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Morbidity status and changes in difficulty in activities of daily living among older adults in India: A panel data analysis

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Abstract

Introduction

The study explored the socioeconomic and demographic factors that determine the onset of difficulty, recovery from difficulty and difficulty remaining in functional activity in later years of life. Additionally, the study examined the effects of several combinations of chronic diseases on the changes in later-life functional difficulty.

Methods

We used data from two rounds of India Human Development Survey (IHDS) conducted during 2004–2005 and 2011–2012. A sample of 13,849 respondents aged 55 years and above with a seven year follow-up was considered for this study. The Katz Index of Independence in activities of daily living (ADL) was used to measure the functional disability as an outcome variable. Multinomial logistic regression has been conducted to fulfil the study objectives.

Results

The overall functional difficulty among older adults was 27.3% and onset of functional difficulty (23.5%) was higher than the recovery from difficulty (2.1%) and remaining with difficulty (1.7%). Onset of functional difficulty in second round was higher among women (27.3%) than men (19.3%). Bivariate and multivariate analyses showed that single and multi-morbidity had a positive significant association with all categories of functional difficulty. Female sex, increasing age and rural place of residence had positive association with onset of difficulty and difficulty remaining in second round. The combinations of morbidities were also found to have positive significant association with functional difficulty i.e., the relative risk (RR) of onset of difficulty in second round is higher among those who had diabetes with high blood pressure (RR-1.7; CI: 1.4–2.0), cataracts with high blood pressure (RR-2.0; CI: 1.5–2.6) and cataracts with asthma (RR-3.1; CI: 2.1–4.6) compared to those with no diabetes and cataract but with high blood pressure or asthma, respectively.

Conclusion

The findings suggest that the risk of onset of functional difficulty is higher among older individuals with single and multiple morbidities compared to their healthy counterparts. It is also found that functional difficulty increased with age and was more prevalent in older women and rural residents, suggesting the need for appropriate policy interventions with special focus on the vulnerable senior adults.

Introduction

The world continues to see an extraordinary and long-term shift in the age structure of the global population, owing to rising life expectancy. People are living longer lives, and the percentage and number of older people in the population are steadily increasing [1, 2]. In the 21st century, population ageing is the major demographic issue in India with enormous consequences for the economy and society. It is almost inevitable that India will experience a transition from a "young country" to an "elder country" in the next decades due to fast changes in the demographic indicators. In 2011, 8.6% of the population (104 million) was over the age of 65. By 2050, India's older age population is projected to be at 19% (around 300 million) [3]. Around 5% of the older population in India are affected by some kind of physical limitation [4], and the burden of disease is predicted to increase substantially due to rising life expectancy and associated population aging.

Previous research has shown that there is a strong association between chronic morbidities and functional limitation [5, 6]. As severe morbidity disrupts normal daily activities, it also reduces quality of life [7–10]. Some studies have found that arthritis [6, 11, 12], cardiovascular disease, lung disorders, vision disabilities, and diabetes [12, 13], are common causes of functional limitation in older ages. The interaction of various chronic diseases with functional limitation [14] and the combined effects of two or more diseases [15] have also been documented in previous studies. Chronic diseases are associated with increased rate of disability, reduced functional levels, increased poly-pharmacy, poor health-related quality of life (HRQoL) and more health care needs [15–20]. The impact of multimorbidity on individuals' health profiles surpasses the impact we would expect from the summed effect of single conditions [21]. Multimorbidity leads to physical decline, and people with more conditions, more severe disease and specific disease patterns experience steeper deterioration [22].

Older individuals with multimorbidity are at greater risk for disability, hospitalization, postoperative complications, and mortality [23, 24]. Longitudinal studies have shown that multimorbid older individuals have poorer quality of life and inferior functional capacity or reduced physical functioning [25, 26], and almost half of those living with any chronic conditions also suffer from some activity limitations [27]. Limitations in physical and cognitive functions due to multimorbidity decisively affect people's illness and treatment burden and their response capacity, which may further increase multimorbidity [28, 29]. According to Kadam and Croft, 24% of the burden of poor physical functioning in the family practice may be attributable to higher prevalence of multimorbidity [30]. Multimorbidity and the severity of morbidities were associated with poor physical functioning [31]. Vancampfort *et al.* (2017) found that older age is highly associated with multimorbidity and low physical activity [32]. Most chronic conditions were associated with low physical activity in the overall sample, although this relationship was most notable among the older population in low and middle-income countries [33]. Furthermore, physical activity was consistently associated with better physical health and mental health in males and females and in young and older adults [34].

