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Keywords

aging, NCDs, socio-economic hierarchy, affluence, Piketty measure of income inequality, gender, urbanisation, diets

Disciplines

Cardiovascular Diseases | Diseases | Family, Life Course, and Society | Inequality and Stratification | Social and Behavioral Sciences

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Key words: Aging, NCDs, Socio-Economic Hierarchy, Affluence, Piketty Measure of Income Inequality, Gender, Urbanisation, Diets.

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1. Introduction

India's burden of non-communicable diseases (NCDs) is rising. NCDs are typically present in individuals aged 55 years or older in many developed countries, but their onset occurs in India a decade earlier (≥45 years of age). Aggravating this problem are the issues of multiple chronic conditions and the fact that many remain undiagnosed due to lack of awareness and insufficient health-care access. Moreover, infectious and parasitic diseases continue as formidable challenges to the public health system in India, resulting in a double burden of disease and a large share of the global burden of disease (Arokiasamy, 2018).

In 2017, as contributions to the Global Burden of Diseases, Risk Factors, and Injuries (GBD) Study, the India State-Level Disease Burden Initiative Collaborators produced an analysis of state variations in epidemiological transition levels (ETL) during 1990–2016. The three separate papers, published in *The Lancet Global Health,* give additional results on the burden of cardiovascular diseases, respiratory diseases, and diabetes. The focus is on long-term trends from 1990 to 2016, state variations, and risk factors that more or less coincide with the onset and rise of NCDs in India.[1]

The GBD studies found that leading cardiovascular diseases—ischaemic heart disease and stroke—made the largest contribution to the total burden of mortality in India in 2016 (about 28%). Besides, the contribution of cardiovascular diseases to mortality rose by over 34% from 1990 to 2016, given rapid population ageing and significantly increasing levels of the main risk factors for cardiovascular diseases—high systolic blood pressure, air pollution, high total cholesterol, high fasting plasma glucose, and high body-mass index. Prevalence of cardiovascular diseases and their share of mortality are higher in the high and higher-middle epidemiological transition level (ETL) states of Andhra Pradesh, Goa, Himachal Pradesh, Kerala, Maharashtra, Punjab, Tamil Nadu, and West Bengal.

When assessing chronic respiratory diseases, the GBD studies show that these diseases—mainly chronic obstructive pulmonary disease (COPD) and asthma—make the second largest contribution to the total mortality burden of India (about 11%). The crude prevalence rates of these diseases rose by over 29% for COPD and 8.6% for asthma during the period in question. The crude COPD prevalence is higher in the northern states of Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and Haryana, which are a mix of lower middle, higher-middle, and high ETL groups.

The diabetes analysis shows that diabetes contributes 3.1% of the total mortality burden, with slightly higher contributions among women (3.4%) than men (2.9%). The age-standardised diabetes prevalence rose by 29.7% in 1990–2016. Diabetes is especially prevalent in southern states.

NCDs are chronic in nature and take a long time to develop. They are linked to aging and affluence, and have replaced infectious diseases and malnutrition as the dominant causes of ill health and death in much of the world including India. The factors associated with NCDs are classified into non-modifiable (e.g., aging) and modifiable risk factors (e.g., unhealthy diet, physical inactivity). The four major NCD categories (cardiovascular diseases, cancer, chronic respiratory diseases and diabetes) share a set of modifiable risk factors: unhealthy diet, physical inactivity, smoking, excessive use of alcohol and failure to detect and control intermediate risk

[1] In what follows, we rely largely on an excellent review of these studies by Arokiasamy (2018). For further details, see the GBD studies cited in the References.

factors such as high blood pressure, high cholesterol, high blood sugar and excess weight. While urbanisation is not a direct driver of NCDs, it contributes through riskier lifestyles (Bloom et al., 2014, 2014a; Yadav et al., 2018).

Some NCDs cause others and create clusters of co-morbid conditions (e.g., diabetes can lead to kidney failure and blindness). Mental health conditions are often co-morbid with each other (e.g., anxiety and depression), as well as with other NCDs (such as cancer and diabetes).[2]

Old-age morbidity is a rapidly worsening curse in India. The swift descent of the elderly in India (60 years +) into non-communicable diseases (e.g., cardiovascular diseases, cancer, chronic respiratory diseases and diabetes) could have disastrous consequences in terms of impoverishment of families, excess mortality, lowering of investment and consequent deceleration of economic growth. Indeed, the government has to deal *simultaneously* with the rising fiscal burden of NCDs and substantial burden of infectious diseases (Bloom et al., 2014, 2014a). As a recent *Lance*t report (Ghebreyesus, 2018) points out, failure to devise a strategy and make timely investment now will jeopardise achievement of sustainable development goals (SDG) 3 and target 4 of a one-third reduction in premature mortality from NCDs by 2030.

The National Sample Survey (NSS) data for 2004 and 2014 show that the burden of NCDs has risen slowly in the aggregate population between 2004 and 2014. However, there is a marked rise among the old. It doubles among 60-69 years and 70-79 years and nearly triples among 80 years and older persons. Besides, the mean prevalence among the old has more than doubled, while among ≤60 years it has declined from 4% to 3.2%. As the population structure remains largely similar, it follows that the higher burden of NCDs displays a marked shift towards the old (Yadav et al., 2018).

Detailed evidence on NCDs and their covariates is particularly relevant in India's context, as the elderly population (60 years +) is growing three times faster than its population as a whole. It is projected that the percentage of elderly people will climb from 8% in 2010 to 19% in 2050. By mid-century, their number is expected to be 323 million (United Nations, 2011). Even more significant in its implications for population ageing is the dramatic rise in life expectancy at age 60 years, from about 12 years in 1950 to 18 years in 2015. This is projected to rise further to more than 21 years by 2050. Average life expectancy at age 80 years has likewise increased significantly, from about 5 years in 1950 to more than 7 years at the present time. By the middle of this century, it is projected to rise to 8.5 years (United Nations, 2015; Agarwal et al., 2016).

This and the projected marked future shift in the share of older Indians in the population is taking place in the context of changing family relationships and severely limited old-age public income support, hence bringing with them a variety of social, economic and health care policy changes (Bear & Bloom, 2014; WHO, 2015).

NCDs hamper growth in different ways. They reduce the supply of labour and redirect resources from productive investments to health care, and thus drain the public and private budgets, raise business costs and undermine competitiveness. In fact, based on WHO's EPIC

[2] Evidence points to common biological mechanisms—such as signalling pathways and cellular pathologies including oxidative stress—that lead to multi-morbidity, even when co-occurring conditions seem unrelated. For example, there is a link between chronic kidney conditions (CKD) and cardiovascular disease risk factors that are mediated by clustering of cardiovascular disease risk factors (such as hypertension, diabetes, and dyslipidaemia). Alternatively, this clustering could be mediated by additional risk factors specific to those with CKD, including mineral malabsorption, oxidative stress, and inflammation (Academy of Medical Sciences, 2018).

model, the potential cumulative losses to India's economy during 2012-2030 are projected to be $6 trillion (Bloom et al., 2014a), nearly thrice India's GDP in 2017.[3]

The objective of this study is to re-examine the covariates of NCDs in India. In doing so, we seek to build on our previous studies and other recent literature in the following ways.

We use the *India Human Development Survey* (IHDS) panel survey data for 2005 and 2012. Our previous study (Yadav et al., 2018) relied on the National Sample Survey (NSS) household/individual data on health and morbidity for 2004 (60th round) and 2014 (71st round). These NSS rounds are two independent cross-sections that do not allow tracking the same individuals/ households during this period. So persistence of NCDs and their cross-associations cannot be analysed. The IHDS panel data are amenable to capturing these associations.

For lack of detailed asset data in the NSS rounds, our previous study used per capita expenditure quartiles. As expenditure is a less reliable measure of a household's affluence- because of consumption smoothing- we replace it with asset quartiles. This allows us to examine whether there is an asset gradient to NCDs.

As there has been much discussion of socio-economic gradient in health, we examine three different dimensions of it (Szreter & Woolcock, 2004; Marmot, 2006): socio-economic hierarchy in the caste system, comparison of health outcomes between the least wealthy and the wealthiest, and, following Piketty (2013), overall inequality in the state income distribution in terms of ratio of share of the top 1% to that of the bottom 50%. This dimension has not figured in the recent literature (including our own study, Yadav et al., 2018).

Another gap in Yadav et al. (2018) is that the NSS rounds did not collect data on participation in social networks. As the literature on social capital has evolved and extended to health (say, from Putnam, 1993; Wilkinson, 1996; Kawachi & Berkman, 2000; Szreter & Woolcock, 2004; and others), different strands of social capital have emerged. Three are found relevant in the present context: bonding, bridging and linking social capital. Bonding social capital involves norms of reciprocity and cooperation between similar individuals (farmers' groups/associations); bridging involves these norms across dissimilar groups (self-help groups with a mix of castes); and, finally, linking social capital which involves access to official authorities, politicians in power and access to institutions of governance. Our review shows that, while there is greater conceptual clarity about their potential role in promoting health, empirical validation of which form(s) matter more is lacking.[4] The long and short of this literature is that greater social cohesion and cooperation are likely to be associated with better health outcomes. However, this should not be taken to mean that material needs do not matter. They do and must go hand in hand with social cohesion.

Some leading commentators (Wilkinson, 1996; Szreter & Woolcock, 2004; Marmot, 2006) are also deeply concerned that inequality going beyond economic may undermine the favourable association of social cohesion with health. An emphatic view is that unequal distribution of economic power impedes empowerment and does not allow individuals to lead the lives that they desire, or to borrow from Sen (1985), their capability to live healthy and productive lives is undermined. We offer a more nuanced view.

Another point of departure is that the present study examines the association between patient-doctor/hospital trust and NCD outcomes. In a previous study (Kulkarni et al., 2019), the focus was on covariates of this trust and whether it differed between private and public providers of

[3] We have updated India's GDP to arrive at this ratio, compared to the 2012 GDP estimate in Bloom et al. (2012).
[4] Szreter and Woolcock (2004) are careful to point out that social capital need not necessarily yield positive outcomes (a case in point being the Mafia). Indeed, linking capital is associated with corruption and bribery.

healthcare. An important insight from the literature reviewed is that behavioural changes induced by trust between patient-doctor/hospital are associated with lower prevalence of NCDs. The evidence, however, is not conclusive. Instead, we limit our analysis to (a reduced form) relation between NCDs and trust.

Section 2

Scheme

Section 3 is devoted to a literature review that draws upon selected studies, some from India and others from other countries. Section 4 focuses on the methodology including salient features of the India Human Development Survey 2015, cross-tabulations of NCDs and their covariates, and the models used for analysing the prevalence of NCDs. Section 5 is devoted to interpretation of three sets of results: a minimalist multinomial probit specification, a probit specification and a complete multinomial probit specification. Section 6 discusses the results from a broader perspective to assess their significance. Finally, Section 7 reviews recent policy initiatives and their lacunae.

Section 3

Literature Review

Here we take into account more recent studies of NCDs and aging, whether patient-doctor trust has a role in preventing morbidity, associations between NCDs and different forms of inequality, and whether social networks mitigate the severity of morbidity.[5]

Focusing on aging and NCDs in a global context, Prince et al. (2015) emphasize that the worldwide epidemic of chronic diseases is driven by population ageing. Disorders with a strong age-dependent relation are likely to increase in prevalence in parallel with the absolute and relative numbers (relative to the total population size) of the older people (≥60 years).

Low-income and middle-income countries face various stages of a double burden of infectious and non-communicable diseases, the balance shifting inexorably towards non-communicable diseases. A globalisation of risk behaviours, including diets rich in saturated fat, increase of tobacco use and low physical activity, with consequent obesity, is partly driving the rapid increase in burden of chronic diseases in these regions.

The main contributors to disease burden in old people (≥60 years) are cardiovascular diseases, malignant neoplasms, chronic respiratory diseases, musculoskeletal diseases, mental and neurological disorders, infectious and parasitic diseases, unintentional injuries, diabetes mellitus, digestive diseases, respiratory infections, and sense organ diseases. The ranking does not vary greatly by regional income, but infectious and parasitic diseases are more pervasive in low-income and middle-income regions, and mental and neurological disorders and musculoskeletal diseases are more prominent in high-income regions. The disease burden per person in old people is higher in low-income and middle-income regions than in high-income regions, which is due to the increased burden per head from cardiovascular disease, chronic respiratory, and infectious disorders in the former region.

