Economic gradient of onset of disability in India

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Abstract

Background: Disability in India is associated with increasing non-communicable diseases, rising longevity, and increasing accidents and injuries. Though studies have examined prevalence, patterns, and socioeconomic correlates of disability, no attempt has been made in estimating age of onset of disability in India.

Objective: This paper investigates the economic gradient of age of onset of locomotor, visual, hearing, speech, mental retardation, mental illness, and other disabilities in India.

Method: We use nationally representative data of 106,894 disabled individuals from the 76th round of National Sample Survey (NSS), 2018. Descriptive statistics, kernel density, Kaplan-Meier survival curves, and linear regression models are used in the analysis.

Result: The disability rate in India was 2184 per 100,000 persons. The disability rate was highest for locomotor (1353) followed by hearing (296), visual (234), speech (228), mental retardation (158), and mental illness (131). Over 85% of mental retardation and 80% of speech disabilities occur at birth, while 82% of locomotor and 81% of visual disabilities occur after birth. Among those who had disability after birth, the median age for mental retardation was 2 years followed by mental illness (28 years), speech (29 years), locomotor (42 years), visual (55 years), and 56 years for hearing disability. Adjusting for socioeconomic covariates, the age of onset of locomotor and speech disabilities among the poorest individuals were 7 and 11 years earlier than the richest, respectively.

Conclusion: The economic gradient of onset of locomotive and speech disabilities are strong. The age of onset of disability was earliest for mental retardation followed by mental illness and speech disability.

Keywords: Disability, Economic gradient, Onset, type of disability, India

Introduction

Disability is an emerging public health, economic, and social challenge worldwide. Globally, over 150 million people have any form of disability and 6 million of them have severe disability [1]. Disability varies largely within and between countries, regions, and by socioeconomic and demographic characteristics owing to disease burden, stages of demographic transition, and definitional differences [2–4]. Efforts for the rights of disabled persons has intensified in recent decades. The convention on the rights of persons with disabilities [5] was featured in the sustainable development goals agenda, which aims to ensure a healthy life and to promote well-being for all at all ages [6–8].

With more countries moving towards later stages of the demographic transition, life expectancy has been increasing across all age groups. Though people are living longer, many are living with disease and deformity. Along with the demographic transition, late stages of the
epidemiological transition are characterised by increases in non-communicable diseases (NCDs), which are the leading causes of mortality and morbidity worldwide [9] and are associated with higher risk of disability [10]. The onset of NCDs is increasingly at younger ages and making people vulnerable to disability [11] earlier in life. Furthermore, poor socioeconomic conditions and unmet health care needs make duration of disability longer [10]. Compared to persons without disabilities, persons with disabilities are more prone to adverse socioeconomic outcomes, poor health, lower educational attainment, higher unemployment and underemployment, increased poverty, increased physiological stress, and decreased accessibility to services [12, 13]. Disability may increase the risk of poverty through lack of employment and education opportunities, lower wages, and higher cost of living [3, 14].

The onset of disability, defined as the age of occurrence of disability, is associated with a set of biological, social, economic, and environmental factors. Studies have shown that disability is more likely to occur at birth and early childhood as well as in old age [12, 15, 16]. For example, in India, one-third of disabilities occur at birth [17]. Disability at birth may be caused by many factors: genetics, care during pregnancy, complications during birth, and infections at time of birth among other factors [18, 19]. Disability following birth is largely due to varying socioeconomic, environmental, and demographic factors [20, 21]. The onset of disability is changing and disability has been increasing across all ages, although disability onset is clustered at younger and older ages [22]. Increasing disability is associated with increasing size and proportion of the elderly population, chronic health diseases, and accidents and injuries [23–25].

India with 1.21 billion population (the second most populous country) is estimated to have 23 million disabled persons in 2011 [26]. About 2.2% of the country’s population were disabled and locomotor disability accounts one-fifth of disabled (20.3%) followed by hearing (19.0%), seeing (18.5%), other disability (18.0%), multiple disability (8.0%), speech (7.5%), mental retardation (5.5%), and mental illness (2.7%). Disability is higher among females than males and higher in older ages. India is also experiencing a rapid increase in its elderly population; about 8% of the overall population were aged 60+ in 2011 and this figure is expected to grow to 11.1% by 2025 [27]. About 60% of deaths in India are due to NCDs and the onset of NCDs is at least 10 years lower than many developed countries [10]. This pattern of disability varies across states and by socioeconomic status [4, 28]. Over one-third of country’s population is living below the poverty line and health care quality and access is poor in poorer regions and among poorer people [29].

