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Chapter

Age- and Sex-Specific Burden of Morbidity and Disability in India: A Current Scenario

Ajit Kumar Yadav and Akansha Singh

Abstract

India is the second most populous country in the world with a population of 1.3 billion; any change in its morbidity and disability pattern is bound to bring change at the Asia level, which is a matter of concern for the developing countries. Disability-free life expectancy (DFLE) and disability-adjusted life years (DALYs) provide summary measures of health across characteristics. The assessments of epidemiological patterns and health system performance of any place and time period display its progress towards the goal of sustainable development goals (SDGs). The main aim of this study is to assess the age and sex pattern of the burden of diseases (mortality and morbidity) and disability in India. The information on disease and deaths was extracted from the 71st round of the National Sample Surveys (NSS) conducted in 2014 (NSS 2014) and the Causes of Deaths Study conducted in the 2010–2013 (RGI 2010–2013) and disability from Census of India 2011 (ORG 2011).

Keywords: morbidity, disability, age, sex and India

1. Introduction

The main aim of the Millennium Development Goal was to remove poverty and improve health. With the end of MDG goals in 2015, a new set of sustainable development goals (SDGs) were proposed to be achieved by the year 2030. The third goal of SDG is to ensure healthy lives and promote well-being at all ages. Reducing the prevalence of non-communicable disease (NCD) is one of the targets of SDG Goal 3. According to Global Burden of Disease Study 2015, DALYs due to communicable disease fell from 1200 million in 1990 to 7416 million in 2015, whereas total DALYs due to non-communicable diseases increased from 1.1 billion to 1.5 billion in 2015. In 2015, communicable accounted for 30.1% of the global DALYs; non-communicable disease accounts for 59.7% and injuries 10.1%. Since 2005, DALYs for the major communicable causes have declined substantially except for a few subsets of infectious diseases [1]. The life expectancy at birth in India has increased from 49.7 years in 1970–1975 to 68.3 years in 2011–2015 [2]. The life expectancy has increased from 23.7 years in 1881 to 66.9 years in 2011–2015 for males and from 25.6 to 70.0 years for females during this period [2, 3]. Further, infant mortality rates reduced from 130 to 37 deaths per 1000 live births from 1970 to 2015 [4, 5]. Child and adult mortality

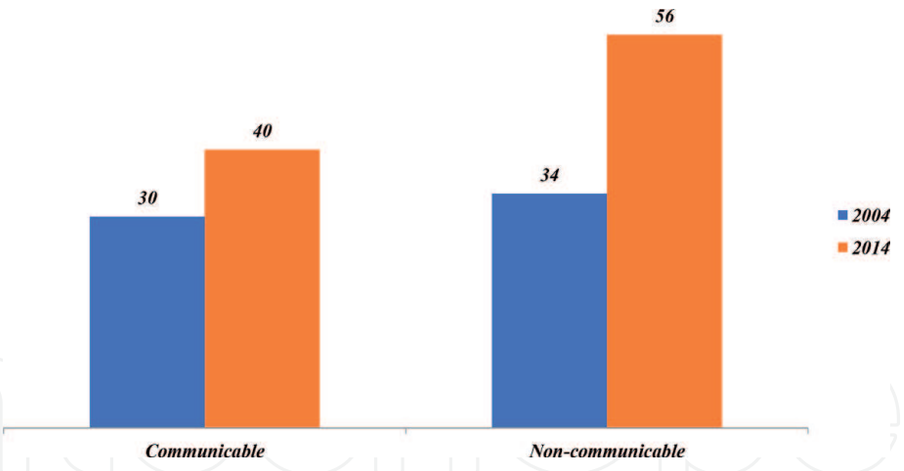

Figure 1.
Change in morbidity prevalence in India from 2004 to 2014.

rates have also declined significantly [6, 7], and there has been a significant increase in the probabilities of surviving to age 60 and 70 [8, 9].

