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Socioeconomic determinants of chronic health diseases among older Indian adults: a nationally representative cross-sectional multilevel study

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ABSTRACT

Objective Study uses multilevel modelling to examine the effect of individual, household and contextual characteristics on chronic diseases among older Indian adults.

Design Nationally representative cross-sectional study.

Participants Data from the nationally representative, India Human Development Survey conducted in 2011–2012 was used in this study. The survey asked information related to the diagnosed chronic illnesses such as cataract, tuberculosis, hypertension, heart disease and others. The sample size of this study comprised 39 493 individuals who belonged to the age group 50 years and above.

Measures Self-reported diagnosed chronic illness.

Method Considering the hierarchal structure of the data multilevel logistic regression analysis was applied to attain the study objective.

Results Older adults aged 80 years and older were found with three times more chances (OR: 3.99, 95% CI 2.91 to 5.48) of suffering from a chronic ailment than 50–54 years old. Lifestyle risk factors such as alcohol and tobacco (smoked and smokeless) consumption were noted to be significantly associated with the presence of chronic illness whereas older adults who have never consumed smokeless tobacco stood 20% fewer chances (OR: 0.80, 95% CI 0.68 to 0.94) of having any chronic illness. Contextual level variables such as older adults residing in the rural areas were found with 17% fewer chances (OR: 0.83, 95% CI 0.70 to 0.97) of suffering from a chronic illness.

Conclusion Even after controlling for various characteristics at the individual, household and contextual levels, significant variations in chronic illness remain unexplained at the community and state level, respectively. The findings of this study could effectively be utilised to consider more contextual variables to examine the chronic health status among the growing older population of India.

Strengths and limitations of this study

- The study provides notable insights into the complex association between various socio-demographic, behavioural and contextual variables and chronic illnesses among older adults in India.
- Factors such as age, gender, marital status, use of tobacco and alcohol and household wealth significantly predict chronic ill-health among older adults.
- The study brought out the vital vignettes explaining the probability of chronic illness among the older adults at the individual as well as at the community (primary sampling unit) level.
- The cross-sectional study design prevents the establishment of any causal inferences from the study results.

INTRODUCTION

The apparent change in the epidemiological transition ratios from 1990 to 2016 shows an increase in non-communicable diseases (NCDs) and a decline of population suffering from communicable, maternal, neonatal and nutritional diseases.[1] The double burden of disease in India is straining a significant amount of the socioeconomic resources of the country, in addition to the immense loss of human lives. Dismal projections about cardiovascular diseases, diabetes and hypertension by 2030 are often attributed to transition in lifestyle consisting of lack of physical exercise, prolonged exposure to stressors[2 3] and adoption of unhealthy food habits prevalent in households impacted by urbanisation.[4 5] The older section of the population is pinned in a difficult position with the high prevalence of risk factors for the NCDs as well as the natural deterioration of overall health status because of ageing, which puts them in greater risk of disease-related mortality. Moreover, the older population is projected to increase from 8% in 2010 to 19% by 2050 which would be sharing about half of the disease burden of the country by 2030.[6] There is an undeniable need to address the issue of chronic illness in the older age group, especially in the context of an upcoming economy like India where the public health sectors

have primarily maintained their focus on maternal and neonatal health.[7 8]

The epidemic of chronic illness cannot be completely addressed without comprehending the socioeconomic determinants of health. Among the various sociodemographic determinants impacting health inequalities, there is ample evidence recognising the gender differences in the prevalence of chronic illnesses among the elderly. Women are found to have low mortality yet reported to be highly affected by chronic illnesses and mental disorders as compared with men.[9 10] Rieker and Bird[11] explored biopsychosocial and evolutionary explanations to the above health paradox, from association of depression and cardiovascular diseases to role of hormones after menopause.[11] With respect to the social stature occupied by women in society, the authors found probabilities of the specific lifestyle choices that may become an antecedent to risk factors for varied morbidities. Patel *et al*[4] found that in an Indian household, there is 44% more chance of a woman to have a chronic illness if her husband had a chronic disease.[4] The elderly population has been known to lack resources to sustain their well-being and they are heavily dependent on their kin for social support; elderly women have been known to face more social isolation by virtue of marital status or the cultural value accorded to them causing psychological distress.[12] Increasing health needs compounded with less access to resources is felt more pronounced in the rural areas of India.[13]

When considering the share in total burden of diseases, among communicable diseases, diarrhoea, lower respiratory and other common infectious diseases account for the majority of total share and cardiovascular and chronic respiratory diseases among NCDs . While diarrhoea and lower respiratory infections are the leading causes of death under the category of communicable diseases, cardiovascular diseases followed by chronic ailments of the respiratory system and cancer take highest toll on human lives under the NCDs category.[1] Communicable and NCDs have differential impacts on the different regions of the country. In majority of north and eastern states, communicable diseases are still quite prevalent, whereas NCDs and other lifestyle-related diseases are affecting considerable population in south and western Indian states. State differentials can be observed in terms of increase in the elderly population in both the southern and northern states of India[12] and the recent epidemiological transition ratios has shown that country suffering from 'age of receding pandemics' in 1990 has now been changed to 'the age of degenerative and man-made diseases' in 2016.[1] This reveals the need to explore the interplay of contextual and cultural factors including social groups and level of education responsible for contemporary trends relating to the health of the elderly.

WHO's Conceptual Framework for Action on the Social Determinants of Health presents an invaluable opportunity to researchers and policy makers to explore the structural and intermediary variables at play in determining social constructs like health equity, which in turn, determines the validity of any health policy.[14] The present study aims to utilise the framework to study the association among individual, household and contextual level variables present in the fabric of Indian society and chronic illnesses in adults aged 50 years and above.

DATE AND METHODS

Study design

The study utilised data from the second round of the India Human Development Survey (IHDS; 2011–12) conducted by the National Council of Applied Economic Research, New Delhi and University of Maryland. IHDS-II is a nationally representative, multitopic survey of 42 152 households in 1503 villages and 971 urban neighbourhoods across India. Nearly 53 582 individuals were interviewed among whom 39 493 belonged to the elderly age group (aged 50 years and above). Interviews spanned for 1 hour each and two interviews were conducted to obtain data about health, education, employment, economic status, marriage, fertility, gender relations, social capital and others.[15] A multistage stratified systematic sampling design was employed in the IHDS survey. Villages and urban blocks (comprising of 150–200 households) formed the primary sampling unit (PSU) from which the households were selected.