Need for the study
In India, studies on disability are limited, largely due to the paucity of data. While the Census of India provides aggregate estimates of disability every 10 years, the National Sample Survey is the only data source that provides individual level data on disability, most recently in 2018. India is rapidly ageing and the disease patterns are changing rapidly. The onset of NCDs in India is at least 10 years lower than many developed countries [11]. Increasing disability is largely due to demographic and epidemiological transitions as well as socioeconomic and environmental causes. Though studies show lower longevity among poorer individuals compared to richer individuals, little is known about the economic gradient of disability [30]. With its limited health care facilities and low coverage social security system, the poor and marginalised in India are likely to suffer most. In this context, the main objective of this paper is to estimate the economic gradient of the onset of seven types of disability in India.

Data and methods
We obtained individual level data from the 76th round, 26.0 schedule of the National Sample Survey (NSS), conducted by the Ministry of Statistics and Programme Implementation, Govt. of India in 2018. The NSS is the official statistical system in the country that collects data on various socioeconomic and health issues through population-based surveys [17]. It used a nationally representative stratified two-stage sampling design. The NSS is the only data source in India that provides an opportunity to understand the onset of disability and its correlates. The 76th round covered 576,569 individuals from 118,152 households in India. A total of 106,894 disabled individuals were included in our analysis. The survey covered seven types of disability: locomotor, visual, hearing, speech, mental retardation, mental illness, and other disability. Additional file 1 presents the definition of each disability in the NSS survey. A person is considered to have a disability if he or she has restrictions or a lack of abilities to perform an activity in the manner or within the range considered normal for a human being. Persons with more than one disability type are considered to have multiple disabilities. The 76th round of the NSS was the first attempt to collect data on the prevalence of mental retardation and mental illness. The survey had a specific question regarding the age (in years) of onset of disability for those who reported to have any form of disability. Disability at age 0 was considered disability at birth.

Methods
Descriptive statistics, disability rate, kernel density curves, Kaplan-Meier survival estimates, and multiple
regression analyses were used in the analyses. Disability rate is defined as the number of disabled persons per 100,000 population. We examined the onset of disability at the 25th percentile, median, and 75th percentile. Kernel density is used to estimate the probability density function of age of onset of disability. The Kaplan-Meier (KM) survival function gives the probability that a person develops a particular disability after a given age \((x)\). In other words, it is the probability that a person survives the age duration (up to age \(x)\) without the occurrence of that disability. The KM estimate of survival time \(S(t)\) is given by:

\[
S(t) = \prod_{t_i \leq t} \left( \frac{n_i - d_i}{n_i} \right),
\]

where \(n_i\) is the number of individuals observed at time \(t_i\) and \(d_i\) is the number of individuals who experienced the disability at time \(t_i\). We tested for statistically significant differences in survival functions by monthly per capita consumption expenditure (MPCE) quintile using log rank tests.

The KM function was suitable because disability onset is a continuous time-to-event outcome and is relatively robust to competing events. A set of multiple linear regression equations are used to estimate the adjusted mean of the onset of disabilities. The regression equation in its general form is given as

\[
Y_i = \alpha + \beta_1 MCPE Quintile_i + \beta_2 Sex_i + \beta_3 Residence_i + \beta_4 Education_i + \beta_5 Religion_i + \beta_6 Social Group_i + \beta_7 Household Size_i + \epsilon_i
\]

Where \(Y_i\) is the type of disability (outcome variable) for individual \(i\) and the \(\beta\)'s are the regression coefficients of independent variables monthly per capita consumption expenditure (MPCE) quintile (poorest, poorer, middle, richer and richest) which is an economic indicator measuring the economic well-being of the household and it is a continuous variable, sex (male/female), place of residence (rural/urban), education (below primary, middle or secondary, and secondary and above), religion (Hindu, Muslim, Others), social group (SC, ST, OBC, and others), and household size (1–28). \(\epsilon_i\) is the error term in the regression model for individual \(i\).