The global burden of disease in old people is projected to increase more or less in line with the increase in the old population, consistent with population ageing being the most important driver of the chronic disease epidemic. The largest increases in disease burden will occur for those disorders that are particularly strongly age-associated (dementia, stroke, COPD, and

[5] Although we rely largely on the literature review in Yadav et al. (2018), it is supplemented with other studies in line with the broader focus of the present study.

diabetes).[6] The association between biological age and morbidity and loss of function underlie the link between population ageing and increasing burden. However, this association is not immutable, as there is much scope for intervention to promote health and prevent disease in old people (Prince et al., 2015; Bloom, 2019).[7]

Another important global study (Academy of Medical Sciences, 2018) focuses on the rise in the burden of multi-morbidity in many regions. This appears to have occurred in the past 10-20 years, and is expected to continue rising. Although there is a close link between aging and multi-morbidity, age alone cannot explain the rising burden of multi-morbidity. In some cases of multi-morbidity, conditions may simply co-occur through chance, especially if the component conditions are individually common at the population level. If such conditions increase in prevalence, it is likely that multi-morbidity will rise.

Several studies have sought to examine the association between multi-morbidity and risk factors known to contribute to single chronic conditions, such as ethnicity, socio-economic status, smoking and alcohol consumption, physical activity, and obesity. Although the association between aging and multi-morbidity remains intact, the evidence on these risk factors is patchy and often contradictory.[8] It is not self-evident that the contradictions do not arise from methodological and sample design issues, a concern that is glossed over.

A recurring theme is the link between socio-economic status and NCDs. There is a vicious cycle of unhealthy behaviours and exposures in low-income populations that increase the risk of NCDs and other diseases and these, in turn, worsen poverty, disparities and illness. Niessen et al. (2018) observe that the correlations between socio-economic status and NCDs are mixed and change over time. Most studies with strong designs (mainly cohort studies) find positive associations, and a few report mixed or unclear associations. An issue, however, is whether there was any allowance for the two-way relationship between NCDs and poverty.

Another major contribution is *The Lancet* Taskforce on NCDs (2018) with several individual contributions on different aspects of NCDs. A distillation of a few of these contributions is given below.

For all health conditions investigated, NCDs are associated with substantial economic burden on patients and their households from all strata, particularly in the poorest populations. Direct medical expenses for medicines, outpatient visits, diagnostics and hospitalisation are the main contributors to out-of-pocket (OOP) costs. Transport costs are substantial in some cases (e.g., about 40% of total medical expenditure for patients receiving a kidney transplant in India). Patients with haemophilia in India reported high transport costs as a major reason for not seeking necessary care during bleeding episodes (Jan et al., 2018).

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[6] A similar view is echoed by the WHO (2015) report. With increasing age, numerous underlying physiological changes occur, and the risk of chronic diseases rises. By age 60, the major burdens of disability and death arise from age-related losses in hearing, seeing and moving, and NCDs, including heart disease, stroke, chronic respiratory disorders, cancer and dementia. In fact, the burden of these diseases on old people is considerably higher in low- and middle-income countries.

[7] An important observation made by Bloom (2019) is that the most explosive growth in the numbers of older people will occur among countries that are currently classified as middle-income. The older population share in middle-income countries is increasing at a much faster rate than in their low and high income counterparts. Moreover, in comparison with high-income countries, today's middle-income countries are projected to have much greater real incomes when their older population shares reach comparably elevated levels. This undermines the assertion that developing countries are getting old before they get rich. Hence the population ageing challenge faced by middle-income countries is not predominantly one of having insufficient income to take care of their older people. The challenge instead is that institutions and policies are not in place to promote economic and social security among older people in a financially sustainable way.

[8] For details, see Academy of Medical Sciences (2018).

The high OOP cost of treating NCDs relative to household income for low-income patients also implies that a substantial proportion of households is impoverished. In China, for example, up to 37% of patients with stroke were impoverished from paying for medical treatment. Evidence further indicates high odds of catastrophic hospitalisation expenditures for certain NCDs. For example, the odds for catastrophic expenditure for cancer are nearly 170% greater, for CVDs and injuries nearly 22% greater than the odds due to infectious diseases (Selvaraj et al., 2018).

The strategies available for coping with the burden of NCDs are more constrained in poor households than in high-income households. For example, Indian patients with cancer from higher-income groups cope predominantly by reducing health expenditure for members not suffering from cancer. By contrast, the poor cancer patients resort to borrowing and/or depletion of their assets (e.g., sale of livestock).

The key messages of the Taskforce include: progress on NCDs is too slow; NCDs are major drivers of poverty; NCDs are important and growing causes of health inequalities; NCDs impose large economic burdens on households—notably, through OOP expenditure on health and long-term care—and are thus an impediment to alleviation of poverty; financial risk protection—especially targeted to the poorest and most vulnerable populations—could dampen the risk of impoverishment; taxes on unhealthy products (e.g., fried food, alcohol and tobacco) will induce substantial health gains; and finally, investments in cardiovascular disease prevention and control yield especially high economic returns (Horton & Sargent, 2018).

Turning to Asia, an important but somewhat dated contribution is Yadav and Arokiasamy (2015). Although it focused on the epidemiological transition in India, it offers a rich analysis of the increase in the prevalence of NCDs among the old. It is based on NSS data for 1986-1987, 1995-1996, and 2004 on morbidity of persons ≥60 years.

The age pattern of morbidity reveals a mounting concentration of morbidity prevalence in 60-64 year olds and older age groups. The rising gradient of morbidity prevalence in the older ages peaks among the older group, 70-79 years.

By sex and residence, the prevalence rate of chronic diseases is highest among urban males and is characterized by a high prevalence among 70-79 year olds and among 80 years and above. Among 60-69 year olds, the rise was much lower.

The beta-binomial model is used to estimate the summary event rate of chronic diseases, which takes into account the variation in the chance of occurrence of chronic NCDs across households. The summary event rate of chronic diseases reveals a steep rise between 1995-1996 and 2004, compared with the marginal increase between 1986-1987 and 1995-1996.[9] This transformed the age pattern of morbidity, specifically since the mid-1990s.

The transformation in distribution of deaths attributed to NCDs unravels a much larger proportion of deaths drifting toward old ages. Comparatively, urban populations experienced a higher burden of NCDs than rural populations over a wide range of ages. There was a rapid increase in the concentration of deaths in older ages, indicating a rapid shift in the distribution of deaths attributable to NCDs.

In brief, the mounting burden of NCDs among the older groups (70-79 and 80 years or above) is accompanied by greater concentration of deaths among them.

There are a few studies of multi-morbidities in India. One of these is Pati et al. (2014). It relies on cross-sectional data from the WHO Study on Global Ageing and Adult Health (SAGE)

[9]The binomial model was rejected because of over dispersion at the 1% level.

wave 1 survey of India in 2007. Respondents in this analysis include individuals 18 years or older.

The mean number of NCDs increases with age, in urban population and with household income, but does not significantly differ by gender or education. The prevalence of multi-morbidity increases considerably by household wealth, from 6.8% in the lowest wealth quintile to 10.7% in the highest wealth quintile.

The presence of multi-morbidity is associated with substantially higher levels of health care utilisation, in both outpatient and hospital settings, with markedly higher OOP expenditure.

This study is largely descriptive with little analytical rigour.

A systematic review of the literature suggests that trust is associated with better access to and utilisation of medical care; increases the likelihood that patients recommend treatment to others and may affect the effectiveness of and adherence to treatment among patients; the quality of interactions, degree of disclosure, amount of autonomy in decision-making, continuity of care and level of engagement in behavioural change are favourably influenced; and, finally, there is some evidence that trust is associated with better self-reported health (Ozawa & Sripad, 2013).

Yet another contribution towards understanding the role of trust in health outcomes is Lee and Lin (2009). Its significance lies in illuminating the processes through which trust influences health outcomes. This study tests relations of trust to both objective and self-rated health. The analysis supports the instrumental role of trust in clinical outcomes. Further, it is found that the influence of trust on clinical outcomes is mainly indirect, through the mediating process of patient adherence. To further explore this link, cognitive factors underlying this mediating process are investigated. The analysis confirms the motivating value of the two cognitions-self-efficacy and outcome expectations-as important antecedents of adherence.[10]

Little is known about the association between health and well-being and social capital across low- and middle-income countries. The dearth of knowledge in this area is even greater when focusing on older adult health.

An important study by Joe et al. (2019) uses a multilevel framework to investigate the associations between social capital (measured at the individual level and village level, separately) and health-related outcomes, including well-being, functionality, psychological distress and cognitive ability, among a nationally representative sample of older adults (>60 years) in India from 2011 to 2012.

Data are from the study 'Building a Knowledge Base on Population Ageing in India' conducted in Himachal Pradesh, Kerala, Maharashtra, Odisha, Punjab, Tamil Nadu and West Bengal. These seven states represent different regions and have a higher share of older adults compared with the national average. In total, the sample included 10,604 older adults from 8,792 households spread across 568 villages or wards.

For men and for urban people, there is a positive association between personal community involvement and good self-rated health. The village proportion having someone to trust is associated with good self-rated health for all strata except for urban dwellers. Personal community involvement and personally having someone to trust are both positively associated

[10] The objective health outcomes include: (1) diabetes-related complications; (2) body mass index (BMI); (3) glycosylated haemoglobin (HbA1C); and (4) blood lipid control, including triglycerides (TG), low-density-lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol. Trust has a positive association with triglycerides but minimal association with BMI and complications.

with low psychological distress for all strata. The village proportion having someone to trust is associated with low psychological distress only for urban dwellers.

Personally having someone to trust and personal community involvement are both associated with highly subjective well-being across all strata. For men and for rural dwellers, the village average level of community involvement was associated with high levels of subjective well-being, although the Wald test does not indicate a statistically significant independent effect for either group. In contrast, the village proportion having someone to trust is associated with high levels of subjective well-being across all strata. These associations represent independently statistically significant effects as indicated by Wald tests. Although both personal social capital variables are associated with good memory function across all strata, neither village-level social capital variable is associated with good memory function across any strata.

The significance of social networks for overcoming stress from morbidity and disability is corroborated by several studies. An innovative and insightful study by Seeman and Berkman (1988) distinguishes between instrumental and emotional support for the elderly. Their analysis shows that, while structural measures reflecting overall network size are positively associated with greater availability of instrumental and emotional support, relatively geographically proximate ties are more important, particularly with respect to the availability of instrumental support. Emotional support is less heavily dependent on geographic distance, being significantly related both to proximal and more distant ties. Furthermore, the evidence does not point to a threshold effect, which our analysis contradicts.

As mentioned in the Introduction, we follow the broad framework of social capita formulated in Szreter and Woolcock (2004), in which three different forms of social capital are distinguished in the context of health: bonding, bridging and linking. Although unable to distinguish them empirically in the present study, we examine the potential of membership of social networks for health outcomes.

Section 4

Methodology

(i) Data

Our analysis draws upon the two rounds of the nationally representative India Human Development Survey 2015 (IHDS) data conducted in 2005 and 2012. The IHDS is conducted jointly by University of Maryland and the National Council of Applied Economic Research (NCAER). The first round (IHDS-1) comprises a survey of 41,554 households in 2004–05. The second round (IHDS-II) involves re-interviews with 83% of the original households as well as split households residing within the same locality, along with an additional sample of 2,134 households.[11] The total for IHDS-II is therefore 42,152 households. The panel of individuals $\geq$60 years is 10,473 individuals. The sample is spread across 33 (now 34) states and union territories, and covers rural as well as urban areas. Throughout the analysis, the computations are based on the 2005 age-distribution and other covariates. However, data constraints do not allow disaggregation of the elderly into 5- year intervals.

[11] An additional sample of 2134 households was added to IHDS-II urban areas to reduce the impact of high attrition on the standard errors of a few key variables. The simulations estimated that the attrition would increase standard errors to unacceptable levels if 8 out of 15 households were unreachable in each urban cluster. Hence, the interviewers were asked to report to NCAER supervisor if they were unable to recontact 5 or more households in a cluster. The supervisor verified the losses and randomly assigned households to the right, the left, or at the original location (for households that migrated) using a predefined rule. A similar addition to the rural sample was not attempted because of much lower attrition rate. (Personal communication by Sonalde Desai).

Repeated interviewing of the same households at two points in time facilitates a richer understanding of which households are able to partake in the fruits of growth, what allows them to move forward, and the process through which they are incorporated into or left out of a growing economy. However, this is problematic because of lack of comparability of some key variables (e.g., degree of confidence in hospitals is not disaggregated by ownership in 2005: private or public, but it is in 2012).

The topics covered by the IHDS relevant in the present context include short-term morbidity, major morbidity (including NCDs), limitations in ADLs, health insurance, trust in health providers, castes, assets, drinking water facilities, education, location, and demographic characteristics (e.g., gender, age, household size). In addition, to capture the association with diet, we have computed food prices at the PSU level.

