The University of Manchester
Global Development Institute

Global Development Institute

Working Paper Series

2018-030

May 2018

ISBN: 978-1-909336-65-0

Aging, disability and disease in India

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Cite this paper as:

Veena S. Kulkarni, Vani S. Kulkarni, and Raghav Gaiha (2018) Aging, disability and disease in India. GDI Working Paper 2018-030. Manchester: The University of Manchester.

Abstract

Obtaining detailed evidence on disabilities and their covariates is important as India's elderly population (60 years or more) is growing three times faster than its population as a whole. This study is the first of its kind to provide an analysis of disability and its covariates among the elderly during 2005–12, based on the *India Human Development Survey* 2015, a nationally representative panel survey. Our econometric analysis throws light on why an increase in life expectancy among the aged has not translated into healthier lives. Based on an ordered probit specification, the reasons for this include the greater vulnerability of the older age group and elderly women, a largely rural population, low assets, non-communicable diseases (NCDs), lack of participation in social networks and a rise in the prevalence of single and multiple disabilities. Although the evidence is not detailed or conclusive, an expansion of morbidity among the aged cannot be ruled out. While The Rights of Persons with Disabilities Act 2016 is laudable in its intent and procedural detail, it is largely silent on disabilities among the elderly.

Keywords

Aging, activities of daily living (ADLs), disabilities, non-communicable diseases (NCDs), mortality

JEL Codes

I10, I12, I14, I30

Acknowledgments:

Acknowledgements are due to KL Krishna, TN Srinivasan, Katsushi Imai, Anil S Deolalikar and Varsha S. Kulkarni for valuable advice; to Manorama Gaiha for advice on the medical links between disabilities and non-communicable diseases; and to Raj Bhatia for meticulous econometric analysis. We are also grateful to an anonymous reviewer for constructive suggestions. The views reflected are personal and not necessarily those of the universities to which we are affiliated.

1. Introduction

A billion people worldwide – 15% of the world's population – live with a disability (Groce and Mont, 2017).[1]

According to the Indian Census 2001, there were 21.91 million disabled people in India, while Census 2011 reported 26.81 million disabled people. On the other hand, a World Bank Report on disabled persons in India indicates that there are 50–80 million disabled people in the country. These differences notwithstanding, this study has shown that a sizeable burden of disability exists in India (Awasthi et al, 2017).

A total of 5,376,205 elderly individuals were disabled in India in 2011, accounting for a disability rate of 5,178 per 100,000 elderly people (5.1%). Disability rates increased as age advanced, with the highest disability rate of 8409 per 100,000 among people aged >80 yrs. Disability rates were higher in males in the age group 60–69 years (4407 vs 3891 per 100,000) and 70–79 years (6258 vs 6186 per 100,000) compared with females. Beyond 80 years of age there was a female preponderance in disability rates (8570 vs 8226 per 100,000) (Velayutham et al, 2016).[2]

The prevalence of disabilities in the rural population was higher than in the urban population in both 2001 and 2011. The rural population has less access to healthcare facilities in comparison with its urban counterpart in India, and this may be the possible cause of the higher prevalence of disability in the rural areas.

Disability is part of the human condition. Almost everyone will be temporarily or permanently impaired at some point in life, and those who survive to old age will experience increasing difficulties in functioning. Disability is neither purely medical nor purely social.[3] Rather, it is an outcome of the interplay of these factors. Non-communicable diseases (NCDs) such as asthma, cancer, cardiovascular disease and stroke are associated with impairments that are aggravated by stigma, discrimination over access to educational and medical services, and the job market. Higher disability rates among older people reflect an accumulation of health risks across a lifespan of disease, injury and chronic illness (WHO and World Bank, 2011). The co-occurrence of

[1] Some of the material below is drawn from Kulkarni et al (2017).
[2] One in every 20 Indian citizens aged 60 years and above (5,178 per 100,000 persons) is either physically or mentally disabled based on the data of the 2011 census survey. This is lower than the 2002 National Sample Survey (NSSO) survey findings, which documented a disability rate of 6,401 per 100,000 in those aged 60 years and above. In addition, the disability rates in the 2002 NSSO survey for the age group 60 years and above are higher compared with this analysis. Jeffery and Singal (2008) offer a partial explanation of these differences in terms of definitions of disabilities used. For example, the NSS definitions of hearing, speech and locomotor impairments are more inclusive, and produce larger estimates than does the Census.
[3] Jeffery and Singal (2008) also observe that the official discourse continues to perceive disability as purely a medical condition (with 40% a magic number known even in villages), to be certified and provided for through aids, appliances and concessions in education and employment. Framing the individual in isolation, without engaging with the wider social and physical context, is common in a medicalised approach.

NCDs and disabilities poses a considerably higher risk of mortality relative to those people not suffering from either.

With increasing age, several physiological changes occur, and the risk of NCDs rises. By age 60, the major burdens of disability and death stem from age-related losses in hearing, seeing and moving, as well as from NCDs this is especially so in low- and middle-income countries (WHO, 2015). Furthermore, aging takes place alongside other broad social trends that will affect the lives of older people. Economies are globalising, people are more likely to live in cities and technology is evolving rapidly. Demographic and family changes mean there will be fewer older people with families to care for them.

There is a bi-directional link between disability and poverty: disability may increase the risk of poverty, and poverty may increase the risk of disability. Households with a disabled member are more likely to experience material hardship – including food insecurity, poor housing, lack of access to safe water and sanitation, and inadequate access to health care. Poverty may increase the likelihood that a person with an existing health condition becomes disabled, for example as the result of an inaccessible environment or lack of access to appropriate health and rehabilitation services.[4]

Detailed evidence on disabilities and their covariates is particularly relevant in the context of India. India's elderly population (60 years or more) 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 aging is the dramatic rise in life expectancy at age 60, 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 Indian life expectancy at age 80 has likewise increased significantly, from about five years in 1950 to more than seven years at the present time. By the middle of this century, it is predicted 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 are taking place in the context of changing family relationships and severely limited old-age income support, hence bringing with them a variety of social, economic and health-care policy challenges.

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 and

[4] Based on the 58th round of the NSSO for 2002, in an innovative two–stage estimation procedure, Pandey (2012) corroborated the two-way relationship between poverty and disability. Disability dampens income, which then results in higher disability, after accounting for the effects of age, gender, location and other covariates.

render these support systems largely ineffective. If the costs in terms of productivity losses are added, the total cost burden of looking after the disabled elderly may be enormously high in the near future. In addition, there are non-economic costs that include social isolation and stress that are difficult to quantify.

In the light of the above trends, the objectives of this study are to: (1) throw light on the rise in the prevalence of disabilities during 2005–12 and their forms; (2) understand better the role of their covariates; and (3) delineate key policy options.

The scheme is as follows. In section 2, notable contributions are reviewed. Section 3 describes salient features of the India Human Development Survey (IHDS), a nationwide panel survey on which our analysis is based. Section 4 focuses on a descriptive analysis, divided into (1) aggregate disability; (2) types of disability(difficulty in walking, difficulty in using toilet facilities, difficulty in dressing, hearing impairment, difficulty in speaking and long and short sightedness); (3) disability and assets; (4) disability by count; and (5) disability and NCDs. Section 5 gives a brief exposition of an ordered probit model with random effects, followed by an interpretation of the results in Section 6. Section 7 discusses how our analysis builds on the extant literature and the policy significance of our findings. Finally, some concluding observations are made in Section 8.

2. Literature review

According to WHO (2015), the common age-related changes include decline in bone mass or density, causing chronic diseases such as osteoporosis, and reduced vision and hearing. Additionally, the effect of malnutrition in old age is more detrimental. It can take the forms of reduced muscle and bone mass, and increases the risk of frailty. Malnutrition is also associated with diminished cognitive function and ability to care for oneself, and a higher risk of becoming care-dependent. Hence the coexistence of both multiple disabilities and morbidities is pervasive, albeit the extent varies by social and economic status of elderly individuals, as corroborated by recent research.[5]

Let us first briefly review two recent studies on aging and disabilities, based on Census data. In a detailed but largely descriptive study, Awasthi et al (2017) focus on trends and levels of disability at the district level, calculated from Census data for 2001 and 2011.

A district level Disability Index was calculated by indexing districts, with computation done separately at the district level.. The methodology of computation of the composite index was adopted from the Human Development Report. The district with the lowest prevalence of disabled people throughout the country was assigned the value 0, while the district with the highest prevalence was assigned the value 100.

[5] For a comprehensive review, see Chatterjee et al (2015).