The term, 'community' used throughout this article refers to the clustering within the same geographical living environment. These communities were measured based on sharing a common PSU in the IHDS data. PSUs were census villages in rural areas and census enumeration blocks in urban areas. Details of sampling techniques and sampling weights are available on the website of IHDS.[15] The study sample includes 39 493 older adults who hail from 2460 PSUs (communities) across 33 states and union territories.

Outcome variable

IHDS asked about the presence of chronic morbidity among all the household members. The specific question was, 'has a doctor ever diagnosed any member in the household as having … Cataract? Tuberculosis? Hypertension? Heart Disease? …'. Questions were asked about a detailed list of chronic diseases, which included diabetes, leprosy, cancer, asthma, polio, paralysis, epilepsy, mental illness and other long-term diseases. Three sets of responses were sought: 'no', 'cured' and 'yes'. The present study considered the response, yes to define that the member of the household was diagnosed with chronic morbidity and suffering from the disease at the time of survey.

Covariates

Socio-demographic characteristics (age, sex, marital status and education), *lifestyle behaviour* (tobacco and alcohol use), *household status* (social group, religion and economic status), *contextual level variables* (illiteracy, social and economic composition of PSU) and place of residence (urban, rural) were considered in the analysis as potential

confounders. The individuals' ages were included in 5-year age groups, from 50 to 54 to 80+. Details of each participant's marital status were included—married, widowed/separated/divorced and never married. Education was measured as the highest completed level with four categories: never attended any school, below primary, below secondary and secondary or higher. The participants' use of tobacco (smoked and chewed) was categorised as 'never', 'sometimes' and 'daily user'. The composition of the Indian population is significantly influenced by religious affiliation and social identity (castes). Previous studies in India have documented poorer health and lower socioeconomic status among certain religious (Muslim) and caste (Scheduled Caste (SC) and Scheduled Tribes (STs)) groups as compared with Hindus and higher castes, respectively.[16 17] Religious affiliation was divided into four groups—Hindus, Muslim, Christian and Others (comprises Jains, Sikhs and Others). The identification of caste group was based on the respondent's self-report and was grouped into Others, Other Backward Castes (OBCs), SCs and STs. Index based on household amenities, assets and durables was derived by factor analysis used for the computation of the wealth index. Household wealth was generated by the data collection agency and was available in the dataset. Households were categorised into quintiles as follows: richest, richer, middle, poorer and poorest.

The association between shared contextual characteristics and health outcomes have been discussed in public health literature both from developed[10 18] and developing countries.[19–21] Contextual factors that are an inherent part of the complexities of a community at the PSU in a multicultural country like India might have significant contribution towards individual's health outcomes. These have an impact on the presence of chronic illness among the elderly. This study considered community education, social and economic composition along with location of the community for analysis. Community education was derived based on the proportion of adult population who never attended any formal level of schooling in the PSU and categories such as—0%–25%, 25%–50%, 50%–75% and 75%–100%. Similarly, community level social and economic composition was derived based on the proportion of households belonging to SC and ST social group and poorest wealth quintile, respectively. Community social and economic status was categorised as: 0%–25%, 25%–50%, 50%–75% and 75%–100%. Considering the geographical and sociocultural attributes, India has been divided into six regions and union territories : North (Delhi, Haryana, Himanchal Pradesh, Jammu & Kashmir, Punjab, Rajasthan and Uttarakhand), Central (Chhattisgarh, Madhya Pradesh and Uttar Pradesh), East (Bihar, Jharkhand, Odisha and West Bengal), West (Goa, Gujarat and Maharashtra), South (erstwhile Andhra Pradesh, Karnataka, Kerala and Tamil Nadu) Northeast (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura) and Union Territories (Chandigarh, Dadra & Nagar Haveli, Daman & Diu, Andaman & Nicobar Island, Lakshadweep and Puducherry).

Analytical approach

Considering the hierarchical structure of the data, the study employed multilevel logistic regression models to examine factors affecting the chronic ill-health status among older adults in India. The IHDS data have a three-level structure—individual, within community and within states. The estimates of the observed covariates are likely to be biased if the study fails to account for the existing hierarchical structure of the survey.[22] In addition to the observed covariates considered at each level, there are likely to be other unobserved factors affecting the chronic ill-health status, and these may operate at any level in the hierarchy.

The basic idea is that the ill-health status has contextual determinants, beyond individual/ household traits. The chronic ill-health status of the elderly in the same community, and in the same household is likely to be similar since they share many characteristics. The multilevel models adjust for this correlation across units of observation. The advantage of multilevel modelling is that it recognises the existing hierarchical structure of the data and estimates accordingly.[23 24] Consequently, the multilevel approach enables assessment of the relative contributions made by individual and area level effects on individual health status.[25] In addition, it provides more accurate SE estimation by accounting for the non-independence of the individual observations and provides for distinguishing between contextual and compositional effects.[26]

The dependent variable in our analysis is older individuals suffering from chronic morbidity (no/yes). Owing to the binary nature of the dependent variable, the multilevel model with logit link function can be described as follows:

$$\ln\left[\frac{p_{ics}}{1-p_{ics}}\right] = \alpha + x_{ics}\beta + w_{cs}\gamma + z_s n + u_{cs} + v_s,$$

where, $\ln\left[\frac{p_{ics}}{1-p_{ics}}\right]$ is the logit in which p_{ics} is the probability of an older person 'i' in the community (PSU) 'c' in the state 's' who suffers from chronic morbidity; x_{ics}, w_{cs} *and* z_s are the vectors of individual/household, community and state level characteristics; α is a constant, while β, γ and n are vectors of estimated parameter coefficient; and u_{cs} and v_s are unexplained residual terms at the community level and state level, respectively. Thus, a multilevel model with three levels was fitted to assess the influence of measured individual, household and community factors as fixed effect and community (u_{cs}) state v_s as random effects on reporting of chronic illness among older adults.

