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# Growing Burden of Non-Communicable Diseases in India

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**Abstract**

The present study provides detailed evidence on NCDs and their covariates. This is particularly relevant in the present Indian context, as the elderly population $\geq 60$ years is growing three times faster than the population as a whole. It is projected that the percentage of elderly people will more than double between 2010-2050. Alongside, old age morbidity (NCDs and their multi-morbidities) has risen significantly during 2004-2014. Using National Sample Survey data for 2004 and 2014, and ordered probit models, the underlying covariates are uncovered. There is a marked shift of NCDs and multi-morbidities from the younger to the old population. Some of the covariates associated with lower prevalence of NCDs and their multi-morbidities include women, education, physical activity, drinking water through tubewells and hand pumps, Scheduled Castes/Scheduled Tribes (the lowest rung of socio-economic hierarchy), while those associated with higher prevalences include urbanisation, widowed and divorced/separated, and being affluent. Above all, there is a (residual) positive time effect confirming higher prevalences of NCDs and their multi-morbidities. On current evidence, given the increases in life expectancy, it is uncertain whether the additional years have translated into healthier and longer lives or longer years of morbidity. The policy challenge, however, is daunting, requiring greater funding for health care, reorientation of the health care system to serve the old better and tackle the growing burden of NCDs and their multi-morbidities, expansion of pension and health insurance, and behavioural changes (e.g., curbing of alcohol consumption, smoking and lifestyle changes) necessary for healthy living.

*Key Words: Old, NCDs, Multi-morbidities, Urbanisation, Gender, Affluence, India*

JEL Codes: I120, I310, H510

# Growing Burden of Non-Communicable Diseases in India

## Introduction

Non-communicable diseases (NCDs) kill 40 million annually, accounting for about 70% of all deaths globally. About 15 million of those deaths occur among the people aged between 30-69 years, and more than 80% of these premature deaths are reported in low-income and middle-income countries (LMICs) (Horton and Sargent, 2018). By 2030, the annual number of deaths from NCDs are projected to rise to 52 million (Jan et al., 2018).

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 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).

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).

Multi-morbidity is defined as the coexistence of two or more chronic conditions. It is more prevalent among old adults (60 years or more). Multi-morbidity is increasing globally, resulting from increasing population of the old, and also by factors such as high body-mass index, urbanisation and the growing burden of NCDs (such as type 2 diabetes), and tuberculosis in low- and middle-income countries. Evidence suggests that co-existence of multiple conditions is associated with an increase in disability and functional decline, and an increased risk of mortality even after accounting for age (Academy of Medical Sciences, 2018).

The association between multi-morbidity and age is due to the greater likelihood of old individuals accumulating chronic conditions over the lifespan. Some clusters of conditions occur for other reasons, such as shared aetiological factors while others may be due to unrelated aetiological conditions stemming from conditions that share a common cause (e.g., environmental pollution).

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).

There is an almost exponential relationship, suggesting that the cost of multi-morbidity is more than the cost of managing the individual component conditions alone. Analyses based on the Sage study show that outpatient out-of-pocket (OOP) expenditure increases with an increasing number of NCDs, with medication costs often accounting for the largest share (Pati et al., 2014). Indirect costs also rise among patients with multi-morbidity-for example, costs

associated with transport and accommodation, and lost productivity of patients and carers (Academy of Medical Sciences, 2018, and Editorial, *Lancet*, 2018).

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 more than doubled, while among $\leq 60$ years it declines 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.

The four NCDs (cardiovascular diseases, cancer, chronic respiratory diseases and diabetes) account for 42% of all deaths in India. These diseases contribute 22% of disability-adjusted life-years in India (or DALYs – the combination of years lived with serious illness and those lost due to premature death). So the cost in terms of lives lost is horrendous. Besides, 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 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.[1]

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 and Bloom, 2014; WHO, 2015).

Three demographic processes are at work: declining fertility rates, increasing longevity and large cohorts advancing to old age (Bloom et al., 2014; Agarwal et al., 2016). As both NCDs and disabilities tend to rise with age, often in tandem, the inadequacies of the present health systems, community networks and family support may magnify to render these support systems largely ineffective with a huge fiscal burden in the near future. In addition, there are non-

[1] We have updated India's GDP to arrive at this ratio, compared to the 2012 GDP estimate in Bloom et al. (2012).

economic costs that include social isolation and stress that are no less important but difficult to quantify.

Motivated by the concern that India's health system is ill-equipped to handle an alarming rise in the prevalence of NCDs and associated multi-morbidities among the old, and likely impoverishment of old patients on a larger scale in the absence of family support and financial protection, it is imperative to identify the determinants of the rise in NCDs and examine policy options towards achievement of SDG 3 and target 4 of a one-third reduction in premature mortality from NCDs by 2030.

As the literature review highlights, there are few systematic studies of determinants of NCDs and associated multi-morbidities in India. An attempt is therefore made to fill this gap and deepen our understanding of why their prevalence has risen during 2004-2014. This is crucial for designing effective policies to curb the growing menace of NCDs. We carry out this analysis using two rounds of the National Sample Survey (NSS) for 2004 and 2014.

**Scheme**

In Section 1, we give a distillation of recent literature on NCDs in low and middle income countries (LMIC) and, against this backdrop, review recent studies focused on India. Salient features of the NSS rounds used are noted in Section 2. Section 3 discusses briefly covariates of NCDs and changes over the period 2004-2014. An algebraic exposition of the ordered probit model follows in Section 4. Section 5 offers an interpretation of the results obtained. Section 6 discusses our findings from a broader policy perspective. Concluding observations are made in Section 7.

## Section 1

### Literature Review

The broad theme of aging and morbidity in a global context has been the subject of several studies, of which the review by Prince et al. (2015) is perhaps one of the most comprehensive and insightful. Drawing upon a large body of data, they offer a rich empirical account. Focusing on aging and NCDs, they 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 ($\geq$ 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 and increase of tobacco use and low physical activity, with consequent obesity, partly causes the rapid increase in burden of chronic diseases in these regions.

The main contributors to disease burden in old people (60 $\geq$ 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 low-income and middle-income regions.

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 diabetes).[2] 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). A major omission is multi-morbidity, which is not just far costlier to treat but also involves a higher mortality risk than a single NCD.

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.[3] It is not self-evident that the contradictions do not arise from methodological and sample design issues, a concern that is glossed over.

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.

A recurring theme is the link between socio-economic status and NCDs. It has been argued that 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. Elaborating this observation, they point out that a positive association between poverty and chronic conditions was found in 73 (38%) of the 194 studies that sampled data from a general population. Similarly, a positive association between poverty and NCDs or their risk factors was found in 32 (74%) of the 43 studies involving representative samples of health-service users. Most studies with strong designs (mainly cohort studies) find positive associations, and a few report mixed or unclear associations. So the conclusion is that the epidemiology of poverty and NCDs in LMICs now converges with the findings for high-income countries (Niessen et al., 2018). An issue, however, is whether there was any allowance for the two-way relationship between NCDs and poverty.

How do households cope with the high costs of treatment associated with NCDs remains a major concern. Another contribution (Jan et al., 2018) addresses this concern meticulously. 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

[2]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.

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

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.

The high OOP cost of treating NCDs relative to household income for low-income patients also implies that a substantial proportion of households are 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).

Health insurance has a role to play in protecting individuals and households from catastrophic expenditure associated with NCDs and, in doing so, facilitating access to health care. However, the protection offered by insurance is far from adequate.

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 and Sargent, 2018).

Let us now turn to Asian studies to serve better as a contextual backdrop to our analysis of rising burden of NCDs in India.

A rich and insightful analysis of the rising burden of NCDs in China and India (Bloom et al., 2014a) covers vast ground-risk factors associated with NCDs, their contribution to DALYs, behavioural changes, the NCD-development nexus, cumulative losses of GDP, and preventive measures. As some comments on this study are already made in the introduction, we will make additional comments on the comparative analysis.

While aging alone contributes to the risk of NCDs, both China and India have experienced a rising burden of early-age NCD deaths. Around 60% of NCD deaths in India and 35% in China occur among people under the age of 70. In addition, 23% of male NCD deaths in China and 38% in India are of men younger than 60. For women, these figures are 17% and 32%, respectively.

Tobacco use, harmful alcohol consumption, poor diet, and sedentary lifestyles and occupations have all risen in the past three decades in both China and India.

India, however, fares better than China in terms of modifiable risk factors, in part because India’s population is younger and poorer than China’s. India has a lower prevalence of most

risk behaviours, especially smoking and physical inactivity, as well as a lower prevalence of biomarkers for future disease such as high blood pressure and cholesterol.[4]

Tobacco consumption is harmful as it causes respiratory problems and cancer. In fact, smoking is the third largest cause of ill-health in both China and India.[5]

Excessive alcohol consumption has risen sharply in India. It is linked to cardiovascular diseases, cancer, mental disorder, and diseases of the liver. Chinese adults drink 12 times more alcohol now relative to 1952. While close to 7% of men exhibit alcohol-linked risk factors for NCDs, the comparable number for India is 3.5%.

Lack of physical activity and unbalanced, high-calorie diets result in weight gain. In India, sugar and dairy fat are largely responsible for weight gain. About 25% of both men and women in China are overweight or obese, versus 15% of women and 12% of men in India. Obesity is a risk factor for diabetes and cardiovascular diseases.

Urbanisation is linked to NCDs in different ways. Availability of high-calorie processed food is greater in urban areas compared to rural; transition from strenuous work in agriculture to work that requires less energy expenditure (e.g., desk-based work) results in lower physical activity; greater reliance on motorised transport and sedentary recreation (e.g., watching tv), also lower energy expenditure in urban areas; and in both countries, indoor and outdoor air pollution are also a significant risk factor.

India, currently behind China in this respect, is poised for rapid urbanisation that is likely to compound the NCD burden and related economic losses.

Although this study draws attention to one NCD leading to another, its treatment of multi-morbidity is sketchy. This gap is filled in another study (Beard and Bloom, 2014).

Turning to studies on India, an informative study of pattern of morbidity among the elderly is Yadav et al. (2017). Although the data used are not-so-recent, it offers a detailed account of NCDs by age. The morbidity analysis is based on SAGE‑2007. It covers a sample of 10,600 households across six states.[6] Binary logistic models are applied to obtain the odds of different types of morbidity among the elderly population in urban India. The dependent variables in the model are chronic lung disease, diabetes, depression, cataracts, arthritis, stroke, angina, asthma, and oral health.

The odds of having diabetes are 2.1 times higher in the age group 60-69 years, compared to the age group 50-59 years. Those consuming alcohol are 1.9 times more vulnerable to diabetes, relative to those who don't. Those with 10 years or more of education are 2.41 times more likely to suffer from diabetes than illiterates. Those belonging to castes other than Scheduled Castes and Scheduled Tribes (SCs/STs) are 2.1 times more likely to be victims of diabetes than the latter. The odds of diabetes are 2.5, 2.5, and 2.7 times more among individuals in the middle, richer, and richest wealth quintiles than among the poorest quartile.

The odds of hypertension are 1.6, 2.3, and 1.9 times higher in the age group 60-69 years, 70-79 years, and 80 years +, relative to the age group 50-59 years. A person belonging to other castes is 1.8 times more likely to have hypertension, compared to SCs/STs. Moreover, the odds of hypertension are 2.2, 2.6, and 2.9 times more in middle, richer, and richest wealth quartiles

[4]For a more detailed discussion of the biomarkers, see Agarwal et al. (2016).
[5]In India tobacco consumption takes different forms, some more harmful than others. *Beedi* smoking accounts for about half of Indian tobacco consumption. *Beedis* are more harmful than cigarettes because they deliver more nicotine, carbon monoxide and tar. Another popular tobacco use is flavored chewing tobacco called *gutka*. It is also more harmful than cigarettes as it brings on cancer faster (Bloom et al. 2014 a, Agarwal, 2016).
[6]That is, Assam, Maharashtra, Karnataka, Uttar Pradesh, West Bengal, and Rajasthan.

than in the poorest. The odds of hypertension are 1.7, 1.9, and 2.5 times more in the age group 60-69 years, 70-79 years, and 80 years +, respectively, as compared to the age group 50-59 years.

The older age group 70-79 years is more prone to chronic lung disease than the age group 50-59 years. The odds were 2.1 times higher in the former. A person consuming alcohol also is more vulnerable to this disease (the odds being 2.3 times higher) than someone who doesn't. Besides, tobacco consumption enhances the odds of this disease by 2.03 times.

Older groups are more susceptible to stroke than the younger age group, as reflected in the odds ratios. These are 3.1 and 3.9 times higher among them, respectively, compared to 50-59 years.

Tobacco consumption is associated with 1.9 times higher odds of stroke. Moreover, the odds of stroke are 6.1 and 6.2 times greater among middle and richest wealth quartiles than among the poorest.

So the conclusion is that the old ($\geq 60$ years) are much more vulnerable to NCDs. One limitation of this study is, however, that it doesn't throw light on co-occurrence of 2 or 3 NCDs (e.g. diabetes and hypertension) which tend to rise with age. An ordered probit would, therefore, have been more appropriate than binary probits. Another limitation is that the results are reported without any explanation.

Updates of NCD burden and risk exposure in different states in India in the context of epidemiological transition are given in a *Lancet* study (India State-Level Disease Burden Initiative Collaborators, 2017). Our review is confined to NCDs and risk exposure during the period 1990-2016.

The all-age prevalence of most leading NCDs increases substantially in India from 1990 to 2016, but the age-standardised prevalence increases only for diabetes, cerebrovascular disease, ischaemic heart disease, and skin diseases. This suggests that the overall increase in NCD prevalence has been a mixed phenomenon, with aging of the population a significant contributor together with additional increases due to changes in risk-exposure for the causes that have an age-standardised increase in prevalence.

The major risk factors for ischaemic heart disease, cerebrovascular disease, and diabetes have been rising across epidemiological transition level (ETL) groups on the basis of the ratio of DALYs from communicable, maternal, neonatal, and nutritional diseases (CMNNDs) to those from non-communicable diseases (NCDs) and injuries combined in 2016. Dietary risks, high systolic blood pressure, high fasting plasma glucose, high total cholesterol, and high body mass index together account for a quarter of the DALYs in India in 2016, which is more than twice their share in 1990. Exposure to air pollution in India is among the highest in the world, contributing to both NCDs and communicable diseases.

Other challenges to the health system over the next few decades are urbanisation and aging. As we have already drawn attention to these challenges, no further comment is necessary except to emphasize that long-term policy responses to these ongoing major transitions are imperative as part of comprehensive health planning for the states of India.

As this study doesn't offer a detailed account of prevalence of NCDs among the old in India, we review below selected studies to fill this gap.

An important contribution in this context is Yadav and Arokiasamy (2015). Although 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 $\geq 60$ years. The NSS has retained the specific section on morbidity and ailing persons for the aged population for the three time periods (1986-1987,

1995-1996, and 2004); however, data on morbidity/NCDs for all ages are available only for the time periods 1995-1996 and 2004.

The prevalence of chronic diseases has surged among the aged population indicating rapid changes in the morbidity profile of India. Hence morbidity analyses are done for the population aged 60 and above for the three data points. The prevalence rates of chronic diseases—hypertension, joint and bones, asthma, heart disease, cancer and other tumours, urinary problems, and diabetes, adjusted for age, sex, residence, living alone, dependency, hospitalisation, education, monthly per capita expenditure (MPCE), and region (north, east, northeast, west, south, and central)—are analysed using a ZIP regression model. A beta-binomial model is used to examine the changes in summary event rate of chronic diseases and also in total NCDs over time for the older population.