In Census 2001, 110 districts had a Disability Index of more than 50, which increased to 130 districts in 2011. Most of the districts with a high Disability Index were concentrated in Orissa (13 out of 30 districts), Tamil Nadu (14 out of 32), Kerala (7 out of 14), Jammu and Kashmir (14 out of 22), Arunachal Pradesh (13 out of 16), Sikkim (2 out of 4), Madhya Pradesh (8 out of 51), and Rajasthan (4 out of 33).

The index for 2011 shows that high Disability Index districts were concentrated in Maharashtra (15 out of 35 districts), Orissa (25 out of 30), Andhra Pradesh (7 out of 23), Jammu & Kashmir (13 out of 22), Bihar (9 out of 38), Punjab (4 out of 20), and Rajasthan (6 out of 33). Most of the districts in Maharashtra and Andhra Pradesh had a Disability Index of less than 30 in 2001, but this changed in 2011, when most of the districts had a high Disability Index. By contrast, most of the districts in Kerala, Tamil Nadu and Arunachal Pradesh had a Disability Index of more than 40 in 2001, which in 2011 changed to most districts having a Disability Index of less than 30.

Another measure used in the study was the Disability Deprivation Index. It takes into account the disabled population's proportion of child labour, adult unemployment, illiteracy, beggars, vagrants, etc, all expressed as a percentage.

The Disability Deprivation Index reveals the living conditions of a disabled population. It shows that the most poorly performing states cover more than 80% of the disabled population of the country.

The majority of the disabled are non-working. This calls for effective rehabilitation measures that would facilitate employment and other opportunities for people with a disability to improve their quality of life.

Unfortunately, there is no analysis of the inter-district variation in these disability indices.

Another study (Velayutham et al, 2016), based on the 2011 Census data, offers a more disaggregated picture of variation across the states in type of disability by age, gender and rural population. (As these are already summarised in the introduction, it is unnecessary to repeat the main findings.) As in the previous study, no attempt was made to analyse the variations in disabilities.

Turning to more analytical research, we have reviewed a mix of studies from the US and India.

In a sample of individuals 60 years or more and resident in the US, Murtagh and Hubert (2004) found that the co-morbid conditions associated with disability among this cohort, which were predominantly musculoskeletal, neurodegenerative and psychological in origin, were generally more prevalent among women than among men, and served, along with greater prescription medication use, to explain the reported higher levels of overall disability in activities of daily living (ADLs), in

instrumental activities of daily living (IADLs) and in mobility limitations among women.[6] The gender differences in disabilities persisted even after controlling for income, alcohol consumption and Body Mass Index (BMI).

Based on the IHDS 2005, Pou (2013) found that more than 50% of the elderly disabled population suffered from more than one disability and 10% had five or more disabilities. Such proportions/prevalence increased with age and decreased with education. The disabled elderly population with five or more disabilities was almost double among the lowest wealth quintile compared with the highest wealth quintile. The proportion among disadvantaged groups, such as Scheduled Castes (SCs) and Scheduled Tribes (STs), with multiple disabilities was almost double that among other castes, as also among Hindus and Muslims relative to other religions. Although not validated statistically, links between living arrangements and social networks, and disability type are indicated. Half of those who were disabled did not belong to any social network and the majority lived with their children. More than half didn't work. Although government financial support made a difference, it benefited fewer than 20% in six of eight disability dimensions or types.

A more recent study (Kumar et al, 2017) examines the association between chronic diseases and disability, based on data obtained from the 'Building a Knowledge Base on Population Aging in India (BKPAI)' survey conducted by UNFPA in 2011. It is a multi-cohort survey of persons 60 years and older in seven states: Himachal Pradesh, Punjab, West Bengal, Odisha (formerly Orissa), Maharashtra, Kerala and Tamil Nadu. The authors distinguished between physical disability and functional disability. The former refers to respondents facing difficulties relating to vision, hearing, walking, chewing, speaking and memory. The latter focuses on whether respondents required help for ADLs such as bathing, dressing, going to the toilet, mobility, continence and feeding.

Binary logistic regression was carried out to capture the effects of chronic morbidities, life style and socioeconomic and demographic covariates on physical and functional disability. The odds of reporting any functional disability were significantly higher among elderly people who had chronic diseases compared with those who didn't. Further, the odds of any functional disability were higher among older (80+) people, among Muslims and among those who lived with others, compared with their respective counterparts.

The likelihood of physical disability was also higher among those who suffered from chronic diseases. Those who smoked or chewed tobacco daily were 1.5 times more likely to have any physical disability, compared with those who didn't. The odds of any

[6] Functional tasks in the daily lives of older persons are divided into two parts, ADLs and IADLs. The former include activities such as walking, bathing, dressing and going to the toilet, while the latter comprise cooking, driving, using the telephone or computer, shopping and keeping track of finances.

physical disability were lower among those who consumed alcohol, as opposed to those who didn't. Unlike functional disability, the odds of physical disability were significantly higher among elderly females, those aged 80+ years, those with 10 or more years of schooling and among Muslims as compared with their respective counterparts.

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

3. Data

Our analysis draws upon the two rounds of the nationally representative IHDS data conducted in 2005 and 2012. The IHDS is conducted jointly by University of Maryland and the National Council of Applied Economic Research. The first round (IHDS-1) comprised a survey of 41,554 households in 2004–05. The second round (IHDS-II) involved re-interviews with 83% of the original households as well as split households residing within the same locality, along with an additional sample of 2,134 households. The total for IHDS-II is therefore 42,152 households. The panel of individuals $\geq$60 years was 10,473 individuals. The sample was spread across 33 (now 34) states and union territories, and covered rural as well as urban areas.

Repeated interviewing of the same households at two points in time facilitates a richer understanding of which households are able to partake in the fruits of growth, what allows them to move forward, and the process through which they are incorporated into or left out of a growing economy.

The topics covered by the IHDS relevant in the present context include short-term morbidity, major morbidity (including NCDs), limitations in ADLs, and access to medical care and insurance.

The NCDs included cataracts, high blood pressure, heart disease, type 2 diabetes, leprosy, cancer, asthma, epilepsy, mental disorders and accidents/injuries.

Disability is usually measured by a set of items on self-reported limitations, with severity of disability ranked by the number of positively answered items. Disabilities in

ADLs show the dependence of an individual on others, with need for assistance in daily life.[7]

The disabilities covered include (1) difficulty walking; (2) difficulty in using toilet facilities; (3) difficulty dressing; (4) difficulty with hearing; (5) difficulty speaking, (6) long sightedness; and (7) short sightedness.[8]

4. Disabilities, disease and other correlates

Tables 1 to 5 present the prevalence rates as well as the distribution of overall disability and major types of disabilities across gender, caste and rural–urban residence and wealth groups.[9] The results from the t-test assess whether the differences in disabilities between 2005 and 2012 are statistically significant.

4.1 Aggregate disability

Table 1 presents the prevalence of disabilities and their covariates over the period 2005–12. There was a significant rise in disability as confirmed by the t-tests between 2005 and 2012. The prevalence rose in both age groups, 60–70 years and >70 years. Although the change in the proportion of the disabled between 2005 and 2012 across the two age groups was not in the same direction, the share of disability among 60–70-year-olds old rose slightly, while that of the older group (>70 years) declined slightly.

There were marked increases in disability among both male and female elderly populations. As expected, the percentage of disabled women in the total disabled population was greater than the corresponding percentage for men. Also, there was a greater rise in disability among the female than the male population.

[7] For a validation of self-reported health and morbidity, see Subramanian et al (2009).
[8] For a consensus around the counting of disabilities, see Groce and Mont (2017).
[9] 'Prevalence rate' (or simply 'prevalence') refers to the proportion of elderly persons suffering from a disability count. The 2001 Census found 6.9% of the population were old ($\underline{\geq}$ 60years). The NSS (58th round for 2002) gave a corresponding estimate of 9.4% and the IHDS (2005) estimate is 8%. Disability rates among the old are varied too. The estimates are 5%, 6% and 4% by the Census, the NSSO and the IHDS, respectively.