The NCDs include cataracts, high blood pressure, heart disease, type 2 diabetes, leprosy, cancer, asthma, epilepsy, and mental disorders. The number of cases of mental disorder and cancer are very small for analysis.

Disabilities in ADLs show the dependence of an individual on others, with need for assistance in daily life.

The (reported) disabilities include (1) difficulty walking; (2) difficulty using toilet facilities; (3) difficulty dressing; (4) difficulty with hearing; (5) difficulty speaking, (6) long sightedness/far sightedness; and (7) short sightedness.

We have constructed two state level variables: state affluence is measured in terms of per capita state income (2005 prices) and state income inequality is measured by using Piketty's measure in terms of ratio of share of income of the top 1% in the income distribution to that of the bottom 50%.

In an important contribution, Vellakkal et al. (2013) offers a critical appraisal of the discrepancy between self-reported and standardised measures of prevalence of NCDs by socio-economic status including a measure of economic affluence (asset quintiles) and education in India.[12] Five major NCDs (under two broad categories) are identified using respondent self-reported diagnoses and standardized measures: i) Cardiovascular diseases: angina, and hypertension, and ii) Non- cardiovascular- diseases: chronic lung diseases (emphysema, bronchitis, chronic obstructive pulmonary disease) and asthma, vision problems and depression (mental disorders). The concentration index of inequality is used to quantify the magnitude of socio-economic disparities in NCD prevalence between groups.

Their main findings include: (i) a significantly lower prevalence rates for all NCDs when a diagnosis is based on self-report of diagnosed cases rather than standardized measures, except asthma and chronic lung diseases; (ii) Self-reported diagnosed cases of disease prevalence are significantly higher in the most affluent quintile compared with the least affluent quintile. Conversely, disease prevalence measured using standardized measures tended to show either negative or no strong association with wealth. Similar trends are observed for educational level too; and (iii) wealth-related and education-related concentration of disease varied with greater concentration among the affluent/educated when using self-reported diagnoses and either among lower SES groups or showed no strong SES gradient when using standardized measures of disease. This may be consistent with observations that NCDs are typically either under-reported or under-diagnosed in LMICs, including India.

[12] For an earlier but less detailed comparison of prevalence of NCDs for Indonesia, see (Thomas and Frankenberg, 2002).

A complete list of the variables and their descriptive statistics are given in Table 1.

Table 1
List of Variables and Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
NCD 2012				
Yes	0.1509	0.3579	0	1
Confidence Medical (2005)				
Hardly any	0.0939	0.2917	0	1
Only some	0.2797	0.4488	0	1
Household Toilet				
Traditional Latrine	0.1230	0.3285	0	1
Vip Latrine	0.0615	0.2403	0	1
Flush Toilet	0.2292	0.4203	0	1
Water Source				
Tube Well	0.1160	0.3202	0	1
Hand Pump	0.3440	0.4750	0	1
Other	0.1718	0.3772	0	1
NCD 2005				
Yes	0.0678	0.2514	0	1
Disability 2005				
Yes	0.0241	0.1532	0	1
Age Group 2005				
31-50	0.4082	0.4915	0	1
51-60	0.1176	0.3222	0	1
61-70	0.0573	0.2324	0	1
>70	0.0183	0.1341	0	1
Gender				
Female	0.4900	0.4999	0	1
Marital Status				
Unmarried	0.1757	0.3806	0	1
Widowed/Divorced	0.0851	0.2790	0	1
Sector				
Urban	0.2893	0.4534	0	1
Caste				
Brahmin	0.0544	0.2268	0	1
High Caste	0.1431	0.3502	0	1
Dalit	0.2161	0.4116	0	1
Adivasi	0.0785	0.2689	0	1
Others	0.1372	0.3441	0	1
Asset Index 2005				
q2	0.2407	0.4275	0	1
q3	0.2757	0.4469	0	1
q4	0.2588	0.4380	0	1
Education				
1-4	0.0866	0.2812	0	1
5-8	0.2261	0.4183	0	1
9-10	0.1644	0.3706	0	1
>10	0.1265	0.3324	0	1
Number of Social Networks				
1	0.1822	0.3860	0	1
>1	0.1746	0.3797	0	1
Household Size				
1	0.0053	0.0728	0	1

2-5	0.5057	0.5000	0	1
Price Ratios				
Rice to Cereals	1.1303	0.2216	0.5183	1.8136
Wheat to Cereals	0.9084	0.1188	0.5379	1.4179
Sugar to Cereals	1.9945	0.3747	0.9767	3.2699
Pulses to Cereals	2.8082	0.5859	0.4259	4.8672
Milk to Cereals	1.2569	0.2682	0.1845	2.4383
Edible Oil to Cereals	5.3909	0.9846	1.2283	9.1304
Meat to Cereals	7.1125	2.4671	0.1500	16.1176
Eggs to Cereals	3.4114	0.8274	0.6473	6.0876
Ratio of Share of top 1% to Bottom 50%	0.4652	0.1240	0.2255	0.8582
Net State Domestic Product (2005)	22566.12	9108.168	7914	63877

(ii) Cross –Tabulations of NCDs by Selected Covariates

These cross-tabulations are essentially descriptive as they do not necessarily capture associations because of lack of control over confounding factors.[13]

The first cross-tabulation by age-group shows that of the total blood pressure cases the highest share is that of the age-group 31-50 years in 2005, followed by that of the older age group, 51-60 years, and then slightly lower share of the combined age-group 61-70 and => 71 years. The share peaks again among 31-50 years old with a marked reduction in 2012, closely followed by that of the combined oldest age-group. So there is a marked rise in the share of the oldest.

The share of heart disease also peaks in the age-group 31-50 years with the (combined) oldest age–groups accounting for barely 30% of the peak in 2005. The peak share registers a sharp drop while that among the oldest catches up within 4 percentage points of it in 2012.

A similar pattern is observed for diabetes with a minor variation. The share of diabetes also peaks in the age-group 31-50 years but that among the oldest age-groups is below half of it in 2005. There is a marked shift in 2012, as the peak in the same age-group drops by over 13 percentage points while the share of the oldest groups rises to within 3.5 percentage points of the peak.

We then consider the shares of multimorbidity which poses greater fatality risk than an individual NCD. The share peaks among the older age-group of 51-60 years but the gap between this and that of the oldest age-groups is about 9 percentage points. There is a *reversal* in 2012 in as much as the peak shifts to the oldest groups with a large margin.

As noted earlier, the caste hierarchy is an important marker of socio-economic inequality and deprivation. *Dalits*/SCs and *Adivasis*/STs are the lowest rungs with the latter more isolated and deprived. OBCs are among the most affluent. The highest share of each NCD (including multimorbidity) is contributed by OBCs and the lowest by *Adivasis*/STs. The share of *Dalits*/SCs –who are more in the mainstream of economic and social activities and better-off than *Adivasis*/STs-contribute a larger share of each NCD. Hence this marker of socio-economic inequality points to the more affluent contributing the largest share of NCDs and the most deprived the lowest in 2005. This pattern with minor variation is replicated in 2012.

Another marker of socio-economic inequality is years of education. While illiterates are generally at the bottom of the ladder, matriculates and above are at the top. Among those

[13] Details will be furnished upon request.

suffering from blood pressure, the highest share is that of illiterates and that of matriculates and above a little over one-third of it in 2005. A similar pattern is obtained for all other NCDs and multimorbidity. A similar pattern is observed in 2012, with the slight variation that the shares of illiterates are slightly larger in most cases, and of matriculates and above lower. Here clearly this socio-economic marker is associated with better NCD outcomes.

A direct measure of affluence is asset quartile. The first quartile represents the least wealthy and the fourth the wealthiest. Here also we see a striking contrast. In each NCD, the share of the most affluent is a multiple of that of the least wealthy in 2005. A similar picture emerges for 2012. For example, the ratio of share of those suffering from high blood pressure in the wealthiest to that in the least wealthy is about 3 in 2005, which declines to 2.5 in 2012. Hence among those suffering from blood pressure, the most likely to suffer from it are the wealthiest relative to the least wealthy.

Except for diabetes in which men accounted for the larger share, in all other NCDs women accounted for the larger shares. The pattern changed in 2012. Men accounted for larger shares of heart disease and diabetes while women accounted for larger shares of total cases of high blood pressure and multimorbidity.

As these are comparisons of means, no inferences can be drawn without controlling for confounding factors. We do so through probit and unordered/multinomial probit estimations.

(iii) Models

Both binary and multinomial probit models are used to examine the persistence of NCDs, their associations with trust, affluence, sanitation, social networks, age, gender and caste affiliations. As the multinomial probit has a more complex structure, we give a brief algebraic exposition below.

Multinomial Probit Model (MNP)

The MNP model is used with discrete dependent variables that take on more than two outcomes that do not have a natural ordering. The stochastic error terms for implementation of this model are assumed to have independent, standard normal distributions.[14]

The MNP model described here uses a latent variable framework. The latent variable for the jth alternative, j = 1,….. J, is

$$\eta_{ij} = \boldsymbol{Z}_i \boldsymbol{\alpha}_j + \varepsilon_{ij}$$

where the 1xq row vector $\boldsymbol{Z}_i$ contains the observed independent variables for the ith person. Associated with $\boldsymbol{Z}_i$ are the J vectors of regression coefficients $\boldsymbol{\alpha}_j$. The $\varepsilon_{i,1}$ …… $\varepsilon_{i,J}$ are distributed independently and identically standard normal. The person chooses the alternative k such that $\eta_{ik} \geq \eta_{im}$ for m≠ k.

Suppose that person i chooses alternative k, and take the difference between latent variable η_{ik} and the J - 1 others:

$$\begin{aligned} \nu_{ijk} &= \eta_{ij} - \eta_{ik} \\ &= \boldsymbol{Z}_i(\boldsymbol{\alpha}_j - \boldsymbol{\alpha}_k) + \varepsilon_{ij} - \varepsilon_{ik} \qquad (1) \\ &= \boldsymbol{Z}_i \gamma_{j'} + \varepsilon_{ij'} \end{aligned}$$

[14] For a detailed exposition, see Cameron and Trivedi (2005).

where $j' = j$ if j<k and $j' = j - 1$ if j>k so that $j' = 1 \dots \dots \dots J - 1, Var\left(\varepsilon_{ij}\right) = Var\left(\varepsilon_{ij} - \varepsilon_{ik}\right) = 2$ and Cov $(\varepsilon_{ij'}, \varepsilon_{il'}) = 1$ for all $j' = l'$. The probability that alternative k is chosen

Pr (i chooses k)=Pr ($v_{i1k} \nleq 0 \dots \dots \dots v_{i,j-1,k} \nleq 0$)

$$= \Pr(\varepsilon_{i1} \nleq -\boldsymbol{Z}_i\gamma_{1,\dots\dots\dots}\varepsilon_{i,J-1} \nleq -\boldsymbol{Z}_i\gamma_{J-1})$$

Hence, evaluating the likelihood function involves computing probabilities from the multivariate normal distribution.

In (1), not all J of the $\boldsymbol{\alpha}_j$ are identifiable. To overcome the indeterminacy, $\boldsymbol{\alpha}_j$ is set to the zero vector, where l is the base outcome. That fixes the lth latent variable to zero so that the remaining variables measure the attractiveness of the other alternatives relative to the base.

The MNP model relaxes the IIA assumptions. The shortcoming of the model is the computational demands. The relevant probabilities that enter the log likelihood function and its derivatives must be approximated by simulation. The Geweeke-Hajivassiliou-Keane smooth recursive simulator (GHK simulator) is commonly used (Greene, 2008).

As the marginal effects/associations differ from the coefficients of the MNP model, our comments are largely on the former.

The binary probit does not require any exposition, as it is easily available in various text books (e.g., Greene, 2012). In this case too, we rely on the marginal effects/associations.

Section 5

Analysis

First, we use a minimalist unordered probit specification with any NCD as the dependent variable in 2012 and explanatory variables comprising trust in health providers and any NCD in 2005. Second, we use a multinomial probit specification to examine the associations of 4 different NCD outcomes (no NCD is omitted in the estimation of the coefficient but not in the marginal associations/effects) in 2012 with NCDs, demographic, socio-economic and other forms of inequality, trust, rural/urban location, living arrangements, sanitation and state affluence in 2005.