This study uses aggregate data by broad age-groups from a survey of causes of death (SCD) for rural areas and mortality statistics of causes of death (MSCD) for urban areas to understand the structural changes in causes of death. For the period 2001-2003, the Registrar General of India (RGI) provides mortality statistics for both rural and urban populations. These data have been combined to construct the distribution of deaths attributable to communicable diseases and to NCDs for rural and urban India, respectively, and to examine the transformation in the distribution of deaths.

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.[7] The manifold rise in the prevalence of NCDs is similar to that reported earlier. 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), 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 doesn't significantly differ by gender or education. The prevalence of multi-

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

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.

## Section 2

### Data

### Salient Features of National Sample Surveys

Our study is based on the National Sample Survey (NSS) household/individual data on health and morbidity for 2004 and 2014. Both NSS rounds ($60^{th}$ and $71^{st}$) follow a stratified multi-stage design and first stage units (FSUs) are villages in rural areas and blocks in the urban sector. FSUs have been selected following probabilities proportional to size with replacement (PPSWR) technique. Further, both rural and urban FSU samples are drawn as two independent sub- samples and equal numbers of samples are allocated to both areas. The households are the ultimate stage units in both the sectors.

NSS surveys on health care and morbidity cover households and individuals belonging to them. The household questionnaire seeks to throw light on the socio-economic status of the household, such as consumption expenditure, social and religious backgrounds, sanitary conditions, among others, whereas the individual section covers hospitalisation and acute morbidity among the population, their reproductive behaviour and elderly economic independence and other aspects of living (e.g., living arrangement, physical mobility, and own perception about health).

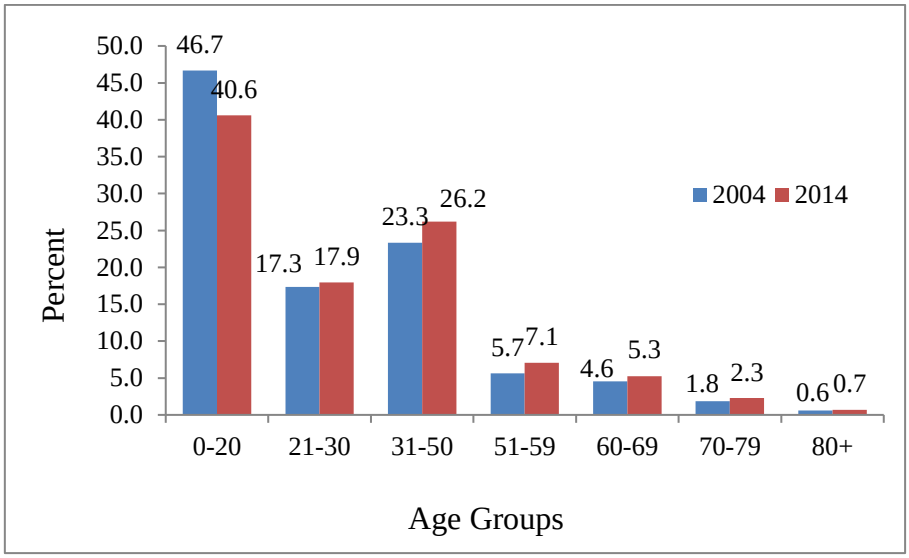
Both communicable (e.g., malaria, tuberculosis or TB, HIV/AIDS, and others) and non-communicable diseases (e.g., heart diseases, hypertension, respiratory diseases, diabetes, heart disease, and cancer) are covered.

The sample size of 2004 survey (NSS, $60^{th}$ round) is 73,835 households across India and rural-urban households' distribution is 72% and 28%, respectively. Further, it collects information on health care and morbidity of 383,338 households' members, where 51% are men and 49% women. The elderly population (60 years +) is about 7% of the total individuals.

The NSS round ($71^{st}$) in 2014 covers 65,932 households from across the rural and urban areas. About 67% of the households belong to rural areas and 33% to urban areas. The number of individuals interviewed is 333,104 and, among them, 51% are men and the rest women. The elderly population is over 8% of the total population and over two-thirds of the elderly live in rural areas.

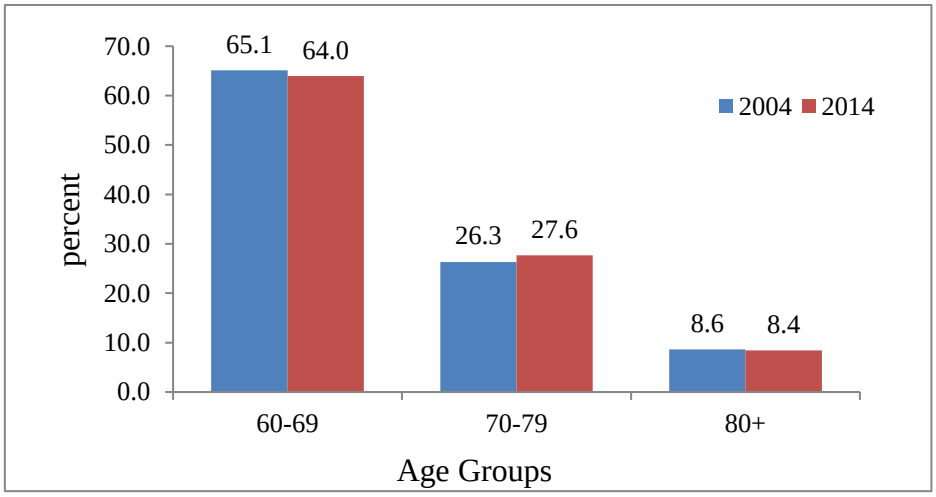
As the analysis is based on two independent cross-sections, it is important to verify whether the age-distribution of India's population has changed much during the period in question. The graphs below illustrate the changes.

**Figure 1: Age Distribution of the Sample Population**




Authors' calculations from the NSS 61st and 70th Rounds

**Figure 2: Elderly Sample Population Distribution**




Authors' calculations from the NSS 61st and 70th Rounds

What these changes imply is that larger shares of population in age-groups, 31-50 and 51-59 years, with unchanged occurrence of NCDs may be associated with reduction in the prevalence rates. There is a sharp drop in the share of 0-20 year olds, that of 21-30 year olds rises slightly, that of 31-50 years by about 3 percentage points, that of 51-59 years by under 1.5 percentage points, that of 60-69 year olds by less than 1 percentage point, and those of two older groups by 0.5 percentage point and 0.1 percentage point, respectively.

As we note in the next section, while the prevalence rate declines among 31-50 year olds, it rises among 51-59 year olds. However, since the age distribution of the old changes slightly, higher prevalence rate of NCDs is largely attributable to their higher occurrence. Figure 2 further illustrates the changes among the old age groups.

## Section 3

### NCDs and Their Covariates

Here we review briefly salient features of the cross-tabulations in Tables A1-A5 in the Appendix. To avoid cluttering the text, we concentrate on how prevalence of NCDs (e.g., (number of persons suffering from any NCD in an age group, say, 60-69 years/number of persons in this age-group)x100), and their shares in the total population x 100 have changed during 2004-2014. The comments are selective.

In Table A1, descriptive statistics are given on the prevalence of NCDs and their covariates. All changes in NCD prevalence by age-group during 2004-2014 are significant. Although the increase in overall prevalence of NCDs in the total population is significant, it is small. Two features of the age-distribution are noteworthy. Among the elderly, age-standardized prevalence rates of NCDs are considerably higher relative to younger age-groups. The highest prevalence in 2014 is among 80 years +, followed by 70-79 years, and then 60-69 years. A similar pattern is observed among the old in 2004 except that the highest prevalence is found among those 70-79 year olds. This is not surprising considering accumulation of risks of NCDs with age. The share of elderly suffering from NCDs in the total population with NCDs shot up from 18.9% to 43.5%, an increase of 2.3 times. A larger share is, however, contributed by younger age-groups, 31-50 and 51-69 year olds in both years.

In urban areas, the prevalence of NCDs increases significantly, and is higher than the rural in both years. While the share of those suffering from NCDs in rural areas declines during 2004-2014, it is still as high as about 56% in 2014. The urban share increases more than moderately. How much of the increase is due to diet changes (e.g., processed food), lack of physical activity and environmental pollution needs to be investigated.

While NCD prevalence declines among men, it increases among women. Men account for the majority in 2004, but women do so in 2014.

Taking marital status into account, NCD prevalence declines significantly among never married; but increases very sharply among widowed and more than moderately among divorced/separated. As there is a stigma attached to widowhood and divorce, lack of family and community support could explain these increases. The share of currently married is largest in both years and increases slightly in 2014. What is surprising is more than doubling of the share of widowed and a substantial decline in that of never married.

Education is associated with NCD prevalence. While low levels of education (including illiteracy) record increases in NCD prevalence, higher levels of education show a decline, especially graduates and above. The highest share is that of illiterates which declines slightly in 2014. This was followed by that of persons with middle-higher secondary education, which also declines in 2014. Education above a threshold makes a difference as it enhances awareness of healthy living and health care facilities.

Caste affiliations mirror socio-economic status. The Scheduled Tribes/STs are at the lowest rung as they are generally most deprived and live in remote locations while Schedule Castes/SCs are not-so-deprived and not-so-isolated. Other Backward Castes (OBCs) are more affluent and Others are most affluent. Each caste group records significantly higher NCD prevalence, with the lowest increase among SCs/STs, during 2004-2014. Affluence influences diets (e.g., processed food) and physical activity (e.g., motorised transport and sedentary lifestyles), which can't be ruled out as potential reasons.

A more direct measure of affluence is monthly per capita expenditure (MPCE). We use per capita expenditure quintiles. While lowest quintile records a low but significant reduction in

the prevalence of NCDs, the fourth and fifth witness significantly higher prevalence, with the highest prevalence among the fifth/richest quintile. The shares among total population of NCDs are also highest among the fourth and fifth quintiles in both years. These outcomes seem to suggest that the more affluent are unable to offset fully the disadvantages of more sedentary lifestyles and unhealthy diets (e.g., processed food, alcohol consumption) by easier affordability of expensive medical treatments.

A few selected NCDs and their covariates are examined in Tables A2-A5. We comment briefly on whether the pattern summarised above is largely reproduced.

Overall prevalence of hypertension, diabetes and CVDs rises significantly during 2004-2014, while that of heart diseases declines. Except the youngest, all age groups record higher prevalence of hypertension, with the largest increase among 60-69 years, followed by older age groups. The share of this old group is also the largest in the total population suffering from NCDs. The highest prevalence of diabetes occurs among 51-59 year olds, with a doubling of it in 2014. Although younger age groups maintained their majority, 60 years + nearly double their share. In contrast, most age groups register declines in the prevalence of heart diseases. The highest prevalence is among the oldest, 80 years +, but the decline is not significant. The share of younger age groups declines while that of the old more than doubles.

Both rural and urban hypertension prevalence rise significantly, with the rural considerably higher than the urban. The urban and rural shares of hypertensive population are nearly equal, with the former only slightly higher. Diabetes prevalence rises in both rural and urban areas, more than doubling during 2004-2014. The prevalence is much higher in urban areas. The rural share is more than half, but declines in 2014 and the urban becomes a large majority. While rural prevalence of heart diseases increases significantly but by a small magnitude, the urban prevalence falls significantly. The share of rural population with heart diseases retains its majority with a moderate increase while that of urban population declines. The rural prevalence of CVDs rises significantly, while the urban remains largely unchanged. The rural share retains its majority in both years with a slight increase in 2014.

Hypertension prevalence increases significantly among both women and men, with the prevalence slightly higher among the former in both years. While men are the majority in 2004, there is a reversal in 2014 as women become the majority. The prevalence rate of diabetes is higher among men in both years, and it more than doubles in 2014. There is an exact doubling of diabetes prevalence among women, but it is well below that of men in 2014. Men retain their majority share in both years but it declines in 2014. The share of women rises more than moderately. Men have higher prevalence of heart diseases than women, but the decrease in men's prevalence is not significant. Women experience a significant decline in diabetes prevalence and large increase in their share while men retain their majority, but with slight erosion in 2014. Both men and women experience significant increases in their CVD prevalence, with the former subject to higher prevalence in 2014. Meanwhile men are the majority in 2004, until their share declines in 2014 and women become the majority.

The highest prevalence of hypertension is among the widowed, followed by currently married in both 2004 and 2014. It increases among currently married and widowed. The highest share is that of the former, which declines in 2014, followed by that of the latter, which more than doubles. Divorced/separated have highest prevalence of diabetes in both years, followed by currently married and widowed. In each case, there is a doubling of the prevalence except divorced/separated. Nearly three quarters of the diabetics are accounted for by currently married in 2004 with a higher share in 2014. The prevalence of heart diseases is highest among currently married in 2004 and second highest in 2014, with a significant reduction. Divorced/separated experience highest prevalence in 2014. The majority of those suffering

from heart diseases are currently married in both year,s but with a slightly higher share in 2014. Those currently married have highest prevalence of CVDs in 2004, which rises significantly in 2014, but ceases to be the highest. Widowed have just slightly lower prevalence than currently married in 2004 but it rises significantly to overtake that of currently married. Currently married account for a vast majority of CVD patients until its decline in 2014.

As educational attainments and specific CVDs show an intriguing pattern, an illustration suffices. There is a doubling of the prevalence of diabetes in each educational category. The higher the educational level, the higher is the prevalence, with the highest prevalence among graduates and above. The highest share is that of middle-higher secondary level in both years, with a slightly reduced share in 2014. If education is a proxy for affluence, without a control for it, the comparison may be contaminated.

The prevalence of hypertension rises with the caste hierarchy—lowest among SCs/STs and highest among Others, with a significant rise in each caste during 2004-2014. While Others accounted for the largest share of hypertensive population in 2004, it declines and OBCs become the largest group.

With minor variation, affluence and individual NCDs are positively correlated.

Some important findings are that (i) there is a shift in the burden of the NCDs from younger age-groups to the old; (ii) urban populations are more vulnerable to the NCDs; (iii) men are more vulnerable to NCDs; (iv) currently married and widowed are highly vulnerable to NCDs; (v) castes with higher socio-economic status are more vulnerable than SCs/STs who belong to the lowest rung; and (vi) there is a strong association between affluence and NCDs.

It may be emphasized that comparisons of averages during 2004-2014 has descriptive value. As there are confounding factors (e.g., educational attainments are closely related to affluence), some of the comparisons may lack credibility. In order to capture robust associations between NCDs and these covariates, we carry out detailed econometric analyses.

## Section 4

### Model Specification

Some of the key questions that we aim to address are: (i) what are the factors associated with the rise in NCDs? (ii) are the aged more likely to suffer from NCDs than the younger population? (iii) are the wealthy more likely to suffer from NCDs? (iv) what are the factors associated with multi-morbidities (e.g., diabetes, hypertension, and cardiovascular diseases)? In order to analyse these multiple outcomes, we have employed an ordered probit model.

Let us begin with a latent variable specification

$$y^* = \boldsymbol{\beta}' \boldsymbol{x} + \varepsilon$$

$y^*$ is unobserved. What we do observe is

y = 0 if $y^* \leq 0$,

= 1 if $0 < y^* \leq \mu_1$

= 2 if $\mu_1 < y^* \leq \mu_2$

.

.

.

=J if $\mu_{j-1} \leq y^*$.