**Results**

Table 1 presents the household characteristics of the overall surveyed population in India. The average

| Variables                                  | Number/prevalence/percentage |
|--------------------------------------------|------------------------------|
| Total Population Covered                   | 576,569                      |
| Number of households                       | 118,151                      |
| Average household size                     | 4.3                          |
| Sex ratio (Number of females per 1000 males) | 929                          |
| Percent Urban                              | 30.4                         |
| Percent SC/ST                              | 27.71                        |
| Median Age                                 | 27                           |
| **Education Attainment in percent**        |                              |
| Illiterate                                 | 26.99                        |
| Up to Primary                              | 29.11                        |
| Middle/Secody                              | 26.23                        |
| Higher Secondary & above                   | 17.67                        |
| Monthly per capita consumption expenditure (in Rupees) | 2297                      |
| Number of disability cases                 | 106,894                      |
| **Any disability rate (Per 100,000 population)** |                              |
| Locomotor disability rate                  | 2184                         |
| Visual disability rate                     | 1353                         |
| Hearing disability rate                    | 234                          |
| Speech disability rate                     | 296                          |
| Mental retardation disability rate         | 228                          |
| Mental illness disability rate             | 158                          |
| Other disability rate                      | 131                          |
|                              | 55                           |
household size was 4.3 persons and about 27% of the population was illiterate. The sex ratio (number of females per 1000 males) was 929 while the median age was 27 years. About 28% of the population were scheduled caste (SC)/scheduled tribe (ST) and 30.4% population were living in urban areas. The average MPCE was 2297 rupees (£25.20 in 2018). The average disability rate (per 100,000 population) in India was 2184 and it was highest for locomotor (1353), followed by hearing disability (296) and visual disability (234). The disability rate was lowest for mental illness (131) and all other disabilities (55).

Figure 1 shows the distribution of disabilities at birth and after birth in India. About 18.53% of locomotor disabilities and 19.34% of visual disabilities were present at birth. In contrast, 85.61% of individuals with mental retardation and 79.67% of individuals with a speech disability had their disability at birth.

Table 2 shows the distribution of onset of disability by MPCE quintile, sex, and residence for the seven types of disabilities in India. The estimates are presented at the 25th, 50th, and 75th percentiles of the distribution. The economic disparity of disability burden was strongest in the case of locomotor and speech disabilities. The 25th percentile of onset of locomotor disability was 8 years for the poorest MPCE quintile, 10 years for poorer and middle MPCE quintiles, 14 years for the rich MPCE quintile, and 24 years for richest MPCE quintile. Similarly, the median age of locomotor disability for people belonging to the poorest MPCE quintile in India was 39 years compared to 49 years for the richest MPCE quintile. In contrast, there are only small differences in the 75th percentile age at onset for locomotor disability across MPCE quintiles. Males had earlier age at onset of locomotor disability compared to females at each percentile of the distribution. The median age at onset of locomotor disability in rural areas is 4 years earlier than that of urban areas.

Visual and hearing disability have similar patterns of onset. The median age at onset of visual and hearing disability across MPCE quintiles varies in a narrow range of 55 to 59 years. Onset of mental retardation disability occurs very early in life across MPCE quintiles, sex, and residence. For most disabilities, onset is earlier in males compared to females and in rural areas compared to urban areas. Notably, the distributions of the onset of hearing, speech, mental retardation, and mental illness disability are similar by residence.

Table 3 shows the adjusted mean onset of each disability from the linear regression. Controlling for socioeconomic factors, the age of onset of all disabilities in India increases with increasing MPCE quintile. For locomotor disabilities, for example, age of onset was 33.5 years (SE = 0.0000526) for people belonging to the poorest MPCE quintile compared to 40 (SE = 0.0000577) years for the richest MPCE quintile. The results show the strongest economic gradient for onset of speech and mental retardation disabilities, with adjusted mean differences between the poorest and the richest quintiles of 11 and 12 years respectively. Disability onset also showed gender differences, with generally earlier age at onset for males compared to females with the notable exception of speech disabilities. These differences were most pronounced for locomotor (5 year difference), mental illness (5 year difference), visual (4 year difference), and mental retardation (4 year difference) disabilities.