With the significant improvement in life expectancy [10], there has been a gradual shift in the age distribution of deaths and disease pattern [11]. The numbers of DALY and DALY rates dropped substantially for communicable disease group between 1990 and 2016. By contrast, numbers of DALYs increased substantially for NCDs. The all-age prevalence of the most leading NCDs increased substantially in India from 1990 to 2016 [12]. Communicable diseases were the major causal agent of mortality in the early 1970s. However, mortality and disease burden are gradually moving towards non-communicable diseases. The premature deaths are shifted to the years lived with disability [13]. The communicable diseases are more concentrated in the people of the lower socio-economic group, and non-communicable diseases are on the rise due to current changes in India's population age structure and improved economic status and lifestyles [13, 14]. In this transition period, studies to understand the relationship between mortality and morbidity has become imperative for giving useful feedback to programme and policy planners who are involved in the public health management.

Studies on mortality and morbidity at the country level have taken central place in the social research domain from several decades (**Figure 1**). Studies addressing the pattern and cause of mortality and morbidity are scarce in India due to paucity of data. This issue has already been studied in the developed countries exhaustively. India is recently going through a phase of both demographic and epidemiological transitions. Health condition has improved along with increasing life expectancy. However, increase in life expectancy is accompanied with the loss of healthy life years. There is a need to examine the recent levels and age pattern of morbidity and its relation to the mortality in the context of India. The main aim of the paper is to see the age pattern of self-reported morbidity by sex in India and to estimate the burden of reported morbidities with a special focus on communicable and non-communicable diseases and disability by age and sex. This paper aims to provide an overall picture of the disease burden on the context of health and social development and throws light for policy investment and future research.

2. Data and methods

We have used 71st round of the National Sample Survey (NSS) data conducted in the year 2014. The 71st round was conducted in two subrounds of 6 months each.

The NSS provides information about the different communicable and non-communicable diseases on any person in surveyed household who were found ill during the last 15 days from the date of survey. Causes of Death data were extracted from the Causes of Death report published by the Registrar General of India (RGI), New Delhi, during 2010–2013. We used cause-specific proportion of deaths for communicable and non-communicable diseases by age and sex. The 2011 census, which covers the entire population of India, provides reported information on seven types of disability and one category for multiple disabilities. The prevalence of disability by age and sex is taken from the 2011 census. The proportion of total deaths by age was extracted from the report of Sample Registration System 2006 [15].

Self-reported ailments were classified into three categories: communicable disease, non-communicable disease, disability and 'other'. The main independent variables considered in this study are age and sex. The other individual socio-demographic factors considered in the analysis are residence, educational attainment and monthly per capita expenditure quintiles. Descriptive statistics and bivariate analysis are used for description of prevalence of diseases and disability and its association with age group. Logistic regression analysis is used for multivariate analysis.

The prevalence of disease was calculated with information from the survey on any person who had fallen ill during the last 15 days from the date of survey:

$$Prevalence = \frac{Number\ of\ diseased\ persons\ during\ the\ reference\ period}{Total\ population\ during\ the\ same\ time\ period} \times 1000 \qquad (1)$$

Summary measures of the health of a population are calculated by combining data on mortality and non-fatal health outcomes into a single number – disability-adjusted life years (DALYs) and disability-free life expectancy (DFLE) are calculated by age for male and female population in India.

Disability-adjusted life year measures health gaps as opposed to health expectancies. It measures the difference between a current situation and an ideal situation where everyone lives up to the age of the standard life expectancy in perfect health. The DALY combines in one measure the time lived with disability and the time lost due to premature mortality:

$$DALY = YLL + YLD \qquad (2)$$

where YLL is the years of life lost due to premature mortality and YLD is the years lived with disability.

The computation formula for YLL is given by:

$$YLL = (N/r) \times (1 - e^{-rL}) \qquad (3)$$

where N is the number of deaths, L is the standard life expectancy at age of death (years) and r is the discount rate (e.g. 3% corresponds to a discount rate of 0.03).