The correlation between the probability of chronic health in the same community and the same state are represented by variance partition coefficients (VPC), which are expressed as VPC_c and VPC_s, respectively[27]:

$$VPC_c = \frac{\sigma_c^2+\sigma_s^2}{\sigma_c^2+\sigma_s^2+3.29} \text{ and } VPC_s = \frac{\sigma_s^2}{\sigma_c^2+\sigma_s^2+3.29}$$

where, σ_c^2 represents the community level variance and σ_s^2 represents the state level variance. The multilevel model with a logistic link function was fitted for the chronic health status among older adults using STATA version 12.[28] We used the penalised quasi-likelihood approximate estimation procedure, which has been found to be the least biassed[29] in the case of binary response data. Since the study considered a range of covariates in the models, we examined for multicollinearity with variance inflation factors, all of which were much lower than 2.5, suggesting that the possibility of high multicollinearity was ostensible.

Ethics statement

This study used the IHDS data available in the public domain for use by researchers, thus no ethical clearance is required for this study.

Patient and public involvement

No patients and or public were involved in the design or planning of the study.

RESULTS

Descriptive statistics

Table 1 shows the sample description of the present study. Majority of older adults were female (51%) and ~77% belonged to the age group, 50–69 years. About 26% of the older adults were widowed/separated/divorced. Over half of the older adults had never attended any formal schooling, while one-fifth had completed secondary schooling and above. Nearly 40% and 52% of the older adults smoked and chewed tobacco, respectively. Social group composition suggests that 41% sample belonged to the OBC, followed by others (33%) and SC (18%). Majority of older adults belonged to the Hindu religion (83%) and over 65% were living in rural areas. The prevalence of any one of the chronic illness accounted for in the questionnaire among older adults was found to be 29% (table 2). The highest prevalence was observed in case of high blood pressure (11%), followed by diabetes (7%), cataract (4%) and asthma (3%). The statewide pattern shows highest prevalence of chronic illness in Kerala (55%), followed by Jammu & Kashmir (40%) and Punjab (38%) (figure 1). On the other hand, North-eastern states (10%), Maharashtra (16%) and Jharkhand (18%) recorded lowest prevalence of NCDs among the older population.

Multilevel analysis

In the multilevel models (table 3), community (PSU) and state were modelled to be random. The unadjusted ORs presented in *Model 1* show age and sex, education, tobacco and alcohol use, social and religious status, household wealth, community contextual level characteristics and place and region of residence significantly associated with the chronic ill-health status among older adults. The results of random intercept model (empty model)

Table 1 Sample distribution of older adults in the survey, IHDS 2011–2012

Background variables	N	%
Individual level		
Sex		
Male	19362	49.0
Female	20130	51.0
Age (years)		
50–54	9465	24.0
55–59	8102	20.5
60–64	7245	18.4
65–69	5682	14.4
70–74	4059	10.3
75–79	2356	6.0
80+	2580	6.5
Current marital status		
Married	28765	72.8
Wid/Sep/Div	10310	26.1
Never married	416	1.1
Education		
Never attended	20120	51.0
Below primary (1-4)	4073	10.3
Below secondary (5-8)	7224	18.3
Secondary and above (>=9)	8014	20.3
Tobacco consumption (smoked)		
Never used	6650	49.3
Sometime	1415	10.5
Daily	5417	40.2
Tobacco consumption (chewed)		
Never used	5423	40.2
Sometime	1050	7.8
Daily	7003	52.0
Alcohol consumption		
Never used	9321	69.2
Sometime user	3208	23.8
Daily user	949	7.0
Household level		
Social groups		
Others	13016	33.1
Other Backward Castes	16145	41.0
Scheduled Castes	7234	18.4
Scheduled Tribes	2992	7.6
Religion		
Hindu	32566	82.5
Muslim	4076	10.3
Christian	1226	3.1
Others	1623	4.1

Continued

Table 1 Continued

Background variables	N	%
Household economic status		
Quintile 1	7900	20.0
Quintile 2	7898	20.0
Quintile 3	7899	20.0
Quintile 4	7897	20.0
Quintile 5	7898	20.0
Contextual level		
Proportion Illiterate in PSU		
0–25	7739	19.6
25–50	8912	22.6
50–75	14425	36.5
75–100	8416	21.3
Proportion SC/ST in PSU		
0–25	23050	58.4
25–50	9341	23.7
50–75	3939	10.0
75–100	3162	8.0
Proportion poor in PSU		
0–25	13729	34.8
25–50	10429	26.4
50–75	9839	24.9
75–100	5495	13.9
Place of residence		
Urban	13552	34.3
Rural	25940	65.7
Total sample	39493	100

IHDS, India Human Development Survey; PSU, primary sampling unit; SC, Scheduled Caste; ST, Scheduled Tribe.

suggest considerable variations in chronic ill-health across communities (24%) and states (17%).

Model 2 shows that the odds of chronic illness among women were 70 percent (95% CI: 1.42 to 2.04) higher than that of their male counterparts. The age-wise pattern suggests a positive association between increase in age and chronic morbidity among older adults. The odds of chronic illness were higher among never married older adults than among those married (OR=1.96; 95% CI: 1.01 to 3.80). The likelihood of chronic illness was lower among those older adults who never smoked (OR=0.79; 95% CI: 0.67 to 0.93), never chewed tobacco (OR=0.77; 95% CI: 0.66 to 0.90) and never consumed alcohol (OR=0.67; 95% CI: 0.52 to 0.87), as compared with those who consumed all the three products daily, respectively. The results of random intercept show a decline after adjusting for individual characteristics, and the variations in chronic illness were 12 percent across communities and 5 percent across states.

Results after adjusting for household level characteristics along with individual variables in *Model* 3, suggest that household wealth significantly determines chronic illness among older adults. For instance, the odds of chronic illness were over two times (OR=2.10; 95% CI: 1.71 to 2.58) higher among older persons who belonged to the wealthiest household as compared with those who belonged to the poorest household. As observed in the previous model, the likelihood of chronic illness was increasing with the increase in age and was higher among women. Lower odds of chronic illness were found among those who never used tobacco (both smoked and smokeless) and alcohol.