(i) Minimalist Multinomial Probit Results

In the minimalist multinomial probit (MNP), the two major hypotheses sought to be validated comprise: (i) whether patient-doctor/hospital trust is associated with lower prevalence of NCDs, and (ii) whether NCDs persist over time. The specification used also allows us to test whether there are cross-effects between NCDs. The NCD outcomes include (i) whether a person suffered from blood pressure, (ii) whether suffered from heart disease,(iii) whether suffered diabetes, and (iv) whether suffered from a multi morbidity in 2012. All baseline variables such as confidence levels and affliction with an NCD are for 2005. As there is no ordering in the NCD outcomes, a multinomial probit specification is appropriate. The coefficients and the marginal associations/effects are given in Tables 2 and 2A. As the latter are of greater analytical interests, our comments are confined to them.

The overall MNP specification is validated by the Wald test at <=1% level.

Table 2
Minimalist MNP Specification of Persistence of NCDs

Number of obs	= 101,073
Wald chi2(20)	= 2493.67
Log pseudolikelihood	= -2.087e+08
Prob > chi2	= 0.0000

	High BP		Heart Disease		Diabetes		Multi-morbidity	
VARIABLES	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Confidence Medical (2005)								
Hardly any	0.0101	(0.0593)	-0.188**	(0.0789)	0.0431	(0.0900)	-0.0902	(0.0603)
Only some	0.0488	(0.0306)	0.0274	(0.0522)	0.00499	(0.0431)	0.0511	(0.0317)
High BP (2005)								
Yes	1.588***	(0.0652)	0.732***	(0.108)	0.676***	(0.0910)	1.351***	(0.0597)
Heart disease								
Yes	0.911***	(0.129)	2.017***	(0.113)	0.998***	(0.138)	1.494***	(0.109)
Diabetes								
Yes	0.690***	(0.119)	0.967***	(0.155)	2.506***	(0.0863)	2.010***	(0.0802)
Constant	-2.668	(0.0172)	-3.375	(0.0294)	-3.072	(0.0244)	-2.718	(0.0181)
Observations	101,073							

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2 A
Marginal Associations/Effects

VARIABLES	No NCD		High BP		Heart Disease		Diabetes		Multimorbidity	
	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err
Confidence Medical (2005)										
Hardly any	0.00349	(0.0043)	0.000969	(0.0028)	-0.00215***	(0.0008)	0.00149	(0.0024)	-0.0038	(0.0024)
Only some	-0.00430*	(0.0024)	0.00209	(0.0015)	0.000243	(0.0007)	-0.000156	(0.0011)	0.00212	(0.0015)
High BP (2005)										
Yes	-0.261***	(0.0140)	0.155***	(0.0120)	0.00450*	(0.0024)	0.00626*	(0.0033)	0.0955***	(0.0082)
Heart disease										
Yes	-0.276***	(0.0251)	0.0328***	(0.0113)	0.104***	(0.0150)	0.0204***	(0.0076)	0.119***	(0.0171)
Diabetes										
Yes	-0.428***	(0.0212)	-0.00326	(0.0054)	0.00305	(0.0031)	0.240***	(0.0188)	0.188***	(0.0159)
Observations	101073									

The patient-doctor/hospital trust has three levels: hardly any confidence, only some confidence and a great deal of confidence. Both public and private providers of health services are lumped together in 2005. Since the highest proportion of those who received medical treatment display a great deal of confidence, this is omitted. Those with hardly any confidence are associated with a significantly lower prevalence of heart disease, as also of multi-morbidity, relative to those with a great deal of confidence. Those with some confidence are associated with a lower probability of no NCD, relative to those with a great deal of confidence. Although in two cases, blood pressure and multimorbidity, some confidence is positively associated with these diseases, the associations are weakly significant (<=15%). These are somewhat intriguing results.

Blood pressure in 2005 is negatively associated with no NCD or lower risk of no NCD, but positively with blood pressure, heart disease, diabetes and multimorbidity in 2012. So not only is there a robust confirmation of persistence of blood pressure over time but also of cross-

associations with other NCDs. The largest association (in absolute value) is with no NCD, followed by with itself, and lowest with diabetes.

A similar picture emerges for heart attack. It is significantly associated with a lower risk of no NCD, but positively with the risks of blood pressure, heart attack, diabetes and multimorbidity in 2012. So there is a persistence of heart attack as well as cross –associations with other NCDs. As in the case of blood pressure, the highest (absolute value) is of the association with the risk of no NCD, followed by that of the association with multimorbidity and then with itself.

Diabetes also confirms robust persistence and significant cross-associations with other NCDs. It is associated significantly with a lower risk of no NCD, and higher risks of itself and of multimorbidity. The largest association (in absolute value) is with the risk of no NCD, followed by that of itself and then multimorbidity.

In sum, the evidence on trust between patient-doctor/hospital is inconclusive while that on persistence of NCDs and the cross-effects between them is robust but without controls.

(ii) Probit Results

There are two ways of looking at prevalence of NCDs: one is by count and another by specific NCD. In order to examine the factors associated with count of NCDs, we use whether a person suffered from one or more NCDs and none as the dependent variable in 2012; and socio-economic, demographic, whether suffered from one or more NCDs, whether suffered from one or more disabilities, location, sanitation (confined to source of drinking water and type of toilet facility), diets, social networks, state affluence, and the Piketty measure of inequality in income distribution at the state level as explanatory variables in 2005. To avoid repetition, our comments on marginal associations/effects in Table 3 are brief.

The overall probit specification in Table 3 is validated by the Wald test at the <= 1% level.

Relative to a great deal of confidence in health providers in 2005, neither hardly any confidence nor some confidence is associated significantly with the risk of NCDs (one or more than one) in 2012.

Table 3
Probit Analysis of Factors Associated with NCDs

Number of obs	=	91,391	
Wald chi2(63)	=	5034.17	
Prob > chi2	=	0.0000	
Log pseudolikelihood	=	-1.981e+08	
Pseudo R2	=	0.1314	

	(1)	(2)	(3)	(4)
VARIABLES	Coef.	Std. Err.	Margins	Std. Err.
Confidence: Medical Services (2005)				
Hardly any confidence at all	0.00671	(0.0298)	0.00137	(0.00609)
Only some confidence	0.00140	(0.0176)	0.000284	(0.00358)
Household Toilet				
Traditional Latrine	0.102***	(0.0259)	0.0208***	(0.00540)
Vip Latrine	0.0882**	(0.0349)	0.0179**	(0.00727)
Flush Toilet	0.140***	(0.0240)	0.0291***	(0.00507)
Water Source				
Tube Well	0.0529*	(0.0290)	0.0109*	(0.00605)
Hand Pump	0.0370*	(0.0218)	0.00757*	(0.00446)
Other	-0.0320	(0.0237)	-0.00634	(0.00468)

NCD (2005)				
Yes	0.667***	(0.0261)	0.173***	(0.00807)
Disability (2005)				
Yes	0.100**	(0.0397)	0.0213**	(0.00879)
Age Group (2005)				
15 - 30	0.459***	(0.0218)	0.0818***	(0.00370)
51 - 60	0.803***	(0.0282)	0.171***	(0.00678)
61 - 70	0.815***	(0.0366)	0.175***	(0.00961)
>70	0.884***	(0.0599)	0.196***	(0.0178)
Gender				
Female	0.159***	(0.0169)	0.0324***	(0.00343)
Marital Status (2005)				
Unmarried	-0.378***	(0.0314)	-0.0675***	(0.00483)
Widowed/Divorced	-0.0363	(0.0276)	-0.00764	(0.00574)
Sector				
Urban	0.0863***	(0.0210)	0.0179***	(0.00440)
Caste				
Brahmin	0.0165	(0.0335)	0.00348	(0.00711)
High Caste	0.00283	(0.0241)	0.000595	(0.00505)
Dalit	-0.0822***	(0.0232)	-0.0166***	(0.00466)
Adivasi	-0.305***	(0.0369)	-0.0553***	(0.00601)
Others	0.0505**	(0.0238)	0.0108**	(0.00514)
Asset Quartile - 2005				
Q2	0.00476	(0.0248)	0.000939	(0.00490)
Q3	0.0262	(0.0251)	0.00522	(0.00498)
Q4	0.111***	(0.0287)	0.0229***	(0.00594)
Education (2005)				
1 - 4	0.0770***	(0.0295)	0.0165**	(0.00644)
5 - 8	0.00678	(0.0222)	0.00141	(0.00462)
9 - 10	-0.0581**	(0.0286)	-0.0117**	(0.00571)
>10	-0.152***	(0.0289)	-0.0294***	(0.00543)
Social Network (2005)				
1	-0.00621	(0.0223)	-0.00127	(0.00456)
>1	-0.0522**	(0.0224)	-0.0105**	(0.00444)
Household Size (2005)				
1	0.189*	(0.106)	0.0397*	(0.0241)
>5	0.115***	(0.0162)	0.0233***	(0.00330)
Price Ratios				
Rice to Cereals	-0.00454	(0.109)	-0.000925	(0.0221)
Wheat to Cereals	-0.148	(0.122)	-0.0301	(0.0248)
Sugar to Cereals	-0.0213	(0.0616)	-0.00433	(0.0125)
Pulses to Cereals	-0.0145	(0.0232)	-0.00295	(0.00473)
Milk to Cereals	0.192***	(0.0522)	0.0392***	(0.0106)
Edible Oil to Cereals	-0.0574***	(0.0211)	-0.0117***	(0.00431)
Meat to Cereals	0.0107	(0.00742)	0.00217	(0.00151)
Eggs to Cereals	0.0579**	(0.0249)	0.0118**	(0.00507)
Ratio of share of top 1% to bottom 50%	5.536***	(0.757)	1.127***	(0.154)
Net State Domestic Product (2005)	-4.87e-05***	(1.01e-05)	-9.92e-06***	(2.05e-06)
State Dummies	Yes			
Constant	-2.449	(0.321)		
Observations	91,391			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

There is a robust persistence between NCDs during 2005-2012. So the higher the prevalence of NCDs in 2005, the higher is the likelihood of NCDs in 2012.

Disabilities are positively associated with NCDs. The higher the prevalence of one or more disabilities in 2005, the greater is the likelihood of NCDs in 2012.

Turning to age as a demographic characteristic, we notice that there is an age-gradient. In other words, the older a person in 2005, the greater is the probability of suffering from NCDs in 2012. Females are more prone to NCDs than males. In the marital status case, the highest proportion in 2005 is that of married. Hence they are omitted. So relative to this category, the unmarried are much less prone to NCDs. Widowed/divorced do not yield a significant association.

Residents of urban areas are more prone to NCDs than those in rural areas.

Living arrangements-living alone or living with family members-are associated with health outcomes. We find that living alone is associated with higher risks of NCDs, as also being a member of households with 2-5 members, relative to larger households. Living alone may imply lack of any support when it is needed-especially among the old. What is surprising is that those belonging to larger households with 2-5 members are also prone to higher vulnerability to NCDs, compared with households with > 5 members. In small households, those suffering from NCDs may be more burdensome and thus more likely to be neglected and possibly abused. As there is no verifiable evidence, this is just a conjecture.

Two aspects of sanitation and hygiene are considered: one is type of toilet, another is source of drinking water.

There are four types of toilets in 2005: none, open fields, traditional latrine, ventilated improved pit toilet (VIP), and flush toilet. As the first type accounts for the largest share, it is omitted. Relative to open defecation, traditional and VIP latrines, and flush toilets have significant positive associations with NCDs. It is arguable that, if not properly maintained, traditional and VIP latrines may not be more hygienic than open defecation. However, on the face of it, the result that flush toilets are less hygienic than open defecation is suspect. But there are extensive reports of dysfunctional flush toilets because of water shortage. In that case, these results are not entirely implausible.

Four sources of water supply are considered: piped water supply, tube wells, hand pumps and others. As piper water supply is considered most potable, it is not surprising that use of tube wells and water pumps are associated with higher risks of NCDs.

The caste hierarchy is an important marker of socio-economic inequality and deprivation. Compared to the OBCs (the largest category), the *Dalits* (or Scheduled Castes/SCs) and *Adivasis* (Scheduled Tribes or STs)- ranked as the lowest rung both socially and economically, with the latter also the most isolated- the latter are much less prone to NCDs. *Others* –found to be largely most affluent- show a higher risk of NCDs. So the socio-economic hierarchy seems to work to the advantage of the socially and economically most deprived.

Each household to which an individual person belongs-whether suffering from one or more NCDs or none-is ranked on the basis of its assets. These are grouped into quartiles. As the first quartile/least wealthy is the largest, it is omitted. So all results are relative to the least wealthy. It is only the wealthiest or those in the fourth quartile who are positively associated with the risk of NCDs. In other words, relative to the least wealthy, the wealthiest are more prone to NCDs.