The etiological pathways from chronic diseases to limitations in activities of daily living or functional difficulties are documented in earlier studies [35, 36]. However, there is a dearth of studies that focus on association of chronic conditions with functional difficulties of older individuals in low and middle-income countries and in India in particular. The ones that do so only focus on cross-sectional associations [32, 37, 38]. The present study is aimed to explore how single and multi-morbidity status longitudinally affects functional difficulty among older adults. The study also explores the socioeconomic and demographic factors that determine the onset of functional difficulty, recovery from functional difficulty and remaining with functional difficulty in later years of life using panel data of older Indian adults. Additionally, the study examines the effects of several combinations of chronic diseases on the changes in late-life functional difficulty.
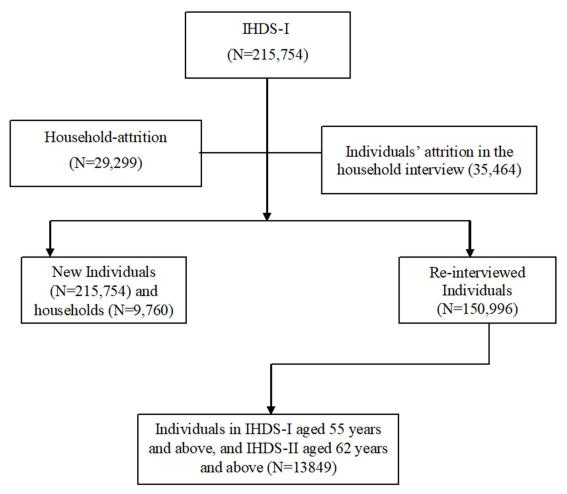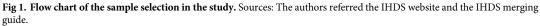
Methods

Data

In this study, we used data from two rounds of India Human Development Survey (IHDS) conducted jointly by the University of Maryland and National Council for Applied Economic Research (NCAER) during 2004–2005 and 2011–2012. The IHDS contains nationally representative multi-topic longitudinal panel data [39, 40]. The first round of IHDS (IHDS-I) (2004–05) covered 41,544 households in 1503 villages and 971 urban neighbourhoods while the second round of IHDS (IHDS-II) (2011–12) covered 42,152 households in 384 districts, 1420 villages and 1042 urban neighbourhoods. About 83 percent of the households interviewed in the first round (2004–05) were re-interviewed in the second round of IHDS [40]. The data is freely available in the public domain and survey agencies that conducted the field survey for the data collection have collected prior consent from the respondent. Therefore, prior ethical approval for using the datasets was not required. As the objective is to explore the determinants of changes in functional health among older population, both the survey rounds have been considered and a panel data have been created (merging of IHDS-I and IHDS-II) for this study.

While merging the data, in IHDS-I, we use the sample of age group 55 years and above who were considered older adults in previous Indian studies [41, 42], and in IHDS-II, we use the follow-up older population aged 62 years and above after seven years. After combining the sample from IHDS-1 and IHDS-II, the new sample was 13,849 older individuals who were followed in both IHDS rounds. The sample selection criteria have been summarized in Fig 1. In the IHDS survey, information on morbidity and reported functional difficulty were recorded in the form of fifteen chronic morbidities and limitations in seven types of Activities of Daily Living (ADL). In this study, we define functional difficulty as "functional limitation" in the performance of ADLs among older individuals aged 62 years and above.

Variable description

Dependent variable. In the present study, we considered a functional limitation in three ADLs among older persons: walking, toileting, and dressing. The question asked in the survey was: "Now, I am going to ask you about any physical difficulty that people above the age of 60 in this household may have. Does anyone in the household have a problem?" If the response is "yes," the next question is: "Can (name of the affected person) still do it with some trouble or is he/she unable to do it?" with options for three types of ADL: "i) walking 1 km; ii) going to the toilet without help; iii) dressing without help". All these options have three responses, namely, "No difficulty", "Can do with difficulty" and "Unable to do it". We computed the Katz index of independence in ADL, referred to as

Fig 1. Flow chart of the sample selection in the study. Sources: The authors referred the IHDS website and the IHDS merging guide.