Table 1: Disability among the elderly (60 years or older) in 2005–12

Category	2005 (%)	2012 (%)	t-tests of difference in means over 2005–12
Disabled			
60-70 years	7.35 (72.34)	33.13 (75.51)	-44.44*
>70 years	13.13 (27.66)	50.18 (24.49)	-26.48*
Total	8.37 (100)	36.3 (100)	-51.24*
Gender			
Male	7.28 (42.70)	32.28 (43.89)	-33.15*
Female	9.43 (57.30)	39.85 (56.11)	-39.36*
Total	8.37(100)	36. 3 (100)	-51.24*
Sector			
Rural	7.88 (69.83)	36.67 (74.15)	-44.96*
Urban	9.69 (31.17)	34.68(25.85)	-24.55*
Total	8.37 (100)	36. 3 (100)	-51.24*
Education			
Illiterate	7.47 (54.96)	37.59 (64.12)	-43.09*
Primary	10.66 (22.59)	36.02 (17.69)	-19.17*
Matriculate	9.44 (17.58)	31.07 (13.41)	-15.68*
>Matriculation	7.47 (4.87)	31.66 (4.78)	-10.86*
Total	8.37(100)	36. 3 (100)	-51.24*
Caste			
Others	9.33 (36.34)	35.11 (31.59)	-27.85*
OBCs	8.15 (42.29)	37.94 (45.44)	-35.14*
SCs	6.86 (15.36)	36.62 (18.93)	-23.58*
STs	9.13 (6.01)	26.52 (4.03)	-8.17*
Total	8.37(100)	36. 3 (100)	-51.24*
Asset quartile (2005)			
First (Least Wealthy)	9.69 (35.03)	39.52 (32.19)	-27.06*
Second	6.59 (18.52)	34.28 (21.72)	-23.49*
Third	6.47 (17.71)	35.57 (21.93)	-24.52*
Fourth (Wealthiest)	9.67 (28.74)	36.05 (24.15)	-24.77*
Total	8.37 (100)	36.3 (100)	-51.24*

Notes: Others is a residual category. Authors' calculations. Figures in parentheses denote column percentages. OBCs denotes Other Backward Castes. NS denotes not significant; +denotes significant at $\leq 5\%\ level$; *and* $*$ *denotes significant at* $\leq 1\%\ level$.

Rural–urban comparisons indicate that disability rose significantly over the period in question. The mean disability in rural areas was lower than that in urban areas in 2005 but rose faster to surpass it in 2012. A vast majority of the disabled lived in rural areas and the share rose in 2012.

Disability rose significantly in each educational category over the period 2005–12. The rise was largest among the illiterate elderly. These people also accounted for the majority of total disabled and their share rose substantially during 2005–12.

The disaggregation by caste reveals that mean disability rose significantly over the period in question. The increase was highest for the SCs, followed by the OBCs and Others. The caste group with the highest percentage of disabled elderly in 2005 was 'Others' but in 2012 it was the OBCs.

The disaggregation of disability by wealth quartiles indicates the following. First, the greatest prevalence of disability was among the least wealthy both in 2005 and in 2012. The next highest prevalence rate was in the fourth quartile (the wealthiest) in 2005 and in 2012. Second, each quartile saw a significant rise in the prevalence of disability over the period in question. Third, between 2005 and 2012 there was a rise in the share of the second and third quartile asset groups in the total disabled population.

With respect to association between prevalence of disability and access to social networks, the results show that, among those who belonged to one or two networks, the mean rose from 8.1% in 2005 to 35.1% in 2012. Although this rise was large and statistically significant (the t-value being -26.63, significant at the 1% level), both means were lower, as also the rise. In the third case of participation in more than two networks, the means rose significantly between 2005 and 2012 (the t value was -13.5, significant at less than 1 %). Although the initial mean was higher than in the previous two cases (10.2 %) but lowest in 2012 (34.8), the rise was lowest. That participation in social networks mitigates the risk of disability is further corroborated by our econometric analysis.

4.2 Type of disability

Table 2 reports the prevalence rates of each disability; the results show that rates of each disability rose significantly between 2005 and 2012. Out of the seven disabilities reported in Table 2, the highest prevalence in 2012 was that of difficulty walking (27.39%), followed by that of being long-sighted (23.02%), and then short-sighted (19.87%). Although the mean disability rose significantly for both men and women, the gap between them became much wider in 2012 across all disabilities.

Table 2: Disability by type among the elderly, 2005–12

Disability type	2005	2012	t-tests of difference in means over 2005–12
Walking			
Age			
60–70 years	3.75 (68.87)	24.60 (73.99)	-41.09*
>70 years	7.93 (31.3)	40.41(26.01)	-29.01*
Total	4.93 (100)	27.39 (100)	-47.65*
Gender			
Male	3.75(41.0)	23.02 (41.29)	-29.59*
Female	5.21 (59.0)	31.61 (58.71)	-21.58*
Total	4.93 (100)	27.39 (100)	-47.65*
Sector			
Rural	4.32(70.29)	27.61 (73.66)	-40.91*
Urban	4.95 (29.71)	26.78 (26.34)	-24.37*
Total	4.93 (100)	27.39 (100)	-47.65*
Toilet			
Age			
60–70 years	1.86 (68.33)	9.25 (67.36)	-15.22*
>70 years	4.03 (31.67)	20.95 (32.64)	-16.12*
Total	2.24 (100)	11.32 (100)	-26.56*
Gender			
Male	2.21 (48.48)	9.37 (40.66)	-15.55*
Female	2.27 (51.52)	13.20 (59.34)	-21.80*
Total	2.24 (100)	11.32 (100)	-26.56*
Sector			
Rural	2.23 (72.73)	11.33 (73.15)	-22.45*
Urban	2.27 (27.27)	11.28 (26.89)	-14.19*
Total	2.24 (100)	11.32 (100)	-26.56*
Dressing			
Age			
60–70 years	1.43 (67.93)	6.62 (65.58)	-17.46*
>70 years	3.16 (32.07)	16.23 (34.42)	-13.81*
Total	1.74 (100)	8.31 (100)	-22.02*
Gender			
Male	1.76 (49.62)	6.45 (38.12)	-11.95*
Female	1.72 (50.38)	10.11 (61.88)	-18.89*
Total	1.74 (100)	8.31 (100)	-22.02*
Sector			
Rural	1.78 (74.88)	8.11 (71.23)	-17.98*
Urban	1.62 (25.12)	8.88 (28.77)	-12.85*
Total	1.74 (100)	8.31 (100)	-22.02*

Disability type	2005	2012	t-tests of difference in means over 2005-12
Hearing			
Age			
60–70 years	2.49 (68.75)	12.47 (72.67)	-25.37*
>70 years	5.28 (31.25)	23.91 (27.33)	-15.26*
Total	2.98 (100)	14.14 (100)	-29.45*
Gender			
Male	2.66 (43.82)	13.29 (46.17)	-20.07*
Female	3.29 (56.18)	14.15 (53.83)	-21.58*
Total	2.98 (100)	14.14 (100)	-29.45*
Sector			
Rural	3.15 (77.21)	14.89 (76.99)	-25.55*
Urban	2.52 (22.79)	12.07 (23.01)	-14.54*
Total	2.98 (100)	14.14 (100)	-29.45*
Speaking			
Age			
60–70 years	1.41(67.55)	5.66 (69.66)	-31.50*
>70 years	3.16 (32.45)	11.52 (30.34)	-9.91*
Total	1.72 (100)	6.70 (100)	-18.08*
Gender			
Male	1.70 (48.53)	5.70 (41.85)	-10.71*
Female	1.74 (51.47)	7.65 (58.15)	-14.73*
Total	1.72 (100)	6.70 (100)	-18.08*
Sector			
Rural	1.73 (73.53)	6.70 (73.15)	-15.22*
Urban	1.69 (26.47)	6.67 (26.85)	-9.77*
Total	1.72 (100)	6.70 (100)	-18.08*
Far-sighted			
Age			
60–70 years	5.11 (71.17)	20.98 (75.06)	-41.09*
>70 years	9.67 (23.83)	32.56 (24.94)	-29.01*
Total	5.92 (100)	23.02 (100)	-36.28*
Gender			
Male	5.41(44.90)	20.48 (43.69)	-23.04*
Female	6.41 (55.10)	25.48 (56.31)	-28.15*
Total	5.92 (100)	23.02 (100)	-36.28*
Sector			
Rural	5.69 (70.27)	23.30 (73.94)	-31.51*
Urban	6.53 (29.73)	22.28 (26.06)	-21.46*
Total	5.92 (100)	23.02 (100)	-36.28*

Short-sighted	2005	2012	t-tests of difference in means over 2005–12
Age			
60–70 years	3.64 (69.89)	18.21 (75.47)	-31.50*
>70 years	7.33 ((30.11)	27.65 (24.53)	-16.93*
Total	4.29 (100)	19.87 (100)	-35.62*
Gender			
Male	3.78 (43.28)	13.29 (43.27)	-22.89*
Female	4.79 (56.72)	22.16 (56.73)	
Total	4.29 (100)	19.87 (100)	-35.62*
Sector			
Rural	4.13 (70.18)	19.79 (72.75)	-30.34*
Urban	4.75 (29.87)	20.11 (22.25)	-17.82*
Total	4.29 (100)	19.87 (100)	-35.62*

*Notes: Authors' calculations. Figures in parentheses denote column percentages. NS denotes not significant; +denotes significant at ≤5% level; *denotes significant at ≤1 % level.*

Difficulty walking

Mean disability in walking was higher among the older population than among those 60–70 years old. In both groups the mean prevalence rose significantly. Among the older group, the proportion suffering from a walking disability rose from 7.93% in 2005 to 40.41% in 2012. For all, this disability rose significantly, from 4.93% to 27.39%.