The $\mu' s$ are unknown parameters to be estimated with $\boldsymbol{\beta}$. Suppose there is a health survey to assess health status of an individual. The respondents have their own preferences which depend on certain measurable factors such as age, gender, and wealth, $\boldsymbol{x}$, and some unmeasurable factors, $\varepsilon$. The essential ingredient is the mapping from an underlying, naturally ordered preference scale to a discrete ordered observed outcome in terms of disease outcomes (in the present case, NCDs and their combinations). Given only, say, three possible answers, they choose the cell that most closely represents their preferences (Greene, 2012).

It is assumed that $\varepsilon$ is normally distributed. The mean and variance are normalized to zero and one, respectively. With the normal distribution, the following probabilities are obtained:

Prob(y=0) =$\Phi(-\boldsymbol{\beta}'\boldsymbol{x})$,

Prob(y=1) = $\Phi(\Phi(\mu_1 - \boldsymbol{\beta}'\boldsymbol{x}) - \boldsymbol{\beta}'\boldsymbol{x}) - \Phi(-\boldsymbol{\beta}'\boldsymbol{x})$,

Prob(y=2) = $\Phi(\mu_2 - \boldsymbol{\beta}'\boldsymbol{x}) - \Phi(\mu_1 - \boldsymbol{\beta}'\boldsymbol{x})$,

.

.

.

Prob(y=J) =1- $\Phi\left(\mu_{j-1} - \boldsymbol{\beta}'\boldsymbol{x}\right)$

In order for all probabilities to be positive, it must be the case

0 <$\mu_1 < \mu_2 \ldots\ldots < \mu_{j-1}$.

The marginal effects are different from the ordered probit (OP) regression coefficients. Both the sign and magnitude of marginal effects vary with the ordered outcome. As Greene (2012) offers a detailed account of how the marginal effects are calculated, we have refrained from an exposition here.

The Wald test examines the linear restrictions $\beta_1 = \beta_2 = \cdots . \beta_{j-1}$ or $H_0$: $\beta_q - \beta_1 = 0$, $q = 2, \ldots, J - 1$.[8]

## Section 5

A more disaggregated list of explanatory variables is used here than in the cross-tabulations for deeper and more insightful analyses. For example, sanitation and hygiene, and sources of cooking medium capture better their diversity. Another important point to note is that the omitted categories account for the largest share in each group (e.g., age, marital status, household size, education, sanitation and hygiene, educational attainments, religion and so on).

### Interpretation of Results

*(a) NCDs by Count*

In Table 1, we give the results from an ordered probit in which the dependent variable is a count of NCDs. The first category is no NCD, the second is 1 NCD and the third is $\geq$ 2 NCDs/multi $-$ morbidities. The entire sample is used but with a focus on the aged.

[8]For a more detailed exposition of the diagnostics, see Greene (2012).

Although multi-morbidities are involved here in a general form, specific cases of multi-morbidity are examined in the next subsection.

The overall specification is validated by the Wald test of joint significance of all coefficients. As the coefficients are not equal to the marginal effects, we will confine our remarks to the latter, as given in Table 1a.

**Tables 1 and 1a here**

As aging and NCDs are closely related (Bloom et al., 2014, 2014a, 2014b; WHO, 2015), we have considered 4 age groups: below 60 years, 60-69 years, 70-79 years and 80 years +. Relative to those below 60 years, each of the three older age-groups is associated with a significantly lower probability of no NCD, and higher probabilities of suffering from 1 NCD and multi-morbidity (2 or more).

Those living in urban areas are less likely to experience no NCD, and more vulnerable to 1 or multi-morbidity (2 or more), compared with rural population. Lifestyle differences or more sedentary lives in urban areas, and dietary patterns with a larger share of processed and unhealthy foods aggravate vulnerability to NCDs, while easier access to medical care attenuates it. But the (net) effect is positive on prevalence of NCDs.

Women are more likely than men to experience no NCD, and less likely to fall prey to one or more NCDs/or multi-morbidity. Although women are generally more deprived than men in the same household and have limited access to health care, they are physically more active and resilient.

Relative to the omitted group of currently married, never married have a higher probability of experiencing no NCD, but lower probabilities of not suffering from a single NCD or multi-morbidity. In contrast, widowed and divorced/separated have lower probabilities of experiencing no NCD, and higher vulnerability to single and multi-morbidities. So it seems that the cushion of marriage (or spousal support) is of little consequence, especially for women. Not only are widows socially ostracized, they are also deprived and struggle to eke out a subsistence with hardly any access to health care. Hence their higher vulnerability to NCDs is plausible. Widowed/separated, especially women, also lack family and community support as they are also stigmatized.

Those with primary to matriculation (10-12 years of school education) and above are associated with significantly higher probabilities of experiencing no NCD, and lower probabilities of one NCD and multi-morbidity, relative to the omitted group of illiterates/or with few years of education. Better awareness of health issues and medical services and healthy diets are key to these findings.

Somewhat surprisingly, those living on their own are more likely to experience no NCD, and less likely to suffer from one NCD and multi-morbidity, as is also the case for those living in households with 6 or more members. Whether those living alone enjoy greater support from friends and the community and those living in small households are more subject to abuse are not unlikely. Larger households (i.e., 6 or more members) presumably offer greater protection to those suffering from NCDs, especially the old.

Another important factor associated with NCDs is physical inactivity. As there is no direct measure of it in the NSS data, we have tried to approximate it by using an occupational classification of households. There are four occupations: others, regular salary/wage earner, self-employed, and (mostly casual) labour. As self-employed (including those in agriculture) are the largest group, it is omitted. Those earning regular wages/salaries enjoy higher probability of experiencing no NCD, and lower probabilities of suffering from any NCD or

multi-morbidity. As this category involves greater physical activity than the self-employed and enjoys easier access to health care (specifically, salary earners), these findings are plausible. Labourers, including casual labourers, are perhaps physically most active but economically highly deprived, are found to have lower probability of no NCD and higher probabilities of suffering from a single NCD and multi-morbidity, as is also the case for the motley group of Others, relative to the self-employed,.

There are some intriguing results linked to aspects of hygiene and sanitation. Septic tank/flush system is associated with a lower probability of no NCD, but higher probabilities of suffering from a single NCD and its multi-morbidity, as also pits, relative to the omitted group of no latrines. By contrast, community toilets are associated with a higher probability of no NCD, and lower probabilities of single NCD and multi-morbidity. If toilets with flush system and septic tanks are not well-maintained and lack regular water supply, more likely among households with low socio-economic status, these findings are not implausible.

Drainage systems are disaggregated into five categories: open kutcha/mud; open pucca/solid, covered pucca, underground and no drains (the largest category and hence omitted). The results are intriguing. Open kutcha/mud and open pucca/solid drainage are associated with higher probabilities of no NCD, and lower probabilities of suffering from a single NCD or multi-morbidity. By contrast, both covered pucca/solid and underground drainage are associated with lower probabilities of no NCD, and higher probabilities of suffering from any NCD and multi-morbidity, relative to the omitted group of no drains. As these drainage systems are more hygienic, the plausibility of these findings is doubtful. Sources of drinking water are disaggregated into: bottled, tap and tank, pucca/solid well, tubewell/hand pump, and other sources. As tubewell/hand pump is the commonest source of drinking water, it is treated as the omitted category. Relative to the omitted category, bottled, tap and tank water, and pucca well are associated with lower probabilities of no NCD, and higher probabilities of single and multi-morbidity of NCDs. These are usually considered safe sources of drinking water, but it is unclear whether these are safer than tubewell/hand pump. Other sources such as community sources (community ponds or wells) have higher probabilities of no NCD, and lower probabilities of suffering from a single or multi-morbidity of NCDs.

Sources of energy are disaggregated into seven categories: LPG/Gobar (cow dung) gas, dung cake, electricity, kerosene, coal/charcoal, other sources, and firewood and chips (the largest category and hence omitted). Use of LPG/Gobar gas, electricity and coal/charcoal yield significant effects. While the first yields higher probability of no NCD, and lower probabilities of suffering from a single NCD or multi-morbidity, a somewhat intriguing result is that use of coal/charcoal has similar effects *despite* their highly polluting effects. An obvious question is whether use of firewood and chips is more polluting. That use of electricity for cooking is associated with higher probability of no NCD, and lower probabilities of single NCD and multi-morbidity is not surprising.

The caste groups comprise Scheduled Tribes and Scheduled Castes (STs/SCs), OBCs, and Others that also mirror their socio-economic hierarchy. As OBCs are the largest category, it is omitted. SCs/STs (the bottom rung) are more likely to experience no NCD, and less likely to suffer from one NCD and multi-morbidity, as also the highest rung of Others, compared to OBCs. Given that the SCs/STs are located in remote locations and thus less subject to stress and pollution, and also more likely to be physically more active, these are not surprising results. What calls for an explanation is why Others (generally, most affluent) experience similar outcomes. Whether their dietary behaviour and access to health care are better than those of OBCs is a conjecture that needs corroboration.

The religious groups are divided into the Hindus, Muslims and other residual religious groups (e.g., Christians, Buddhists, and Sikhs). As the Hindus are the largest group, they are the omitted category. So relative to them, the Muslims are less likely to experience no NCD, and more likely to suffer from one NCD and multi-morbidity. An explanation may be sought in their living conditions (e.g., poorer than the Hindus, they are more likely to live in slums and other congested clusters) and diets rich in carbohydrates and meats.

Per capita expenditure quintiles are constructed to assess economic status or affluence or more broadly as a proxy for wealth. Relative to the lowest, all other quintiles are less likely to experience no NCD, and more likely to fall prey to any one NCD or more (multi-morbidity). Their greater vulnerability is due to sedentary life styles, unhealthy diets (greater reliance on processed foods, higher consumption of alcohol and tobacco) but also partly offset by easier access to and affordability of expensive medical care.

Controlling for all these effects, the time dummy shows a lower probability of no NCD, and higher probabilities of suffering from one and more NCDs. So vulnerability to NCDs and their multi-morbidities has risen in 2014, relative to 2004.

**(b) Multi-Morbidities of NCDs**

Here we examine factors associated with *selected* multi-morbidities of NCDs. The selection is guided by adequacy of sample size. The ordered probit results on diabetes and its multi-morbidity with hypertension are given in Table 2 and the marginal effects in Table 2a.

The model specification is validated by the Wald test of joint significance of all coefficients. Since the marginal effects are of greater interest, we review them below.

**Table 2 and Table 2a here**

The three aged groups are less likely to experience no NCD, and more likely to suffer from diabetes and its multi-morbidity with hypertension, relative to those <60 years.

Those living in urban areas are less likely to experience no NCD, and more likely to suffer from diabetes and its multi-morbidity with hypertension, compared with those in rural areas. Sedentary urban lifestyles and greater dependence on processed food and higher consumption of alcohol and smoking probably are important contributory factors. As urbanisation is growing rapidly and is irreversible, it poses a major threat to containing the spread of this multi-morbidity.

Women are more likely to experience no NCD, and less likely to suffer from diabetes and multi-morbidity with hypertension. If serious multi-morbidities such as this are due to lack of access to health care, the risk of fatality is likely to be higher.

Never married are more likely to experience no NCD, and less likely to suffer from diabetes and its multi-morbidity, relative to currently married. By contrast, widowed and divorced/separated display lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity with hypertension, relative to the omitted category. Widows are socially ostracized as well as looked down upon within the family, aggravating their misery and vulnerability to NCDs. The stigma attached to divorced/separated women comes in their way of parental support and access to health care. Thus marriage fails to provide much protection and mitigation-especially to women.

Matriculation (10-12 years of school education) and above as an educational threshold yields higher probability of no NCD, and lower probabilities of diabetes and the multi-morbidity, compared with illiteracy and a few years of education.

Those living alone are more likely to experience no NCD and less likely to suffer from diabetes and its multi-morbidity with hypertension, as also those living in larger households with 6 or more members, relative to those living in small households with 2-5 members. These results are plausible if those living alone enjoy better social support as a substitute for family support while NCD patients-especially the old-in small households suffer greater abuse than in larger households.

Relative to self-employed, Others record lower probability of no NCD and higher probabilities of diabetes and multi-morbidity, presumably because the former-especially self-employed in agriculture- engage in more strenuous activities.

As in the previous case, hygiene and sanitation have mixed effects. Both septic tank/flush system and pits are associated with lower probabilities of no NCD, and higher probabilities of suffering from diabetes and multi-morbidity with hypertension, relative to the omitted category of no latrine. If septic tank/flush system are not well- maintained due to scarcity of water supply, these findings may have some plausibility.

Open kutcha and open pucca drainage are associated with higher probabilities of no NCD, and lower probabilities of diabetes and its multi-morbidity with hypertension, relative to no drains. By contrast, the safer drains- both covered pucca and underground-are associated with lower probabilities of no NCDs, and higher probabilities of suffering from diabetes and the multi-morbidity, relative to no drains. A clue may be poor maintenance of the safer drainage systems-especially among households with low socio-economic status.

Bottled, tap and tank water, and pucca well are associated with lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity with hypertension, relative to tubewell/hand pump. There is, however, limited evidence for slums that water supply through taps and tanks is contaminated by industrial effluents (Lumagbas et al., 2018).

Out of the sources of energy for cooking, LPG/Gobar gas and dung cake present a striking contrast. While the former is associated with a lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity with hypertension, dung cakes are associated with a higher probability of no NCD and lower probabilities of diabetes and its multi-morbidity with hypertension, relative to firewood and chips.

STs/SCs display higher probability of no NCD, and lower probabilities of suffering from diabetes and its multi-morbidity with hypertension, as also Others, relative to the omitted group of OBCs. The reasons for similar outcomes may be different: SCs/STs are subject to lower environmental stress, and enjoy healthier diets and engage in more physically demanding activities while Others being the most affluent may have easier access to expensive medical treatments that more than compensates for their sedentary life styles and unhealthy diets.

Both the Muslims and Other religious groups have lower probabilities of no NCDs, and higher probabilities of diabetes and its multi-morbidity, relative to the dominant category of the Hindus. The contrast between the Muslims and the Hindus is striking in terms of lifestyles and dietary behaviour. As noted earlier, the Muslims are more concentrated in slums and other congested clusters, and tend to rely more on unhealthy diets in terms of higher intakes of oily and fried foods and meats. Comparison of the residual religious group and the Hindus is, however, not straightforward.

There is a striking affluence gradient to diabetes and the multi-morbidity. Relative to the first expenditure quintile, higher quintiles are associated with lower probabilities of no NCD and higher probabilities of diabetes and its multi-morbidity with hypertension. Affluence breeds sedentary lives, unhealthy diets, heavy consumption of alcohol and tobacco, which lead to greater vulnerability to these NCDs.

The residual time effects imply lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity with hypertension in 2014 relative to 2004. So vulnerability to diabetes and multi-morbidity with hypertension rose significantly, between 2004-2014.

Another major morbidity is diabetes with heart disease. The ordered probit results are given in Table 3 and the marginal effects in Table 3a. The model specification is validated by the Wald test of joint significance of all coefficients.

Each old age group shows a lower probability of no NCD, and higher probabilities of suffering from diabetes and multi-morbidity of diabetes and heart disease, relative to those <60 years.

Urban population is associated with a lower probability of no NCD, and higher prevalence of diabetes and its multi-morbidity with heart disease, compared with rural population.

Women are associated with a higher probability of no NCD, and lower probabilities of suffering from diabetes and the multi-morbidity, relative to men.