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the 'Kz score', to assign coding to these categories. Hence, a Kz score = 0 signifies "Unable to do it", a Kz score = 1 signifies "Can do with difficulty", and a Kz score = 2 signifies "No difficulty". The Katz Index of Independence in ADL, also called "Katz ADL" is the standardised index for measuring the index of functional difficulty in ADL [43]. We classify all types of functional difficulties in binary form, where, "1" represents "no difficulty or functional independence" and "0" represents functional dependence that includes both "can do it with difficulty" and "unable to do it". The 'Kz score' was created by adding the scores for all three forms of functional difficulties. Now, we create final dependent variable by using merged data (panel data) of both rounds (IHDS-I & IHDS-II). Here variable term "no difficulty in both round" refers to "those individuals who experienced no functional difficulties in both rounds"; "onset of difficulty in second round" refers to "those individuals who did not experience functional difficulties in IHDS-I but experienced functional difficulties in IHDS-II"; "difficulty recovered in second round" refers to "those individuals who experienced functional difficulties in IHDS-I but not in IHDS-II"; and "functional difficulty remains in both the rounds" refers to "those individuals who experienced functional difficulties in both rounds".

Final dependent variable was recoded to four categories as; i) no functional difficulty in both the rounds ii) onset of functional difficulty in second round iii) functional difficulty recovered in second round and iv), functional difficulty remains in both the rounds.

Exposure variables.   The main exposure variable in our analysis was the presence of chronic morbidities. The exact question was: "Has a doctor ever diagnosed any member in the household as having–high BP/heart disease/diabetes/cancer/cataract/tuberculosis/asthma?" These morbidities were recoded as, '1' that refers to "morbidities present" and '0' that refers to "morbidities absent". Following the available literature [44–46], we included a set of demographic and socioeconomic variables in the regression model. These are: age (62–69, 70–79, 80 and above); sex (male or female); headship (yes, no); tobacco chewing (ever, never); tobacco smoking (ever, never), alcohol consumption (ever, never); below poverty line (BPL) (yes, no) (assessed through the question, "does the household have a BPL card?" which captures the aspect of financial inclusion, unlike wealth index [47]); place of residence (rural or urban); marital status (currently married and other); religion (Hindu, Muslim and other); caste (Scheduled Caste (SC) / Scheduled Tribe (ST), Other Backward Class (OBC) and Others), wealth quintiles (poorer, poorest, middle, richer and richest); education (illiterate, primary, secondary and higher); morbidity (no morbidity, single and two and above morbidity) and region (north, south, east, west. northeast and central).

Statistical analysis

First, we used descriptive statistics and bivariate analysis. Further, Chi-square test was used to show the level of significance in the possible associations between functional difficulty and background characteristics. Dyads pattern was identified by utilizing a basic matrix technique to conduct an exhaustive study of all conceivable combinations of two co-morbid conditions using a simple descriptive statistical method [48]. Dyads of chronic morbidities in the study include diabetes with cataract, heart disease, asthma and high blood pressure; cataract with heart disease, asthma and high blood pressure; heart disease with asthma and high blood pressure; and asthma with high blood pressure. To analyze the relationships between morbidity, socioeconomic characteristics and functional difficulties, we used multinomial logistic regression model.

Multinomial logistic regression equation is written as:

$$RR = \frac{P(Y=1|X+1)/P(Y=base\ category|X+1)}{P(Y=1|X)/P(Y=base\ category|X)}$$

The estimates of multinomial logistic regression are presented in the form of Relative Risk (RR) and P is the probability of occurrences in the equation.

Multinomial logistic regression was used with four categories of functional difficulties; i) no functional difficulty in both rounds ii) onset of functional difficulty in second round iii) functional difficulty recovered in second round and iv) functional difficulty in both rounds. No functional difficulty was considered as reference category.

Results

Table 1 depicts the percentage distribution of panel data by the socioeconomic and demographic characteristics of the study participants. In the panel data, 47.2% of the participants belonged to 62–69 years, 37.8% to 70–79 years and 15% to 80 years and above.