Education is another marker of socio-economic differentiation. Illiterates, for example, are the poorest and matriculates and above are (relatively) affluent. As illiterates account for the largest share in 2005, they are the omitted group. So relative to it, those with minimal education of 1-4 years are more prone to NCDs; however, those with higher levels of education, 9-10 years

and >10 years, are less prone to NCDs. Higher education not only adds to awareness of such risks but also of healthier life styles and diets, and is thus associated with lower risks of NCDs.

Social networks (e.g., self-help groups, women's associations, farmers' associations) are diverse in nature and depending on the type reflect bonding social capital (comprising similar members), bridging social capital (comprising heterogeneous members, say, of different castes) and linking social capital (comprising members with links to politicians in power, official agencies). We are unable to test for differences in their associations with NCDs. So we consider just number of networks to which a household/member belongs: none, 1 or >1. We find that relative to no membership, those who belonged to more than 1 network display a significantly lower risk of NCDs. So social capital is associated with better health outcomes, as measured here.

An innovation of this study is the focus on diets through food prices. These are unit values aggregated at the PSU level (since household unit values are likely to be endogenous to food quality). All prices are relative to cereal prices. For ease of exposition, we comment on the marginal associations/effects of changes in the numerator. The higher the price of milk, the lower is the consumption of milk, and the higher the risks of NCDs. In sharp contrast, the higher the price of edible oil, the lower is its intake, and the lower the risks of NCDs. The higher the price of eggs, the lower is the intake and the higher the risks of NCDs. All these are plausible results and corroborate the important association of diet with the risks of NCDs.

As noted earlier, State affluence is measured in terms of state domestic product per capita. Its association with prevalence of NCDs is significantly negative, implying that more affluent states show lower prevalence. However, the economic magnitude of the marginal association/effect is negligible. This could imply that the correlation between state income and state expenditure on health is positive but weak.

Another important measure is income inequality at the state level, which we have sought to capture using the Piketty measure. There is a strong positive association between this measure and prevalence of NCDs. It has been argued that the negative association between social capital and health outcomes-or, between social cohesion and health outcomes-is undermined in a context of high overall inequality. Extreme inequality comes in the way of life that individuals would like to live- or, more specifically, in the present context, the capability to live a healthy and productive life. Hence this finding is plausible and compelling.

(iii) Multinomial Probit Results

As the nature of NCDs is not specified, we carry out a more detailed analysis using multinomial probit. Five categories are considered: no NCD, blood pressure, heart disease, diabetes, and multimorbidity (>1 NCD). The results are given in Tables 4 and 4a.

Table 4
MNP Analysis of Factors Associated with NCDs

Number of obs	= 91,844
Wald chi2(244)	= 6729.26
Log pseudolikelihood	= -1.672e+08
Prob > chi2	= 0.0000

	High BP		Heart Disease		Diabetes		Multi-morbidity	
VARIABLES	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Confidence Medical (2005)								
Hardly any	0.0435	(0.0657)	-0.249***	(0.0871)	0.174*	(0.0948)	-0.00181	(0.0694)
Only some	0.00766	(0.0359)	-0.0211	(0.0561)	-0.0192	(0.0486)	0.0423	(0.0370)
High BP (2005)								
Yes	1.081***	(0.0718)	0.363***	(0.112)	0.232**	(0.0921)	0.765***	(0.0649)
Heart disease								
Yes	0.675***	(0.137)	1.798***	(0.120)	0.742***	(0.143)	1.202***	(0.115)

Diabetes								
Yes	0.314**	(0.124)	0.617***	(0.159)	1.953***	(0.0951)	1.460***	(0.0867)
Age Group (2005)								
31-50	0.753***	(0.0520)	0.609***	(0.0726)	0.906***	(0.0783)	1.029***	(0.0549)
51-60	1.167***	(0.0610)	1.045***	(0.0878)	1.309***	(0.0922)	1.532***	(0.0648)
61-70	1.059***	(0.0700)	0.836***	(0.0978)	0.994***	(0.103)	1.570***	(0.0722)
>70	0.991***	(0.108)	0.942***	(0.148)	0.873***	(0.141)	1.554***	(0.0983)
Gender								
Female	0.327***	(0.0344)	-0.0369	(0.0511)	-0.113**	(0.0451)	0.203***	(0.0356)
Marital Status								
Unmarried	-0.904***	(0.101)	-0.550***	(0.123)	-0.523***	(0.116)	-0.647***	(0.0920)
Widowed/Divorced	0.0654	(0.0542)	-0.0426	(0.0911)	-0.00144	(0.0728)	-0.0243	(0.0574)
Sector								
Urban	0.262***	(0.0428)	0.219***	(0.0636)	0.405***	(0.0622)	0.375***	(0.0404)
Caste								
Brahmin	0.157**	(0.0657)	0.0191	(0.103)	0.0580	(0.0920)	0.0301	(0.0652)
High Caste	0.168***	(0.0495)	0.00710	(0.0727)	-0.00208	(0.0602)	0.0348	(0.0505)
Dalit	-0.0483	(0.0481)	-0.0905	(0.0779)	-0.106	(0.0729)	-0.192***	(0.0514)
Adivasi	-0.330***	(0.0850)	-0.0873	(0.147)	-0.201	(0.125)	-0.456***	(0.0834)
Others	0.188***	(0.0501)	0.164**	(0.0707)	0.0739	(0.0604)	0.246***	(0.0520)
Asset Index 2005								
q2	0.0979*	(0.0538)	0.0861	(0.0838)	0.134	(0.0852)	0.112*	(0.0585)
q3	0.299***	(0.0518)	0.160*	(0.0825)	0.278***	(0.0785)	0.176***	(0.0534)
q4	0.417***	(0.0540)	0.433***	(0.0920)	0.633***	(0.0851)	0.396***	(0.0561)
Education								
1-4	0.123**	(0.0624)	0.141	(0.0962)	0.240**	(0.108)	0.178***	(0.0642)
5-8	0.0180	(0.0458)	0.112	(0.0690)	0.172**	(0.0690)	0.104**	(0.0481)
9-10	0.0657	(0.0586)	0.0814	(0.0843)	0.172**	(0.0745)	0.0462	(0.0571)
>10	0.00255	(0.0596)	-0.0679	(0.0881)	0.0427	(0.0854)	-0.0501	(0.0619)
Number of Social Networks								
1	-0.000862	(0.0461)	-0.0112	(0.0767)	-0.0261	(0.0605)	0.0504	(0.0469)
>1	-0.0340	(0.0482)	-0.0598	(0.0693)	-0.141**	(0.0649)	-0.0388	(0.0488)
Household Size								
1	0.305	(0.231)	0.188	(0.348)	-0.555	(0.362)	0.176	(0.215)
2-5	0.102***	(0.0320)	0.0924*	(0.0509)	0.0290	(0.0468)	0.185***	(0.0348)
Water Source								
Tube Well	0.102*	(0.0562)	-0.0519	(0.0947)	0.0623	(0.0825)	0.128**	(0.0632)
Hand Pump	-0.0398	(0.0474)	-0.134**	(0.0680)	0.0162	(0.0647)	-0.0744	(0.0535)
Other	-0.0464	(0.0511)	-0.130	(0.0871)	0.0221	(0.0679)	-0.0921*	(0.0509)
Ratio of Share of top 1% to Bottom 50%	3.567**	(1.512)	3.392	(2.408)	-2.944	(1.846)	15.79***	(1.757)
Net State Domestic Product (2005)	-6.68e-05***	(1.86e-05)	-5.98e-05**	(2.87e-05)	7.14e-05***	(2.47e-05)	-0.000135***	(2.71e-05)
Price Ratios								
Rice to Cereals	-0.0950	(0.155)	0.172	(0.252)	-0.00953	(0.216)	-0.00192	(0.180)
Wheat to Cereals	-0.194	(0.227)	-0.271	(0.336)	-0.570	(0.356)	-0.0473	(0.305)
Sugar to Cereals	-0.308***	(0.119)	-0.0629	(0.191)	-0.319*	(0.193)	-0.398***	(0.126)
Pulses to Cereals	0.0652	(0.0524)	0.0573	(0.0748)	-0.0751	(0.0638)	0.139***	(0.0534)
Milk to Cereals	0.411***	(0.117)	0.458***	(0.158)	0.329**	(0.138)	0.427***	(0.117)
Edible Oil to Cereals	-0.0408	(0.0371)	-0.0818	(0.0633)	-0.00240	(0.0540)	-0.0817	(0.0663)
Meat to Cereals	0.0160	(0.0145)	-0.0416*	(0.0213)	0.0461**	(0.0204)	0.0211	(0.0159)
Eggs to Cereals	-0.0237	(0.0421)	0.0826	(0.0884)	-0.106*	(0.0550)	0.0855	(0.0564)
State Dummies	Yes							
Constant	-2.746	(0.572)	-3.842	(0.955)	-3.864	(0.858)	-6.901	(0.687)
Observations	91,844							

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The overall multinomial probit specification is validated by the Wald test. Since the marginal effects/associations are more useful, our comments are confined to Table 4a.

Hardly any confidence between patient-doctor/hospital is associated with a lower risk of heart attack while it is positively related with that of diabetes in 2012, relative to a great deal of confidence in health providers in 2005. The latter is plausible. Some confidence, however, does not yield any significant associations.

In order to check persistence of these NCDs, we have included three NCDs in 2005: blood pressure, heart disease and diabetes. Blood pressure in 2005 is negatively associated with no NCD in 2012, implying that the likelihood of the latter is considerably lower. There is robust

persistence of blood pressure during this period. Moreover, blood pressure is positively associated with the risk of multimorbidity, or, the likelihood of the latter is higher. Thus there is a significant cross-association between blood pressure and combination of NCDs.

Heart diseases is associated with a significantly lower likelihood of no NCD; positive association with blood pressure; its own persistence; and positive associations with diabetes and multimorbidity of NCDs. Thus, along with persistence of heart disease over time, it yields cross-associations with other NCDs.

Diabetes is associated with a significantly lower likelihood of no NCD; positive associations with itself (or persistence over time), and multi-morbidity. However, somewhat surprising is the negative association with blood pressure.

Relative to the young (<30 years), the older age-group of 31-50 years is negatively associated with the likelihood of no NCD, and positively associated with blood pressure, heart disease, diabetes and multi-morbidity. A similar pattern is observed among the still older group, 51-60 years, those in the age-group 61-70 years and among the oldest, & 71 years or more. What is striking is that in each age-group the largest marginal association (in absolute value) is with no NCD, followed by those with multi-morbidity.

Females are subject to lower likelihood of no NCD, higher likelihood of blood pressure, lower likelihood of heart disease and diabetes but higher likelihood of multimorbidity, relative to males.

Spousal support is often cited as crucial for alleviating chronic medical conditions. Since married are the largest group, it is omitted. So, relative to the married, the unmarried are found to have a significantly higher likelihood of no NCD; but the likelihood of any of the CDs (including multi-morbidity) is significantly lower. In sharp contrast, widowed/divorced do not yield any significant association. Hence the important role of spousal support is not corroborated.

As the share of the population living in rural areas is larger than that of the urban, the former is the omitted category. The association between urban location and no NCD is significantly lower, relative to the rural, implying that the likelihood of no NCD is lower in urban areas. In contrast, the likelihood of each NCD (including multimorbidity) is significantly higher in urban areas.

As noted earlier, the caste is a marker of socio-economic inequality. The highest ranked but not necessarily the most prosperous are the *Brahmins*. They are associated with a lower likelihood of no NCD; and a higher likelihood of blood pressure, relative to the OBCs. Other high caste groups are associated with a lower probability of no NCD; and a higher probability of blood pressure than the OBCs. The *Dalits*/SCs –among the most disadvantaged and ranked in the lower rungs of social hierarchy-are associated with a lower probability of no NCD; and a higher probability of multimorbidity. In contrast, the *Adivasis*/STs-the most disadvantaged and isolated-are more likely to be free from NCDs; less likely to suffer from blood pressure; and less likely to suffer from any multimorbidity. *Others*, often the most affluent-do not fare so well. They are associated with a lower likelihood of no NCD; higher probabilities of blood pressure and multimorbidity, and weakly with heart disease (significant at the >12% level). However, the caveat of a reporting bias in the lower segment of the socio-economic hierarchy should not be overlooked.