**Table 3 and Table 3a here**

Relative to currently married, never married enjoy higher probability of no NCD, and lower probabilities of suffering from diabetes and its multi-morbidity with heart disease. In contrast, widowed and divorced/separated display lower probabilities of no NCD, and higher probabilities of diabetes and the multi-morbidity. As noted earlier, this raises further doubts about the role of spousal and family support in preventing and mitigating these diseases among women.

Those above matriculation (10-12 years of school education) enjoy a higher probability of no NCD, and lower probabilities of suffering from diabetes and the multi-morbidity, relative to illiterates or with a few years of education. Presumably, this threshold of education manifests healthier diets and behaviour (e.g., lower alcohol and tobacco consumption).

Relative to self-employed, Others display a lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity with heart disease. As the occupational classification is not just a proxy for physical activity but also varying economic status (e.g., labourers are likely to be the poorest), the outcomes are likely to be influenced by both factors. So what labourers and regular wage-earners might gain through more strenuous tasks may be more than offset by their limited access to expensive medical care.

Relative to no latrines, toilets, septic tanks/flush system, and pits are associated with lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity with heart disease. These results are intriguing in the absence of knowledge of how the more hygienic toilet systems (e.g., septic tank/flush) are maintained under endemic water shortage in different parts of India.

Another set of intriguing results relate to different drainage systems. Relative to no drains, open kutcha and open pucca drains are associated with higher probabilities of no NCD, and lower probabilities of diabetes and heart diseases. By contrast, the more sanitary covered pucca and underground drains are associated with lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity with heart diseases. A clue is again quality of maintenance of safer drainage systems.

Three supposedly safe water sources (e.g., bottled, tap and tank water and pucca well) display lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity, relative to tubewell/hand pump. Without greater knowledge of their relative pollution, no valid inference can be drawn.

Among the sources of energy for cooking, LPG/Gobar gas is associated with lower probability of no NCD, and higher probabilities of suffering from diabetes and its multi-morbidity with heart disease, while dung cakes are associated with higher probability of no NCD, and lower probabilities of diabetes and its multi-morbidity with heart disease, compared with firewood and chips.

Caste affiliation matters. The lowest rung of SCs/STs are associated with higher probability of not suffering from any NCD, and lower probabilities of diabetes and its multi-morbidity, as also Others, relative to OBCs. As noted earlier, the reasons for similar outcomes differ.

Religion matters too. Relative to the omitted group of the Hindus, both the Muslims and Others (e.g., Christians, Sikhs, and Buddhists) experience lower probabilities of no NCD, and higher probabilities of suffering from diabetes and heart diseases. It is conjectured that the differences between the Hindus and Muslims lie in different quality of living conditions and diets.

Consumption expenditure quintiles show lower probabilities of no NCD, and higher probabilities of diabetes and heart disease, relative to the bottom quintile (or poorest). Thus there is an affluence gradient to these NCDs.

In comparison with 2004, there is a lower probability of no NCD, and higher probabilities of suffering from diabetes and the multi-morbidity in 2014. Thus there is an unambiguous rise in the prevalence of these NCDs over time.

The last major multi-morbidity is between diabetes and CVDs. The OP results are given in Table 4 and the marginal effects in Table 4a. The model speciation is validated by the Wald test of joint significance of all coefficients.

**Table 4 and Table 4a here**

Each old age-group shows a lower probability of no NCD, and higher probabilities of suffering from diabetes and its multi-morbidity with CVDs, relative to the younger population of <60 years.

Urban populations display lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity with CVDs, compared with rural population.

Women have higher probability of no NCD, and lower probabilities of diabetes and its multi-morbidity with CVDs. As there is some evidence suggesting that women are biologically stronger than men—for example, higher survival rates under famines- this could explain these findings despite the fact that they are more deprived than men within the same family in terms of lack of adequate dietary intake and health care but longer hours of work (Frymorgen, 2018).

Marriage fails to provide adequate protection against and mitigation of NCDs. Relative to the largest group of currently married, never married display higher probability of no NCD, and lower probabilities of suffering from diabetes and its multi-morbidity with CVDs, while widowed and divorced/separated experience lower probabilities of no NCD, and higher probabilities of suffering from diabetes and its multi-morbidity. The reasons differ, as greater vulnerability of married women could be due to lack of adequate spousal/ family support while widowed, women especially are socially ostracized and economically more deprived, relative to Others. Divorced/separated are despised too, both by their own parental families and local communities.

Education above a threshold, above matriculation, is associated with a higher probability of no NCD, and lower probabilities of suffering from diabetes and its multi-morbidity with CVDs, relative to illiterates and few years of education. As observed earlier, these findings could be attributed to healthier diets and lifestyles.

Both individuals living alone and members of larger households of 6 or more members are associated with higher probabilities of no NCD, and lower probabilities of diabetes and its multi-morbidity with CVDs, relative to those living in 2-5 members' households. This raises questions about whether social networks act as a substitute for family support for those living alone, and whether those living in small households suffer abuse because of financial and other constraints.

Others enjoy a lower probability of no NCD, and higher probabilities of diabetes and CVDs, relative to the self-employed. As the latter are physically more active (especially self-employed in agriculture), it is not surprising that Others (comprising unemployed or occasionally employed or just dependent on the family) are more vulnerable to NCDs.

Aspects of sanitation and hygiene captured here produce mixed/intriguing results. Toilets with septic tanks /flush system, and pits are associated with lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity with CVDs, relative to no latrines. What may lend some plausibility to these findings is that the supposedly more hygienic toilets, especially with septic tanks/flush facility, are often not properly maintained for lack of adequate water supply.

Drainage produces seemingly implausible results. Open kutcha and open pucca drains are both associated with higher probabilities of no NCD, and lower probabilities of diabetes and its multi-morbidity, relative to no drains. In sharp contrast, the more sanitary covered pucca and underground drains are associated with lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidity with CVDs, relative to no drains. A definitive view is difficult as we lack knowledge of how safer drains are maintained when they get clogged, especially among households with low socio-economic status.

Safe sources of drinking water-bottled, tap and tank water, and pucca wells are associated with lower probabilities of no NCDs, and higher probabilities of diabetes and its multi-morbidity with CVDs, relative to tubewell and hand pumps. More corroborative evidence is needed to support this inference-especially whether tubewell and hand pump water are least polluted.

Among the sources of energy for cooking, LPG/Gobar gas is associated with a lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidity, while dung cakes are associated with a higher probability of no NCD, and lower probabilities of suffering from diabetes and the multi-morbidity, relative to firewood and chips.

Both SCs/STs and Others are better-off than OBCs (more affluent than SCs/STs and less affluent than Others), as they have higher probabilities of no NCD and lower probabilities of diabetes and the multi-morbidity. The reasons, however, differ because SCs/STs lead more active lives, rely on healthier diets and are subject to lower environmental stress, while Others more than compensate for more sedentary lives and unhealthy diets through easier access to medical care.

The Muslims and other residual religious groups are subject to lower probabilities of suffering from any NCD and higher probabilities of diabetes and its multi-morbidity with CVDs, relative to the vast majority of the Hindus. Between the Muslims and Hindus, two striking differences are less sanitary living conditions and unhealthy diets of the former.

There is further confirmation that affluence and NCDs (at least those considered here) tend to go together. There is an affluence gradient to NCDs and their multi-morbidities. The greater the affluence, the higher is the probability of diabetes and its multi-morbidity with CVDs.

Controlling for all these factors, the residual time effect suggests lower probabilities of no NCD, and higher probabilities of diabetes and its multi-morbidities. So the inescapable

conclusion is that the burden of diabetes and its multi-morbidity is much higher in 2014, relative to 2004.

## Section 6

### Discussion

Some observations are made from a broad policy perspective.

The present study provides detailed evidence on NCDs and their covariates. This is particularly relevant in the present Indian context, as the elderly population $\geq 60$ years is growing three times faster than its population as a whole. It is projected that the percentage of elderly people will more than double between 2010-2050. A significant feature of population ageing is the dramatic rise in the life expectancy of the old (Agarwal et al., 2016).

NCDs 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 four major NCDs (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 factors such as high blood pressure, high cholesterol, high blood sugar, and obesity. Although urbanisation is not a direct driver of NCDs, it contributes through riskier lifestyles (e.g., more sedentary lifestyles, diets rich in carbohydrates, excessive use of alcohol, smoking) (Beard and Bloom, 2014; Bloom et al., 2014, 2014a; Agarwal et al., 2016).[9]

Multi-morbidity is increasing globally due to increasing population of the old along with factors such as high BMI, urbanisation and the growing burden of NCDs (such as type 2 diabetes). Evidence suggests that multi-morbidity is associated with functional decline and increased risk of mortality (Beard and Bloom, 2014; Academy of Medical Sciences, 2018).

The association between multi-morbidity and age is due to the greater likelihood of old individuals accumulating chronic conditions over the life span. Some clusters occur for other reasons, such as common aetiological factors while others may be due to unrelated aetiological conditions arising from conditions that share a common cause (environmental pollution).

The present study focuses on factors associated with selected NCDs and their multi-morbidities and on whether these have risen over time.

Our econometric analysis builds on the *mostly* patchy and methodologically weak literature on India, with a few exceptions, and draws upon two independent cross-sections from the 60$^{th}$ and 71$^{st}$ rounds of the NSS. We use state-of-art econometric models that yield robust results on factors associated with NCDs and multi-morbidity and throw light on whether the burden of multi-morbidities has grown over the period 2004-2014.

Consider, for example, the case of diabetes and its multi-morbidity with CVDs. The residual time effect, after controlling for all demographic and socio-economic factors, is positive for both diabetes and the multi-morbidity but larger for the former. This suggests that the rise in diabetes is larger than of the multi-morbidity with CVDs. Note also that the marginal effects of time are larger for diabetes than for other associated multi-morbidities.

[9] Beard and Bloom (2014) point out that old people are more likely to have multiple, coexistent and inter-related problems and this multi-morbidity is commonly manifested through a loss of function and the broad geriatric syndromes of frailty and impaired cognition, continence, gait and balance.

As emphasized in the literature, there is robust evidence of a shift of NCDs and their multi-morbidities from the younger to the old population. As the old population has grown rapidly over time, it has also become more vulnerable to NCDs and their multi-morbidities. Among the old, 70-79 year olds display highest probabilities of diabetes and its multi-morbidities with hypertension, heart disease and CVDs. This raises a very serious policy concern. As observed earlier, 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 shrinking public income support and health care, and thus poses grimmer prospects for their survival. Besides, some doubts are raised about whether longer lives are translating into healthier lives. For a more conclusive corroboration, more evidence is required on onset and duration of NCDs.[10]

In all cases, urbanisation is associated with higher probabilities of any NCD, diabetes and its multi-morbidities. Apart from riskier lifestyles, environmental pollution is a key contributory factor. With growing nuclearisation of families, dependence on eating out and consuming diets rich in carbohydrates have increased rapidly without a concomitant expansion of health care.

Women are often more deprived in food and access to medical care and involved in long hours of work, especially in rural areas where they assist in raising children, cook and perform other domestic chores, and frequently assist with farm and non-farm activities. Yet they are subject to lower probabilities of any NCD, diabetes and associated multi-morbidities. Their lower intakes of alcohol and tobacco could be one important reason. Besides, whether their lower vulnerability reflects mainly their greater biological strength and resilience can't be ruled out.

Given the weakness of social support system and the stigma attached to widowhood and divorced/separate, especially women, it is not surprising that they are more prone to any NCD, diabetes and its multi-morbidities, relative to currently married. Greater vulnerability of widowed and divorced/separated is due largely to social and family neglect. In contrast, never married are better-off than currently married. Thus it follows that marriage is not necessarily a barrier against NCDs and their multi-morbidities. Specifically, currently married, especially women, are highly vulnerable too, as they are subject to discrimination in food and health care. What are their exit options? Few, if any, as Heath (2013) argues persuasively, there is a positive correlation between work and domestic violence, but only among women with low education or those married young. These results suggest that women with low bargaining power, victims of child marriage specifically, face increased risk of domestic violence upon entering the labour force as their husbands seek to counteract their increased bargaining power. So, more generally, outside employment option may not work for large segments of married women, and divorce or separation are widely stigmatised.[11]

As expected, there is an educational threshold, above matriculation, at which vulnerability to any NCD, diabetes and its multi-morbidities declines. This points to greater awareness of health issues, access to health care and healthier diets. So clearly expansion of education is a priority in dealing with the scourge of growing NCDs.

Living arrangements are important as they determine access to health care and food. Those living alone, especially the old, are often destitute and unable to access and afford expensive medical care. Yet they enjoy lower probabilities of any NCD, diabetes and associated

[10] Beard and Bloom (2014) make an important observation that, although life expectancy in older age is increasing in almost all countries-including India- doubts remain about the quality of these additional years. More specifically, it is difficult to say whether people are living longer and healthier lives or are simply experiencing extended periods of morbidity.

[11] Beard and Bloom (2014) take a more forward-looking perspective on evolving gender roles. Overburdened with traditional carer role, women's participation in formal workforce will enable them to challenge gender norms, and overcome this inequitable burden and enhance their access to quality health care.

morbidities, as also those living in larger households with 6 or more members, relative to small households of 2-5 members. It is plausible that those living alone in destitution enjoy greater support from friends and local community as a substitute for family support, while those living in larger households offer greater protection against abuse, relative to small households. So deep questions arise about the efficacy of family support in fighting the scourge of NCDs and whether support of friends and other members of the community is a substitute for family support.

Physical activity acts as a barrier against NCDs. However, hardly any nation-wide estimates of physical activity are available. We therefore relied on the occupational classification of households as a proxy for physical activity. Relative to the self-employed-especially self-employed in agriculture-none performs better. The motley group of Others, mostly unemployed and occasional workers and those largely dependent on family support, are subject to greater vulnerability to the NCDs and their multi-morbidities with diabetes. Although wage earners and (mostly, casual) labourers engage in physically demanding tasks, they largely lack resources for expensive medical cure. So the outcomes are jointly determined by the interplay of economic status and physical activity. Provisions of sidewalks and parks that enable people to take walks in urban areas have considerable potential for physical fitness in the context of rapid and largely unplanned urbanisation.

Sanitation and hygiene variables yield mixed, but intriguing, results. Toilets with septic tanks and flush system are associated with higher probabilities of any NCD, diabetes and associated multi-morbidities, as also covered and underground drainage systems, compared with respective omitted groups. Fragmented evidence exists on limited and erratic water supply to toilets with flush system and infrequent unclogging and repair of clogged and broken drains. Even if more corroborative evidence is found, it is not clear why the outcomes in terms of NCDs and their multi-morbidities would be so unfavorable.

Sources of drinking water (i.e., bottled, tap and tank water pucca well) are associated with higher probabilities of suffering from any NCD, diabetes and associated multi-morbidities, relative to tubewell/hand pump. A recent review of Indian slums shows (Lumagbas et al., 2018) that there is acute scarcity of safe drinking water as much of it is contaminated by vectors that raise NCD risk. This is elaborated by Sly et al. (2016) who emphasize the important contributory role of chemicals present in water that have toxic, carcinogenic, or endocrine disruptive actions, and their transmission through food cooked with polluted water.[12]

In Table 1a, out of the energy sources, LPG/Gobar case, electricity and coal/charcoal are associated with lower probabilities of single NCD and multi-morbidities, relative to firewood and chips. It is not self-evident that coal/charcoal are less polluting than firewood and chips. In other cases, diabetes and its multi-morbidities, there is an interesting contrast. While LPG/Gobar gas is associated with a lower probability of no NCD, and higher probabilities of diabetes and its multi-morbidities, use of dung cakes yields higher probability of no NCD, and lower probabilities of diabetes and its multi-morbidities, relative to firewood and chips. The sign reversal of LPG/Gobar gas is intriguing since this source is supposed to be less harmful than the omitted category.