Table 2 presents the bivariate analysis showing the prevalence estimates of changes in functional difficulty from first round to second round among older adults in India, and it varies by background characteristics, which had four categories "no difficulty in both the rounds",

Table 1. Distribution of older adults by their socio-economic and demographic characteristics.

Characteristics	Panel sample (n = 13,849)	
	n	**%**
Age		
62–69	6,534	47.2
70–79	5,235	37.8
80 and above	2,079	15.0
Sex		
Male	6,932	50.1
Female	6,917	50.0
Headship		
Yes	7,313	52.8
No	6,536	47.2
Marital status		
Currently married	7,992	58.3
Not currently married	5,716	41.7
Education		
No education	2,830	20.4
Primary	4,617	33.4
Secondary	3,637	26.3
Higher	2,761	19.9
Smoking tobacco		
Never	11,769	85.0
Ever	2,080	15.0
Chewing tobacco		
Never	10,640	76.8
Ever	3,209	23.2
Consuming alcohol		
Never	12,693	91.7
Ever	1,156	8.3
Wealth Index		
Poorest	3,519	25.4
Poorer	2,142	15.5
Middle	2,350	17.0
Richer	2,609	18.8
Richest	3,229	23.3
BPL		
Yes	2,853	20.6
No	10,996	79.4
Religion		
Hindu	11,642	84.1
Muslim	1,269	9.2
Others	938	6.8
Caste		
SC/ST	3,446	24.9
OBC	5,168	37.3
Others	5,235	37.8
Place of residence		
Rural	10,292	74.3

(*Continued*)

Table 1. (Continued)

Characteristics	Panel sample (n = 13,849)	
	n	**%**
Urban	3,557	25.7
Region		
North	1,949	14.1
Central	2,928	21.1
East	2,938	21.2
North-East	297	2.1
West	2,242	16.2
South	3,494	25.2

Panel sample refers to the population who were alive in both rounds of IHDS; n: Un-weighted count, %: Weighted percentages to account for population estimates.

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Table 2. Prevalence of onset, recovery from and remaining with functional difficulty among older adults by background characteristics.

Characteristics	Change in functional difficulty status								
	Onset of functional difficulty			Recovered from functional difficulty			Remained with functional difficulty		
	N	**%**	**p-value**	**N**	**%**	**p-value**	**N**	**%**	**p-value**
Morbidity									
No	1,785	19.2	<0.001	162	1.7	<0.001	114	1.1	<0.001
Single morbidity	944	29.6		93	2.8		78	2.2	
Multi-morbidity	576	37.7		56	3.6		79	4.9	
Age									
62–69	1,038	15.9	<0.001	90	1.4	<0.001	72	1.1	<0.001
70–79	1,361	26.0		145	2.8		86	1.6	
80 and above	851	40.9		62	3.0		80	3.9	
Sex									
Male	1,359	19.7	<0.001	139	2.0	<0.001	93	1.2	<0.001
Female	1,946	27.3		172	2.3		178	2.2	
Headship									
Yes	1,440	20.7	<0.001	143	2.1	0.036	93	1.5	<0.001
No	1,865	27.3		168	2.2		178	2.1	
Marital status									
Currently married	1,582	19.4	<0.001	154	1.8	0.002	107	1.2	0.001
Not currently married	1,693	29.2		155	2.7		161	2.5	
Education									
No education	622	24.9	<0.001	60	2.2	0.031	35	1.4	0.208
Primary	1,149	24.5		92	2.0		98	1.8	
Secondary	929	23.3		108	2.5		82	2.0	
Higher	604	20.5		50	1.8		56	1.6	
Smoking tobacco									
Never	2,879	24.1	<0.001	272	2.2	0.180	237	1.8	0.212
Ever	426	20.1		39	2.0		34	1.3	
Chewing tobacco									
Never	2659	23.9	0.500	265	2.3	0.022	232	1.9	0.021
Ever	646	22.1		46	1.7		39	1.1	

(*Continued*)

Table 2. (Continued)