Similarly, the formula for YLD is $YLD = (I \times DW \times L \times (1 - e^{-rL}))/r$.

where I is the number of incident/prevalence cases, DW is the disability weight, L is the duration of disability (years) and r is the discount rate.

Disability weight was borrowed from the Global Burden of Disease Study 2000.

Sullivan's health expectancy method reflects the current health of a real population adjusted for mortality and disability level and is independent of age structure. Health expectancy calculated by Sullivan's method is the number of remaining years at a particular age that an individual can expect to live in a healthy state.

Disability-free life expectancy is one of the prime Sullivan's health expectancies. DFLE is found by partitioning the person year lived in the interval into those who

have lived with and without disability. If we assume two states called disability-free and with disability, then the disability-free life expectancy at age x ($DFLE_x$) and the life expectancy with disability (DLE_x) at age x are defined by:

Years lived with disability between ages x and x + 5 = ${}_5YD_x = {}_5L_x \times {}_5Prev_x$;

Years lived without disability between ages x and x + 5 = ${}_5YWD_x = {}_5L_x \times (1 - {}_5Prev_x)$.

DLE_x = sum of years lived with disability for ages x and above, divided by l_x.

$DFLE_x$ = sum of years lived without disability for ages x and above, divided by l_x.

where l_x is the number of survivors at exact age x, ${}_5L_x$ is the number of years of life lived by the life table cohort between ages x and x + 5 and ${}_5Prev_x$ is the prevalence of disability between ages x and x + 5 in the population.

3. Results

The prevalence of all self-reported communicable and non-communicable morbidities has increased from 2004 to 2014 in India. The prevalence of communicable diseases increased by 10 points and non-communicable diseases by more than 20 points. The prevalence of all diseases was higher for females than males (**Figure 2**). The prevalence of disability was the same for males and females (4%). The maximum difference in the prevalence rate was observed for the category of non-communicable disease (33% in males and 51% in females) (**Figure 2**).

The study examines the prevalence rate of self-reported morbidities by age and sex in India for the year 2014. Females are at higher risk of suffering from disease. Risk of suffering from non-communicable diseases and other diseases increased with increasing age and reduced steadily for the communicable disease. The infant in the age group of 0–1 year suffered the largest burden of communicable diseases (overall 108 per 1000; male, 121 per 1000; female, 93 per 1000). Non-communicable disease prevalence was highest in the age group 70 and above (overall 274 per 1000 population; male 281 and female 267). Similarly, other disease prevalence remains higher for elderly age 70 years old and above. Male–female gap