As the first asset quartile accounts for the largest share, it is omitted. All results are relative to this quartile (or the least wealthy). The second quartile is associated with a lower likelihood of no NCD; and weakly (>11%), but positively with multimorbidity. In sharp contrast, the third

Table 4A
MNP Marginal Associations with NCDs

Average marginal effects
Number of obs = 91,844
Model VCE: Robust

VARIABLES	No NCD		High BP		Heart Disease		Diabetes		Multimorbidity	
	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err	dy/dx	Std. Err
Confidence Medical (2005)										
Hardly any	-0.00283	(0.0046)	0.00181	(0.0030)	-0.00300***	(0.0008)	0.00458*	(0.0027)	-0.000554	(0.0027)
Only some	-0.00111	(0.0024)	0.000205	(0.0016)	-0.000357	(0.0008)	-0.000565	(0.0011)	0.00183	(0.0015)
High BP (2005)										
Yes	-0.108***	(0.0095)	0.0755***	(0.0082)	0.0013	(0.0018)	-0.00145	(0.0020)	0.0323***	(0.0046)
Heart disease										
Yes	-0.169***	(0.0191)	0.0168*	(0.0087)	0.0777***	(0.0124)	0.00963*	(0.0052)	0.0652***	(0.0114)
Diabetes										
Yes	-0.207***	(0.0166)	-0.00846*	(0.0043)	0.00165	(0.0027)	0.123***	(0.0129)	0.0916***	(0.0102)
Age Group (2005)										
31-50	-0.0595***	(0.0022)	0.0203***	(0.0015)	0.00420***	(0.0007)	0.0121***	(0.0011)	0.0228***	(0.0012)
51-60	-0.119***	(0.0049)	0.0397***	(0.0028)	0.0102***	(0.0016)	0.0220***	(0.0025)	0.0471***	(0.0031)
61-70	-0.105***	(0.0056)	0.0335***	(0.0033)	0.00620***	(0.0014)	0.0114***	(0.0021)	0.0534***	(0.0040)
>70	-0.0996***	(0.0094)	0.0294***	(0.0057)	0.00872***	(0.0030)	0.00846***	(0.0028)	0.0530***	(0.0065)
Gender										
Female	-0.0156***	(0.0022)	0.0136***	(0.0014)	-0.00120*	(0.0007)	-0.00406***	(0.0010)	0.00722***	(0.0014)
Marital Status										
Unmarried	0.0488***	(0.0030)	-0.0224***	(0.0016)	-0.00392***	(0.0009)	-0.00660***	(0.0017)	-0.0160***	(0.0021)
Widowed/Divorced	-0.00135	(0.0040)	0.0034	(0.0027)	-0.000653	(0.0012)	-0.0000948	(0.0017)	-0.0013	(0.0023)
Sector										
Urban	-0.0320***	(0.0031)	0.00887***	(0.0020)	0.00174*	(0.0009)	0.00793***	(0.0015)	0.0135***	(0.0018)
Caste										
Brahmin	-0.00806*	(0.0047)	0.00696**	(0.0031)	-0.0000672	(0.0014)	0.000899	(0.0022)	0.00026	(0.0027)
High Caste	-0.00750**	(0.0034)	0.00769***	(0.0023)	-0.000202	(0.0009)	-0.000591	(0.0014)	0.000611	(0.0021)
Dalit	0.00983***	(0.0030)	-0.000828	(0.0020)	-0.000743	(0.0010)	-0.00166	(0.0016)	-0.00660***	(0.0018)
Adivasi	0.0252***	(0.0043)	-0.00957***	(0.0026)	0.00000834	(0.0019)	-0.00247	(0.0025)	-0.0132***	(0.0022)
Others	-0.0191***	(0.0037)	0.00696***	(0.0023)	0.00163	(0.0011)	0.000313	(0.0014)	0.0102***	(0.0025)
Asset Index 2005										
q2	-0.00857***	(0.0031)	0.00282	(0.0019)	0.000639	(0.0009)	0.00181	(0.0014)	0.00331	(0.0021)
q3	-0.0204***	(0.0031)	0.0108***	(0.0021)	0.00111	(0.0009)	0.00406***	(0.0013)	0.00443**	(0.0019)
q4	-0.0428***	(0.0037)	0.0141***	(0.0023)	0.00438***	(0.0013)	0.0124***	(0.0018)	0.0119***	(0.0022)
Education										

1-4	-0.0160***	(0.0048)	0.00391	(0.0029)	0.0013	(0.0014)	0.00467*	(0.0027)	0.00609**	(0.0028)
5-8	-0.00798**	(0.0031)	-0.000302	(0.0019)	0.00123	(0.0010)	0.00347**	(0.0015)	0.00358*	(0.0020)
9-10	-0.00745**	(0.0038)	0.00219	(0.0026)	0.000798	(0.0011)	0.00356**	(0.0017)	0.000906	(0.0023)
>10	0.00134	(0.0038)	0.000341	(0.0025)	-0.000785	(0.0010)	0.00108	(0.0018)	-0.00198	(0.0023)
Number of Social Networks										
1	-0.00105	(0.0031)	-0.000214	(0.0020)	-0.000209	(0.0010)	-0.000772	(0.0014)	0.00225	(0.0020)
>1	0.00524*	(0.0031)	-0.000895	(0.0021)	-0.000575	(0.0009)	-0.00288**	(0.0013)	-0.000893	(0.0019)
Household Size										
1	-0.0142	(0.0171)	0.0152	(0.0134)	0.00226	(0.0057)	-0.00956***	(0.0033)	0.00636	(0.0091)
2-5	-0.0108***	(0.0022)	0.00339**	(0.0014)	0.00079	(0.0007)	-0.000223	(0.0011)	0.00686***	(0.0014)
Water Source										
Tube Well	-0.00879**	(0.0042)	0.00403	(0.0027)	-0.00116	(0.0013)	0.000809	(0.0019)	0.00512*	(0.0029)
Hand Pump	0.00478	(0.0032)	-0.00123	(0.0020)	-0.00167*	(0.0009)	0.000806	(0.0015)	-0.00269	(0.0021)
Other	0.00539	(0.0033)	-0.00145	(0.0022)	-0.00159	(0.0011)	0.00101	(0.0016)	-0.00337*	(0.0020)
Ratio of Share of top 1% to Bottom 50%	-0.611***	(0.1040)	0.0825	(0.0649)	0.0184	(0.0318)	-0.129***	(0.0419)	0.640***	(0.0695)
Net State Domestic Product (2005)	6.03e-06***	(0.0000)	-2.39e-06***	(0.0000)	-5.57E-07	(0.0000)	2.29e-06***	(0.0000)	-5.37e-06***	(0.0000)
Price Ratios										
Rice to Cereals	0.00194	(0.0109)	-0.00444	(0.0067)	0.00247	(0.0033)	-0.000121	(0.0049)	0.000155	(0.0072)
Wheat to Cereals	0.0206	(0.0172)	-0.00663	(0.0098)	-0.00285	(0.0045)	-0.0124	(0.0081)	0.00122	(0.0122)
Sugar to Cereals	0.0296***	(0.0083)	-0.0108**	(0.0052)	0.000471	(0.0025)	-0.00535	(0.0044)	-0.0138***	(0.0051)
Pulses to Cereals	-0.00601*	(0.0034)	0.00231	(0.0023)	0.000522	(0.0010)	-0.00238	(0.0015)	0.00556***	(0.0022)
Milk to Cereals	-0.0382***	(0.0074)	0.0147***	(0.0051)	0.00466**	(0.0021)	0.00493	(0.0032)	0.0139***	(0.0047)
Edible Oil to Cereals	0.00488	(0.0032)	-0.00129	(0.0016)	-0.000916	(0.0008)	0.000366	(0.0012)	-0.00304	(0.0027)
Meat to Cereals	-0.00161	(0.0010)	0.000554	(0.0006)	-0.000654**	(0.0003)	0.000999**	(0.0005)	0.000714	(0.0006)
Eggs to Cereals	-0.000892	(0.0031)	-0.00134	(0.0018)	0.0011	(0.0012)	-0.00273**	(0.0013)	0.00386*	(0.0023)
State Dummies	Yes									
Observations	91844									

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

quartile is associated with a lower probability of no NCD; and higher probabilities of blood pressure, diabetes and multimorbidity. The fourth quartile (the wealthiest) are associated with a lower probability of no NCD; and higher probabilities of all NCDs including multimorbidity. In sum, NCDs show a wealth gradient. In other words, the wealthier segments are more vulnerable to NCDs than the least wealthy, subject to the caveat of a reporting bias.

Educational attainment is another socio-economic marker as higher education is associated with more remunerative employment and better awareness of healthy living. Relative to illiterates, those with minimal education of 1-4 years are associated with a lower probability of no NCD; a higher probability of diabetes, as also of multimorbidity. Additional years of schooling of 5-8 years yield similar outcomes: lower probability of no NCD, and higher probabilities of diabetes and multimorbidity. Still higher levels of education, 9-10 years, are associated only with a significantly lower probability of no NCD. The highest level, >10 years of education, does not yield any significantly different associations, relative to illiteracy. This is intriguing. The caveat stated earlier is pertinent here too. As those with no education or a few years of education are more likely to under-report their illness, and those with higher education more likely to report their illness, the difference seems lower partly because of a reporting bias.

Living arrangements yield significant associations. Three types are considered: living alone, living in a household with 2-5 members, and living in larger households (=> 6 members). As these households constitute the largest category, it is omitted and all results are relative to this group. Those living alone are less vulnerable to diabetes, and there are no other significant associations with other NCDs. This suggests that those living alone are not so susceptible to NCDs. Those living in households with 2-5 members are in fact worse-off: they are less likely to be free from NCD; but more likely to suffer from blood pressure, and multi morbidity.

Sources of drinking water comprise: piped water supply, tubewell, hand pump, and others. As piped water supply is most common, it is omitted. Relative to this, tubewell is associated with a lower likelihood of no NCD, a weakly (>12%) higher likelihood of blood pressure and higher likelihood of multimorbidity. Use of hand pump is weakly (>13%) positively associated with no NCD, and negatively with heart disease. Other sources are positively associated with likelihood of no NCD and negatively with multimorbidity. As potable drinking water is a key aspect of sanitation, and associated with better health outcomes, these are plausible findings, since piped water supply is considered most hygienic.[15]

Membership of social networks is considered important as it signifies social cohesion. More specifically, depending on the network, it could subsume bonding social capital (among similar individuals), bridging (among dissimilar persons) and linking social capital (individuals have access to officials, politicians in power and other authorities). Our data constraints do not allow us to make these distinctions. So we rely on a somewhat crude distinction: whether a household did not belong to any network (omitted), belonged to one and belonged to more than 1. So relative to the omitted group, membership of a single network does not yield any significant association with any NCD. However, membership of two is associated with higher likelihood of no NCD; and a lower likelihood of diabetes.

Although preventive role of healthy diet is emphasised, it is seldom validated in a rigorous manner. One of the distinctive features of the present analysis is to capture the association of selected food items, through their prices at the PSU level, with NCD outcomes. As in the probit specification, we get significant associations.

[15] Although the probit specification in Table 3 yields significant NCD outcomes for different types of toilet, the MNL probit procedure failed to converge. Hence toilet variables are omitted.

Neither the price of rice nor that of wheat yield significant associations with any NCD. However, the price of sugar is associated positively with the likelihood of no NCD, implying that the higher the price of sugar, the lower the intake of sugar, and the higher is the probability of no NCD. The sugar price is negatively associated with the risk of blood pressure, implying that the higher the price, the lower is sugar intake and the lower is the risk of blood pressure. A similar finding is obtained for the risk of multimorbidity. The higher the sugar price, the lower is the sugar intake and the lower the likelihood of multimorbidity. The higher the price of pulses, the lower is the intake, and the lower is the likelihood of no NCD; there is a negative association between the price and diabetes, implying that the higher the price, the lower is the sugar intake and the lower the risk of diabetes. The association between price of pulses and multimorbidity is positive, implying that higher the price, the lower is the intake of pulses and the higher the risk of multimorbidity. The price of milk is negatively associated with the likelihood of no NCD, implying that the higher the price, the lower the milk intake and the lower the likelihood of no NCD. In all other cases (high blood pressure, heart, diabetes (at >11% level), and multimorbidity) the associations between the price of milk and these outcomes are positive, implying that the higher the milk price, the lower is the intake and the higher the risks of these NCDs. Somewhat surprisingly, the price of edible oil does not yield any significant association with any NCD including multimorbidity. The price of meat, however, does yield significant associations with NCDs. It has a negative association with no NCD, implying that the higher the price, the lower is the meat intake and the lower is the likelihood of no NCD. There is also a negative association between the price of meat and likelihood of heart disease, implying that the higher the price of meat, the lower is its intake and the lower the probability of diabetes. However, the association between the price of meat and multimorbidity is positive, implying the higher the price, the lower its intake and the higher the risk of multimorbidity. This is somewhat intriguing. The association between the price of eggs and diabetes is negative. So the higher the price of eggs, the lower the intake and the lower the risk of diabetes. However, the association is positive with multimorbidity, implying that the higher the price of eggs, the lower the intake and the higher the risk of multimorbidity.