Characteristics	Change in functional difficulty status								
	Onset of functional difficulty			Recovered from functional difficulty			Remained with functional difficulty		
	N	%	p-value	N	%	p-value	N	%	p-value
Consuming alcohol									
Never	3,095	24.0	<0.001	285	2.1	0.862	258	1.8	0.044
Ever	210	18.1		26	2.5		13	1.1	
Wealth Index									
Poorest	803	25.3	<0.001	67	2.1	0.534	66	2.0	0.550
Poorer	476	24.6		45	2.0		33	1.2	
Middle	544	22.0		44	1.8		48	1.8	
Richer	638	22.3		75	2.5		57	2.0	
Richest	844	22.8		80	2.2		67	1.4	
BPL									
Yes	688	24.7	0.006	55	1.9	0.503	60	2.1	0.209
No	2,617	23.2		256	2.2		211	1.6	
Religion									
Hindu	2,736	23.5	0.436	245	2.1	0.133	207	1.6	<0.001
Muslim	304	22.2		35	2.6		25	1.7	
Others	265	25.3		31	2.6		39	3.8	
Caste									
SC/ST	736	21.9	<0.001	67	1.9	0.450	50	1.6	0.086
OBC	1,283	26.1		107	2.2		98	1.7	
Others	1,286	22.0		137	2.3		123	1.8	
Place of residence									
Rural	2,475	24.0	0.002	227	2.1	0.925	214	1.9	0.020
Urban	830	21.8		84	2.3		57	1.3	
Region									
North	770	24.6	<0.001	75	2.4	<0.001	50	1.4	<0.001
Central	741	25.7		29	1.0		45	1.3	
East	384	19.9		59	2.7		22	1.1	
North-East	19	6.6		1	0.2		1	0.4	
West	359	18.5		41	1.9		22	1.2	
South	1,032	28.6		106	2.8		131	3.3	
Total	**3,305**	**23.5**		**311**	**2.1**		**271**	**1.7**	

N: Un-weighted counts, %: Weighted percentages to account for population estimates; p-values are based on Chi-square test.

"onset of difficulty in second round", "recovery from difficulty in second round" and "difficulty in both the rounds". The onset of difficulty, difficulty recovery and difficulty remaining increased with increasing age. The onset of difficulty in the second round (27.3% vs 19.7%), difficulty recovery in the second round (2.3% vs 2.0%) and difficulty remaining in second round (2.2% vs 1.2%) were higher among females as compared to males. In case of geographical regions, southern region (28.6%) showed higher functional difficulty and north-east region (6.6%) had lower level of onset of functional difficulty in the second round.

Table 3 reveals the correlates of onset, recovery and remaining with functional difficulty among older adults. Older participants with single morbidity were 1.9 times more likely to have onset of difficulty, 2 times more likely to have difficulty recovered and 2.5 times more

Table 3. Relative risk ratio from multinomial logistic regression showing the association of multi-morbidity with onset, recovery from and remaining with functional difficulty among older adults (ref: No functional difficulty in both rounds) by background characteristics.

Characteristics	Change in functional difficulty status		
	Onset of functional difficulty	Recovered from functional difficulty	Remained with functional difficulty
	RR (95% CI)	RR (95% CI)	RR (95% CI)
Morbidity			
NoⓇ			
Single morbidity	1.9***(1.76 2.15)	2.0***(1.55 2.63)	2.5***(1.87 3.42)
Multi-morbidity	3.3***(2.87 3.74)	3.0***(2.16 4.23)	6.0***(4.33 8.36)
Age			
62–69Ⓡ			
70–79	1.8***(1.66 2.01)	2.0***(1.53 2.63)	1.9***(1.38 2.58)
80 and above	3.8***(3.35 4.29)	3.5***(2.52 4.93)	5.7***(4.04 8.03)
Sex			
MaleⓇ			
Female	1.4***(1.2 1.57)	1.0 (0.72 1.49)	1.7***(1.16 2.58)
Head			
YesⓇ			
No	1.1 (0.97 1.22)	1.3 (0.95 1.76)	1.2 (0.85 1.64)
Marital status			
Not currently married Ⓡ			
Currently married	1.3***(1.13 1.38)	1.3**(1.01 1.74)	1.5***(1.14 2.09)
Education			
No educationⓇ			
Primary	1.0 (0.89 1.14)	0.8 (0.54 1.09)	1.6**(1.02 2.38)
Secondary	0.9 (0.79 1.05)	0.9 (0.63 1.32)	1.4 (0.9 2.25)
Higher	0.8**(0.69 0.97)	0.6**(0.36 0.91)	1.5 (0.89 2.52)
Smoking tobacco			
EverⓇ			
Never	1.0 (0.88 1.13)	0.9 (0.66 1.29)	0.7*(0.46 1.01)
Chewing tobacco			
EverⓇ			
Never	0.9 (0.83 1.03)	1.1 (0.84 1.51)	1.2 (0.88 1.71)
Consuming alcohol			
EverⓇ			
Never	1.1 (0.91 1.24)	0.9 (0.63 1.43)	1.4 (0.8 2.33)
Wealth Index			
PoorestⓇ			
Poorer	0.9 (0.78 1.04)	1.0 (0.68 1.5)	0.7*(0.43 1.05)
Middle	0.9**(0.74 0.98)	0.8 (0.53 1.19)	0.8 (0.51 1.14)
Richer	0.8**(0.73 0.96)	1.1 (0.76 1.6)	0.7*(0.48 1.06)
Richest	0.8***(0.7 0.93)	0.8 (0.57 1.25)	0.6***(0.37 0.84)
BPL			
NoⓇ			
Yes	1.1*(0.99 1.24)	1.0 (0.75 1.41)	1.5***(1.12 2.13)
Religion			
HinduⓇ			
Muslim	1.0 (0.82 1.14)	1.2 (0.77 1.75)	0.9 (0.56 1.47)
Others	1.2**(1.03 1.45)	1.4 (0.91 2.1)	1.9***(1.29 2.91)