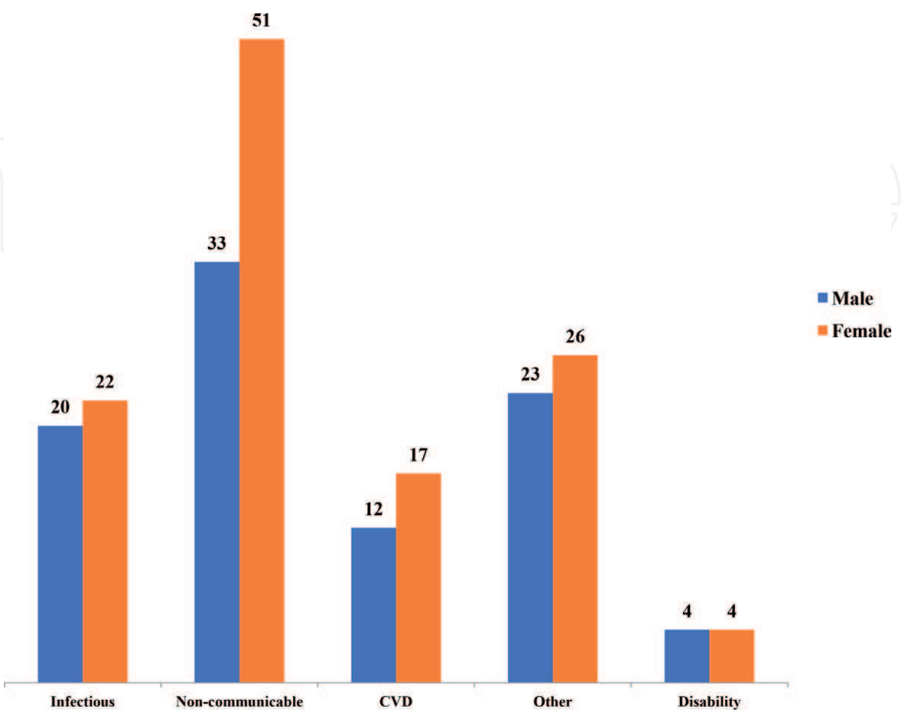

Figure 2.
Prevalence of different self-reported morbidities in India by Gender (2014).

in the communicable disease prevalence was the highest for the infant age group. Females overpass the male prevalence of communicable disease from the age group 15–19 years and remain on the higher side except the oldest age group (65 and above). The prevalence of non-communicable diseases was higher for females than males in all the age group except the 70+ and less than 10 years. Similar pattern by sex was observed for the other diseases and disability status (**Figure 3**).

Table 1 shows the results of logistic regression analysis by age after controlling the effect of other socio-economic factors. It is evident from the results that the odds of suffering from communicable diseases were maximum in the reference age group. The odds reduced significantly in the adult ages and increased steadily afterwards in the elderly age groups. This age pattern does not change significantly by sex. The lowest odds were observed in the age group of 25–30 (OR, 0.19) and 30–35 years old (OR, 0.20). A significant positive association can be seen between risk of suffering from non-communicable disease and age. The risk of suffering from non-communicable diseases is more than 10 times higher in the age group 40 and above with the highest risk in the age group 70+. The risk of suffering from NCD was 52 times higher for the elderly age 70 and above. Elderly males (70+) have 48 times and