Model 4, adjusting for contextual level variables along with individual and household characteristics, shows lower odds of chronic illness among communities dominated by over 70 percent of SC & ST population (OR=0.74; 95% CI: 0.56 to 0.98) as compared with communities where the proportion of SC/STs was less than 25 percent of the overall population. The likelihood of chronic illness was lower in rural areas than in urban areas (OR=0.83; 95% CI: 0.70 to 0.97). A similar pattern of association between age and sex with chronic illness was observed. Never married older adults experienced higher odds of chronic illness as compared with married adults (OR=1.99; 95% CI: 1.02 to 3.87). The likelihood of chronic illness was lower among older adults who never used tobacco and alcohol than among those who consumed these daily. Findings of random intercepts suggest that community (9%) and state (2%) level variations in chronic illness have declined further after adjusting for contextual level variables.

DISCUSSION AND CONCLUSION

The present study provides notable insights into the complex association of various socio-demographic and contextual variables and chronic illnesses among older adults in India. The association was gauged at three levels, namely, individual, household and contextual. At the individual level, elderly females were suffering more from chronic illness than males and the pattern remained similar when household and contextual factors were accounted for in the analysis. The finding substantiates considerable research conducted on the same in India and beyond.[30–32] Elderly females were also found to be highly affected by multiple morbidities from the age of 50 to 69 years.[32] Morbidity pattern governed by gender could be described by two hypotheses, one explaining higher levels of morbidity in women due to scarce reach to healthcare facilities compounded by the burden of gender roles.[33] The second hypothesis grounds the higher reporting of morbidity by women on the differential perception towards psychological and material antecedents of health.[9 34]

Study found that elderly individuals who have never been married stand double the odds of having a chronic disease compared with their married counterparts. Marriage accompanies social ties and it leads to

Table 2 Prevalence of different chronic morbidities among older adults, India, IHDS 2011–2012

Type of illness	n	Prevalence	SE	95% CI
Cataract	1537	3.9	0.001	3.7 to 4.1
Tuberculosis	285	0.7	0.000	0.6 to 0.8
High blood pressure	4357	11.0	0.002	10.7 to 11.3
Heart disease	1064	2.7	0.001	2.5 to 2.9
Diabetes	2634	6.7	0.001	6.4 to 6.9
Leprosy	51	0.1	0.000	0.1 to 0.2
Cancer	81	0.2	0.000	0.2 to 0.2
Asthma	1314	3.3	0.001	3.2 to 3.5
Polio	28	0.1	0.000	0.0 to 0.1
Paralysis	621	1.6	0.001	1.4 to 1.7
Epilepsy	153	0.4	0.000	0.3 to 0.4
Mental illness	189	0.5	0.000	0.4 to 0.5
Other long-term illness	3545	9.0	0.001	8.0 to 8.5
Any chronic morbidity	15859	29.3	0.002	28.9 to 29.8

IHDS, India Human Development Survey.

extensive social engagement, which renders it to be a valuable norm providing a social support system to cope with adversities and daily hassles alike. Social isolation, discrimination[35] and loneliness, which usually accompany widowhood, separation or a divorce or even if a person has never married till an advanced age, have been known to diminish the quality of life and undermine cardiovascular health.[36] Loneliness has been noted more in older women especially based on their marital status,[37] if they are less educated[38] and possess less wealth.[35 39] Occupying a median position between collectivism and individualism in India, women are expected to be the 'nurturer' of the family and are often provided with means of sustenance. As they grow older, they become more dependent in terms of nutrition, social and economic support.[40] Older women in the country have been noted to be treated as liabilities often leading to abuse and neglect,[41 42] the possible consequences of which concur with the findings of distress being the major risk factor for chronic illness in the elderly age group of women.[37 43] Compared with women, men were found to be less impacted by the consequences of widowhood.[37 44]

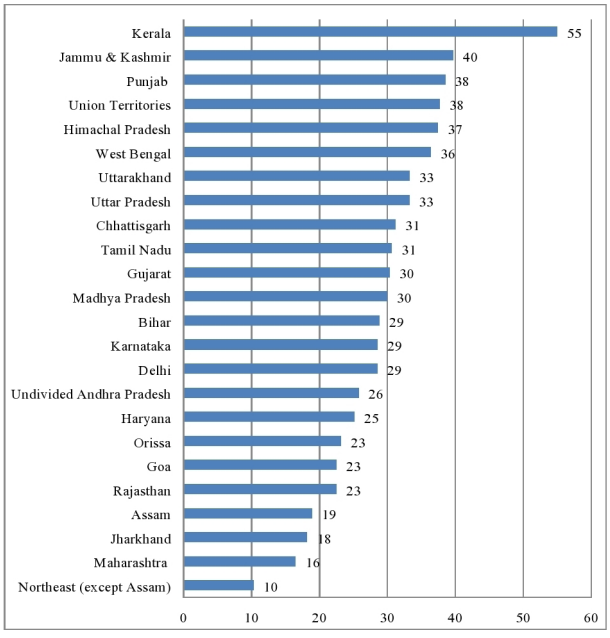

Figure 1 Statewise difference in chronic illness (in %) among older adults, India 2011–2012.

Among the varied risk factors for NCDs, the best known modifiable lifestyle risk factors are consumption of tobacco and alcohol.[45] In recent estimates, tobacco was found to be causing 6 percent of the total burden of disease[1] in India and the country is a major contributor to the total proportion of oral cancers in the world.[3] Tobacco is known for causing cancer in addition to cardiovascular diseases and males belonging to the 40–60 years and above account for more than 80 percent of total tobacco usage in the country.[46] The present study found that elderly individuals who have not yet smoked or chewed tobacco when compared with daily users stand fewer odds of having a chronic illness. Early findings on the consumption of tobacco found the major proportion being contributed by households belonging to the poorer and less educated sections of society.[46] This has changed considerably, presenting differentials in the mode of consumption (smoked or chewed) among different strata of society[47] highlighting the need to observe contemporary trends in order to introduce more relevant policy changes. The study also found that non-users of alcohol have 28 percent less chance of suffering from chronic illnesses compared with daily users. Heavy alcohol usage has also been noted to increase the risks for chronic diseases in elderly where more usage was observed among the age group of 60 to 69 years in similar studies.[48 49]