(*Continued*)

Table 3. (Continued)

Characteristics	Change in functional difficulty status		
	Onset of functional difficulty	**Recovered from functional difficulty**	**Remained with functional difficulty**
	RR (95% CI)	**RR (95% CI)**	**RR (95% CI)**
Caste			
SC/STⓇ			
OBC	1.1**(1 1.26)	1.1 (0.78 1.49)	1.2 (0.8 1.66)
Others	1.0 (0.89 1.14)	1.1 (0.79 1.55)	1.3 (0.9 1.92)
Place of residence			
UrbanⓇ			
Rural	1.2***(1.06 1.31)	1.2 (0.88 1.55)	1.9***(1.35 2.57)
Region			
North-EastⓇ			
North	1.3***(1.14 1.49)	0.6**(0.37 0.93)	1.4 (0.9 2.2)
Central	0.7***(0.56 0.77)	1.2 (0.83 1.77)	0.7 (0.42 1.23)
East	0.2***(0.11 0.29)	0.1**(0.02 0.81)	0.2*(0.02 1.27)
West	0.7***(0.57 0.77)	0.9 (0.57 1.28)	0.7 (0.43 1.22)
South	1.3***(1.15 1.46)	1.5**(1.07 2.04)	2.6***(1.84 3.79)

Ⓡ: Reference category

* if p<0.10

** if p<0.05

*** if p<0.01, RR: Relative Risk, CI: Confidence Interval.

likely to have difficulty remained, compared to those with no morbidity. Older adults who had multi-morbidity were 3.3 times more likely to have onset of difficulty, 3 times more likely to have difficulty recovered and 6 times more likely to have difficulty remained, compared to those with no morbidity.

Table 4 presents the percentage distribution, bivariate and multivariable estimates of change in functional difficulty status by morbidity combinations during both the rounds. Having no functional difficulty in both rounds was taken as the base category, and having no morbidity combination was taken as the reference category for each morbidity combination. Participants with combination of diabetes and cataract were 1.6 times (RR: 1.6, CI: 1.1, 2.4) more likely to have onset of functional difficulty than those who had no morbidity combination. Older adults with diabetes and heart disease were 3.2 times (RR: 3.2, CI: 1.3, 7.9) more likely to be remain with functional difficulty in second round. Older adults with diabetes and asthma were 1.7 times (RR: 1.7, CI: 1.0, 30.) more likely to have onset of difficulty than their counterparts. Respondents with diabetes and high blood pressure were 1.7 times (RR: 1.7, CI: 1.4, 2) more likely to have onset of difficulty, 1.9 times (RR: 1.9, CI: 1.1, 3) more likely to have recovered from functional difficulty and 3.8 times (RR: 3.8, CI: 2.5, 5.8) more likely to remain with difficulty than those who had no morbidity combination. Older individuals with heart disease and high blood pressure were 1.4 times (RR: 1.4, CI: 1, 2) more likely to have onset of functional difficulty compared to those who had no morbidity combination.