Two state level of affluence and inequality in income distribution are used. The former is measured in terms of state domestic product per capita and the latter relies on the Piketty measure of income inequality: the ratio of share of top 1% in total income to that of the bottom 50%.

State affluence yields a mixed pattern of associations with NCDs. The former is positively associated with no NCD, implying that the greater the state affluence, the higher is the likelihood of no NCD. The association with blood pressure is negative, implying that the more affluent a state is, there is a lower probability of blood pressure. However, state affluence is positively associated with diabetes, implying that greater affluence is accompanied by greater likelihood of diabetes. However, the association between affluence and multimorbidity is negative, implying a lower likelihood of the latter. As health is a state subject with substantial financial assistance from the Centre, it is plausible that there is a correlation between state affluence and its health expenditure. The important point, however, is that while the associations are significant, their economic magnitude is a very tiny fraction.

The associations between state income inequality and NCDs are not just statistically significant but also economically considerable in two cases. Inequality and no NCD are negatively associated, suggesting that the higher the inequality, the lower is the likelihood of no NCD. The marginal association is large. Income inequality and diabetes are negatively associated, implying that the greater the inequality, the lower is the likelihood of diabetes. However, there is a positive association between inequality and multimorbidity, implying that the greater the inequality, the greater is the risk of multimorbidity.

In sum, extreme inequality is associated with worse NCD outcomes, with the exception of diabetes (negative association) and heart disease (no significant association). Extreme inequality comes in the way of enabling individuals to live the life that they desire. Indeed, it could weaken the benefits of social capital through networks of support to individuals and rob them of the capability to live a healthy and productive life.

Section 6

Discussion

Here we summarise the main findings from a broad policy perspective. First, we comment on the probit results in which the dependent variable is count of NCDs: none or at least 1.

There is an age-gradient to prevalence of NCDs. In other words, the older a person in 2005, the greater is the probability of suffering from an NCD in 2012. This and the projected marked future shift in the share of older persons (=>60 years) in the share of the Indian population in the context of changing family relationships and severely limited old-age public income support require a variety of changes in social, economic and healthcare policy changes (Bear & Bloom, 2014).

There is a robust persistence of NCDs between 2005 and 2012. If a person suffered from an NCD in 2005, he/she is more likely to suffer from it in 2012, relative to the person who did not in 2005. Disabilities are positively associated with NCDs. The higher the prevalence of one or more disabilities in 2005, the greater is the likelihood of NCD in 2005.

Women are more prone to NCDs than men. Often noted are two facts: females are generally neglected in household allocation of food and healthcare. It is observed that men are fed first and the female spouses eat last. Unless the health condition is acute, women are generally not allowed to seek medical advice outside without a male relative. Haque-Rahman and Gaiha (2019) find that larger shares of old women suffering from at least 1 NCD had their first treatment at home and in the same village, compared with old men with a similar condition, implying that women had lower access to costlier and more specialised treatment despite their greater vulnerability to NCDs. As argued by Amartya Sen (1989) in a forceful critique of altruist models of households, such discrimination stems from a "false consciousness" of women's self-interest (i.e. non-individualistic, self-denying perceptions of women) and of their contribution to family well-being.[16] In the division of labour in which women are often confined to working within the household, while men earn an income from outside, the male productive role may well be perceived as very much stronger than the female contribution and consequently division of benefits. Whether outside employment for women is likely to influence these perceptions is likely but subject to a caveat as pointed out by Heath (2013). Unless women are better endowed with, say, human capital (e.g., education) and enjoy some bargaining power, outside employment could produce a backlash. Besides, as shown by Calvi (2019), women's bargaining power declines with age, with older women's poverty rates closely matching their mortality rates by age.

[16] In the general intra-household altruistic allocation model, altruistic parents maximise unified preferences that depend, inter alia, on the levels of adult labour earnings of each of their children and on other adult income of each of their children). Other income depends on transfers from the parents (or others) in the form of financial and physical assets. Two special cases of the parental altruism model-the wealth model of Becker and Tomes (1976, 1979) and the SET (separable earnings-transfers) model of Behrman, Pollak and Taubman (1982)-make stronger assumptions and yield sharper conclusions. These two special cases differ in their implications regarding whether parents allocate resources to compensate for or to reinforce endowment differences, whether child income capacities are distributed equally among members of a family, and whether human resource investments are likely to be efficient. For an admirably clear exposition of these and "bargaining" models, see Behrman (1994).

Urban populations are more prone to NCDs, compared with rural population, despite easier access to medical facilities for the former. It is largely attributable to greater stress, unhealthy diets, environmental pollution and noise in urban areas. As a recent WHO (2017) report points out, environmental factors are main causes of non-communicable diseases (NCDs); ambient (outdoor) and household air pollution together caused more than 6 million deaths from cardiovascular diseases, chronic respiratory diseases and lung cancer in 2012. Other important environmental risks include second-hand tobacco smoke, exposure to chemicals, radiation and noise, and occupational risks.

Some living arrangements are worse than others, depending largely on attitudes of family members towards the aged suffering from NCDs. Living alone is associated with higher risks of NCDs, as also those in households with 2-5 members, relative to larger households. Living alone often implies lack of any support, lack of adherence to treatment advised, and unhealthy/irregular diets. It is, however, somewhat surprising that they are also more vulnerable to NCDs. Although a definitive explanation cannot be offered for lack of evidence, it is conjectured that in these households the aged and suffering from NCDs are seen as more of a burden and thus neglected and often abused.

Sanitation and hygiene are closely linked not just to infectious diseases but also NCDs. Using a more detailed classification of types of toilets and sources of drinking water than in our previous study (Yadav et al. 2018), we get one seemingly implausible result. Relative to open defecation, traditional and VIP latrines are positively associated with the likelihood of NCDs. These are plausible results. However, the positive association between NCDs and flush toilets is somewhat surprising except that there are extensive reports of dysfunctional flush toilets because of water shortage. So it is not so much lack of hygienic toilet facilities but shortage of water that seems to underlie some of these positive NCD outcomes.

Equally important is potable water supply. As piped water supply is considered safest and most widely used, and relative to it, it is not surprising that use of tubewells and water pumps are associated with higher risks of NCDs.

A different perspective on the association between NCD and socio-economic inequality emerges: consider the caste hierarchy as an important marker of socio-economic inequality and deprivation: *Dalits* and *Adivasis*-the latter the most deprived and isolated-are much less prone to NCDs than *Others* who are among the most affluent and highly ranked. So the most disadvantaged fare much better than the most affluent. In other words, this measure of socio-economic inequality serves the disadvantaged better. The reasons include healthier diets and physically more active life styles, and perhaps also due to greater reliance on indigenous medical knowledge systems. These findings are subject to the caveat that those in the lower socio-economic hierarchy tend to under-report their illness.

A direct measure of economic affluence is in terms of assets. We constructed asset quartiles. We obtain a striking result: the wealthiest (the fourth quartile) are more highly prone to NCDs relative to the least wealthy/or those in the first quartile. As the wealthiest are known to live sedentary lives, eat rich diets, smoke, and consume excess alcohol, they are more vulnerable to NCDs. So again inequality in affluence is associated with better NCD outcomes among the least wealthy. This is also subject to the caveat that the least affluent may underreport their illness for lack of access to healthcare while the most affluent may be better informed and thus more likely to report their illness.

However, a Piketty measure of economic inequality (2013), ratio of share of top 1% of the state income distribution to that of the bottom 50%, yields a robust positive association with NCD outcome. So the greater the income inequality in a state, the higher is the prevalence of NCDs.

Indeed, in a state characterised by extreme income inequality, the FGT indices of poverty are higher (Kulkarni & Gaiha, 2018). Worse, such inequality corrodes social cohesion, cooperation and support, undermining the capability to live a healthy productive life, as argued below in the context of social networks.

Another state level variable used is affluence defined as state domestic product per capita. As health is largely a state subject with large infusions from the Centre (e.g., *Ayushman Bharat*), state affluence could translate into larger health expenditure. So it is not surprising that state affluence has a significant negative association with NCD outcome. However, the (absolute) value of the marginal association is negligible.

The role of social networks in improving health outcomes has been much emphasised and elaborated in the recent literature (e.g., from Putnam, 1993 to Wilkinson, 1996; Kawachi & Berkman, 2000; Szreter & Woolcock, 2004; Marmot, 2006; Joe et al., 2019). A salient feature of these studies is to link membership of these networks to social capital and its role in promoting health. As noted earlier, three distinct forms of social capital are distinguished: bonding, bridging and linking, with varying potential for health outcomes (e.g., Szreter & Woolcock, 2004). Unable to distinguish these three forms, we rely on number of networks a household is affiliated to. This is a crude approximation to social capital but cannot be refined because of data constraints. We find that relative to no membership, those who belong to more than one network are less prone to NCDs. So social cohesion, support and reciprocity are associated with better NCD outcome. But, as observed earlier, this association is likely to be weakened in a highly unequal overall economic environment.

Among the departures from the previous study (Yadav et al. 2018) and others is the spotlight on the association between NCDs and diets, based on food prices relative to cereals at the PSU level. This circumvents endogeneity of unit values to quality. Failure to analyse this association is surprising as diets are closely linked to NCDs. For ease of exposition we confine our remarks to the price in the numerator. The higher the price of milk, the lower is the consumption of milk, and the higher the risks of NCDs. In sharp contrast, the higher the price of edible oil, the lower is its intake, and the lower the risks of NCDs. The higher the price of eggs, the lower is the intake and the higher the risks of NCDs. All these are plausible results and corroborate the important association of diet with the risks of NCDs. As sugar intake is underestimated because its intake through beverages is not taken into account, its lack of significance is not so surprising.

An extension based on an unordered probit analysis allows us to disaggregate NCDs into three major diseases: diabetes, heart disease and blood pressure, and an additional category of multimorbidity. As there is variation in disease-specific associations with the explanatory variables, this analysis is more useful from a policy perspective. To avoid repetition, we will note the similarities briefly and focus more on disease-specific differences.

Let us first consider the associations between trust and NCDs. Hardly any confidence between patient-doctor/hospital is associated with a lower risk of heart disease while it is positively associated with that of diabetes, relative to a great deal of confidence. The latter is plausible. One reason why the hypothesised positive associations of hardly any confidence and some confidence with NCDs are not validated is that trust between patient-doctor/hospital and NCDs is mediated through behavioural changes in the patient-adherence to treatment, life style changes, healthy diets, physical activity. So a direct relation between trust and NCD outcomes requires a prior validation of behavioural changes.

There is robust confirmation of persistence of blood pressure, diabetes and heart disease. There is also confirmation of cross-effects such as the association between blood pressure and

multimorbidity, between heart disease and blood pressure, but somewhat surprising is the negative association between diabetes and blood pressure. This suggests a coordinated medical care which takes into account both the persistence and cross-associations between NCDs.

There is an age-gradient in all NCDs except that in high blood pressure and heart disease the marginal association peaks in the age-group 51-60 years. In all other cases, the marginal associations are highest in the (combined) older age-group, 61-70 years and >70 years). Women are more vulnerable than men to NCDs in all cases except heart disease. Unmarried persons are less vulnerable than married.

As in the case of NCDs by count, urban populations are more vulnerable to each NCD than those living in rural areas despite the fact that medical facilities are better in the former. However, environmental pollution is greater in urban areas, as also stress and unhealthy diets (e.g., growing dependence on energy dense fast food).

Living arrangements are significant too. Relative to large households (>5 persons), those living alone are not worse-off. However, those living in medium sized households (2-5 persons) are worse-off in terms of higher likelihood of high blood pressure, heart disease and multimorbidity. The highest likelihood pertains to multimorbidity. Although there is not much evidence at hand, anecdotal accounts abound of abuse of elderly suffering from chronic diseases. Lacking a regular source of income, they are treated as a burden-especially in urban areas. In that case, influencing inter-personal relationships with a view to reducing abuse is challenging. Whether network support can help overcome negligence and abuse within a family needs scrutiny.

Another aspect of living arrangements is sanitation and hygiene. As the specification with different toilet facilities does not converge, we are restricted to drinking water facilities. Relative to piped water supply, tubewells are positively associated with the likelihood of high blood pressure and multimorbidity; while other sources are negatively associated with the risk of multimorbidity. As WHO (2017) points out, the risk of cardiovascular diseases is higher with arsenic in drinking-water.