The caste system manifests a socio-economic hierarchy. The STs are the most isolated and deprived, followed by the SCs, and then OBCs and Others. Their cultural beliefs, lifestyles and diets differ greatly. Their use of medical knowledge systems varies too. So their vulnerabilities to NCDs are likely to differ. As our analysis shows, relative to the largest group of OBCs,

[12] Although micro-parasites such as bacteria define the class of CDs, macro-parasites such as harmful industries may significantly influence the spread of NCDs (Sly et al. 2016).

SCs/STs have lower probabilities of suffering from any NCD, diabetes and associated multi-morbidities, as also Others. So, while affluence matters, it is the complex interaction between it and cultural beliefs, lifestyles and medical systems that produces such outcomes.

In some measure, this argument also applies to the religious groups considered here. Relative to the Hindus, the Muslims display higher probabilities of suffering from any NCD, diabetes and its multi-morbidities, as also the residual religious group. On average, the Muslims are poorer than the Hindus and are more concentrated in slums and congested clusters. So differences in affluence interact with religious beliefs and dietary behaviour (e.g., vegetarianism is an important aspect of Hindu diets while Muslim diets are rich in oil and meats) underlie these outcomes.

That there is an affluence gradient to NCDs and their multi-morbidities is robustly confirmed. Their prevalence is highest among the richest, relative to the poorest in all cases. As affluence is associated with sedentary lifestyles, diets rich in carbohydrates, higher intake of alcohol, it is not surprising that richer individuals are more vulnerable to NCDs despite easier affordability of expensive health care.

Attention is drawn to a few limitations. Although more prominent NCDs are covered here primarily because the samples are relatively large, other NCDs such as cancer, COPD, stroke are excluded because the data are scanty. Another limitation is that the NSS doesn't include estimates of alcohol and tobacco use. As these are reported to be important explanatory variables for NCD prevalence, this implies that the specifications used are incomplete. Finally, social networks can be either complementary to or substitute for family support in preventing and mitigating the NCD burden but the NSS doesn't provide any data.[13] This is particularly important in the context of increased spatial mobility and changes in family structure that imply that old people are increasingly living alone or as part of a couple, rather than in the larger, multidimensional households of the past. Since old people have less opportunity to share the resources typically available in larger households, they are at increased risk of isolation, depression and suicide (Beard and Bloom, 2014).

Despite these limitations, we believe that the strengths of the present analysis outweigh its limitations in so far as the methodology used is state-of-art and new insights are obtained that could help design more effective policies for NCDs' prevention and mitigation.

## Section 7

## Concluding Remarks

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).

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

[13] An important contribution is Berkman et al. (2014) who are emphatic that older men and women are not only on the receiving end of support, but also contribute to the dynamic and interdependent aspects of social institutions. This bidirectional force is often less emphasized as societies begin to have larger older populations with a consequent undue emphasis on how burdensome they are in rapidly evolving societies such as India.

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.

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. In the context of declining family support and severely limited old-age income security, catastrophic consequences for destitute individuals afflicted with these conditions can't be ruled out (Jan et al., 2018). Besides, continuing neglect and failure to anticipate these demographic and epidemiological shifts-from infectious diseases to NCDs-may result in enormously costlier policy challenges. An estimate provided by Bloom et al. (2014a) suggests NCDs may cost as much as $6 trillion in productivity losses and health-care expenditure between 2012 and 2030, close to thrice India's annual GDP in 2017.[14]

Another policy initiative launched is National Dialysis Programme under the auspices of the National Health Mission, which provides free dialysis services to those with lower income. It is proposed in public-private partnership (PPP) mode. Dialysis is expensive—it consumes 2–6% of the healthcare expenditure, even though end-stage kidney disease (ESKD) patients account for only 0.1–0.2% of the total population. Any proposed service must therefore be cost efficient. The proposed service focuses on hemodialysis (HD), while neglecting other options such as kidney transplantation, and peritoneal dialysis (PD), which is cheaper to the healthcare system and can be done at home. Hence it is the preferred treatment modality for state-funded dialysis programs.

Conservative estimates suggest that about 68,970 dialysis machines will be needed to treat 206,900 patients in the very first year, and the figure will rise to a staggering 1.4 to 2.2 million subjects (Jha, 2016). So questions of adequacy of funding and regulation of the private sector's quality of dialysis service are central.

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.

A total of 298 District NCD Cells and 293 District NCD Clinics have been established in the country. Also, there are 103 functional Cardiac Care Units for emergency cardiac care and 64 Day-Care Centres for Cancer care at the District levels in the country.

[14] Jan et al. (2018) provide additional details.

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). Specifically, health systems need to be reorganised to better provide coordinated and informed geriatric services that enable old people to age in place. An important suggestion is to retain old health workers, and recruit and train old people as new health workers to be more sensitive to the needs of old patients (Beard and Bloom, 2014; WHO, 2015).

The majority of health-care systems, including India's, are geared to treat single conditions. For patients with multi-morbidity, it involves interfacing with multiple health-care providers, increased risk of inappropriate polypharmacy from lack of provider communication, and potentially sub-optimal care.[15] Another shift required is patient technology to support self-management of conditions-especially for the old. Integration of care in creative ways such as treatment centres for multi-morbidity clusters is thus a priority (Editorial, *Lancet*, 2018).

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; Academy of Medical Sciences; Bloom et al., 2014a; Agarwal et al., 2016). A distillation is given here to guide policy design.

Lack of physical activity and unbalanced high-calorie diet promote weight gains. The culprits are sugar and dairy fat. 15% of women and 12% of men are obese in India. Obesity is a risk factor for cardiovascular and diabetes and can aggravate symptoms of COPD such as emphysema and bronchitis.

Limiting tobacco consumption is expected to benefit at the individual level but wider reductions in multi-morbidity prevalence require 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; Bloom et al., 2014a). It is reassuring therefore that taxation of *beedis* and smokeless tobacco (SLT) has spiked in the recent Goods and Services Tax (GST).

Given the lacklustre performance of NPCDCS, more must be said on the benefits of early detection. In India, 65 million cases of diabetes are undiagnosed, making eventual treatment more expensive and prognosis more cautious. Pap smears can prevent cervical cancer at low cost. Similarly, early detection of hypertension and diabetes and treatment with lifestyle changes and cheap drugs can prevent strokes, heart attacks, kidney failure and blindness. But early detection by itself can't bring about reduction in NCD multi-morbidities as much depends on the quality of treatment and lifestyle changes (Bloom et al., 2014a).

As far as treatment is concerned, apart from changes recommended to deal with NCD multi-morbidity, there are some highly cost-effective options available, including aspirin for people

[15] Treatment burden is defined as the negative impact on a patient's time and energy due to accessing care from multiple providers, complying with complex treatment plans involving multiple drugs, and coordinating other aspects of their care. Studies of patients with single conditions such as diabetes, heart failure, and cancer show that treatment burden is an important concern as patients who feel overwhelmed are less likely to adhere to medications and are less likely to maintain self-care (Academy of Medical Sciences, 2018).

who have suffered heart attacks. Access to essential medicines such as insulin, chemotherapy and other life-saving drugs must be expanded.

The higher the level of OOP costs for long-term therapy relative to the costs of other competing household needs, the lower is the incentive for individuals to adhere to treatment. Encouraging the individuals to prioritize spending on long-term treatment and prevention of NCDs is particularly challenging in resource-poor settings (Jan et al., 2018).

In sum, the curse of old age has worsened. Along with expansion of old-age pension and health insurance, and public spending on programmes targeted to the health care of the old, careful attention must be given to reorient the health systems to accommodate the needs of disease prevention and control, especially NCD multi-morbidities, by enhancing the skills of health-care providers and equipping health-care facilities to provide services related to health promotion, risk detection, and risk reduction. These need to be supplemented with measures designed to influence behavioural changes (e.g., curbs on smoking, alcohol consumptions, high calorie processed food, sugar and dairy fats, and promotion of physical activity). Given these policy challenges, achievement of SDG 3 and target 4 of a one-third reduction in premature mortality from NCDs by 2030 seems a long haul.

**Table 1: Factors Associated with Multi-Morbidity of NCDs in General Population: Ordered Probit**

| Socio-demographic variables | Number of obs = 702328<br>Wald chi2(41) = 38368.48<br>Prob > chi2 = 0.0000<br>Log pseudolikelihood = -168337.9<br>Pseudo R2 = 0.1215 | |
|---|---|---|
| | **Coefficient** | **Standard Error** |
| **Year** | | |
| 2014 | 0.097*** | 0.0055 |
| **Age Group** | | |
| 60-69 | 0.593*** | 0.0081 |
| 70-79 | 0.726*** | 0.0123 |
| 80+ | 0.642*** | 0.0214 |
| **Place of Residence** | | |
| Urban | 0.047*** | 0.0074 |
| **Gender** | | |
| Women | -0.096*** | 0.0053 |
| **Marital Status** | | |
| Never married | -0.647*** | 0.0067 |
| Widows and widowers | 0.156*** | 0.0094 |
| Divorced/separated | 0.150*** | 0.034 |
| **Educational Attainment** | | |
| Primary to Matriculation | -0.059*** | 0.006 |
| Above Matriculation | -0.229*** | 0.0091 |
| **Household Size** | | |
| Single Member hhs | -0.168*** | 0.0187 |
| Six and above members' hhs | -0.063*** | 0.0055 |
| **Household Occupation** | | |
| Regular wages/salary | -0.047*** | 0.0097 |
| Labour | 0.060*** | 0.0071 |
| Others | 0.182*** | 0.0088 |
| **Type of Toilet** | | |
| Septic tank/flush system | 0.110*** | 0.0085 |
| Pit | 0.194*** | 0.0085 |
| Service and others | -0.062*** | 0.0145 |
| **Drainage System** | | |
| Open kutcha | -0.088*** | 0.0082 |
| Open pucca | -0.042*** | 0.0082 |
| Covered pucca | 0.023** | 0.0097 |
| Underground | 0.067*** | 0.0099 |
| **Source of Drinking Water** | | |
| Bottle | 0.116*** | 0.0172 |
| Tap and tank water | 0.056*** | 0.0064 |
| Pucca well | 0.218*** | 0.0091 |
| Other sources | -0.032** | 0.015 |
| **Source of Energy for Cooking** | | |
| LPG/Gobar gas | -0.026*** | 0.008 |
| Dung cake | 0.014 | 0.0124 |
| Electricity | -0.134** | 0.0656 |
| Kerosene | 0.004 | 0.0184 |
| Coal/charcoal | -0.075*** | 0.0219 |
| Other source | -0.009 | 0.0226 |
| **Social Group** | | |
| SCs/STs | -0.132*** | 0.0073 |
| Other social group | -0.011* | 0.0061 |
| **Religion** | | |
| Muslim | 0.021*** | 0.0078 |
| Others (Christians, Sikhs, etc.) | 0.002 | 0.0097 |
| **HHs Consumption Quintile** | | |
| 2nd | 0.087*** | 0.0096 |
| 3rd | 0.171*** | 0.0095 |
| 4th | 0.285*** | 0.0097 |
| Highest | 0.457*** | 0.0106 |
| **/cut1** | 1.708 | 0.0112 |
| **/cut2** | 2.164 | 0.0117 |

Note: *** *p<0.01*, ** *p<0.05*, * *p<0.1*.

**Table 1a: Marginal Effects of Factors Associated with Multi-Morbidity of NCDs in General Population, based on Ordered Probit**

| Socio-demographic variables | Outcome 1 = 0 (No NCD) | | Outcome 2 =1 (one NCD) | | Outcome 3 =2 (Two or more NCDs) | |
|---|---|---|---|---|---|---|
| | Dy/Dx | Std. Error | Dy/Dx | Std. Error | Dy/Dx | Std. Error |
| **Year** | | | | | | |
| 2014 | -0.0102*** | 0.00057 | 0.0051*** | 0.00029 | 0.0051*** | 0.00028 |
| **Age Group** | | | | | | |
| 60-69 | -0.0624*** | 0.00086 | 0.0314*** | 0.00046 | 0.0311*** | 0.00045 |
| 70-79 | -0.0764*** | 0.00130 | 0.0384*** | 0.00068 | 0.0380*** | 0.00067 |
| 80+ | -0.0675*** | 0.00225 | 0.0339*** | 0.00114 | 0.0336*** | 0.00113 |
| **Place of Residence** | | | | | | |
| Urban | -0.005*** | 0.00077 | 0.0025*** | 0.00039 | 0.0025*** | 0.00039 |
| **Gender** | | | | | | |
| Women | 0.0101*** | 0.00056 | -0.0051*** | 0.00028 | -0.0050*** | 0.00028 |
| **Marital Status** | | | | | | |
| Never married | 0.068*** | 0.00072 | -0.0342*** | 0.00039 | -0.0339*** | 0.00040 |
| Widowed | -0.0164*** | 0.00099 | 0.0083*** | 0.00050 | 0.0082*** | 0.00049 |
| Divorced/separated | -0.0157*** | 0.00357 | 0.0079*** | 0.00179 | 0.0078*** | 0.00178 |
| **Educational Attainment** | | | | | | |
| Primary to Matriculation | 0.0062*** | 0.00063 | -0.0031*** | 0.00032 | -0.0031*** | 0.00031 |
| Above Matriculation | 0.0241*** | 0.00095 | -0.0121*** | 0.00048 | -0.0120*** | 0.00048 |
| **Household Size** | | | | | | |
| Single Member hhs | 0.0177*** | 0.00197 | -0.0089*** | 0.00099 | -0.0088*** | 0.00098 |
| Six and above members' hhs | 0.0066*** | 0.00058 | -0.0033*** | 0.00029 | -0.0033*** | 0.00029 |
| **Household Occupation** | | | | | | |
| Regular wages/salary | 0.0049*** | 0.00102 | -0.0025*** | 0.00051 | -0.0024*** | 0.00051 |
| Labour | -0.0063*** | 0.00075 | 0.0032*** | 0.00038 | 0.0031*** | 0.00037 |
| Others | -0.0192*** | 0.00092 | 0.0096*** | 0.00047 | 0.0095*** | 0.00046 |
| **Type of Toilet** | | | | | | |
| Septic tank/flush system | -0.0116*** | 0.00089 | 0.0058*** | 0.00045 | 0.0058*** | 0.00044 |
| Pit | -0.0204*** | 0.00089 | 0.0102*** | 0.00045 | 0.0101*** | 0.00045 |
| Service and others | 0.0065*** | 0.00152 | -0.0033*** | 0.00077 | -0.0032*** | 0.00076 |
| **Drainage System** | | | | | | |
| Open kutcha | 0.0093*** | 0.00086 | -0.0047*** | 0.00043 | -0.0046*** | 0.00043 |
| Open pucca | 0.0044*** | 0.00086 | -0.0022*** | 0.00043 | -0.0022*** | 0.00043 |
| Covered pucca | -0.0024** | 0.00103 | 0.0012** | 0.00052 | 0.0012** | 0.00051 |
| Underground | -0.0071*** | 0.00104 | 0.0035*** | 0.00052 | 0.0035*** | 0.00052 |
| **Source of Drinking Water** | | | | | | |
| Bottle | -0.0122*** | 0.00180 | 0.0061*** | 0.00091 | 0.0061*** | 0.00090 |
| Tap and tank water | -0.0059*** | 0.00067 | 0.0030*** | 0.00034 | 0.0030*** | 0.00033 |
| Pucca well | -0.023*** | 0.00095 | 0.0115*** | 0.00048 | 0.0114*** | 0.00048 |
| Other sources | 0.0033** | 0.00158 | -0.0017** | 0.00079 | -0.0017** | 0.00078 |
| **Source of Energy for Cooking** | | | | | | |
| LPG/Gobar gas | 0.0027*** | 0.00084 | -0.0014*** | 0.00042 | -0.0014*** | 0.00042 |
| Dung cake | -0.0015 | 0.00131 | 0.0008 | 0.00066 | 0.0008 | 0.00065 |
| Electricity | 0.0141** | 0.00690 | -0.0071** | 0.00347 | -0.0070** | 0.00343 |
| Kerosene | -0.0004 | 0.00194 | 0.0002 | 0.00097 | 0.0002 | 0.00096 |
| Coal/charcoal | 0.0079*** | 0.00230 | -0.0040*** | 0.00116 | -0.0039*** | 0.00115 |
| Other source | 0.001 | 0.00238 | -0.0005 | 0.00119 | -0.0005 | 0.00118 |
| **Social Group** | | | | | | |
| SCs/STs | 0.0139** | 0.00076 | -0.0070*** | 0.00038 | -0.0069*** | 0.00038 |
| Other social group | 0.0012* | 0.00064 | -0.0006* | 0.00032 | -0.0006* | 0.00032 |
| **Religion** | | | | | | |
| Muslim | -0.0022** | 0.00082 | 0.0011*** | 0.00041 | 0.0011*** | 0.00041 |
| Others (Christians, Sikhs, etc.) | -0.0002 | 0.00102 | 0.0001 | 0.00051 | 0.0001 | 0.00051 |
| **HHs Consumption Quintile** | | | | | | |
| 2nd | -0.0091*** | 0.00101 | 0.0046*** | 0.00051 | 0.0045*** | 0.00050 |
| 3rd | -0.018*** | 0.00100 | 0.0090*** | 0.00050 | 0.0089*** | 0.00050 |
| 4th | -0.0299*** | 0.00102 | 0.0150*** | 0.00051 | 0.0149*** | 0.00051 |
| Highest | -0.0481*** | 0.00112 | 0.0241*** | 0.00057 | 0.0239*** | 0.00057 |