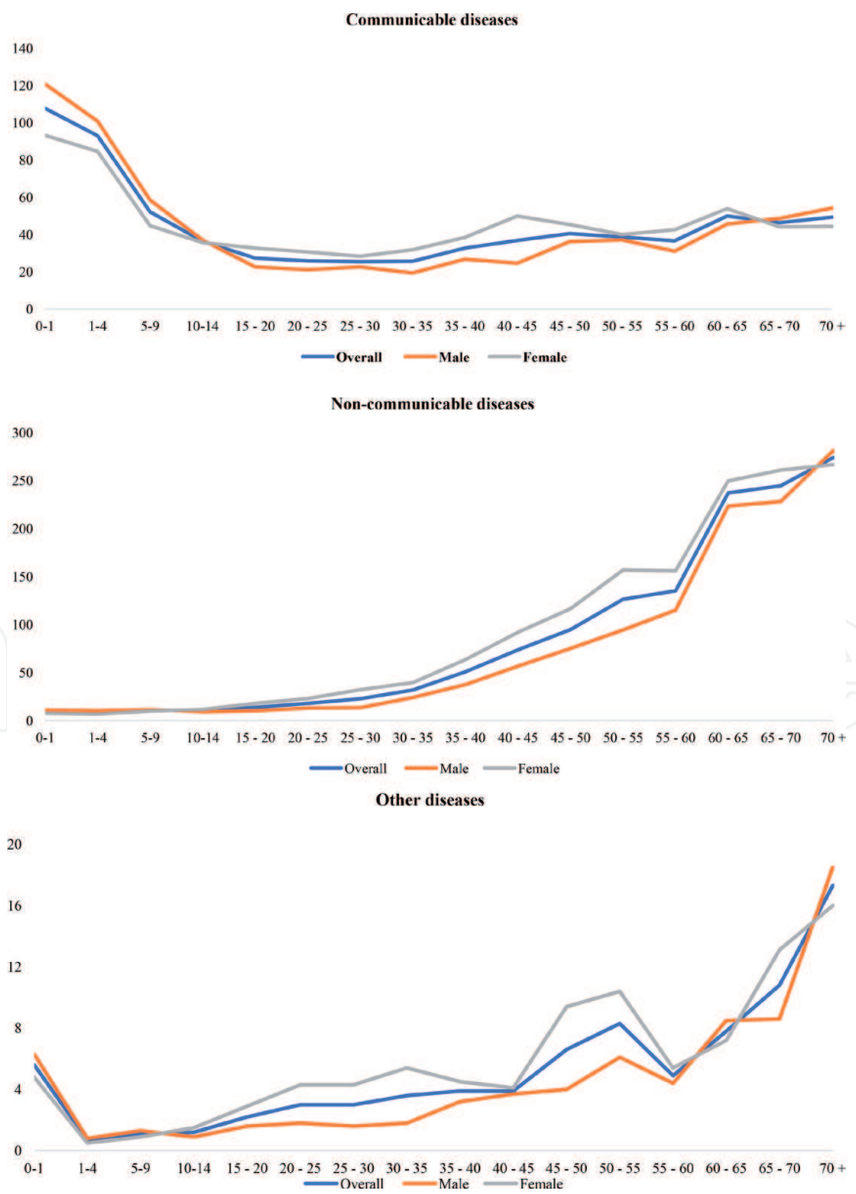

Figure 3.
Prevalence of self-reported morbidities by age and sex in India (2014).

females (70+) 58 times higher odds of suffering from non-communicable diseases. With the increase of age, the likelihood of other diseases also increased significantly. For other diseases, the impact was greatest for the elderly population in the 70-year age group who have three times higher risk than the reference age group. In each age group, the odds of suffering from each type of disease were higher among females than males except a few age groups in the other disease category (**Table 1**).

The result for DALYs from **Table 2** shows that the burden of communicable diseases was highest in the infancy (0–1 years), followed by 1–5 years. The two age groups contribute to 60% of the total DALYs in male children and 56% in females. The result clearly indicates that the burden of infectious diseases was higher during infancy and noticeably greater among males than females. The women in the age group 15–49 contribute to 21% of the total DALYs. The age distributions of the DALY indicated that individuals aged below 5 and above 60 years were more susceptible to infections. The DALYs in each age group are higher for females than males except children aged below 5 years and the elderly aged 70+. Females in the adult age group were more at risk of having infectious diseases than their male counterparts. The age distributions of the non-communicable disease DALYs

Age group	Communicable disease			Non-communicable disease			Disability and others		
	Odds ratio	95% CI		Odds ratio	95% CI		Odds ratio	95% CI	
Overall									
0–1 Reference category									
1–4	0.77	0.72	0.82	1.17	0.95	1.43	0.30	0.20	0.44
5–9	0.43	0.40	0.46	1.28	1.05	1.55	0.29	0.20	0.43
10–14	0.28	0.25	0.30	1.39	1.15	1.69	0.29	0.20	0.43
15–20	0.24	0.22	0.26	2.09	1.74	2.51	0.52	0.37	0.71
20–25	0.22	0.20	0.24	2.27	1.90	2.72	1.09	0.84	1.43
25–30	0.19	0.18	0.21	2.74	2.30	3.26	0.96	0.73	1.26
30–35	0.20	0.19	0.22	4.00	3.37	4.76	0.86	0.64	1.14
35–40	0.25	0.23	0.27	6.69	5.64	7.93	0.93	0.69	1.25
40–45	0.31	0.28	0.34	10.66	9.01	12.62	1.24	0.93	1.66
45–50	0.29	0.26	0.32	15.03	12.72	17.76	1.36	1.02	1.82
50–55	0.29	0.26	0.33	18.79	15.91	22.20	1.84	1.39	2.43
55–60	0.30	0.27	0.33	22.16	18.77	26.16	1.45	1.08	1.95
60–65	0.35	0.32	0.40	39.53	33.46	46.69	2.53	1.90	3.37
65–70	0.39	0.35	0.44	39.52	33.40	46.77	2.01	1.46	2.78
70 +	0.38	0.34	0.43	52.09	44.14	61.47	3.15	2.40	4.14
Male									
0–1 Reference category									
1–4	0.75	0.69	0.82	1.19	0.91	1.56	0.35	0.21	0.60
5–9	0.42	0.38	0.46	1.21	0.94	1.57	0.31	0.18	0.52
10–14	0.25	0.22	0.28	1.27	0.98	1.64	0.22	0.12	0.40
15–20	0.19	0.17	0.22	1.72	1.35	2.20	0.36	0.22	0.59