Table 3 Multilevel analysis of chronic illness among older adults, India, IHDS 2011–2012

	Model 1 (unadjusted)			Model 2 (individual)			Model 3 (model 2+household)			Model 4 (model 3+contextual)		
Background variables	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**	**OR**	**P value**	**95% CI**
Fixed effects												
Individual level												
Sex												
Male (ref.)	1.00			1.00			1.00			1.00		
Female	1.20	0.000	1.15 to 1.25	1.70	0.000	1.42 to 2.04	1.59	0.000	1.32 to 1.92	1.60	0.000	1.32 to 1.92
Age (years)												
50–54 (ref.)	1.00			1.00			1.00			1.00		
55–59	1.19	0.000	1.11 to 1.27	1.05	0.544	0.89 to 1.24	1.05	0.543	0.89 to 1.24	1.05	0.581	0.89 to 1.23
60–64	1.38	0.000	1.29 to 1.48	1.49	0.000	1.26 to 1.76	1.49	0.000	1.26 to 1.76	1.48	0.000	1.25 to 1.75
65–69	1.66	0.000	1.54 to 1.78	1.88	0.000	1.57 to 2.25	1.84	0.000	1.54 to 2.21	1.85	0.000	1.54 to 2.22
70–74	1.74	0.000	1.61 to 1.89	2.39	0.000	1.94 to 2.95	2.33	0.000	1.89 to 2.89	2.34	0.000	1.89 to 2.89
75–79	1.86	0.000	1.69 to 2.05	2.26	0.000	1.72 to 2.97	2.21	0.000	1.68 to 2.91	2.22	0.000	1.68 to 2.92
80+	1.83	0.000	1.67 to 2.01	4.26	0.000	3.11 to 5.83	4.03	0.000	2.94 to 5.53	3.99	0.000	2.91 to 5.48
Current marital status												
Married (ref.)	1.00			1.00			1.00			1.00		
Wid /Sep/Div	1.22	0.000	1.16 to 1.28	1.06	0.501	0.90 to 1.24	1.06	0.471	0.90 to 1.25	1.06	0.499	0.90 to 1.25
Never married	0.83	0.115	0.67 to 1.05	1.96	0.046	1.01 to 3.80	1.95	0.049	1.00 to 3.80	1.99	0.044	1.02 to 3.87
Education												
Never attended (ref.)	1.00			1.00			1.00			1.00		
Below Primary (1-4)	1.27	0.000	1.18 to 1.37	1.12	0.213	0.94 to 1.33	1.06	0.507	0.89 to 1.27	1.07	0.447	0.90 to 1.29
Below Secondary (5-8)	1.24	0.000	1.16 to 1.31	0.96	0.652	0.82 to 1.13	0.85	0.043	0.72 to 1.00	0.84	0.045	0.71 to 1.00
Secondary and above (≥9)	1.34	0.000	1.27 to 1.42	1.26	0.008	1.06 to 1.49	0.98	0.837	0.82 to 1.18	0.96	0.646	0.79 to 1.16
Tobacco consumption (smoke)												
Daily user (ref.)	1.00			1.00			1.00			1.00		
Sometime user	0.85	0.020	0.75 to 0.98	0.85	0.108	0.69 to 1.04	0.84	0.100	0.69 to 1.03	0.87	0.197	0.71 to 1.07
Never used	0.83	0.000	0.76 to 0.90	0.79	0.004	0.67 to 0.93	0.78	0.003	0.67 to 0.92	0.80	0.008	0.68 to 0.94
Tobacco consumption (chew)												

Continued

Table 3 Continued

Background variables	Model 1 (unadjusted)			Model 2 (individual)			Model 3 (model 2+household)			Model 4 (model 3+contextual)		
	OR	P value	95% CI	OR	P value	95% CI	OR	P value	95% CI	OR	P value	95% CI
Daily user (ref.)	1.00			1.00			1.00			1.00		
Sometime user	0.94	0.429	0.81 to 1.09	0.73	0.008	0.58 to 0.92	0.75	0.012	0.59 to 0.94	0.76	0.020	0.60 to 0.96
Never used	0.98	0.675	0.91 to 1.07	0.77	0.001	0.66 to 0.90	0.80	0.006	0.68 to 0.94	0.80	0.006	0.68 to 0.94
Alcohol consumption												
Daily user (ref.)	1.00			1.00			1.00			1.00		
Sometime user	0.77	0.000	0.70 to 0.84	0.88	0.088	0.76 to 1.02	0.96	0.576	0.82 to 1.11	0.95	0.490	0.82 to 1.10
Never used	0.63	0.000	0.54 to 0.75	0.67	0.003	0.52 to 0.87	0.73	0.017	0.56 to 0.94	0.72	0.013	0.55 to 0.93
Household level												
Social groups												
Others (ref.)	1.00						1.00			1.00		
Other Backward Castes	0.89	0.000	0.84 to 0.93				0.94	0.407	0.81 to 1.09	1.10	0.377	0.89 to 1.34
Scheduled Castes	0.72	0.000	0.68 to 0.77				0.89	0.188	0.74 to 1.06	0.92	0.713	0.59 to 1.44
Scheduled Tribes	0.34	0.000	0.31 to 0.38				0.50	0.000	0.39 to 0.65	0.96	0.828	0.64 to 1.43
Religion												
Hindu (ref.)	1.00						1.00			1.00		
Muslim	1.34	0.000	1.25 to 1.43				1.13	0.242	0.92 to 1.37	1.10	0.377	0.89 to 1.34
Christian	1.26	0.000	1.12 to 1.42				0.78	0.270	0.50 to 1.21	0.92	0.713	0.59 to 1.44
Others	1.25	0.000	1.12 to 1.39				0.88	0.546	0.59 to 1.32	0.96	0.828	0.64 to 1.43
Household economic status												
Quintile 1 (ref.)	1.00						1.00			1.00		
Quintile 2	1.30	0.000	1.21 to 1.41				1.21	0.027	1.02 to 1.44	1.22	0.022	1.03 to 1.45
Quintile 3	1.53	0.000	1.42 to 1.64				1.28	0.008	1.07 to 1.53	1.32	0.004	1.09 to 1.59
Quintile 4	1.91	0.000	1.77 to 2.05				1.80	0.000	1.49 to 2.16	1.85	0.000	1.53 to 2.25
Quintile 5	2.37	0.000	2.21 to 2.55				2.10	0.000	1.71 to 2.58	2.14	0.000	1.72 to 2.66
Contextual level												
Proportion Illiterate in PSU												
0–25 (ref.)	1.00									1.00		
25–50	0.80	0.000	0.75 to 0.85							0.91	0.468	0.72 to 1.17