Note: *** *p<0.01*, ** *p<0.05*, * *p<0.1*.

**Table2: Factors Associated with Diabetes and Multi-Morbidity of Diabetes and Hypertension in General Population, based on Ordered Probit**

| Socio-demographic variables | Number of obs = 665370<br>Wald chi2(41) = 7908.24<br>Prob > chi2 = 0.0000<br>Log pseudolikelihood = -29608.126<br>Pseudo R2 = 0.1984 | |
|---|---|---|
| | **Coef.** | **Std. Error** |
| **Year** | | |
| 2014 | 0.393*** | 0.0124 |
| **Age Group** | | |
| 60-69 | 0.574*** | 0.0161 |
| 70-79 | 0.603*** | 0.0248 |
| 80+ | 0.443*** | 0.0451 |
| **Place of Residence** | | |
| Urban | 0.092*** | 0.0154 |
| **Gender** | | |
| Women | -0.091*** | 0.0110 |
| **Marital Status** | | |
| Never married | -0.814*** | 0.0193 |
| Widowed | 0.124*** | 0.0190 |
| Divorced/separated | 0.147** | 0.0650 |
| **Educational Attainment** | | |
| Primary to Matriculation | -0.017 | 0.0132 |
| Above Matriculation | -0.215*** | 0.0184 |
| **Household Size** | | |
| Single Member hhs | -0.262*** | 0.0429 |
| Six and above members hhs | -0.046*** | 0.0115 |
| **Household Occupation** | | |
| Regular wages/salary | -0.023 | 0.0202 |
| Labour | 0.009 | 0.0165 |
| Others | 0.198*** | 0.0174 |
| **Type of Toilet** | | |
| Septic tank/flush system | 0.177*** | 0.0192 |
| Pit | 0.196*** | 0.0191 |
| Service and others | -0.036 | 0.0357 |
| **Drainage System** | | |
| Open kutcha | -0.107*** | 0.0197 |
| Open pucca | -0.063*** | 0.0179 |
| Covered pucca | 0.052*** | 0.0199 |
| Underground | 0.083*** | 0.0198 |
| **Source of Drinking Water** | | |
| Bottle | 0.305*** | 0.0297 |
| Tap and tank water | 0.096*** | 0.0142 |
| Pucca well | 0.373*** | 0.0188 |
| Others | 0.001 | 0.0352 |
| **Source of Energy for Cooking** | | |
| LPG/Gobar gas | 0.064*** | 0.0169 |
| Dung cake | -0.126*** | 0.0368 |
| Electricity | 0.194 | 0.1207 |
| Kerosene | 0.021 | 0.0388 |
| Coal/charcoal | -0.071 | 0.0511 |
| Other source | -0.007 | 0.0584 |
| **Social Group** | | |
| SCs/STs | -0.187*** | 0.0163 |
| Other social group | -0.101*** | 0.0124 |
| **Religion** | | |
| Muslim | 0.032** | 0.0161 |
| Others (Christians, Sikhs, etc.) | 0.083*** | 0.0192 |
| **HHs Consumption Quintile** | | |
| 2nd | 0.072*** | 0.0251 |
| 3rd | 0.222*** | 0.0236 |
| 4th | 0.333*** | 0.0234 |
| Highest | 0.545*** | 0.0245 |
| | | |
| **/cut1** | 2.884 | 0.0275 |
| **/cut2** | 4.366 | 0.0404 |

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 2a: Marginal Effects of Factors Associated with Diabetes and Multi-Morbidity of Diabetes & Hypertension in General Population, based on Ordered Probit**

| Socio-demographic variables | Outcome 1 =0 (no NCDs) | | Outcome 2 =1 (having diabetes) | | Outcome 3 =2 (having diabetes & hypertension) | |
|---|---|---|---|---|---|---|
| | Dy/Dx | Std. Error | Dy/Dx | Std. Error | Dy/Dx | Std. Error |
| **Year** | | | | | | |
| 2014 | -0.0085*** | 0.00027 | 0.0083*** | 0.00027 | 0.0002*** | 0.00002 |
| **Age Group** | | | | | | |
| 60-69 | -0.0125*** | 0.00036 | 0.0122*** | 0.00036 | 0.0003*** | 0.00003 |
| 70-79 | -0.0131*** | 0.00055 | 0.0128*** | 0.00054 | 0.0003*** | 0.00003 |
| 80+ | -0.0096*** | 0.00098 | 0.0094*** | 0.00096 | 0.0002*** | 0.00003 |
| **Place of Residence** | | | | | | |
| Urban | -0.0020*** | 0.00034 | 0.0019*** | 0.00033 | 0.00005*** | 0.00001 |
| **Gender** | | | | | | |
| Women | 0.0020*** | 0.00024 | -0.0019*** | 0.00023 | -0.00005*** | 0.00001 |
| **Marital Status** | | | | | | |
| Never married | 0.0177*** | 0.00044 | -0.0173*** | 0.00043 | -0.0004*** | 0.00004 |
| Widowed | -0.0027*** | 0.00041 | 0.0026*** | 0.00040 | 0.0001*** | 0.00001 |
| Divorced/separated | -0.0032** | 0.00141 | 0.0031** | 0.00138 | 0.0001** | 0.00004 |
| **Educational Attainment** | | | | | | |
| Primary to Matriculation | 0.0004 | 0.00029 | -0.0004 | 0.00028 | -0.00001 | 0.00001 |
| Above Matriculation | 0.0047*** | 0.00040 | -0.0046*** | 0.00039 | -0.0001*** | 0.00001 |
| **Household Size** | | | | | | |
| Single Member hhs | 0.0057*** | 0.00093 | -0.0055*** | 0.00091 | -0.0001*** | 0.00003 |
| Six and above members hhs | 0.0010*** | 0.00025 | -0.0010*** | 0.00024 | -0.00002*** | 0.00001 |
| **Household Occupation** | | | | | | |
| Regular wages/salary | 0.0005 | 0.00044 | -0.0005 | 0.00043 | -0.00001 | 0.00001 |
| Labour | -0.0002 | 0.00036 | 0.0002 | 0.00035 | 0.000005 | 0.00001 |
| Others | -0.0043*** | 0.00038 | 0.0042*** | 0.00037 | 0.0001*** | 0.00001 |
| **Type of Toilet** | | | | | | |
| Septic tank/flush system | -0.0038*** | 0.00042 | 0.0037*** | 0.00041 | 0.0001*** | 0.00001 |
| Pit | -0.0043*** | 0.00042 | 0.0042*** | 0.00041 | 0.0001*** | 0.00001 |
| Service and others | 0.0008 | 0.00078 | -0.0008 | 0.00076 | -0.00002 | 0.00002 |
| **Drainage System** | | | | | | |
| Open kutcha | 0.0023*** | 0.00043 | -0.0023*** | 0.00042 | -0.0001*** | 0.00001 |
| Open pucca | 0.0014*** | 0.00039 | -0.0013*** | 0.00038 | -0.00003*** | 0.00001 |
| Covered pucca | -0.0011*** | 0.00043 | 0.0011*** | 0.00042 | 0.00003*** | 0.00001 |
| Underground | -0.0018*** | 0.00043 | 0.0018*** | 0.00042 | 0.00004*** | 0.00001 |
| **Source of Drinking Water** | | | | | | |
| Bottle | -0.0066*** | 0.00065 | 0.0065*** | 0.00063 | 0.0002*** | 0.00002 |
| Tap and tank water | -0.0021*** | 0.00031 | 0.0020*** | 0.00030 | 0.0001*** | 0.00001 |
| Pucca well | -0.0081*** | 0.00041 | 0.0079*** | 0.00040 | 0.0002*** | 0.00002 |
| Other sources | 0.0000 | 0.00077 | 0.0000 | 0.00075 | 0.0000003 | 0.00002 |
| **Source of Energy for Cooking** | | | | | | |
| LPG/Gobar gas | -0.0014*** | 0.00037 | 0.0013*** | 0.00036 | 0.00003*** | 0.00001 |
| Dung cake | 0.0027*** | 0.00080 | -0.0027*** | 0.00078 | -0.0001*** | 0.00002 |
| Electricity | -0.0042 | 0.00263 | 0.0041 | 0.00256 | 0.0001 | 0.00007 |
| Kerosene | -0.0005 | 0.00084 | 0.0005 | 0.00082 | 0.00001 | 0.00002 |
| Coal/charcoal | 0.0015 | 0.00111 | -0.0015 | 0.00108 | -0.00004 | 0.00003 |
| Other source | 0.0001 | 0.00127 | -0.0001 | 0.00124 | -0.000004 | 0.00003 |
| **Social Group** | | | | | | |
| SCs/STs | 0.0041*** | 0.00036 | -0.0040*** | 0.00035 | -0.0001*** | 0.00001 |
| Others | 0.0022*** | 0.00027 | -0.0021*** | 0.00026 | -0.0001*** | 0.00001 |
| **Religion** | | | | | | |
| Muslim | -0.0007** | 0.00035 | 0.0007** | 0.00034 | 0.00002** | 0.00001 |
| Others (Christians, Sikhs, etc.) | -0.0018*** | 0.00042 | 0.0018*** | 0.00041 | 0.00004*** | 0.00001 |
| **HHs Consumption Quintile** | | | | | | |
| 2nd | -0.0016*** | 0.00055 | 0.0015*** | 0.00053 | 0.00004*** | 0.00001 |
| 3rd | -0.0048*** | 0.00051 | 0.0047*** | 0.00050 | 0.0001*** | 0.00002 |
| 4th | -0.0073*** | 0.00051 | 0.0071*** | 0.00050 | 0.0002*** | 0.00002 |
| Highest | -0.0118*** | 0.00054 | 0.0116*** | 0.00053 | 0.0003*** | 0.00003 |

Note: *** *p<0.01, ** p<0.05, * p<0.1.*

**Table 3: Factors Associated with Diabetes, Diabetes and Multi-Morbidity of Diabetes & Heart Diseases in General Population, based on Ordered Probit**

| Socio-demographic variables | Number of obs = 665370<br>Wald chi2(41) = 7921.63<br>Prob > chi2 = 0.0000<br>Log pseudolikelihood = -29903.656<br>Pseudo R2 = 0.1976 | |
|---|---|---|
| | **Coef.** | **Std. Error** |
| **Year** | | |
| 2014 | 0.395*** | 0.0123 |
| **Age Group** | | |
| 60-69 | 0.572*** | 0.0160 |
| 70-79 | 0.605*** | 0.0249 |
| 80+ | 0.447*** | 0.0451 |
| **Place of Residence** | | |
| Urban | 0.093*** | 0.0154 |
| **Gender** | | |
| Women | -0.096*** | 0.0110 |
| **Marital Status** | | |
| Never married | -0.815*** | 0.0193 |
| Widows and widowers | 0.126*** | 0.0189 |
| Divorced/separated | 0.145** | 0.0648 |
| **Educational Attainment** | | |
| Primary to Matriculation | -0.018 | 0.0132 |
| Above Matriculation | -0.217*** | 0.0184 |
| **Household Size** | | |
| Single Member hhs | -0.254*** | 0.0431 |
| Six and above members' hhs | -0.047*** | 0.0115 |
| **Household Occupation** | | |
| Regular wages/salary | -0.027 | 0.0202 |
| Labour | 0.008 | 0.0164 |
| Other Occupation | 0.194*** | 0.0174 |
| **Type of Toilet** | | |
| Septic tank/flush system | 0.177*** | 0.0192 |
| Pit | 0.196*** | 0.0191 |
| Service and others | -0.036 | 0.0357 |
| **Drainage System** | | |
| Open kutcha | -0.106*** | 0.0197 |
| Open pucca | -0.064*** | 0.0179 |
| Covered pucca | 0.052*** | 0.0199 |
| Underground | 0.086*** | 0.0198 |
| **Source of Drinking Water** | | |
| Bottle | 0.305*** | 0.0297 |
| Tap and tank water | 0.096*** | 0.0141 |
| Pucca well | 0.374*** | 0.0187 |
| Other sources | 0.004 | 0.0352 |
| **Source of Energy for Cooking** | | |
| LPG/Gobar gas | 0.065*** | 0.0169 |
| Dung cake | -0.127*** | 0.0368 |
| Electricity | 0.147 | 0.1142 |
| Kerosene | 0.028 | 0.0389 |
| Coal/charcoal | -0.067 | 0.0512 |
| Other source | -0.004 | 0.0584 |
| **Social Group** | | |
| SCs/STs | -0.186*** | 0.0163 |
| Others | -0.100*** | 0.0124 |
| **Religion** | | |
| Muslim | 0.032** | 0.0160 |
| Others (Christians, Sikhs, etc.) | 0.084*** | 0.0192 |
| **HHs Consumption Quintile** | | |
| 2nd | 0.071*** | 0.0250 |
| 3rd | 0.222*** | 0.0235 |
| 4th | 0.335*** | 0.0234 |
| Highest | 0.546*** | 0.0244 |
| | | |
| **/cut1** | 2.884 | 0.0275 |
| **/cut2** | 4.194 | 0.0356 |