Age group	Communicable disease			Non-communicable disease			Disability and others		
	Odds ratio	95% CI		Odds ratio	95% CI		Odds ratio	95% CI	
20–25	0.18	0.16	0.21	1.85	1.45	2.36	0.38	0.24	0.63
25–30	0.15	0.14	0.18	2.00	1.57	2.53	0.37	0.23	0.60
30–35	0.15	0.13	0.18	2.82	2.23	3.56	0.41	0.25	0.67
35–40	0.18	0.16	0.21	4.51	3.59	5.67	0.61	0.38	0.96
40–45	0.21	0.18	0.24	7.47	5.96	9.36	1.00	0.65	1.54
45–50	0.21	0.18	0.25	10.85	8.69	13.55	1.05	0.68	1.62
50–55	0.26	0.23	0.31	14.11	11.30	17.61	1.57	1.04	2.37
55–60	0.26	0.23	0.30	17.37	13.95	21.63	1.51	1.01	2.27
60–65	0.31	0.27	0.37	33.57	26.93	41.84	2.53	1.69	3.80
65–70	0.38	0.32	0.45	31.30	25.05	39.11	1.87	1.18	2.96
70 +	0.35	0.31	0.41	48.27	38.81	60.02	3.05	2.08	4.48
Female									
0–1 Reference category									
1–4	0.79	0.71	0.87	1.14	0.83	1.57	0.24	0.13	0.44
5–9	0.44	0.39	0.49	1.37	1.02	1.85	0.28	0.16	0.49
10–14	0.31	0.27	0.35	1.57	1.17	2.10	0.37	0.22	0.62
15–20	0.30	0.27	0.34	2.61	1.98	3.45	0.69	0.44	1.06
20–25	0.26	0.23	0.29	2.79	2.13	3.65	1.66	1.16	2.37
25–30	0.24	0.22	0.27	3.69	2.83	4.80	1.51	1.05	2.18
30–35	0.27	0.24	0.31	5.71	4.39	7.43	1.35	0.92	1.98
35–40	0.34	0.30	0.39	9.79	7.56	12.69	1.27	0.85	1.90
40–45	0.44	0.39	0.50	15.05	11.63	19.47	1.48	0.99	2.22
45–50	0.39	0.34	0.45	20.63	15.98	26.63	1.66	1.12	2.48
50–55	0.33	0.29	0.38	24.70	19.14	31.88	2.06	1.40	3.04
55–60	0.36	0.31	0.41	28.81	22.33	37.18	1.39	0.91	2.12
60–65	0.41	0.35	0.48	47.49	36.77	61.33	2.52	1.68	3.79
65–70	0.41	0.34	0.49	51.15	39.51	66.21	2.16	1.38	3.39
70 +	0.42	0.36	0.49	57.55	44.59	74.28	3.25	2.20	4.79

Table 1.
Logistic regression analysis with the disease status as a dependent variable.

(**Table 2**) indicated that individuals aged above 45 years are more susceptible to non-communicable diseases. The largest contribution of the total DALYs in non-communicable diseases is from the age group 65–70 (males, 14%, and females, 13%). The result also shows that the adult working age male and female population contributes more than half of the total DALYs in non-communicable diseases. The DALYs for non-communicable disease are higher in the male population than females in most of the age groups contrary to the fact that the prevalence of non-communicable disease has been higher among females.