The associations of caste hierarchy differ by NCD and somewhat limited. Brahmins, Other High Castes, and *Others* display higher probabilities of high blood pressure, while *Adivasis* display a lower probability, relative to OBCs. *Dalits* and *Adivasis* are less prone to multimorbidity while *Others* are more prone to it. Although Brahmins and Other High Castes are generally more affluent than *Adivasis* and *Dalits*, they are scattered in diverse occupations many of which are not so remunerative and physically demanding. They shirk menial occupations and tend to opt for more prestigious occupations which are more sedentary (e.g., priests are invariably Brahmins). Yet their (relative) affluence predisposes them to NCDs while *Adivasis* and *Dalits* are less prone to them (specifically, blood pressure and multimorbidity) because of their physically active and healthier diets, and use of indigenous medical knowledge systems. So the point made earlier about socio-economic inequality manifesting in lower likelihood of NCDs is reinforced but in fewer significant associations. These findings are subject to the caveat of under-reporting of illness by those at the bottom of the socio-economic hierarchy.

A direct measure of affluence is assets owned by quartile. The associations are richer as these are disease-specific and display more variation across asset quartiles. First, there is an asset gradient across all NCDs including multimorbidity. While the second quartile yields significant positive associations with only High Blood Pressure and multimorbidity, in both cases there is an asset gradient, relative to the least wealthy/affluent. The wealthier/more affluent quartiles are significantly associated with each NCD with a marked asset gradient. So the least wealthy

are least worse- off and the wealthiest are worst-off. This is also subject to the reporting bias in so far as the least wealthy are more likely to under-report their illness.

As noted earlier, education level is another socio-economic marker, with higher educational attainments associated with higher social status and economic well-being. The results, as in the probit specification, are somewhat patchy. Relative to illiterates, those with minimal education of 1-4 years worse-off as they are more likely to suffer from high blood pressure, diabetes and multimorbidity; those with 5-8 years of education are more likely to suffer from diabetes and multi-morbidity; and those with 9-10 years of education are more prone to diabetes. It is not clear why this pattern is observed unless affluence more than offsets the benefit of greater awareness of healthier life styles and diets. Besides, since no schooling or a few years of schooling is more likely to result in under-reporting of illness, some of these differences are likely to reflect reporting bias.

Overall income inequality at the state level using Piketty's measure (2013) –ratio of share of the top 1% in the state income distribution to that of the bottom 50%- has a robust positive association with high blood pressure and multi-morbidity. The large value of the marginal association in both cases suggests that it could dilute the favourable outcomes of social cohesion and support, as delineated below. As argued earlier, and following Marmot (2006) and Szreter and Woolcock (2004) and others, a high degree of inequality in the overall environment could restrict life choices –in particular, the capability to live a healthy and productive life. Although income redistribution is unlikely to be politically feasible, one option is to promote livelihoods for the aged and suffering from NCDs.

In sharp contrast to the probit results in which NCD by count is considered, only one social network association is significant. Membership of more than 1 network is associated with a lower probability of diabetes. This is surprising as in other chronic conditions too, social support in different forms- especially for the aged-has considerable potential for reducing stress, facilitating access to medical services and provision of financial support. One reason for the patchiness of the results is that the subsamples for specific diseases with social networks are much too small to capture the associations between them.

State affluence measured in terms of state domestic product per capita displays robust negative associations with each NCD including multimorbidity. However, marginal associations (in absolute value) are much too small in magnitude. So, while the negative associations are plausible, they are much too small to have policy relevance. Public health expenditure as a fraction of state domestic product is likely to yield more compelling results.

Diet approximated by food prices (relative to cereal prices) yields useful insights in so far as their associations with NCDs are often mentioned but rarely validated in the Indian context. The higher the (relative) price of sugar, the lower is its intake and lower are the risks of blood pressure, diabetes and multimorbidity. The (absolute) value of the marginal association is highest for multimorbidity, followed by that for diabetes and then high blood pressure. However, these variations occur in a narrow range. The price of pulses has a positive association with multimorbidity, implying the higher the price, the lower is the intake of pulses and the higher is the likelihood of multimorbidity. The price of milk has significant positive associations with each NCD including multimorbidity, implying the higher the price, the lower is milk intake and the higher the chances of NCDs. The largest marginal association is with heart disease, followed by that of multimorbidity and then high blood pressure. The higher the meat price, the lower is its intake and the higher the likelihood of heart disease. As large segments of India's population suffer from protein deficiency, and meat consumption continues to be low but rising, this association is plausible. The price of eggs shows a negative association with diabetes, implying the higher the price of milk, the lower is its intake, and the higher the

likelihood of diabetes. What is indeed surprising is that oil intake does not yield any significant association. Although we are unable to examine the association between alcohol consumption and NCDs, and between smoking and NCDs, enough evidence exists for restricting their intake through taxes and raising awareness of their ill-effects. Other dietary changes would also benefit from behavioural changes through better awareness.

Attention is drawn to some limitations of this study. (i) As the panel data comprises two waves, a dynamic model of evolution of NCDs is not feasible. (ii) Whether trust between patient-doctor/hospital yields better NCD outcomes requires first an analysis of behavioural outcomes in terms of adherence to the treatment prescribed, life style changes (e.g., more physical activity), healthier diets and reduced consumption of alcohol and smoking. This is to be followed by an analysis of prevalence of NCDs through behavioural changes. This analysis is underway.

Section 7

Concluding Observations

The present analysis highlighted the persistence of NCDs, their cross associations, and how these are linked to different forms of inequality-socio-economic, gaps in affluence and in the overall economic environment. Some forms of inequality are not insidious, as those at the bottom of the caste hierarchy and least wealthy exhibit lowest vulnerability to NCDs despite their deprivation and limited access to healthcare facilities. What seems to underlie their lowest vulnerability is their physically demanding occupations (e.g., agricultural labour), healthy diets (e.g., coarse grains), and lower dependence on fats. How these life style and dietary patterns more than offset the disadvantages of living in slums with unsanitary conditions needs scrutiny. However, overall economic inequality, using Piketty's (2013) measure, is insidious as it corrodes social cohesion and support, and the capability to live a healthy and productive life. So the policy interventions have to be not just medical but much broader in scope, as delineated below.

The growing menace of NCDs in a context of rapidly increasing old population calls for bold policy initiatives. Although such initiatives are not lacking, they are either underfunded or limited in coverage and uncoordinated (Chatterjee, 2017). These assume greater significance as the Indian family as an elderly support mechanism is under growing stress, owing to a combination of fewer adult children, the elderly living longer and often with disability, migration for work, increasing healthcare expenses, and other financial costs of supporting elderly relatives. Consequently, there is a growing gap between elderly needs and the financial, healthcare and social support available to them. Healthcare spending is of special concern, being almost 2-5 times as high for individuals aged 60-years and older compared to younger adults (Cherian, 2015).

In order to prevent and control major NCDs, the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS), was launched in 2010 with a focus on strengthening infrastructure, human resource development, health promotion, early diagnosis, management and referral.

Under NPCDCS, now a nation-wide programme, NCD Cells are being established at National, State and District levels for programme management, and NCD Clinics are being set up at District and CHC levels, to provide services for early diagnosis, treatment and follow-up for common NCDs.

Although there are no immediate policy goals to ensure population-based screening, opportunistic screening of selected chronic diseases is an important strategy under NPCDCS. However, surveillance activities under this programme are inefficient due to funding

constraints, weak operational guidelines and inadequate clinical, technical and managerial staff. It is imperative that public health system devote additional resources towards active population-based surveillance. Besides financing, there is a need to develop institutional mechanisms for engagement of adequate human resources for surveillance and disease management (Mishra et al., 2016; Chatterjee, 2017).

A National Health Policy was announced in 2017. It proposed raising public health expenditure progressively to 2.5% of the GDP by 2025 and advocated a major chunk of resources to primary health care, followed by secondary and tertiary health care. This policy together with the NITI Aayog action agenda have set targets for reduction of premature death and morbidity due to major NCDs in India. Monitoring of this progress would be aided by the ongoing production of reliable state-level estimates of disease burden and risk factors. There are two serious concerns, however. One is that scant attention is given to where the resources will come from. Another glaring omission is that little is said about the rapid rise in the share of the old in the total population and associated multi-morbidities of NCDs. Besides, continuing neglect and failure to anticipate these demographic and epidemiological shifts-from infectious diseases to NCDs-may result in enormously costlier policy challenges (Jan et al., 2018).

Given the rapid deterioration in the quality of public healthcare and rising life expectancy and expectations of good quality health care, the supply –demand imbalance is likely to widen sharply. So the first priority is to hike substantially expenditure on health. But more important than higher financial allocation is reorganisation of the health care system and effective regulation. As argued emphatically by Patel et al. (2015), it is imperative to develop a fully integrated population- based healthcare system that brings together the public and private sectors and the allopathic and indigenous systems, and is well-coordinated at different levels of service delivery platforms-primary, secondary and tertiary. It should address acute and chronic healthcare needs, offer accessible, good quality healthcare choices, and be cashless at the point of service delivery. The primary healthcare provider should be a strengthened public care system with a clearly defined role of the private system, especially in specialised services. Moreover, Patel et al. (2015) propose a shift from a standard health insurance model to an entitlement-*based model.*

The Ayushman Bharat Yojana (ABY), launched in 2018, is a partial response. It offers much larger inpatient benefits in the amount and conditions covered in its hospital insurance component, covers more people (almost 500 million or the poorest 40% of India's population), places no limits on household members covered, and seeks to address gaps in outpatient services in the form of almost 150,000 health and wellness centres spread throughout the country. Geriatric services are planned at these centres.[17]

Assuming, for example, that hospital utilisation rates of the bottom 40% of Indians rise to the level of the top quintile (following the introduction of benefits under ABY), this would result in an extra cost of almost 1,000 billion rupees for 500 million Indians, almost 12 times the current budgetary provision for ABY.

ABY benefits will only accrue to the elderly if they are aware of the programme benefits and in a position to use them. This can be especially problematic for the poor disabled elderly or the very old, who are often left out of social transfer schemes for which they are eligible (Asri, 2017). Although the focus is on the less well-off, neither the state health insurance plans nor ABY make special provisions for targeting households containing the elderly.

Increased spending on health is unlikely to be enough. The funds would also need to be spent effectively. Human resources are an area of concern. While incentives around service delivery

[17] This and the following draws upon Mahal and Mohanty (2019).

and absenteeism attract much attention, many frontline workers are also poorly motivated because they are inadequately trained, lack opportunities for continuing medical education and advancement, and bear a heavy patient workload (Mahal & Mohanty, 2019).

Whether good intentions alone will result in huge private financing is doubtful. Another major weakness of ABY is neglect of primary health care and a lop-sided emphasis on secondary and tertiary healthcare.

As individual-level risk factors are influenced by broader environmental, economic, infrastructural and social conditions, addressing these risk factors requires multisectoral action by agencies beyond ministries of health. In particular, creating environments that facilitate greater physical activity and allow for affordable and healthy dietary choices as complementary goals may be beneficial (Karen et al., 2014).

India's urbanisation is poised for rapid expansion and associated increases in NCDs and their multi-morbidities. The association is mediated by availability of high calorie processed food and a marked shift towards more sedentary lifestyles, and greater environmental pollution. Exposure to environmental pollution is linked to increased risk of several chronic conditions, including respiratory conditions such as COPD but also hypertension, stroke and kidney diseases. A principal source of atmospheric carbon monoxide (accounting for nearly 90%) is exhaust from gasoline engines, while bonfires, forest fires and waste treatment and disposal processes contribute a large part of the remaining 10%. India is about to overtake China as the most polluted country in the world. Yet, unfortunately, there is no systematic and comprehensive national policy to address these issues.

Behavioural changes are no less important and perhaps also no less challenging. A few important contributions using evidence from LMIC and from India yield useful insights (WHO, 2015). Lack of physical activity and unbalanced high-calorie diet promote weight gains. Obesity is a risk factor for cardiovascular and diabetes and can aggravate symptoms of CVD such as emphysema and bronchitis. Limiting tobacco consumption is expected to benefit at the individual level but wider reduction in multi-morbidity prevalence requires taxation on unhealthy products. For example, there is evidence that tobacco taxation reduces smoking and such benefits might also lead to a reduction in certain multi-morbidity clusters (Academy of Medical Sciences, 2018). It is reassuring therefore that taxation of *beedis* and smokeless tobacco (SLT) has risen sharply in the recent Goods and Services Tax (GST).

In conclusion, as formidable and daunting the reforms in the medical system, insurance and behavioural changes may seem, the challenges posed by them are not insurmountable.

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