Discussion

This study aimed to find the prevalence of functional difficulty and explore the determinants of onset, recovery from and remaining with functional difficulty among older population using a panel data in India. Our study found that there is a substantial increase in the onset of

Table 4. Percentage distribution, bivariate and multivariable estimates of changes in functional difficulty (ref: No functional difficulty in both rounds) by morbidity dyads.

Morbidity Combination	N (%)	Functional difficulty					
		Onset of difficulty (%)	RR (95% CI)	Recovery from difficulty (%)	RR (95% CI)	Remained with difficulty (%)	RR (95% CI)
No morbidity combination Ⓡ							
DI+CA	199 (1.44)	49.0	1.6*** (1.1 2.4)	4.7	1.7 (0.7 4.1)	5.4	1.0 (0.4 2.4)
DI+HD	174 (1.26)	41.8	1.3 (0.8 1.9)	3.4	1.8 (0.6 5.2)	7.7	3.2** (1.3 7.9)
DI+ASTH	80 (0.58)	50.4	1.7* (1.0 3.0)	4.3	2.7 (0.5 13.2)	10.2	1.5 (0.5 4.9)
DI+HBP	660 (4.77)	38.2	1.7*** (1.4 2.0)	4.1	1.9** (1.1 3.0)	6.6	3.8*** (2.5 5.8)
CA+HD	105 (0.76)	38.6	0.8 (0.5 1.4)	1.9	0.4 (0.1 1.9)	5.5	0.7 (0.2 2.3)
CA+ASTH	163 (1.18)	42.6	3.1*** (2.1 4.6)	2.4	2.0 (0.6 7.0)	7.5	4.2*** (1.8 9.8)
CA+HBP	308 (2.23)	44.5	2*** (1.5 2.6)	5.0	3.1*** (1.6 6.0)	6.1	3.7*** (1.9 7.3)
HD+ASTH	79 (0.57)	37.4	1.3 (0.7 2.4)	0.0	1.1 (0.8 3.5)	9.1	2.9* (0.9 8.8)
HD+HBP	272 (1.96)	36.8	1.4** (1.0 2.0)	2.9	1.1 (0.4 3.1)	5.5	0.7 (0.2 1.9)
ASTH+HBP	173 (1.25)	38.9	1.2 (0.8 1.7)	0.3	0.2 (0.0 1.6)	8.2	1.4 (0.5 3.7)

N: Un-weighted counts, %: Weighted percentages to account for population estimates, Ⓡ: Reference category

* if p<0.10

** if p<0.05

*** if p<0.01, RR: Relative Risk, CI: Confidence Interval, DI- Diabetes, CA- Cataract, HD-Heat Disease, ASTH- Asthma, HBP- High Blood Pressure.

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functional difficulty with age i.e., 16 percent in the age group 62–69 to 41 percent in the age group 80 and above. The finding corroborates with the findings of a previous study in India that reported that 63% of older adults at the baseline and 67.3% of them at the follow-up after two year had at least one ADL limitation [49]. Similarly, functional difficulty in ADL and instrumental ADL is most frequently reported in the age group of 65 years and over than the age group of 40–64 years [6]. Another important finding of our study is the higher onset of disability among older women compared to men. This is in line with earlier studies in developed countries that have documented that, women have greater prevalence of impairment in most of the health outcomes [12, 50–52]. Recent population-based studies in India also reported that older women rate their health as poor more often than older men and have higher rates of functional difficulties [37, 53]. Gender disparity in disability is also explained by the fact that women live longer than men and therefore they are more likely to age with disability [54, 55].