Age group	Communicable		Non-communicable	
	DALY per 100,000		DALY per 100,000	
	Male	Female	Male	Female
0–1	2896	2489	470	320
1–4	641	541	104	70
5–9	233	236	154	130
10–14	217	221	143	122
15–19	102	163	204	173
20–24	109	167	219	176
25–29	118	174	236	184
30–34	128	156	493	374
35–39	126	154	484	372
40–44	135	177	517	425
45–49	128	125	748	634
50–54	145	149	845	759
55–59	166	172	1073	767
60–64	151	157	971	702
65–69	185	188	1191	841
70+	102	96	472	307

Table 2.
Burden of communicable and non-communicable disease by age and sex for total population in India, 2011.

	Total life		Proportion with disability (π_x)		Disability-free		Suffering	
	Expectancy (e_x)				Life expectancy		Disability life years	
Age group	Male	Female	Male	Female	Male	Female	Male	Female
0–1	65.8	69.3	0.046066	0.050826	58.1	61.5	7.7	7.8
1–4	67.9	71.7	0.046066	0.050826	59.9	63.6	8.0	8.1
5–9	64.6	68.7	0.072173	0.07391	56.7	60.7	7.9	8.0
10–14	59.9	64.0	0.174172	0.169639	52.3	56.4	7.6	7.7
15–19	55.1	59.3	0.174172	0.169639	48.3	52.4	6.8	6.9
20–24	50.4	54.6	0.161413	0.149764	44.5	48.6	5.9	6.0
25–29	45.8	50.0	0.161413	0.149764	40.7	44.7	5.2	5.3
30–34	41.3	45.4	0.140982	0.128796	36.9	40.8	4.4	4.6
35–39	36.8	40.8	0.140982	0.128796	33.1	36.8	3.8	4.0
40–44	32.5	36.2	0.123556	0.106899	29.4	32.8	3.1	3.4
45–49	28.3	31.7	0.123556	0.106899	25.7	28.7	2.6	2.9
50–54	24.2	27.2	0.095472	0.089786	22.2	24.8	2.0	2.5
55–59	20.4	23.0	0.095472	0.089786	18.7	20.9	1.7	2.1
60–64	16.9	19.0	0.093039	0.106845	15.6	17.2	1.3	1.7
65–69	13.6	15.4	0.093039	0.106845	12.7	14.1	1.0	1.3
70+	10.9	12.3	0.059046	0.074803	4.1	4.2	6.9	8.1

Table 3.
Burden of disability by age and gender in India, 2011.

The DFLE result (**Table 3**) shows that at birth, males in India are expected to live 58 years of life without disability out of the 66 years of the total life expectancy at birth. Similarly, females are expected to live 62 years of life without disability out of the total 69 years of life expectancy at birth. The age pattern of disability-free life expectancy does not change considerably till the age 70 in India. The elderly population aged 70 years and above are expected to live around two-thirds of their life in disability. Elderly males aged 70 years and above are expected to live 63% and females 66% of their total life with disability.

4. Discussion

The paper aims to examine the age and sex pattern of morbidity and its linkage with summary measures of health such as DALY and DFLE. India is also experiencing a similar epidemiological transition along with demographic transition. It is observed that during transition period, the age pattern of mortality and morbidity will be altered [16]. There has been a significant transition in age pattern of morbidity in India. A comparison of this study with other previous studies' findings suggests that the age-specific communicable and non-communicable diseases have increased over the last 20 years' time. The increase in the rate of non-communicable disease was much higher. With the increase in age, prevalence and odds of suffering from non-communicable diseases increase significantly. The risk of non-communicable diseases increases from middle-aged adults to elderly population among males, and for females, the risk of having non-communicable diseases was significantly higher among the elderly age group. This finding supports the previous studies' findings that communicable diseases are more likely to occur in the younger ages while non-communicable diseases occur in the elderly population [17, 18].