The difference between rural and urban populations with this disability was low and nearly the same in 2005 but it rose significantly in both elderly populations. More than a quarter suffered from this disability in both populations. The proportion of rural people among the disabled total was higher than that of urban dwellers in both 2005 and 2012.

Difficulty in using toilet facilities

There was a significant rise in difficulty in using toilet facilities from 2.24% in 2005 to 11.32% in 2012. The prevalence rates among both age groups rose significantly over this period – especially among the older group. The rate was particularly high among older people in 2012 (20.95% compared with 9.25% among those who were 60–70 years old).

The majority of those suffering from this disability were elderly females and their share rose during 2005–12. The mean prevalence rate rose significantly among both male and female elderly people over this period, with that among the latter (females) higher than among the former in 2012.

This disability was shared almost equally among the rural and urban elderly in both 2005 and 2012. Both means rose significantly over this period. Roughly 73% of those who had difficulty in using toilet facilities were located in rural areas. The rural and urban shares changed little during 2005–12.

Difficulty dressing

Difficulty dressing rose from 1.74% to 8.31%. Older persons experienced greater difficulty in dressing than did 60–70-year-olds. The means rose significantly in both age groups during 2005–12, with that of the older group two–and–a–half times higher in 2012. Although the share of 60–70 year olds among the total for this difficulty accounted for a large majority, it declined slightly in 2012. Gender comparisons show that, similarly to that in 2005, the mean disability in dressing was much higher among females in 2012. Both means (for males and females), however, rose significantly during 2005–12. While the share of females among the total disabled experiencing difficulty in dressing rose significantly between 2005 and 2012, that of males fell significantly.

The rural–urban contrast in this disability is striking too, with a large majority in rural areas in 2005; this declined slightly in 2012. Both means rose significantly during this period but remained nearly equal in both years.

Difficulty hearing

Hearing impairment rose significantly from 2.98% in 2005 to 14.14% in 2012. The mean difficulty in hearing was higher among the older group and rose significantly during 2005–12. The mean in the age group 60–70 years also rose significantly but remained below that among the older group. The share of the former among the total, however, was large and had increased to about 73% in 2012. Elderly females experienced greater difficulty than men in hearing in both 2005 and 2012. The rural mean was higher than the urban mean in both years, while both means rose significantly during 2005–12. There was near parity in the means of hearing impairment in rural and urban elderly populations during 2005–12 and they rose significantly. A large concentration of the hearing impaired, however, remained in rural areas.

Difficulty speaking

Difficulty speaking was confined to a small segment of the elderly but rose significantly during 2005–12. Mean disability rose significantly in both age groups but remained higher among the older group. A large majority of those disabled nevertheless belonged to the age group 60–70 years and their share rose slightly during 2005–12. Between males and females the mean difference in this disability remained small but both means rose significantly. The mean disability was slightly higher among elderly females. A majority of those with this disability were females and their share rose moderately in 2012.

Far sightedness

Far sightedness became significantly more pervasive during 2005–12, with the mean rising from 5.92% to 23.02%. The mean rose significantly among both age groups of elderly, with the mean for the older group rising from 9.67 % to 32.56 %. However, the proportion of total disabled among 60–70 year olds became larger in 2012.

Elderly females experienced greater disability in this category, with the mean difference much larger in 2012. The means for both males and females rose significantly. The latter accounted for a majority of the disabled, with their share becoming larger in 2012.

Both rural and urban means rose significantly during 2005–12, with the increase in the former exceeding the latter in both years. The concentration of this disability also became larger among the rural elderly in 2012.

Short sightedness

Short sightedness also became much more pervasive during 2005–12, with the prevalence rate rising from 4.29% in 2005 to 19.87% in 2012. The older of the two age groups recorded higher mean disabilities in both years. Both groups experienced significantly higher prevalence rates in 2012. The concentration among 60–70 years old grew larger, from about 70% in 2005 to 75.47% in 2012.

Both males and females experienced a significantly higher prevalence of this disability during 2005–12, with the females recording higher rates in both years. The male–female gap became larger in 2012. While the majority of those suffering from this disability were elderly females, their share remained unchanged during 2005–12.

The means were nearly similar between the rural and urban areas and remained so in 2012, with the urban mean slightly higher. Both means rose significantly during 2005–12. A large majority of the short-sighted were located in rural areas, with a slight increase during this period.

4.3 Disability and assets

Table 3 depicts a mixed pattern with respect to the association between prevalence of disability and assets.[10] Comparisons are presented between the least (first quartile) and most wealthy (fourth quartile). As far as walking disability is concerned, the difference in means between the first and fourth quartiles was not significant in either 2005 or 2012.

[10] Household assets comprise 33 items in the IHDS. A principal component analysis was done to construct asset quartiles. Details will be furnished upon request.

Table 3: Shift in disability between quartiles among the elderly, 2005 and 2012

t-test of difference between first and fourth quartile		
Disability	**2005**	**2012**
Walking	0.73^{NS}	-0.86^{NS}
Toilet	3.08^{***}	0.24^{NS}
Dressing	2.26^{+}	0.45^{NS}
Hearing	4.01^{***}	3.90^{***}
Speaking	2.93^{***}	3.90^{***}
Far sightedness	-0.28^{NS}	6.67^{***}
Short sightedness	-0.12^{NS}	4.34^{***}

Notes: Authors' calculations. NS denotes not significant; +denotes significant at $\leq 5\%\ level$; $*** \ denotes\ significant\ at\ \leq 1\ \%\ level$.

However, first–fourth quartile comparisons with respect to difficulties in using toilet facilities and dressing indicate that these were significantly higher among the least wealthy in 2005 but that the difference ceased to be significant in 2012. Difficulties in hearing and speaking were also significantly higher among the least wealthy in both 2005 and 2012. Differences in far and short sightedness were significant only in 2012, with the mean difficulty being higher among the least wealthy relative to the wealthiest.

4.4 Disability by count

Severity of disability is often measured in terms of the number of disabilities suffered. For convenience of analysis, we have classified the number of disabilities into three groups: 1 disability, 2–4 disabilities and >4 disabilities. The prevalence rates for 2005 and 2012 in Table 4 show that the number of individuals with disabilities rose between 2005 and 2012.

Table 4: Disabilities by count among the elderly, 2005–12

Number of disabilities	2005	2012	t-tests of difference in means over 2005-12
1 disability			
Age			
60–70 years	2.70 (77.24	8.25 (78.50)	-16.11*
>70 years	3.72 (22.76)	10.56 (21.50)	-8.17*
Total	2.88 (100)	8.66 (100)	-18.05*
Gender			
Male	2.45 (41.72)	8.0 (45.42)	-12.62*
Female	3.30 (58.28)	9.28 (54.58)	-12.95*
Total	2.88 (100)	8.66 (100)	-18.05*
Asset quartile (2005)			
First (least wealthy)	3.25 (36.04)	9.66 (31.81)	-9.65*
Second	1.84 (15.93)	8.73 (22.35)	-10.0*
Third	1.53 (12.85)	7.74 (19.28)	-9.57*
Fourth (wealthiest)	3.85 (35.18)	9.81 (26.56)	-8.90*
Total	2.88 (100)	8.66 (100)	
2–4 disabilities			
Age			
60–70 years	3.34 (72.38)	18.58 (77.87)	-33.01*
>70 years	5.95 (27.62)	24.66 (22.13)	-16.41*
Total	3.80 (100)	19.65 (100)	-36.79*
Gender			
Male	3.14 (40.59)	18.22 (45.55)	-25.25*
Female	4.43 (59.41)	24.03 (54.45)	-26.81*
Total	3.80 (100)	19.65 (100)	-36.79*
Asset quartile (2005)			
First (least wealthy)	4.13 (31.89)	19.97 (30.84)	-18.38*
Second	3.43 (20.99)	18.06 (21.69)	-15.62*
Third	3.34 (19.54)	19.88 (23.24)	-17.14*
Fourth (wealthiest)	4.40 (27.98)	19.07 (24.23)	-17.52*
Total	3.80 (100)	19.65 (100)	-36.79*
>4 disabilities			
Age			
60–70 years	1.31 (63.86)	6.30 (66.29)	-17.26*
>70 years	3.46 (36.14)	14.96 (33.71)	-12.38*
Total	1.69 (100)	7.83 (100)	-21.08*
Gender			
Male	1.69 (49.13)	6.06(38.02)	-11.42*
Female	1.69 (50.87)	9.53 (61.98)	-18.04*
Total	1.69 (100)	7.83 (100)	=21.08*
Asset quartile (2005)			
First (least wealthy)	2.32 (40.54)	9.89 (35.79)	-11.74*
Second	1.32 (17.90)	7.50 (21.09)	-9.78*
Third	1.60 (21.23)	7.96 (21.32)	-9.68*
Fourth (wealthiest)	1.41 (20.33)	7.17 (21.32)	-10.74*
Total	1.69 (100)	7.83 100)	