Adjusted for other socioeconomic indicators, we observed gaps in the onset of disability between social groups. These differences were most pronounced for mental retardation with mean onset at age 22.75 for ST (SE = 0.0000614), 17.37 for SC (SE = 0.0000458), and 14.89 for OBC (SE = 0.0000312). However, this pattern was reversed for hearing disability with mean onset at age 45.41 for ST (SE = 0.0000562), 45.86 for SC (SE = 0.0000405), and 48.51 for OBC (SE = 0.0000276). Across all disabilities, Muslims showed lower mean age of onset.
disability onset compared to Hindus. The most pronounced difference was mental retardation with mean age at onset of 12.85 years (SE = 0.0000253) for Muslims compared to 18.57 years (SE = 0.0000253) for Hindus. Education did not show a clear gradient across disability types. For locomotor and visual disabilities, lower education had later onset than higher education, while for speech and mental retardation it was reversed. Other disabilities such as hearing and mental illness had the lowest age of onset for middle/secondary education, while primary education and secondary and above had higher ages of onset. There were no major differences in age of onset across disabilities by household size.

Figure 2 shows the kernel density estimates of onset of disability across age groups for the seven types of disabilities. The purpose of the kernel density is to reflect the proportion of disability in each age group. Locomotor disability onset has two peaks, at ages 0 and 60, with a minimum at age 25 (Fig. 2a). The normal curve shows an expected peak of onset of disability by the age 36 after which it starts declining. The kernel density plots of visual (Fig. 2b) and hearing (Fig. 2c) disability show that onset is likely to occur in the early to mid-60s, each with a smaller peak in early childhood about age 6 consisting of about 1% of cases. Speech disability also has a bimodal kernel density plot with a peak before 5 years old and a smaller peak in the mid-50s. The mental retardation and mental illness plots are both unimodal with peaks in early childhood and early adulthood respectively. The low age peak for mental retardation is expected given the high proportion of cases present at birth. For all other disabilities similarly sized peaks occurred in early childhood and about age 60.

Figure 3 shows the KM survival curves for all types of disabilities by MPCE quintile in India. The curves differed by MPCE quintile. Log rank tests showed people in the poorest MPCE quintile had a higher probability of occurrence of disabilities at earlier ages compared to the richest MPCE quintile. With increasing MPCE quintile, the age of onset of disability increases in a type of dose-response relationship. Locomotor disability had the highest probability of onset among working age groups in India.

Figure 4 presents the KM survival curves by type of disability stratified by sex. The KM survival curves for males remained below those for females across all ages for locomotor, visual, mental retardation, and mental illness disability, reflecting earlier onset of these disabilities in males. There were no substantial differences in the survival curves for hearing, speech, and other disabilities by sex.

Discussion
To our knowledge, this is the first study to estimate the onset of seven major disabilities by socioeconomic and demographic characteristics in India. It improves our understanding of how the age of onset of disability is distributed over the life course among different types of disabilities as well as the association between economic and socioeconomic variation in age of onset of disabilities.
| MPCE Quintile | Gender | Residence | Education | Religion | Social group | Household Size |
|---------------|--------|-----------|-----------|----------|-------------|---------------|
|               |        |           |           |          |             |               |
| Poorest       | Male   | Rural     | Below Primary | Hindu   | ST          | 1–4           |
| 33.56 0.0000526 | 33.78 0.0000351 | 35.28 0.0000304 | 42.09 0.0000212 | 36.44 0.0000286 | 35.99 0.0000746 | 36.6 0.000041 |
| Poor          | Female | Urban     | Middle/Secondary | Muslim | SC          | 5–8           |
| 34.88 0.0000567 | 38.75 0.0000348 | 29.23 0.0000334 | 39.54 0.000016 | 33.36 0.0000644 | 33.71 0.000056 | 36.11 0.0000562 |
| Middle        | Male   | Rural     | Secondary & above | Hindu | OBC         | 9–28          |
| 35.77 0.0000557 | 38.19 0.0000407 | 27.64 0.0000448 | 44.53 0.0000402 | 36.44 0.0000286 | 35.08 0.0000376 | 34.78 0.0000821 |
| Rich          | Female | Urban     | SC          | Muslim | Others      |               |
| 36.96 0.0000576 | 38.75 0.0000348 | 33.71 0.000056 | 45.13 0.000056 | 33.36 0.0000644 | 39.75 0.0000494 |               |
| Richest       | Male   | Rural     | OBC         | Others | ST          |               |
| 39.74 0.0000577 | 38.19 0.0000407 | 35.08 0.0000376 | 45.84 0.0000494 | 39.75 0.0000494 | 35.99 0.0000746 |               |
|               | Female | Urban     | Others      |        |             |               |
| 39.75 0.0000494 | 38.19 0.0000407 | 39.75 0.0000494 |               |               |               |               |