Note: *** *p<0.01,* ** *p<0.05,* * *p<0.1.*

**Table 3a: Marginal Effects of Factors Associated with Diabetes, Multi-Morbidity of Diabetes and Heart Diseases in General Population, based on Ordered Probit**

| Socio-demographic variables | Outcome 1 =0 (No NCDs) | | Outcome 2 =1 (diabetes patient) | | Outcome 3 =2 (having diabetes & heart Diseases) | |
|---|---|---|---|---|---|---|
| | Dy/Dx | Std. Error | Dy/Dx | Std. Error | Dy/Dx | Std. Error |
| **Year** | | | | | | |
| 2014 | -0.0086*** | 0.00027 | 0.0082*** | 0.00026 | 0.0004*** | 0.00003 |
| **Age Group** | | | | | | |
| 60-69 | -0.0124*** | 0.00036 | 0.0119*** | 0.00035 | 0.0005*** | 0.00004 |
| 70-79 | -0.0132*** | 0.00055 | 0.0126*** | 0.00053 | 0.0005*** | 0.00004 |
| 80+ | -0.0097*** | 0.00099 | 0.0093*** | 0.00095 | 0.0004*** | 0.00005 |
| **Place of Residence** | | | | | | |
| Urban | -0.0020*** | 0.00033 | 0.0019*** | 0.00032 | 0.0001*** | 0.00001 |
| **Gender** | | | | | | |
| Women | 0.0021*** | 0.00024 | -0.0020*** | 0.00023 | -0.0001*** | 0.00001 |
| **Marital Status** | | | | | | |
| Never married | 0.0177*** | 0.00044 | -0.0170*** | 0.00043 | -0.0007*** | 0.00005 |
| Widows and widowers | -0.0027*** | 0.00041 | 0.0026*** | 0.00040 | 0.0001*** | 0.00002 |
| Divorced/separated | -0.0032** | 0.00141 | 0.0030** | 0.00135 | 0.0001** | 0.00006 |
| **Educational Attainment** | | | | | | |
| Primary to Matriculation | 0.0004 | 0.00029 | -0.0004 | 0.00028 | -0.00002 | 0.00001 |
| Above Matriculation | 0.0047*** | 0.00040 | -0.0045*** | 0.00038 | -0.0002*** | 0.00002 |
| **Household Size** | | | | | | |
| Single Member hhs | 0.0055*** | 0.00094 | -0.0053*** | 0.00090 | -0.0002*** | 0.00004 |
| Six and above members hhs | 0.0010*** | 0.00025 | -0.0010*** | 0.00024 | -0.00004*** | 0.00001 |
| **Household Occupation** | | | | | | |
| Regular wages/salary | 0.0006 | 0.00044 | -0.0006 | 0.00042 | -0.00002 | 0.00002 |
| Labour | -0.0002 | 0.00036 | 0.0002 | 0.00034 | 0.00001 | 0.00001 |
| Other Occupation | -0.0042*** | 0.00038 | 0.0041*** | 0.00036 | 0.0002*** | 0.00002 |
| **Type of Toilet** | | | | | | |
| Septic tank/flush system | -0.0039*** | 0.00042 | 0.0037*** | 0.00040 | 0.0002*** | 0.00002 |
| Pit | -0.0043*** | 0.00042 | 0.0041*** | 0.00040 | 0.0002*** | 0.00002 |
| Service and others | 0.0008 | 0.00078 | -0.0007 | 0.00074 | -0.00003 | 0.00003 |
| **Drainage System** | | | | | | |
| Open kutcha | 0.0023*** | 0.00043 | -0.0022*** | 0.00041 | -0.0001*** | 0.00002 |
| Open pucca | 0.0014*** | 0.00039 | -0.0013*** | 0.00037 | -0.0001*** | 0.00002 |
| Covered pucca | -0.0011*** | 0.00043 | 0.0011*** | 0.00041 | 0.00005*** | 0.00002 |
| Underground | -0.0019*** | 0.00043 | 0.0018*** | 0.00041 | 0.0001*** | 0.00002 |
| **Source of Drinking Water** | | | | | | |
| Bottle | -0.0066*** | 0.00065 | 0.0064*** | 0.00062 | 0.0003*** | 0.00003 |
| Tap and tank water | -0.0021*** | 0.00031 | 0.0020*** | 0.00030 | 0.0001*** | 0.00001 |
| Pucca well | -0.0081*** | 0.00041 | 0.0078*** | 0.00040 | 0.0003*** | 0.00003 |
| Other sources | -0.0001 | 0.00077 | 0.0001 | 0.00073 | 0.000004 | 0.00003 |
| **Source of Energy for Cooking** | | | | | | |
| LPG/Gobar gas | -0.0014*** | 0.00037 | 0.0014*** | 0.00035 | 0.0001*** | 0.00002 |
| Dung cake | 0.0028*** | 0.00080 | -0.0026*** | 0.00077 | -0.0001*** | 0.00003 |
| Electricity | -0.0032 | 0.00248 | 0.0031 | 0.00238 | 0.0001 | 0.00010 |
| Kerosene | -0.0006 | 0.00085 | 0.0006 | 0.00081 | 0.00002 | 0.00003 |
| Coal/charcoal | 0.0015 | 0.00111 | -0.0014 | 0.00107 | -0.0001 | 0.00005 |
| Other source | 0.0001 | 0.00127 | -0.0001 | 0.00122 | -0.000004 | 0.00005 |
| **Social Group** | | | | | | |
| SCs/STs | 0.0040*** | 0.00036 | -0.0039*** | 0.00034 | -0.0002*** | 0.00002 |
| Others | 0.0022*** | 0.00027 | -0.0021*** | 0.00026 | -0.0001*** | 0.00001 |
| **Religion** | | | | | | |
| Muslim | -0.0007** | 0.00035 | 0.0007** | 0.00033 | 0.00003** | 0.00001 |
| Others (Christians, Sikhs, etc.) | -0.0018*** | 0.00042 | 0.0018*** | 0.00040 | 0.0001*** | 0.00002 |
| **HHs Consumption Quintile** | | | | | | |
| 2nd | -0.0015*** | 0.00054 | 0.0015*** | 0.00052 | 0.0001*** | 0.00002 |
| 3rd | -0.0048*** | 0.00051 | 0.0046*** | 0.00049 | 0.0002*** | 0.00003 |
| 4th | -0.0073*** | 0.00051 | 0.0070*** | 0.00049 | 0.0003*** | 0.00003 |
| Highest | -0.0119*** | 0.00054 | 0.0114*** | 0.00052 | 0.0005*** | 0.00004 |

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 4: Factors Associated with Diabetes, Multi-Morbidity of Diabetes and Cardiovascular Diseases in General Population based on Ordered Probit**

| Socio-demographic variables | Number of obs = 665370<br>Wald chi2(41) = 7962.38<br>Prob > chi2 = 0.0000<br>Log pseudolikelihood = -30254.506<br>Pseudo R2 = 0.1960 | |
|---|---|---|
| | **Coef.** | **Std. Error** |
| **Year** | | |
| 2014 | 0.3937*** | 0.0123 |
| **Age Group** | | |
| 60-69 | 0.5738*** | 0.0160 |
| 70-79 | 0.6073*** | 0.0248 |
| 80+ | 0.4425*** | 0.0450 |
| **Place of Residence** | | |
| Urban | 0.0926*** | 0.0154 |
| **Gender** | | |
| Women | -0.095*** | 0.0110 |
| **Marital Status** | | |
| Never married | -0.814*** | 0.0193 |
| Widows and widowers | 0.1272*** | 0.0189 |
| Divorced/separated | 0.1421** | 0.0646 |
| **Educational Attainment** | | |
| Primary to Matriculation | -0.017 | 0.0132 |
| Above Matriculation | -0.216*** | 0.0184 |
| **Household Size** | | |
| Single Member hhs | -0.257*** | 0.0430 |
| Six and above members hhs | -0.047*** | 0.0115 |
| **Household Occupation** | | |
| Regular wages/salary | -0.025 | 0.0202 |
| Labour | 0.0082 | 0.0164 |
| Other Occupation | 0.1966*** | 0.0174 |
| **Type of Toilet** | | |
| Septic tank/flush system | 0.1771*** | 0.0192 |
| Pit | 0.1963*** | 0.0191 |
| Service and others | -0.035 | 0.0357 |
| **Drainage System** | | |
| Open kutcha | -0.107*** | 0.0196 |
| Open pucca | -0.063*** | 0.0179 |
| Covered pucca | 0.0511*** | 0.0199 |
| Underground | 0.0841*** | 0.0197 |
| **Source of Drinking Water** | | |
| Bottle | 0.3033*** | 0.0296 |
| Tap and tank water | 0.0976*** | 0.0141 |
| Pucca well | 0.373*** | 0.0187 |
| Others sources | 0.0033 | 0.0351 |
| **Source of Energy for Cooking** | | |
| LPG/Gobar gas | 0.0632*** | 0.0169 |
| Dung cake | -0.127*** | 0.0367 |
| Electricity | 0.1798 | 0.1189 |
| Kerosene | 0.0248 | 0.0389 |
| Coal/charcoal | -0.07 | 0.0511 |
| Other source | -0.007 | 0.0583 |
| **Social Group** | | |
| SCs/STs | -0.186*** | 0.0163 |
| Others | -0.101*** | 0.0124 |
| **Religion** | | |
| Muslim | 0.0328** | 0.0160 |
| Others (Christians, Sikhs, etc.) | 0.0825*** | 0.0192 |
| **HHs Consumption Quintile** | | |
| 2nd | 0.0719*** | 0.0250 |
| 3rd | 0.2231*** | 0.0235 |
| 4th | 0.336*** | 0.0234 |
| Highest | 0.5473*** | 0.0244 |
| **/cut1** | 2.8847 | 0.0274 |
| **/cut2** | 4.0473 | 0.0331 |

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

**Table 4a: Marginal Effects of Factors Associated with Diabetes, Multi-Morbidity of Diabetes& Cardiovascular Diseases in General Population, based on Ordered Probit**

| Socio-demographic variables | Outcome 1 =0 (No NCDs) | | Outcome 2 =1, (having Diabetes) | | Outcome 3 =2 , (having Diabetes & Cardiovascular) | |
|---|---|---|---|---|---|---|
| | Dy/Dx | Std. Error | Dy/Dx | Std. Error | Dy/Dx | Std. Error |
| **Year** | | | | | | |
| 2014 | -0.0086*** | 0.00027 | 0.0080*** | 0.00026 | 0.0005*** | 0.00003 |
| **Age Group** | | | | | | |
| 60-69 | -0.0125*** | 0.00036 | 0.0117*** | 0.00034 | 0.0008*** | 0.00005 |
| 70-79 | -0.0132*** | 0.00055 | 0.0124*** | 0.00052 | 0.0008*** | 0.00006 |
| 80+ | -0.0096*** | 0.00098 | 0.0090*** | 0.00092 | 0.0006*** | 0.00007 |
| **Place of Residence** | | | | | | |
| Urban | -0.0020*** | 0.00033 | 0.0019*** | 0.00031 | 0.0001*** | 0.00002 |
| **Gender** | | | | | | |
| Women | 0.0021*** | 0.00024 | -0.0019*** | 0.00023 | -0.0001*** | 0.00002 |
| **Marital Status** | | | | | | |
| Never married | 0.0177*** | 0.00044 | -0.0166*** | 0.00042 | -0.0011*** | 0.00006 |
| Widows and widowers | -0.0028*** | 0.00041 | 0.0026*** | 0.00039 | 0.0002*** | 0.00003 |
| Divorced/separated | -0.0031** | 0.00140 | 0.0029** | 0.00132 | 0.0002** | 0.00009 |
| **Educational Attainment** | | | | | | |
| Primary to Matriculation | 0.0004 | 0.00029 | -0.0004 | 0.00027 | 0.0000 | 0.00002 |
| Above Matriculation | 0.0047*** | 0.00040 | -0.0044*** | 0.00038 | -0.0003*** | 0.00003 |
| **Household Size** | | | | | | |
| Single Member hhs | 0.0056*** | 0.00094 | -0.0052*** | 0.00088 | -0.0004*** | 0.00006 |
| Six and above members hhs | 0.0010*** | 0.00025 | -0.0010*** | 0.00023 | -0.0001*** | 0.00002 |
| **Household Occupation** | | | | | | |
| Regular wages/salary | 0.0005 | 0.00044 | -0.0005 | 0.00041 | -0.00003 | 0.00003 |
| Labour | -0.0002 | 0.00036 | 0.0002 | 0.00033 | 0.00001 | 0.00002 |
| Other Occupation | -0.0043*** | 0.00038 | 0.0040*** | 0.00036 | 0.0003*** | 0.00003 |
| **Type of Toilet** | | | | | | |
| Septic tank/flush system | -0.0039*** | 0.00042 | 0.0036*** | 0.00039 | 0.0002*** | 0.00003 |
| Pit | -0.0043*** | 0.00042 | 0.0040*** | 0.00039 | 0.0003*** | 0.00003 |
| Service and others | 0.0008 | 0.00078 | -0.0007 | 0.00073 | -0.00005 | 0.00005 |
| **Drainage System** | | | | | | |
| Open kutcha | 0.0023*** | 0.00043 | -0.0022*** | 0.00040 | -0.0001*** | 0.00003 |
| Open pucca | 0.0014*** | 0.00039 | -0.0013*** | 0.00036 | -0.0001*** | 0.00002 |
| Covered pucca | -0.0011*** | 0.00043 | 0.0010*** | 0.00040 | 0.0001*** | 0.00003 |
| Underground | -0.0018*** | 0.00043 | 0.0017*** | 0.00040 | 0.0001*** | 0.00003 |
| **Source of Drinking Water** | | | | | | |
| Bottle | -0.0066*** | 0.00065 | 0.0062*** | 0.00061 | 0.0004*** | 0.00005 |
| Tap and tank water | -0.0021*** | 0.00031 | 0.0020*** | 0.00029 | 0.0001*** | 0.00002 |
| Pucca well | -0.0081*** | 0.00041 | 0.0076*** | 0.00039 | 0.0005*** | 0.00004 |
| Other sources | -0.0001 | 0.00076 | 0.0001 | 0.00072 | 0.000004 | 0.00005 |
| **Source of Energy for Cooking** | | | | | | |
| LPG/Gobar gas | -0.0014*** | 0.00037 | 0.0013*** | 0.00034 | 0.0001*** | 0.00002 |
| Dung cake | 0.0028*** | 0.00080 | -0.0026*** | 0.00075 | -0.0002*** | 0.00005 |
| Electricity | -0.0039 | 0.00259 | 0.0037 | 0.00242 | 0.0002 | 0.00016 |
| Kerosene | -0.0005 | 0.00085 | 0.0005 | 0.00079 | 0.00003 | 0.00005 |
| Coal/charcoal | 0.0015 | 0.00111 | -0.0014 | 0.00104 | -0.0001 | 0.00007 |
| Other source | 0.0002 | 0.00127 | -0.0001 | 0.00119 | -0.00001 | 0.00008 |
| **Social Group** | | | | | | |
| SCs/STs | 0.0040*** | 0.00035 | -0.0038*** | 0.00033 | -0.0003*** | 0.00003 |
| Others | 0.0022*** | 0.00027 | -0.0021*** | 0.00025 | -0.0001*** | 0.00002 |
| **Religion** | | | | | | |
| Muslim | -0.0007** | 0.00035 | 0.0007** | 0.00033 | 0.00004** | 0.00002 |
| Others (Christians, Sikhs, etc.) | -0.0018*** | 0.00042 | 0.0017*** | 0.00039 | 0.0001*** | 0.00003 |
| **HHs Consumption Quintile** | | | | | | |
| 2nd | -0.0016*** | 0.00054 | 0.0015*** | 0.00051 | 0.0001*** | 0.00003 |
| 3rd | -0.0049*** | 0.00051 | 0.0045*** | 0.00048 | 0.0003*** | 0.00004 |
| 4th | -0.0073*** | 0.00051 | 0.0068*** | 0.00048 | 0.0005*** | 0.00004 |
| Highest | -0.0119*** | 0.00054 | 0.0112*** | 0.00051 | 0.0007*** | 0.00005 |