Notes: Authors' calculations. NS denotes not significant; +denotes significant at $\leq 5\%$ *level; and* $*$ *denotes significant at* $\leq 1\%$ *level.*

The prevalence of a single disability was higher in the older age group than in the younger in both 2005 and 2012. Both age groups experienced significant increases during 2005–12. However, the difference in the percentage of the disabled population (of the total disabled) across 2005 and 2012 for the two age groups remained small. The 60–70 year olds were a large majority in 2005 and there was a slight increase in that share in 2012.

There was a slightly higher prevalence of elderly females with a single disability than elderly males in both 2005 and 2012. For females, the means rose significantly during this period. However, while the majority of those suffering from a single disability were females, their (female) share among the total number with one disability fell slightly in 2012.

The wealthiest had the highest prevalence of disability in 2005 and in 2012, followed by the least wealthy. However, there were changes in the distribution among the quartiles. While the largest proportion of the disabled was in the least wealthy quartile, followed by that of the most wealthy (in 2005), over the period in question the share of the least wealthy declined while that of those in the second and third quartiles rose more than moderately.

The prevalence of 2–4 disabilities among the elderly rose significantly from 3.80% to 19.65% during 2005–12, with the burden among the older much higher in 2012. The majority of the disabled experiencing 2–4 disabilities were in the 60–70 age group in 2005 and 2012. Both male and female prevalence rates rose significantly during this period, with the latter rising to a greater extent, from 4.43 % to 24.03 %. Consequently, the gap between females and males widened. The majority of those in this disability range were females but their share declined in 2012.

The prevalence rates of 2–4 disabilities in both the first and fourth quartiles rose significantly, with the former surpassing the latter in 2012. Every quartile saw a significant, the highest being in the first quartile, followed by the third and then the fourth. The shares of every quartile among those suffering from 2–4 disabilities changed slightly, with the highest in the first quartile declining slightly, second highest in the fourth also declining and those in the second and third rising.

The prevalence of >4 disabilities among the elderly – the most severe situation – recorded a significant rise, from 1.69% in 2005 to 7.83% in 2012. The prevalence in the population aged more than 70 was higher than among 60–70 year olds in both years. Their means rose significantly during this period. The shares also changed, with the majority for 60–70 year olds rising moderately.

Although the means for males and females were low and equal in 2005, they rose significantly in 2012, with that for females surpassing that for males. The share of females among the total of those with >4 disabilities was almost equal to that of males in 2005, but it became greater than that of males in 2012.

Distribution by wealth quartile indicates that in 2005 the highest prevalence of multiple disabilities was in the first quartile, followed by the third quartile and then the fourth.

Each mean rose significantly between 2005 and 2012, with that in the first quartile remaining highest, followed by the third and then the second in 2012.

Table 5 reports the prevalence of the coexistence of disabilities and NCDs. To ensure a sufficient number of observations for the joint distribution of morbidities and disabilities, the latter are considered in two groups: 1-4 and > 4 disabilities, together with a few NCDs.

Table 5: Disability count and NCDs among the elderly, 2005–12

NCDs and disabilities	1–4 (t-tests of difference in means over 2005–12)	>4 (t-tests of difference in means over 2005–12)
High blood pressure and disabilities	-4.60***	2.65***
Heart disease and disabilities	-3.15***	Insufficient observations
Diabetes and disabilities	-2.54***	-2.88***
High blood pressure + diabetes and disabilities	-0.30^{NS}	2.4^{+}
High blood pressure + heart disease and disabilities	-1.60^{NS}	-10.74^{*}

*Notes: *** denotes significant at ≤ 1 % level; +denotes significant at 5% level; NS denotes not significant.*

The prevalence of combinations of high blood pressure, heart disease and diabetes separately with 1–4 disabilities rose significantly during 2005–12. However, there is no significant increase in the prevalence when the two cases (high blood pressure and diabetes combined with disabilities, and high blood pressure and heart disease combined with disabilities) of multi-morbidity are considered. The change between 2005 and 2012 is not significant.

In the category of >4 disabilities, the pattern of change across 2005 and 2012 for the coexistence of NCDs and disabilities is more mixed in terms of the direction of change compared with that of the category of 1–4 disabilities. While the combination of high blood pressure and >4 disabilities decreased significantly over this period, there was an increase in the combination of diabetes and four or more disabilities. The case of heart disease and >4 disabilities could not be analysed because of an insufficiency of observations.

The results for the combination of multi-morbidity and disabilities show that, for the case of high blood pressure, diabetes and disabilities, there is a significant reduction between 2005 and 2012. In contrast, the combination of high blood pressure, heart disease and disabilities registers a significant increase between 2005 and 2012.

5. Ordered probit with random effects

As the cross-tabulations cannot unravel causal relationships, we employ panel data models: a binary probit (whether an individual is suffering from a disability or not) with random effects at the individual level (60 years or older) to capture unobserved heterogeneity; and an ordered probit with random effects that allows for a range of disabilities as the dependent variable. To avoid repetition, we present below an algebraic exposition of a basic ordered probit with random effects.

The starting point for our econometric specification is an unobserved latent dependant variable *y** which describes a measure of health. The possible outcomes are y_{it} = {0, 1, 2} which denote no disability, single disability and two disabilities among individuals aged 60 years or more. We can then estimate the following model:

$$y_{ijt}^{*} = \boldsymbol{x}_{it}'\boldsymbol{\beta} + \boldsymbol{z}_{i}'\boldsymbol{\gamma} + \boldsymbol{s}'_{j}\boldsymbol{\delta} + \boldsymbol{\nu}_{it} \quad \textbf{for } i = 1, 2, \ldots N, \; j = 1 \ldots\ldots J, \text{ and } t = 1, 2, \ldots T \tag{1}$$

where the subscript *i* stands for the individual, j for state, and t for time/year, respectively; $\boldsymbol{x}_{it}'$ is a vector of exogenous time-varying determinants of the health status as specified, in the sense that E $(\boldsymbol{x}_{it}', \boldsymbol{\nu}_{js)}, = \boldsymbol{0})$ and $\boldsymbol{\beta}$ is the coefficient vector, $\boldsymbol{z}_{i}'$ is another vector of exogenous but time-invariant determinants with $\boldsymbol{\gamma}$, to be estimated. In addition, we seek to capture state-level heterogeneity by including state dummies ($\boldsymbol{s}_{j}$) with $\boldsymbol{\delta}$ as the coefficient vector**.**

Then we exploit the panel structure of our data, taking into account the unobserved heterogeneity factors that could affect an individual's health status. We control for these effects by estimating a random-effects ordered probit model, since the fixed-effects probit model does not permit use of time-invariant exogenous determinants (Greene, 2012).

In the random-effects specification the error term, $\boldsymbol{\nu}_{it}$, is the sum of two components: $\boldsymbol{\nu}_{it} = \boldsymbol{\eta}_{i} + \boldsymbol{\varepsilon}_{it}$, where the term $\boldsymbol{\eta}_{i}$ is assumed to be a time-independent individual specific random effect with 0 mean and variance σ^2 ($\boldsymbol{\eta}$), reflecting the unobserved individual heterogeneity, while $\boldsymbol{\varepsilon}_{it}$ is assumed to be a normally distributed random-error term with 0 mean and a constant variance $\sigma^2\boldsymbol{\varepsilon}_{it}$ that is serially independent both among individuals and over time. The random-effects model also imposes the restriction that the correlation between successive error terms for the same individual is a constant: corr $(\boldsymbol{\nu}_{it}, \boldsymbol{\nu}_{is}) = \boldsymbol{\rho} = \frac{\boldsymbol{\sigma}_{\eta}}{(\mathbf{1}+\boldsymbol{\sigma}_{\eta})}$ if t≠ s.