Other disability includes: Parkinson’s disease, multiple sclerosis, other chronic neurological conditions, hemophilia, thalassemia, sickle cell disease.
We show that the age of onset of disability varies by type of disability in India. Among the seven types of disabilities, the median age of onset of disability was lowest for mental retardation (2 years) and highest for hearing (56 years). Mental retardation and mental illness appear at earlier ages compared to other disabilities, some of
which primarily appear in later life including hearing and visual disabilities. Several disabilities also show bimodal patterns of age of onset with the highest proportion of burden occurring in early childhood and old age. We observed a clear economic gradient of onset of disability both overall and by specific type of disability. This gradient was strongest for locomotor and speech disabilities. Controlling for sociodemographic correlates, people in poorer strata are more prone to experience early age of onset of locomotor and speech disability, at least 7 years before the richest. Differences by sex were also seen with age of onset of locomotor and visual disability occurring earlier among males than females while speech and other disabilities had earlier onset among females. Notably, rural populations were more likely to have lower age of onset of disability compared to urban populations.

When we look into the interrelationship between disability and economic characteristics, enduring disability throughout the life course may lead to poverty and social exclusion, in part brought about by the burden of familial financial dependency. Disabled individuals are more vulnerable to economic disempowerment than non-disabled individuals [31]. Our findings are consistent with the extant literature. Prior studies suggest higher disability among the poor [2, 32]. Possible explanations include lack of adequate health care quality and access. The higher proportion of disability among males compared to females is also consistent with the literature [33]. This disparity may be due to higher NCD burden among males compared to females [34]. This study’s findings regarding age of onset of disability differences by socioeconomic and demographic factors corroborates previous literature. Previous study results show that the age of onset of disability is associated with geographical region, education level, and wealth quintile [14, 35]. Children and older adults are more prone to diseases and health complications and so age of onset of disability was higher at younger and older ages [21]. The high locomotor disability rate in rural populations is coupled with earlier age of onset of disability [2, 32, 36].

This study has several limitations. First, the age of onset of disability is self-reported and not clinically validated. Less than one-third of disabled persons had a medical certificate while the majority of disabled persons lacked such documentation. Second, we did not explore the causes of disability such as diseases, accidents, injuries, genetics etc. Third, the state level variation across types of disabilities could not be analysed due to insufficient sample size.

Conclusion
Despite these limitations, this study provides numerical estimates on age of onset of disability that would be helpful for national and state planning. Though national and state governments provide some benefits to disabled persons (reserved spots in education and job placements as well as pension benefits for disabled persons), there is limited health provisioning for the disabled population in India. Providing free health care facilities, universal health insurance coverage for disabled, and economic security for disabled persons could mitigate suffering.
Fig. 4 Kaplan-Meier survival estimate of (a) locomotor (b) visual (c) hearing (d) speech (e) mental retardation (f) mental illness and (g) other disabilities by sex in India, 2018.
Different disabilities require different accommodations and this study illuminates how burden is shared unequally across populations and through the life course, which may help guide policymakers and public health practitioners focus their efforts more effectively.

Abbreviations
NCD: Non communicable disease; NSS: National sample survey; MPCE: Monthly per capita consumption expenditure; SC: Schedule caste; ST: Schedule tribe; OBC: Other backward classes; SE: Standard error; KM: Kaplan Meier; WHO: World health organization

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12889-021-10826-5.

Acknowledgements
Not applicable.

Authors’ contributions
RSM; analysis and interpretation of data: RSM, SKM, and US; drafting the manuscript: RSM, SKM, and US; critical revision of the manuscript: RSM; analysis and interpretation of data: RSM, SKM, and US; drafting the manuscript: RSM, SKM, RRS and US, JC, RS.

Declarations
Not applicable.

Competing interests
The authors declare that they do not have any competing interest.

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Received: 12 January 2021 Accepted: 12 April 2021

Published online: 21 April 2021

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