The study further shows that the prevalence of self-reported non-communicable morbidities and disabilities was higher among females than their male counterparts in each age group and communicable. Gender gap in health and mortality exists all over the world. The unequal utilization of health care is the major factor that leads to uneven health disparity. Various reasons for differential morbidity are kinship system, gender ideologies, poverty, nutritional status, socio-economic condition, level of education and violence [19, 20]. The age pattern of the disease also suggests that the prevalence of communicable and non-communicable diseases was higher among the females, but the gender gap was not apparent in disability.

In order to understand the burden of communicable and non-communicable disease for male and female population in India, we calculated the disability-adjusted life year. The result shows that the burden of communicable disease was higher in infant males compared to infant females in India during 2014. In medical terms, it is seen that male children are more biologically weaker than female children and thus are more prone to various diseases and spend a larger amount of time fighting for the disease [21]. Contrary to the prevalence sex pattern, DALYs for non-communicable diseases in each age group were higher for males as compared to the females. The burden of non-communicable disease was more prominent in higher age group (60 years and above) of population across both sexes. The result also shows that the adult working age male and female population (15–59 years) contributes half of the total DALYs in non-communicable diseases, which is a serious cause of concern. The socio-economic impact of this morbidity and disability due to non-communicable diseases is enormous since these deaths often affect the main income earner in the household and those who rear those children [22].

The DFLE result shows that elderly 70 years and above are spending more than one-third of their life in disability. Further, females spend more life suffering from

disability as compared to males. Due to higher life expectancy among females in the later ages, females spend more suffering years. The previous study for the earlier decade also suggests that the gender inequalities in DFLE are more evident in India and other low- and middle-income countries [23].

5. Conclusions and limitations

India's population is increasing at a tremendous rate. With increase in population, the prevalence of morbidity is also increasing. In spite of the vigorous efforts to reduce mortality and morbidity in India, India is still struggling with its unfinished agenda of restricting communicable disease. On the other side, the prevalence of non-communicable is rising rapidly. This leads to heavy double burden of disease in India. The prevalence of communicable diseases in the younger ages has become a threat for the newly born child, whereas the prevalence of non-communicable diseases in middle-aged adult and the older ages is concerning the adults and elderly population. Thus, both the working and dependent populations are in the clutch of morbidity and putting a question on the health system. Females are the real victims of disease sufferers and disability. The increasing significance of non-communicable disease burden also suggests the need for serious intervention strategies to prevent non-communicable disease burden not only for the elderly but also for the adult age group. The basic challenge would be to implement appropriate prevention strategies to halt the growing trend in non-communicable diseases against a background of infectious diseases, which remain out of control. The increasing burden of diseases among working adults and elderly in a country will impose high financial hardship on its government and households.

Though this study examines the burden of communicable and non-communicable disease in India, the result presented in the paper should be interpreted keeping the following limitation in mind: First, all the diseases estimated in this research paper are based on self-reporting rather than medical investigation. Self-reported morbidity is the only variable that gives us information about morbidity in the absence of information from medical fields. One of the major doubts that arise is about the validity of self-morbidity. In the absence of proper knowledge about the ailment, cultural and societal factors, lack of media exposure and socio-economic condition may lead to under- or overreporting and biasness towards self-reported morbidity. The states which are socio-economically well-off report higher morbidity in comparison to the other underprivileged states. A study states that Kerala which is the most developed state in country reports higher morbidity than Bihar which has lower life expectancy and lower educational level. The adequate measurement of morbidity is one of the important factors that do could give us a precise depiction of the prevalence of morbidity [24]. Second, information used (cause of death) in calculation of DALY is based on sample survey rather than complete enumeration. Third, age- and cause-specific proportion of death was not available at state level; therefore, we used the national-level estimate. Fourth, information on proportion of disability was given at 10 years of interval, which is bifurcated in 5 years of interval.

Abbreviations

DFLE	disability-free life expectancy
DALY	disability-adjusted life year
SDG	sustainable development goal

NSS	national sample surveys
YLLs	years of life lost
YLDs	years of life lived with disability
NCD	non-communicable disease
CD	communicable disease
RGI	Registrar General of India
ORG	Office of Registrar General of India

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