Since y_{ijt}^{*} is unobservable, what we obseve is different health outcomes (in the present case, different numbers of disabilities) for individual i at time t. Conditional on being in a health category, y_{ijt} is related to this latent variable and a cut-off parameter, μ, as

$$y_{ijt} = \begin{cases} 0 \; if \; y_{ijt}^{*} \leq 0 \\ 1 \; if \; 0 < y_{ijt}^{*} \leq \mu, \\ 2 \; if \mu \leq y_{it}^{*}. \end{cases} \tag{2}$$

Under the restrictive assumption of normality of $\boldsymbol{\varepsilon_{it}}$, the associated probabilities of being in each state of health/range of disabilities k (=0, 1, 2) are:

$$Py_{ijt} = 0 = \Phi\left(-\boldsymbol{x'}_{it}\boldsymbol{\beta} + \boldsymbol{z_i'\gamma} + \boldsymbol{s'}_{j}\boldsymbol{\delta} + \eta_i\right)$$

$$Py_{ijt} = 1 = \Phi\left(\mu - \boldsymbol{x'}_{it}\boldsymbol{\beta} + \boldsymbol{z_i'\gamma} + \boldsymbol{s_j\delta} + \eta_i\right) - \Phi\left(-\boldsymbol{x'}_{it}\boldsymbol{\beta} + \boldsymbol{z_i'\gamma} + \boldsymbol{s'}_{j}\boldsymbol{\delta} + \eta_i\right) \quad (3)$$

$$Py_{ijt} = 2 = 1 - \Phi\left(\mu - \boldsymbol{x'}_{it}\boldsymbol{\beta} + \boldsymbol{z_i'\gamma} + \boldsymbol{s'}_{j}\boldsymbol{\delta} + \eta_i\right)$$

The parameters of the model, the $\boldsymbol{\beta s}$ (the coefficients on the **x** variables), the $\boldsymbol{\gamma_s}$ (the coefficients on the time invariant variables) and the $\boldsymbol{\delta s}$ (the coefficients on the state dummy variable), and the unknown cut-off values (the μ_s) can be estimated by maximising the likelihood function using a standard normal distribution Φ (.).[11]

6. Interpretation of results

We first consider the case in which a binary probit model with random effects is used. An aged person suffering from a disability is assigned the value 1 and 0 otherwise. Two specifications are considered: one without state dummies and another with state dummies.

One important result in Table 6 is that, between 2005 and 2012, the probability of being disabled among the aged rose significantly. Females were more likely to be disabled than males. Widows were highly likely to be disabled. Older persons in the age group (70 years and above) were more likely to be disabled than in the age group 60–69. Among the caste groups, OBCs were more likely than Others to be disabled. Surprisingly, educational attainments were not significantly related to disability. Asset quartiles show that the probability of being disabled is consistently lower at higher quartiles relative to the lowest (or least wealthy). There is also a sharp rural–urban divide as the probability of being disabled is significantly lower in urban areas. There is a robust relationship between suffering from any NCD and disability. This implies that those suffering from NCDs are highly likely also to suffer from a disability. That social networks are effective in providing support to the aged is far from axiomatic, depending on whether it is proximal or non-proximal and whether there is social harmony. If social networks are instrumental in bonding together in periods of personal crises, this could compensate for a lack of family support (eg widows and others living alone) and help alleviate morbidity.[12] It is therefore surprising that neither of the network variables is significant. In another specification, however, with state dummies, networks are significantly negatively related to the probability of being disabled.

[11] For an exposition of how the marginal effects are calculated, see Greene (2012).
[12] Social networks include Mahila Mandal, religious groups, caste associations, cooperatives and, self-help groups. Their number was slightly larger in 2012 than in 2005. However, given our specification, this doesn't matter much.

Table 6: Determinants of disability based on binary probit with random effects(without state dummies)

	(1)	(2)
Variables	**Coefficient**	**Margins**
Year		
2012	0.998*** (0.0290)	0.234*** (0.00553)
Gender		
Female	0.143*** (0.0295)	0.0329*** (0.00677)
Marital status		
Widowed	0.156*** (0.0285)	0.0365*** (0.00670)
Others	0.0872 (0.0930)	0.0200 (0.0218)
Sector		
Urban	-0.0963*** (0.0296)	-0.0219*** (0.00666)
Caste		
OBCs	0.0724** (0.0294)	0.0168** (0.00678)
SCs	-8.07e-05 (0.0381)	-1.83e-05 (0.00866)
STs	-0.0573 (0.0582)	-0.0128 (0.0129)
Asset quartile		
Second quartile	-0.132*** (0.0347)	-0.0311*** (0.00811)
Third quartile	-0.165*** (0.0333)	-0.0385*** (0.00773)
Fourth quartile	-0.166*** (0.0358)	-0.0388*** (0.00829)
Education		
=< Primary	0.0397 (0.0346)	0.00924 (0.00809)
=< Matriculation	-0.0408 (0.0407)	-0.00931 (0.00923)
> Matriculation	-0.0630 (0.0639)	-0.0143 (0.0143)
Any NCD?		
Yes	0.762*** (0.0281)	0.199*** (0.00733)
Age group		
70 + years	0.403*** (0.0321)	0.0995*** (0.00820)
Social networks		
1–3	-0.00833 (0.0260)	-0.00192 (0.00597)
>3	0.00508 (0.0560)	0.00117 (0.0129)
Constant	-1.760 (0.0501)	
States	No	
Observations	19,674	19,674
Wald chi (2)	1894.57***	
Log likelihood	-8993.4883	

Notes: Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

The null hypothesis that all coefficients except the constant are 0 is rejected by the Wald test.[13] Rho is the proportion of the total variance contributed by the panel-level variance component. When the rho is zero, the panel-level variance component is not important, and the panel estimator is no different from the pooled probit estimator. The estimated value is 0.19. A likelihood-ratio test of this in terms of the p value of the χ^2 statistic rejects the pooled probit estimator.

In another specification with state dummies, there are a few changes. To avoid repetition, we will confine our remarks largely to the changes.

Most of the key determinants in Table 6 remain significant in Table 7 but with a few exceptions. One is that the caste variable (OBCs) ceases to be significant. However, education variables (primary and middle school) have significant negative effects on disability relative to illiterates. This may imply that even a modicum of education (4–8 years) enhances awareness of assistive devices and of how to overcome the limitations and thus avoid disabilities. Another significant change is that social networks (more than three) help mitigate some of the debilitating effects of disabilities and enable normal functioning.

[13] Between the log likelihood test ratio and the Wald test, the latter has the advantage that it only requires estimation of one model.

Table 7: Determinants of disability based on binary probit with random effects

As in Table 6, all specification tests are validated.

	(1)	(2)
Variables	**Coefficient**	**Margins**
Year		
2012	1.020***	0.240***
Gender		
Female	0.0831***	0.0192***
Marital status		
Widowed	0.163***	0.0381***
Others	0.0773	0.0177
	(0.0895)	(0.0209)
Sector		
Urban	-0.133***	-0.0302***
Caste		
OBCs	-0.00801	-0.00186
SC	-0.0191	-0.00443
ST	-0.0540	-0.0124
Asset quartile		
Second quartile	-0.139***	-0.0332***
Third quartile	-0.184***	-0.0432***
Fourth quartile	-0.204***	-0.0477***
Education		
=< Primary	-0.0818**	-0.0188**
=< Matriculation	-0.107***	-0.0244***
> Matriculation	-0.0849	-0.0195
Any NCD?		
Yes	0.673***	0.176***
Age group		
70 + years	0.370***	0.0913***
Social networks		
1–3	-0.0292	-0.00676
>3	-0.145**	-0.0324**
Constant	-1.638	
States	Yes	
Observations	19,674	19,674
Wald chi (2) (39)	2102.28***	

Notes: Standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

6.1 Marginal effects of probit with random effects

The marginal effects refer to the specification with state dummies unless stated otherwise.

The marginal effect of time is positive and highly significant. In other words, accounting for all the other explanatory variables, the probability of occurrence of disabilities was much higher in 2012 relative to 2005.

Aged females were more likely to suffer from disabilities than males. Widows were more vulnerable to disabilities than married women.

Those living in urban areas were significantly less likely to be disabled compared with rural residents.

Somewhat surprisingly, caste was not significantly associated with disabilities. In another specification without state dummies, however, the marginal effect of belonging to OBCs was positive and significant relative to Others.