Continued

Table 3 Continued

Background variables	Model 1 (unadjusted) OR	P value	95% CI	Model 2 (individual) OR	P value	95% CI	Model 3 (model 2+household) OR	P value	95% CI	Model 4 (model 3+contextual) OR	P value	95% CI
50–75	0.63	0.000	0.59 to 0.67							0.89	0.374	0.69 to 1.15
75–100	0.55	0.000	0.52 to 0.59							0.96	0.766	0.71 to 1.28
Proportion SC/ST in PSU												
0–25 (ref.)	1.00									1.00		
25–50	0.87	0.000	0.82 to 0.91							1.09	0.249	0.94 to 1.27
50–75	0.72	0.000	0.67 to 0.78							1.04	0.744	0.84 to 1.29
75–100	0.52	0.000	0.47 to 0.57							0.74	0.033	0.56 to 0.98
Proportion poor in PSU												
0–25 (ref.)	1.00									1.00		
25–50	0.76	0.000	0.72 to 0.80							0.95	0.610	0.79 to 1.14
50–75	0.66	0.000	0.63 to 0.70							1.11	0.303	0.91 to 1.37
75–100	0.51	0.000	0.48 to 0.55							1.16	0.268	0.89 to 1.50
Place of residence												
Urban (ref.)	1.00									1.00		
Rural	0.70	0.000	0.67 to 0.74							0.83	0.022	0.70 to 0.97
Region												
North (ref.)	1.00									1.00		
Central	1.04	0.204	0.98 to 1.12							1.45	0.101	0.93 to 2.27
East	0.89	0.001	0.82 to 0.95							1.33	0.190	0.87 to 2.05
West	0.61	0.000	0.56 to 0.66							0.80	0.392	0.48 to 1.33
South	1.15	0.000	1.08 to 1.22							1.42	0.096	0.94 to 2.15
Northeast	0.39	0.000	0.33 to 0.45							0.70	0.186	0.42 to 1.18
Union Territories	1.36	0.015	1.06 to 1.75							1.32	0.617	0.44 to 3.93
Random effects												
State random variance (SE)	0.729	(0.240)		0.189	(0.076)		0.149	(0.058)		0.080	(0.036)	
State VPC (%)	16.8			5.0			4.0			2.2		
PSU random variance (SE)	0.326	(0.022)		0.277	(0.059)		0.263	(0.058)		0.244	(0.057)	
PSU VPC (%)	24.3			12.4			11.1			9.0		

MLE fixed-effects coefficients, adjusting for random intercepts by state and PSU.

Findings reveal that compared with the elderly with no formal education, individuals who have attained an education of at least below secondary level are less likely to develop a chronic illness. A closely-knit factor related to education is wealth and it was found that as wealth increased in the household, the odds of having a chronic illness increased too. Lifestyle choices of individuals belonging to wealthier quintiles are more prone to a sedentary lifestyle and hence, can present it to be a risk factor to develop a chronic illness. The trend has found inconsistent evidence for the general population in India[50–53] and the reliability of the findings have been put to question as it is often self-reported and prone to imprecise interpretation.[54] Yet, it is noteworthy to observe that among the elderly, greater wealth has been found to be associated with higher multi-morbidity,[55 56] which emphasises the need of improving awareness about consequences of prolonged exposure to a sedentary lifestyle.

There is a paucity of research assessing the impact of the lifestyle of households and individuals belonging to specific castes on the status of chronic illness in that community in a multicultural setting such as India. At the contextual level, results exhibit that a high proportion of SCs/STs present almost 26 percent less likelihood of a household with elderly having a chronic illness. This contradicts the traditional notion that disadvantaged communities are prone to poor health conditions[17] and it is noteworthy to observe that compared with others castes in Model 3, households with elderly belonging to the ST presented 50% less likelihood of having a chronic illness. Dietary habits of adults belonging to SCs/STs when compared with others have been found to be less risky for diabetes,[57] yet the evidence falls short of the countrywide generalisation for the caste and future studies should certainly explore this direction of community health status. The other possible reason for the less proportion of chronic illness in the STs is possibly due to underreporting or under diagnosis of chronic diseases[58] as the caste differentials have inherently hampered equitable access to healthcare services by the SCs and STs.[59] Underreporting of health conditions by a disadvantaged community presents a multifold burden and becomes more pronounced in the case of an elderly person who is dependent on his/her kin for means of sustenance.

Place of residence is considered a contextual factor in assessing its impact on the status of chronic illness in the PSU; rural residences presented 17 percent less likely to have chronic illness among the elderly compared with the urban areas. The present finding adds to the pool of similar evidence found by other research studies[49 60 61] yet, the probability of under reporting remains, due to prior inequitable distribution of healthcare services compounded by the lack of attention given to the elderly in an already scant environment.[62]

The Government of India has taken steps towards handling the epidemic of NCDs by introducing the National Programme for Prevention and Control of Cancers, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) in 2010–11 to focus on health promotion, early diagnosis and tertiary prevention of NCDs by strengthening infrastructure and capacity building. Government has installed state NCD Cells in all states and district NCD Cells including 388 district NCD clinics, 2115 CHC NCD Clinics, 133 Cardiac Care Units (CCU) and 82 Day Care Centres till March 2017 with the vision of providing free diagnostic facilities and drugs.[63] Focusing on geriatric healthcare, the National Programme for the Healthcare of the Elderly (NPHCE) was introduced to implement the essence of the National Policy on Older Persons and UN Convention on the Rights of Persons with Disabilities to form a comprehensive framework of strategies to provide timely and feasible healthcare services focusing specially on NCDs. Nearly 100 districts have been covered so far by the programme with plans to extend the services to 325 districts.[63] Finding of this study revealed that along with enhancing the healthcare infrastructure at different administrative levels, consideration must also be given in the ongoing policy initiatives to target community based approach, including identification of communities dominated by vulnerable socioeconomic composition and providing them necessary care within the community who are unable to reach healthcare services due to various reasons.

