. conceptualized the essay, interpreted the results and wrote the essay. D.J.C. led the literature review and analysis and contributed to interpretation and writing. M.A.S. contributed to literature review, interpretation and writing. G.D.S. contributed to critical revisions and writing of the manuscript.

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KEY MESSAGES

- With the exception of smoking; cardiovascular diseases and risk factors such as obesity, diabetes, elevated lipids and hypertension are substantially more prevalent among the higher SES groups in India.
- Despite what the evidence reveals there appears to be considerable eagerness to declare either that cardiovascular disease and associated risk factors are a generalized burden in India or to (incorrectly) assert that cardiovascular risk factors disproportionately affect the poor in India.
- Interpreting the association between SES and cardiovascular health in India through the lens of the Western 'reversal' or 'crossover' in socioeconomic gradient is problematic, since it is neither grounded in an extensive evidence base from the West, nor do the macro socioeconomic realities afflicting the majority of the Indian population support the possibility for such reversal or crossover in the near future.
- Relevance of the intrauterine origins of adult chronic diseases in India needs extensive critical empirical examination.
- Resource-allocation efforts that do not reflect the disease burden faced by the majority of the population, especially the more than three-fourths who live on less than $2/day, could make the 'free' and 'universal' health care initiative in India inequitable and unfair.

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Commentary: Shielding against a future inferno: the not-so-problematic discourse on socioeconomic status and cardiovascular health in India

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We applaud Subramanian *et al*. for seeking to hold authors accountable for their enthusiastic interpretations of the published data in their article 'Jumping the gun: the problematic discourse on socioeconomic status and cardiovascular health in India'.[1] The article includes several important arguments that data from India are being reported in a way that supports the case that cardiovascular diseases (CVD) are no longer confined to affluent people, but are an increasing threat even for poorer sections of India.

Ironically, in our opinion, Subramanian *et al.*'s commentary-style comprehensive review also falls prey to over-stretching interpretations of available data to make their point. For example, in arguing the pitfalls of the socioeconomic status-CVD gradient reversal, the authors attribute the lowering of mean serum low-density lipoprotein (LDL levels) in affluent groups in the USA to the diffusion of statins, disregarding a volume of literature that shows higher prevalence of dyslipidaemias among lower