Asset quartiles reveal an interesting pattern. The marginal effect of asset quartile was negative and significant relative to the first and bottom quartiles. In fact, wealthier people were less likely to be disabled and the wealthiest were the least likely to suffer from disabilities.

Relative to illiterates, the marginal effects of primary and matric education were negative and significant. The fact that the marginal effect of the latter was slightly larger (in absolute value) than that of the former implies that, with higher education, the probability of being disabled would diminish.

Of particular importance is the positive and significant effect of NCDs (in 2005) on disability. Those who suffered from any NCD were significantly more vulnerable to disabilities. For example, diabetics are more likely to suffer from a vision impairment.

That disabilities are more likely among older persons (those 70 years or older) is corroborated by the positive and significant effect of the older group on the probability of disabilities.

Social networks help not only in alleviating the debilitating effects of disabilities but also in overcoming some of them. Those belonging to or affiliated to more than three networks were more likely to overcome some disabilities, as indicated by the negative and significant effect of this variable.

We now turn in Table 8 to the results of ordered probit with random effects.

Table 8: Determinants of multiple disabilities based on ordered probit with random effects (without state dummies)

	(1)
Variables	**Coefficient**
Year	
2012	0.999*** (0.0341)
Gender	
Female	0.118*** (0.0391)
Marital status	
Widowed	0.178*** (0.0365)
Others	-0.0154 (0.0959)
Sector	
Urban	-0.0403 (0.0322)
Caste	
OBC	0.103*** (0.0354)
SC	0.0242 (0.0493)
ST	-0.0635 (0.0724)
Asset quartile	
Second quartile	-0.130*** (0.0425)
Third quartile	-0.189*** (0.0431)
Fourth quartile	-0.150*** (0.0420)
Education	
=< Primary	-0.0143 (0.0424)
=< Matriculation	-0.0739 (0.0492)
>Matriculation	-0.0990 (0.0685)
Any NCD?	
Yes	0.675*** (0.0325)
Age group	
70 + years	0.418*** (0.0383)
Social networks	
1–3	0.00300 (0.0331)
>3	0.0216 (0.0620)
States	No
Observations	19,674
Wald chi2(18)	1448.02***
Log pseudo-likelihood	-79047203
Cut1	1.783*** (0.0605)
Cut2	2.058*** (0.0649)
Cut3	2.940*** (0.0752)
sigma2_u	0.198*** (0.0360)

Notes: Standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

For multiple disabilities Outcome 1 = 0 disability, Outcome 2 = 1 disability, Outcome 2 = 2–4 disabilities, and Outcome 4 = >4 disabilities.

Table 9: Determinants of multiple disabilities based on ordered probit with random effects (with state dummies)

	(1)
Variables	**Coefficient**
Year	
2012	1.018*** (0.0339)
Gender	
Female	0.0578 (0.0366)
Marital status	
Widowed	0.178*** (0.0344)
Others	-0.0168 (0.101)
Sector	
Urban	-0.119*** (0.0318)
Caste	
OBC	0.0258 (0.0353)
SC	-0.0141 (0.0466)
ST	-0.104 (0.0718)
Asset quartile	
Second quartile	-0.131*** (0.0414)
Third quartile	-0.201*** (0.0416)
Fourth quartile	-0.189*** (0.0433)
Education	
=< Primary	-0.136*** (0.0418)
=< Matriculation	-0.136*** (0.0489)
>Matriculation	-0.129* (0.0691)
Any NCD?	
Yes	0.610*** (0.0324)
Age group	
70 + years	0.398*** (0.0370)
Social networks	
1–3	-0.0548 (0.0340)
>3	-0.183*** (0.0657)
States	Yes
Observations	19,674
Wald chi2 (39)	1716.35***
Log pseudo-likelihood	-76919590
Cut1	1.675*** (0.110)
Cut2	1.948*** (0.112)
Cut3	2.816*** (0.118)
sigma2_u	0.0876*** (0.0323)

Notes: Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*
For multiple disabilities Outcome 1 = 0 disability, Outcome 2 = 1 disability, Outcome 2 = 2–4 disabilities, and Outcome 4 = >4 disabilities.

Table 10: Marginal effects of determinants of multiple disabilities based on ordered probit with random effects (With state dummies)

	Outcome (1)		Outcome (2)		Outcome (3)		Outcome (4)	
	dy/dx	Std Err	dy/dx	Std Err	dy/dx	Std Err	dy/dx	Std Err
Year								
2012	-0.239***	0.0072	0.0473***	0.0027	0.124***	0.0047	0.0674***	0.0028
Gender								
Female	-0.0134	0.0085	0.00221	0.0014	0.00653	0.0041	0.00467	0.0030
Marital status								
Widowed	-0.0419***	0.0083	0.00687***	0.0014	0.0204***	0.0040	0.0146***	0.0029
Others	0.00373	0.0224	-0.000664	0.0040	-0.00186	0.0112	-0.00121	0.0072
Sector								
Urban	0.0272***	0.0072	-0.00455***	0.0012	-0.0133***	0.0036	-0.00934***	0.0025
Caste								
OBC	-0.00602	0.0083	0.00098	0.0013	0.00293	0.0040	0.00212	0.0029
SC	0.00326	0.0107	-0.000539	0.0018	-0.00159	0.0052	-0.00113	0.0037
ST	0.0233	0.0158	-0.004	0.0028	-0.0115	0.0078	-0.00784	0.0052
Asset quartile								
Second quartile	0.0313***	0.0099	-0.00496***	0.0016	-0.0151***	0.0048	-0.0112***	0.0035
Third quartile	0.0470***	0.0096	-0.00767***	0.0016	-0.0228***	0.0047	-0.0165***	0.0034
Fourth quartile	0.0444***	0.0101	-0.00721***	0.0017	-0.0215***	0.0050	-0.0156***	0.0036
Education								
=< Primary	0.0313***	0.0094	-0.00521***	0.0016	-0.0153***	0.0046	-0.0108***	0.0032
=< Matriculation	0.0312***	0.0109	-0.00520***	0.0019	-0.0152***	0.0054	-0.0108***	0.0037
> Matriculation	0.0297*	0.0154	-0.00493*	0.0027	-0.0145*	0.0076	-0.0103**	0.0052
Any NCD?								
Yes	-0.158***	0.0086)	0.0240***	0.0017	0.0768***	0.0046	0.0571***	0.0036
Age group								
70 + years	-0.0995***	0.0097	0.0146***	0.0014	0.0472***	0.0045	0.0377***	0.0042
Social networks								
1–3	0.0127	0.0078	-0.00208	0.0013	-0.00617	0.0038	-0.00444	0.0027
>3	0.0408***	0.0140	-0.00703***	0.0026	-0.0201***	0.0070	-0.0137***	0.0045
States	Yes							

*Notes: *** p<0.01, ** p<0.05, * p<0.1*

For multiple disabilities Outcome 1 = 0 disability, Outcome 2 = 1 disability, Outcome 2 = 2–4 disabilities, and Outcome 4 = >4 disabilities.

6.2 Marginal effects of ordered probit with random effects

Both specifications of the ordered probit with random effects are validated by appropriate tests, as shown in Tables 8 and 9.

In the ordered probit with random effects, we are able to capture the marginal effects of the explanatory variables on multiple disabilities which are ordered. In our analysis, the disabilities are grouped into four outcomes: outcome 1 denotes 0 disability, outcome 2 refers to 1 disability, outcome 3 represents 2–4 disabilities, and outcome 4 to >4 disabilities.

As the signs of coefficients in an ordered probit with random effects differ from those of the coefficients (in Tables 8 and 9), we shall confine our discussion to the marginal effects computed from the coefficients reported in Table 9. The marginal effects for different outcomes are reported in Table 10. Although our comments are confined to the specification with state dummies, any differences in the marginal effects between the two specifications (with and without state dummies) are noted.

As the marginal effect in no disability case (outcome 1) is negative and significant in 2012, it suggests a substantially lower probability of no disability relative to 2005. However, in all other outcomes the marginal effects were positive and significant, with the highest associated with outcome 3 (2–4 disabilities). This suggests that the probability of suffering from 2–4 disabilities was the one to rise most rapidly.

Somewhat surprisingly, the marginal effects associated with aged females were negative in the first outcome but positive in all other outcomes. All these effects were, however, weakly significant (a little over the 10% level). However, in the specification without state dummies the marginal effects were positive and significant in all outcomes.

Widows were positively and significantly associated with disability in all outcomes except the first (no disability) in which the effect was negative and significant. Comparing the magnitudes (leaving aside Outcome 1), the largest marginal effect was associated with outcome 3 (2–4 disabilities).