The present study revealed higher chances of disability among the respondents with single or multiple morbidities in comparison to people with no morbidity. Concordantly, a previous study in a community-setting in Canada has shown that people with adverse health condition and comorbidity were 19 times more likely to have moderate to severe disability than those without such conditions [56]. Various longitudinal and cohort analyses have also found the negative influence of adverse health behaviors and morbidity on functional health among older individuals [57–59]. Notably in India, as people age, disability becomes a significant concern, increasing the caregiving burden for those who have to care for them [1]. On the other

hand, a study shows that the old-age disability decreases with a lower rate of chronic morbidity [7]. Hence, individual disease-based interventions are required to ensure active aging among older Indian adults. Another finding of the current study showed that recovery from functional difficulty is higher among older adults with multi-morbidity. This finding can be explained by the higher attrition rate in the IHDS survey among urban residents (about 26%) than rural counterparts (about 9%) [60] and studies showed the differential morbidity and mortality pattern across socioeconomic groups in adulthood [61, 62]. The finding can also be attributed to the low sample size in the multi-morbid category and lack of statistical power in the current analysis. Similarly, the methodological shortcoming of the multinomial logistic regression leading to biased coefficient estimates when the sample size is small is acknowledged in previous studies [63]. Therefore, this needs to be further investigated with large sample size and more information from future longitudinal datasets.

Another important finding of the present study is the association of multimorbidity with functional difficulty. We had considered 7 diseases for calculating multimorbidity. The older adults in our study suffering from both cataract and asthma or diabetes and high blood pressure were more likely to have functional difficulty (either the onset of functional difficulty or to remain with functional difficulty in both the rounds of the survey). The study corroborates with earlier studies reporting three way combinations of chronic conditions such as hypertension, heart disease and arthritis [48]. The findings are also in line with a study that demonstrated the most common pairing of hypertension and diabetes with arthritis [64]. The same study revealed the presence of arthritis and chronic pain in most of the disease triads, quartets and quintets. It is suggested that any acute or sub-acute condition can affect the management of other diseases, for instance, leg injury of individuals can affect their mobility which can negatively affect their diabetes control and increase the chances of osteoarthritis [65].

Further, in the present study, functional difficulty is observed higher among currently unmarried respondents including widows. This supports the notion that in India where women have traditionally depended on the spouses for support, widowhood may have considerable negative impact on their socioeconomic and health status [41, 66]. The older people from the poorest and BPL category had a higher onset of functional difficulty compared to the richest and non-BPL population. Their lower functional health may be a result of their lower-income and lack of resources especially when they have higher levels of morbidity [18]. This is also supported by a positive poverty-disability association as reported in a systematic review including 150 studies in low- and middle-income countries [67]. A recent study found that the economically better-off older population experienced a lower prevalence of functional difficulty [46]. Supporting this, the disability among older adults in rural areas and those with socioeconomically poor backgrounds was higher than among urban resident and high socioeconomic groups, which is also similar to previous findings [4]. Another study conducted among 750 older individuals aged 60 years and above in Tamil Nadu, India, showed that physical disability was higher in rural areas [68]. Similarly, older people from southern region of the current study were more likely to have functional difficulty than those from other regions of the country, suggesting the need for further investigation of regional variations in the trajectory of functional difficulty.

There are several limitations of the study to be acknowledged. Because of the smaller sample size, we could not include the individual impact of significant morbidities on functional limitation. It would have been better for policy recommendations if the sample size had been large enough to independently analyse each disease and associated functional difficulty. Also, self-reporting and proxy reporting were possible in some situations, while there were differences in older adults' health state in multiple places. However, the literature on the direction of proxy respondents' reporting (either under-reporting or over-reporting) is not convincing

[69]. Data from the IHDS share information on the disability conditions of the older population as reported by women (aged 15–49) in homes that meet the study requirements. The absence of information of disability directly from respondents rather than proxy respondents might lead to several biases and can be a drawback of this study. Notwithstanding these, the panel data which provide comprehensive information of an older cohort in two different time periods is the major strength of the study. Also, the combinations of different diseases were possible with multiple options, which adds to the present study's credibility.

Conclusion

This study provides information on morbidity status and associated changes in functional difficulties among older population in India. It is clearly evident that the single and multimorbidity status affects functional difficulty among older adults. The findings suggest that the likelihood of onset of functional difficulty is higher in older population with single and multiple morbidities compared to their healthy counterparts. It is also found that functional difficulty increased with age and was highly prevalent in older women compared to men. Higher levels of education and household wealth are revealed to be reducing functional difficulty and increasing the recovery rate. The current finding of the higher recovery from functional difficulty among older adults with multimorbidity requires further investigation with future longitudinal datasets. Marital status, religion, and place of residence also determined the changes in functional difficulty in the present study, suggesting the need for appropriate policy interventions with special focus on older women and oldest old adults.

Author Contributions

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