The present study has some limitations. All the morbidities were evaluated based on self-reporting of the individual. This may provide a misclassification bias even though self-reported diagnosis is considered an adequate and common source of information used in population based studies.[64 65] Biomarkers, and anthropometric measurements such as height and weight of an individual could not be included in this study due to missing cases and inconsistency in the data. The study is cross-sectional in design, which limits causal inference. Nevertheless, study examines the socioeconomic and cultural composition of communities along with influence of place of residence to assess the relationship of these contextual factors with health status of the elderly at PSU level. The findings from the present study can be used by future studies to explore qualitative and econometric methods in evaluating further salient factors impacting the health of the elderly in a diverse society like India.

Contributors PKS conceived the study. LS and PKS performed statistical analysis. RD and PKS analyzed and interpreted the data. LS and RD drafted the manuscript. SS and RM provided comments and contributed to the development of the final draft of the manuscript. All authors have supervised and approved the manuscript.

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REFERENCES

1. ICMR, PHFI I. *India : health of the nation's states: the india state-level disease burden initiative*. New Delhi, India, 2017.
2. Castelli WP. Epidemiology of coronary heart disease: the Framingham study. *Am J Med* 1984;76:4–12.
3. Gupta R. Convergence in urban–rural prevalence of hypertension in India. *J Hum Hypertens* 2016;30:79–82.
4. Patel SA, Dhillon PK, Kondal D, *et al*. Chronic disease concordance within Indian households: a cross-sectional study. *PLoS Med* 2017;14:e1002395.
5. Reddy KS, Prabhakaran D, Chaturvedi V, *et al*. Methods for establishing a surveillance system for cardiovascular diseases in Indian industrial populations. *Bull World Health Organ* 2006;84:461–9.
6. Population Reference Bureau. *India's aging population*. Washington, DC, 2012.
7. Chokshi M, Patil B, Khanna R, *et al*. Health systems in India. *J Perinatol* 2016;36:S9–S12.
8. Mehdi A, Chaudhry D, Tomar P. *Prevention of chronic diseases: reorienting primary health systems in India*, 2016.
9. McDonough P, Walters V. Gender and health: reassessing patterns and explanations. *Soc Sci Med* 2001;52:547–59.
10. Nunes BP, Chiavegatto Filho ADP, Pati S, *et al*. Contextual and individual inequalities of multimorbidity in Brazilian adults: a cross-sectional national-based study. *BMJ Open* 2017;7:e015885.
11. Rieker PP, Bird CE. Rethinking gender differences in health: why we need to integrate social and biological perspectives. *Journals of Gerontology: Series B* 2005;60:S40–7.
12. Dey S, Nambiar D, Lakshmi J. Health of the elderly in india: challenges of access and affordability. In: *Aging in Asia: findings from new and emerging data initiatives*, 2012: 371–86.
13. Kinra S, Bowen LJ, Lyngdoh T, *et al*. Sociodemographic patterning of non-communicable disease risk factors in rural India: a cross sectional study. *BMJ* 2010;341.
14. Marmot M, Friel S, Bell R, *et al*. Closing the gap in a generation: health equity through action on the social determinants of health. *Lancet* 2008;372:1661–9.
15. Desai S, Vanneman R. *India human development Survey-II (IHDS-II), 2011-12. ICPSR36151-v2*. Ann Arbor: MI Inter-university, 2015.
16. Desai S, Kulkarni V. Changing educational inequalities in India in the context of affirmative action. *Demography* 2008;45:245–70.
17. Nayar KR. Social exclusion, caste & health: a review based on the social determinants framework. *Indian J Med Res* 2007;126:355-63.
18. Jung D, Kind A, Robert S, *et al*. Linking neighborhood context and health in community-dwelling older adults in the Medicare advantage program. *J Am Geriatr Soc* 2018;66:1158–64.
19. Van Minh H, Byass P, Wall S. Multilevel analysis of effects of individual characteristics and household factors on self-rated health among older adults in rural Vietnam. *Geriatr Gerontol Int* 2010;10:209–15.
20. Wen M, Gu D. The effects of childhood, adult, and community socioeconomic conditions on health and mortality among older adults in China. *Demography* 2011;48:153–81.
21. Yen IH, Michael YL, Perdue L. Neighborhood environment in studies of health of older adults: a systematic review. *Am J Prev Med* 2009;37:455–63.
22. Stephenson R, Baschieri A, Clements S, *et al*. Contextual influences on the use of health facilities for childbirth in Africa. *Am J Public Health* 2006;96:84–93.
23. Kravdal Ø. Child mortality in India: the community-level effect of education. *Popul Stud* 2004;58:177–92.
24. Subramanian SV, Chen JT, Rehkopf DH, *et al*. Comparing individual- and area-based socioeconomic measures for the surveillance of health disparities: a multilevel analysis of Massachusetts births, 1989-1991. *Am J Epidemiol* 2006;164:823–34.
25. Ross CE. Walking, exercising, and smoking: does neighborhood matter? *Soc Sci Med* 2000;51:265–74.
26. Goldstein H, Browne W, Rasbash J. Multilevel modelling of medical data. *Stat Med* 2002;21:3291–315.
27. Kiros G-E, White MJ. Migration, community context, and child immunization in Ethiopia. *Soc Sci Med* 2004;59:2603–16.
28. StataCorp L. *Stata statistical software: release 12*. 2011. College Station, TX: Stata-Corp LP, 2011.
29. Goldstein H, Rasbash J. Improved approximations for multilevel models with binary responses. *J R Stat Soc Ser A Stat Soc* 1996;159:505–13.
30. Olivares DEV, Chambi FRV, Chañi EMM, *et al*. Risk factors for chronic diseases and multimorbidity in a primary care context of central Argentina: a web-based interactive and cross-sectional study. *Int J Environ Res Public Health* 2017;14. 10.3390/ijerph14030251
31. Krishnan MN, Zachariah G, Venugopal K, *et al*. Prevalence of coronary artery disease and its risk factors in Kerala, South India: a community-based cross-sectional study. *BMC Cardiovasc Disord* 2016;16:12.
32. Kowal P, Williams S, Jiang Y. Aging, health, and chronic conditions in china and india: results from the multinational study on Global AGEing and Adult Health (SAGE). In: *Aging in Asia: findings from new and emerging data initiatives*, 2012.
33. Arber S, Cooper H. Gender differences in health in later life: the new paradox? *Soc Sci Med* 1999;48:61–76.
34. Gorman BK, Read JG. Gender disparities in adult health: an examination of three measures of morbidity. *J Health Soc Behav* 2006;47:95–110.
35. Agarwal A, Lubet A, Mitgang E. *Population aging in India: facts, issues and options*, 2016.
36. Thurston RC, Kubzansky LD, Women KLD. Women, loneliness, and incident coronary heart disease. *Psychosom Med* 2009;71:836–42.
37. Perkins JM, Lee H-Y, James KS, *et al*. Marital status, widowhood duration, gender and health outcomes: a cross-sectional study among older adults in India. *BMC Public Health* 2016;16:1032.
38. Steptoe A, Shankar A, Demakakos P, *et al*. Social isolation, loneliness, and all-cause mortality in older men and women. *Proc Natl Acad Sci U S A* 2013;110:5797–801.
39. Jeon G-S, Choi K, Cho S-I. Impact of living alone on depressive symptoms in older Korean widows. *Int J Environ Res Public Health* 2017;14:1191.
40. Vlassoff C. Gender differences in determinants and consequences of health and illness. *J Health Popul Nutr* 2007;25:47-61.
41. Sebastian D, Sekher T V. Abuse and neglect of elderly in Indian families: findings of elder abuse screening test in Kerala. *J Indian Acad Geriatr* 2010;2:54–60.
42. Shankardass MK, Rajan SI. *Abuse and neglect of the elderly in India*, 2018.
43. ISEC, UNFPA, IEG T. *Older women in India: economic, social and health concerns*. New Delhi, India, 2015.
44. Jamuna D, Reddy LK. The impact of age and length of widowhood on the self concept of elderly widows. *Indian J Gerontol* 1997;7:91–5.
45. Wu F, Guo Y, Chatterji S, *et al*. Common risk factors for chronic non-communicable diseases among older adults in China, Ghana, Mexico, India, Russia and South Africa: the study on global ageing and adult health (SAGE) wave 1. *BMC Public Health* 2015;15:88.
46. Rani M, Bonu S, Jha P, *et al*. Tobacco use in India: prevalence and predictors of smoking and chewing in a national cross sectional household survey. *Tob Control* 2003;12:4e–4.
47. Bhan N, Karan A, Srivastava S, *et al*. Have socioeconomic inequalities in tobacco use in India increased over time? trends from the national sample surveys (2000-2012). *Nicotine Tob Res* 2016;18:1711–8.
48. Adaji EE, Ahankari AS, Myles PR. An investigation to identify potential risk factors associated with common chronic diseases among the older population in India. *Indian J Community Med* 2017;42:46–52.
49. Anchala R, Kannuri NK, Pant H, *et al*. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. *J Hypertens* 2014;32:1170-7.
50. Basu S, King AC. Disability and chronic disease among older adults in India: detecting vulnerable populations through the who SAGE study. *Am J Epidemiol* 2013;178:1620–8.
51. Bhan N, Millett C, Subramanian SV, *et al*. Socioeconomic patterning of chronic conditions and behavioral risk factors in rural South Asia: a multi-site cross-sectional study. *Int J Public Health* 2017;62:1019–28.
52. Geldsetzer P, Manne-Goehler J, Theilmann M, *et al*. Diabetes and hypertension in India: a nationally representative study of 1.3 million adults. *JAMA Intern Med* 2018;178:363–72.
53. Subramanian SV, Corsi DJ, Subramanyam MA, *et al*. Jumping the gun: the problematic discourse on socioeconomic status and cardiovascular health in India. *Int J Epidemiol* 2013;42:1410–26.
54. Arokiasamy P, Uttamacharya JK. Multi-morbidity, functional limitations, and self-rated health among older adults in India: cross-sectional analysis of LASI pilot survey, 2010. *Sage Open* 2015;5.
55. Talukdar B. Prevalence of multimorbidity (chronic NCDS) and associated determinants among elderly in India. *Demogr India* 2017:69–76.
56. Mini GK, Thankappan KR, Pattern TKR. Pattern, correlates and implications of non-communicable disease multimorbidity among older adults in selected Indian states: a cross-sectional study. *BMJ Open* 2017;7:e013529.