Location matters, as the marginal effects were negative and significant for urban residents in all outcomes, except outcome 1, in which it was positive and significant, relative to the rural. Thus urban residents were less likely to be disabled in single and multiple disabilities. In the alternative specification without state dummies, however, urban location didn't make a significant difference.

None of the caste variables had significant marginal effects on disabilities. In an alternative specification without state dummies, however, the marginal effect associated with OBCs was positive and significant relative to Others.

The probability of not being disabled was higher among all asset quartiles, relative to the lowest. In addition, all asset quartiles in outcomes 2–4 had significant negative marginal effects. In other words, the probability of being disabled in different ranges diminished among wealthier groups – especially among the third and fourth quartiles.

Any level of education enhanced the probability of being non-disabled, compared with illiteracy. In all other outcomes, education had negative and significant effects on disabilities. These effects reflect the strong influence of education in overcoming disabilities. This is in sharp contrast to the non-significant effects of any level of education in any of the outcomes.

NCDs reduced the probability of being non-disabled. Further, NCDs had positive and significant effects on disabilities across the range. The largest marginal effect was associated with outcome 3 (2–4 disabilities).

Social networks (participation in >3 networks) are found to reduce the severity of disabilities. First, participation in them significantly enhances the probability of being non-disabled. Second, in all other outcomes, participation in >3 networks significantly reduces disabilities in the remaining outcomes (2–4).

The marginal effects associated with older persons were significantly negative in the first outcome (non-disabled) group, implying a lower probability of being non-disabled relative to those in age group 60–69 years old, while they were significantly positive in all other outcomes with single and multiple disabilities.

7. Discussion

That the curse of old age has worsened is undeniable. Although the evidence is not sufficient to argue that the aged have experienced an expansion of morbidity without estimates of when disabilities began and their duration, the evidence presented is suggestive.

Among older persons, the probabilities of single and multiple morbidities rose. Aged females were more vulnerable to disabilities. Widows were significantly more likely to suffer from disabilities compared with currently married women.

Urban residents were also likely to be non-disabled, as well as less likely to suffer from disabilities relative to the aged in rural areas. This is not surprising given lower access to medical facilities, to devices that lower disabilities and/or their severity, and to rehabilitation programmes.

Disabilities displayed a gradient across asset quartiles, relative to the least wealthy. Thus wealth acts as a barrier to disabilities among the aged.

Somewhat surprisingly, castes and disabilities were unrelated except that, in one specification, OBCs were more vulnerable than Others.

Education has a strong effect in lowering disabilities but the effect varies with the specification. As we are more inclined to prefer the specification with state dummies, there is a strong case for promoting education to enhance awareness of government and other programmes for overcoming disabilities and methods for achieving this objective. As noted earlier, lack of awareness is a major impediment to functioning better.

Although we have not tried to examine the bi-directional relationship between NCDs and disabilities, our analysis provides a robust confirmation that NCDs result in a range of disabilities. As aging makes the population more susceptible to NCDs, and as the aging population has increased and is likely to continue rapidly to do so, the risks arising from sedentary lifestyles, unhealthy diets and obesity must be addressed early on.

Social networks, trust and bonding during personal crises are found to have significant roles in mitigating such crises. Not being able to perform the activities of daily living and being dependent on others - especially for widows and other aged individuals living alone - can be humiliating and stressful. If social networks (such as self-help groups, women's associations and other informal groups) are dense and closely knit, the severity of disabilities could be substantially mitigated. Our analysis confirms this. The threshold suggested by our analysis is participation in more than three networks. We need to build on this analysis.

Accounting for all these factors, single and multiple disabilities were higher in 2012 relative to 2005.

One extension of our analysis is to understand the determinants of types of disability (difficulty walking, vision impairments, difficulty using toilet facilities). Another extension is to examine the effects of disabilities on the occurrence of NCDs.

8. Concluding observations

To avoid repetition, we make a few observations from a broad policy perspective.

Although the evidence offered here is not sufficient to validate 'the expansion of morbidity' hypothesis – specifically because we have not analysed the data on the year of onset and duration of disability – it is difficult to avoid the inference that disabilities and their severity have risen among the elderly. It is the co-occurrence of NCDs and disabilities that is most likely to be fatal. In any case, the increase in life expectancy among the elderly has not translated into healthier lives.

Along with the expansion of old age pensions and health insurance, and public spending on programmes targeted at health care for the elderly, careful attention must be paid to reorienting health systems to accommodate the needs for prevention and control of NCDs 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.

In this context, The Rights of Persons with Disabilities Act 2016 is laudable in its intent and procedural detail. Yet it is largely silent on disabilities among the elderly. Indeed, primarily for this reason, it is arguable that its overarching goal -- "The appropriate Government shall ensure that the persons with disabilities enjoy the right to equality, life with dignity and respect for his or her integrity equally with others" – is mere rhetoric, if not a pipe dream (Ministry of Law and Justice, 2016, p 4).

In conclusion, a multidimensional approach comprising a strategy to overcome disabling barriers, as well as prevention and treatment of underlying health conditions, is required.

References

Agarwal, A., Lubet, A., Mitgang, E., Mohanty, S. and Bloom, D.E. (2016). *Population Aging in India: Facts, Issues and Options*. PGDA Working Paper No 132, Harvard School of Public Health.

Awasthi, A., Pandey, C.M., Dubey, M. and Rastogi, S. (2017). 'Trends, prospects and deprivation index of disability in India: evidences from Census 2001 and 2011'. *Disability and Health Journal 10*, 247–256.

Bloom, D.E., Hu, P., Arokiasamy, P., Risbud, A., Sekhar, T.V., Mohanty, S.K., Kale, V., O'Brien, J., Chien, S. and Lee, J. (2014). 'Longitudinal aging study in India: biomarker data documentation'. Boston MA: Harvard University Programme on the Global Demography of Aging.

Chatterjee, S., Byles, J., Cutler, D., Seeman, T. and Verdese, E. (2015). 'Health, functioning, and disability in older adults – present status and future implications'. *Lancet*, *385*, 563–575.

Greene, W. H. (2012). *Econometric Analysis*. 7th Edition. London: Pearson.

Groce, N. E. and Mont, D. (2017). 'Counting disability: emerging consensus on the Washington Group questionnaire'. *Lancet*, *5*, e649–e651.*India Human Development Survey* (2015). Delhi: NCAER and University of Maryland.

Jeffrey, R., and Singal, N. (2008). 'Measuring disability in India'. *Economic and Political Weekly*, 22 March.

Kulkarni, Vani S., Gaiha, R. and Kulkarni, Veena S. (2017). 'The high cost of aging'. *The Hindu*, 22 June.

Kumar, S., Pradhan, M.R. and Singh, A.K. (2017). 'Chronic diseases and their association with disability among the elderly in India'. *Social Science Spectrum 3*, 27–37.

Ministry of Law and Justice (Govt of India) (2016). The Rights of Persons with Disabilities Act.

Murtagh, K.N. and Hubert, H.B. (2004). 'Gender differences in physical disability among an elderly cohort'. *American Journal of Public Health 94*, 1406–1411.

Pandey, M.K. (2012). 'Poverty and disability among Indian elderly'. *Journal of Disability Policy Studies 23*, 39–49.

Pou, L.M.A. (2013). 'Burden of multiple disabilities among the older population in India: an assessment of socioeconomic differentials'. Paper presented at the XXVII IUSSP International Population Conference.

Seeman, T.E. and Berkman, L.F. (1988). 'Structural characteristics and their relationship with social support in the elderly: who provides support?'. *Social Science & Medicine 26*, 737–749.

Subramanian, S.V., Subramanyama, M.A., Selvaraj, S. and Kawachi, I. (2009). 'Are self-reports of health and morbidities in developing countries misleading? Evidence from India'. *Social Science & Medicine 68*, 260–265.

United Nations (2011). *World Population Prospects: The 2010 Revision*. Vol 1. New York: Department of Economic and Social Affairs, United Nations.

United Nations (2015). *World Population Prospects: The 2015 Revision*. Geneva: United Nations Department of Economic and Social Affairs Population Division.

Velayutham, B., Kangusamy, B., Joshua, V. and Mehendale, S. (2016). 'The prevalence of disability in elderly in India – analysis of 2011 census data'. *Disability and Health* [online resource available at http://dx.doi.org/10.1016/j.dhjo.2016.04.003].

World Health Organisation (WHO) and World Bank (2011). *World Report on Disability*. Geneva: WHO.

WHO (2015). *World Report on Ageing and Health*. Geneva: WHO.