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

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## Appendix

**Table A 1: NCDs in General Population by Socio-Economic Status**

| Socio-demographic variables | 2004 (%) | 2014 (%) | t-test of difference in means between 2014-2004 |
|---|---|---|---|
| By Age Group | | | |
| 0-20 | 1.8(18.8) | 0.6 (4.6) | -31.8*** |
| 21-30 | 3.8(14.5) | 1.0(3.5) | -35.3*** |
| 31-50 | 7.2(36.4) | 5.3(28.1) | -16.3*** |
| 51-59 | 9.3(11.4) | 14.1(20.3) | 16.9*** |
| 60-69 | 11.7(11.6) | 24.5(26.2) | 36.7*** |
| 70-79 | 14.5(5.8) | 27.6(12.8) | 23.4*** |
| 80+ | 11.6(1.5) | 32.0(4.5) | 22.1*** |
| All | 4.6(100.0) | 4.9(100.0) | 6.5*** |
| Place of Residence | | | |
| Rural | 4.0(64.1) | 3.9(55.9) | -0.4 |
| Urban | 6.5(35.9) | 7.2(44.1) | 7.7*** |
| Distribution by Gender | | | |
| Men | 5.1(56.7) | 4.2(43.8) | -12.9*** |
| Women | 4.1(43.3) | 5.7(56.2) | 22.3*** |
| Marital Status | | | |
| Never Married | 2.0(21.1) | 0.8(7.1) | -29.6*** |
| Currently Married | 6.9(68.0) | 7.0(69.1) | 1.1 |
| Widowed | 9.3(10.2) | 21.3(22.9) | 33.3*** |
| Divorced/Separated | 8.0(0.7) | 13.2(0.9) | 4.3*** |
| Educational Attainment | | | |
| Illiterate | 4.1(38.0) | 5.8(37.1) | 19.3*** |
| Primary & Below | 3.9(25.5) | 4.3(26.6) | 4.9*** |
| Middle-Higher Secondary | 5.8(30.1) | 4.5(29.3) | -13.9*** |
| Graduation & Above | 8.1(6.4) | 5.6(7.0) | -10.3*** |
| Social Group | | | |
| SCs/STs | 3.2(19.5) | 3.4(19.3) | 2.5*** |
| OBC | 4.5(39.4) | 5.0(45.0) | 5.9*** |
| Others | 5.9(41.1) | 6.3(35.7) | 4.1*** |
| HHs Consumption Quintile | | | |
| Lowest | 2.4(12.3) | 2.0(10.3) | -5.4*** |
| 2nd | 3.2(15.6) | 3.4(13.6) | 1.5 |
| 3rd | 4.2(18.1) | 4.1(16.1) | -1.2 |
| 4th | 5.7(22.9) | 6.3(24.6) | 4.7*** |
| **Highest** | **8.7(31.1)** | **10.5(35.4)** | **11.7*****|

Note: Authors' calculations based on NSS data. Figures in parenthesis indicate percentage distribution by column; ** * represent significance at <=1% level.

**Table A 2**: **Population Suffering from Hypertension by Socio-Economic Background**

| Socio-demographic variables | 2004 (%) | 2014 (%) | t-test of difference in means between 2014-2004 |
|---|---|---|---|
| **By Age Group** | | | |
| 0-20 | 6.1(8.7) | 0.7(0.2) | -8.9*** |
| 21-30 | 12.2(13.5) | 10.6(1.7) | -1.5 |
| 31-50 | 13.9(38.7) | 18.4(24.5) | 7.4*** |
| 51-59 | 17.2(15.0) | 20.8(19.6) | 4.3*** |
| 60-69 | 17.2(15.4) | 26.6(32.6) | 12.6*** |
| 70-79 | 15.1(6.8) | 26.5(15.8) | 11.7*** |
| 80+ | 15.6(1.9) | 26.4(5.6) | 6.5*** |
| All | 13.1(100.0) | 21.3(100.0) | 26.1*** |
| **Place of Residence** | | | |
| Rural | 10.1(49.2) | 18.8(49.0) | 21.4*** |
| Urban | 18.5(50.8) | 24.6(51.0) | 12.2*** |
| **Distribution by Gender** | | | |
| Men | 11.9(51.5) | 20.7(42.2) | 18.0*** |
| Women | 14.6(48.5) | 21.8(57.8) | 13.4*** |
| **Marital Status** | | | |
| Never Married | 7.1(11.3) | 2.5(0.8) | -7.5*** |
| Currently Married | 14.6(75.8) | 21.6(70.2) | 15.6*** |
| Widowed | 15.3(12.2) | 26.7(28.4) | 11.3*** |
| Divorced/Separated | 13.6(0.7) | 14.4(0.6) | 0.2 |
| **Educational Attainment** | | | |
| Illiterate | 9.9(28.9) | 18.9(32.3) | 16.1*** |
| Primary & Below | 12.7(24.7) | 22.1(27.9) | 13.2*** |
| Middle-Higher Secondary | 15.7(36.1) | 22.9(31.7) | 10.4*** |
| Graduation & Above | 21.1(10.3) | 24.5(8.1) | 2.3** |
| **Social Group** | | | |
| SCs/STs | 10.3(15.2) | 18.3(16.6) | 10.7*** |
| OBC | 11.3(33.9) | 21.0(44.4) | 17.4*** |
| Others | 16.2(50.9) | 23.4(39.0) | 12.0*** |
| **HHs Consumption Quintile** | | | |
| Lowest | 4.7(4.3) | 17.2(8.1) | 13.7*** |
| 2nd | 8.4(10.0) | 16.0(10.1) | 9.0*** |
| 3rd | 10.9(15.1) | 20.0(15.0) | 10.9*** |
| 4th | 13.5(23.7) | 20.8(24.1) | 9.9*** |
| Highest | 19.7(46.9) | 25.5(42.7) | 8.5*** |

Note: Authors' calculations based on NSS data. Figures in parenthesis indicate percentage distribution by column;* * *stand for the significance level <=1%, ** denote significance level at <=5% level.

## Table A 3: Diabetes by Socio-Economic Background: All Population

| Socio-demographic variables | 2004 (%) | 2014 (%) | t-test of difference in means between 2014-2004* |
|---|---|---|---|
| **By Age Group** | | | |
| 0-20 | 5.6(11.0) | 6.1(1.3) | 0.7 |
| 21-30 | 9.8(14.9) | 4.1(0.7) | -6.3*** |
| 31-50 | 9.9(37.9) | 21.3(28.3) | 19.5*** |
| 51-59 | 11.9(14.2) | 28.9(27.0) | 19.6*** |
| 60-69 | 11.5(14.1) | 24.8(30.1) | 19.2*** |
| 70-79 | 10.9(6.7) | 16.3(9.7) | 6.6*** |
| 80+ | 6.8(1.2) | 14.4(3.2) | 6.0*** |
| All | 9.5(100.0) | 21.5(100.0) | 39.8*** |
| **Place of Residence** | | | |
| Rural | 7.7(52.0) | 16.6(43.3) | 23.6*** |
| Urban | 12.8(48.0) | 27.5(56.7) | 30.8*** |
| **Distribution by Gender** | | | |
| Men | 9.6(57.1) | 24.9(50.5) | 30.7*** |
| Women | 9.4(42.9) | 18.8(49.5) | 19.2*** |
| **Marital Status** | | | |
| Never Married | 7.1(15.6) | 10.0(3.3) | 4.0*** |
| Currently Married | 10.3(73.6) | 23.6(76.3) | 30.5*** |
| Widowed | 8.5(9.3) | 18.1(19.2) | 11.4*** |
| Divorced/Separated | 22.1(1.6) | 28.6(1.2) | 1.3 |
| **Educational Attainment** | | | |
| Illiterate | 6.7(26.8) | 16.6(28.2) | 19.4*** |
| Primary & Below | 9.0(23.9) | 20.2(25.5) | 17.0*** |
| Middle-Higher Secondary | 12.7(39.9) | 26.2(36.1) | 19.6*** |
| Graduation & Above | 14.1(9.4) | 31.5(10.2) | 11.6*** |
| **Social Group** | | | |
| SCs/STs | 6.9(14.1) | 18.0(16.2) | 15.5*** |
| OBC | 10.3(42.3) | 22.6(47.5) | 21.9*** |
| Others | 10.1(43.6) | 21.9(36.4) | 21.3*** |
| **HHs Consumption Quintile** | | | |
| Lowest | 5.1(6.5) | 8.1(3.8) | 4.2*** |
| 2nd | 4.4(7.2) | 13.9(8.8) | 12.8*** |
| 3rd | 9.0(17.1) | 17.0(12.7) | 10.4*** |
| 4th | 8.9(21.4) | 23.7(27.3) | 20.4*** |
| Highest | 14.6(47.8) | 28.5(47.4) | 20.6*** |

Note: Authors' calculations based on NSS data. Figures in parenthesis indicate percentage distribution by column;*** stand for the significant level <=1%.

**Table A4: Heart Diseases by Socio-Economic Status: All Population**

| Socio-demographic variables | 2004 (%) | 2014 (%) | t-test of difference in means over 2014-2004* |
|---|---|---|---|
| **By Age Group** | | | |
| 0-20 | 7.6(12.7) | 9.8(4.7) | 2.8*** |
| 21-30 | 9.4(12.2) | 8.6(3.1) | -0.9 |
| 31-50 | 12.6(41.0) | 8.1(24.5) | -8.9*** |
| 51-59 | 13.8(14.0) | 10.6(22.4) | -4.7*** |
| 60-69 | 10.9(11.4) | 8.6(23.7) | -4.2*** |
| 70-79 | 12.8(6.8) | 11.7(15.7) | -1.4 |
| 80+ | 13.7(2.0) | 12.3(5.9) | -1.0 |
| All | 11.2(100.0) | 9.5(100.0) | -6.6*** |
| **Place of Residence** | | | |
| Rural | 8.8(50.2) | 9.3(54.9) | 1.7** |
| Urban | 15.5(49.8) | 9.7(45.1) | -14.7*** |
| **Distribution by Gender** | | | |
| Men | 12.1(61.3) | 11.5(52.9) | -1.3 |
| Women | 10.0(38.7) | 7.9(47.1) | -5.4*** |
| **Marital Status** | | | |
| Never Married | 8.2(15.4) | 8.0(5.9) | -0.2 |
| Currently Married | 12.1(73.6) | 10.2(74.3) | -5.4*** |
| Widowed | 11.2(10.1) | 7.8(18.8) | -4.9*** |
| Divorced/Separated | 10.9(0.7) | 10.8(1.0) | 0.0 |
| **Educational Attainment** | | | |
| Illiterate | 8.5(29.0) | 8.6(33.3) | 0.3 |
| Primary & Below | 10.7(24.3) | 10.7(30.5) | 0.0 |
| Middle-Higher Secondary | 13.8(37.3) | 9.4(29.4) | -8.0*** |
| Graduation & Above | 16.5(9.4) | 9.3(6.8) | -6.2*** |
| **Social Group** | | | |
| SCs/STs | 7.9(13.8) | 9.2(18.6) | 2.1** |
| OBC | 9.1(32.1) | 9.4(44.5) | 0.6 |
| Others | 14.7(54.1) | 9.8(36.9) | -10.0*** |
| **HHs Consumption Quintile** | | | |
| Lowest | 7.7(8.4) | 10.5(11.1) | 3.3*** |
| 2nd | 8.4(11.8) | 8.1(11.4) | -0.5 |
| 3rd | 8.2(13.3) | 9.8(16.5) | 2.3** |
| 4th | 11.6(23.9) | 8.8(23.0) | -4.7*** |
| Highest | 15.3(42.6) | 10.1(38.0) | -9.9*** |

Note: Authors' calculations based on NSS 61st and 70th rounds. Figures in parenthesis indicate percentage distribution by column; *** stand for the significance level <=1%, and ** stand for significance level <=5%.

**Table A 5: Cardiovascular Diseases by Socio-Economic Status: All Population**

| Socio-demographic variables | 2004 (%) | 2014 (%) | t-test of difference in means over 2014-2004 |
|---|---|---|---|
| **By Age Group** | | | |
| 0-20 | 13.3(10.4) | 10.2(1.5) | -3.3*** |
| 21-30 | 21.5(13.0) | 19.0(2.2) | -1.8** |
| 31-50 | 26.3(39.8) | 26.2(24.6) | -0.1 |
| 51-59 | 30.9(14.6) | 31.0(20.5) | 0.2 |
| 60-69 | 28.0(13.6) | 34.8(29.8) | 8.2*** |
| 70-79 | 27.5(6.8) | 37.7(15.8) | 9.0*** |
| 80+ | 28.7(1.9) | 37.7(5.6) | 4.7*** |
| All | 24.0(100.0) | 30.4(100.0) | 17.1*** |
| **Place of Residence** | | | |
| Rural | 18.8(50.1) | 27.8(50.9) | 18.1*** |
| Urban | 33.4(49.9) | 33.8(49.1) | 0.7 |
| **Distribution by Gender** | | | |
| Men | 23.6(55.7) | 31.8(45.4) | 13.7*** |
| Women | 24.6(44.3) | 29.4(54.6) | 7.9*** |
| **Marital Status** | | | |
| Never Married | 14.9(13.0) | 10.3(2.4) | -5.1*** |
| Currently Married | 26.5(75.0) | 31.4(71.5) | 9.3*** |
| Widowed | 26.2(11.4) | 34.0(25.4) | 7.0*** |
| Divorced/ Separated | 21.6(0.6) | 25.2(0.7) | 0.7 |
| **Educational Attainment** | | | |
| Illiterate | 18.3(29.0) | 27.2(32.6) | 13.4*** |
| Primary & Below | 23.4(24.7) | 32.4(28.8) | 10.8*** |
| Middle-Higher Secondary | 29.0(36.4) | 32.0(31.0) | 3.7*** |
| Graduation & Above | 37.3(9.9) | 33.3(7.6) | -2.3** |
| **Social Group** | | | |
| SCs/STs | 18.1(14.7) | 26.9(17.0) | 9.8*** |
| OBC | 20.0(32.7) | 30.1(44.5) | 15.3*** |
| Others | 30.7(52.6) | 32.8(38.5) | 3.0*** |
| **HHs Consumption Quintile** | | | |
| Lowest | 12.5(6.3) | 27.6(9.1) | 13.0*** |
| 2nd | 16.7(10.9) | 23.7(10.5) | 6.8*** |
| 3rd | 19.0(14.3) | 29.5(15.5) | 10.7*** |
| 4th | 24.9(23.8) | 29.3(23.8) | 5.1*** |
| Highest | 34.5(44.7) | 35.0(41.2) | 0.7 |

Note: Authors' calculations based on NSS 61st and 70th rounds. +Absolute number is less than 100 without weight; ** * stand for the significance level <=1%, and ** stand for the significance level <=5% level.