57. Agrawal S, Millett C, Subramanian SV, *et al*. Frequency of fish intake and diabetes among adult Indians. *J Am Coll Nutr* 2014;33:215–30.
58. Vellakkal S, Subramanian SV, Millett C, *et al*. Socioeconomic inequalities in non-communicable diseases prevalence in India: disparities between self-reported diagnoses and standardized measures. *PLoS One* 2013;8:e68219.
59. Cohen L. *No aging in India: Alzheimer's, the bad family, and other modern things*. Univ of California Press, 1998.
60. Kumar R, Singh MC, Singh MC, *et al*. Urbanization and coronary heart disease: a study of urban-rural differences in northern India. *Indian Heart J* 2006;58:126–30.
61. Srinath Reddy K, Shah B, Varghese C, *et al*. Responding to the threat of chronic diseases in India. *Lancet* 2005;366:1744–9.
62. Ingle GK, Nath A. Geriatric health in India: concerns and solutions. *Indian J Community Med* 2008;33:214–8.
63. DGHS. *National programme for prevention and control of cancer, diabetes, cardiovascular diseases and stroke (NPCDCS*. New Delhi, India, 2017.
64. Smith KV, Goldman N. Measuring health status: self-, interviewer, and physician reports of overall health. *J Aging Health* 2011;23:242–66.
65. Miilunpalo S, Vuori I, Oja P, *et al*. Self-rated health status as a health measure: the predictive value of self-reported health status on the use of physician services and on mortality in the working-age population. *J Clin Epidemiol* 1997;50:517–28.