Indian J Med Res 159, May 2024, pp 441-448
DOI:10.25259/ijmr_865_22

Quick Response Code:

Short Paper

Regional variation in prevalence of frailty in India: Evidence from longitudinal ageing study in India (LASI) wave-1

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Received April 13, 2022

***Background & objectives*: Frailty is a geriatric syndrome with clinical and public health implications. It represents the state of increased vulnerability. This study aimed to estimate the prevalence of frailty and pre-frailty by demographic characteristics and geographical regions in India. Furthermore, it also aimed to examine the association of this prevalence with selected health outcomes using data from the Longitudinal Ageing Study of India (LASI).**

***Methods*: This is a secondary analysis of LASI wave-1 data. A total of 26,058 respondents aged ≥60 yr were included for analysis. Frailty was assessed using Fried's frailty phenotype, including slowness, shrinking, low physical activity, weakness, and low endurance. Descriptive statistics were used to study frailty distribution. The odds ratio (OR) of health events across the frailty categories was computed using ordinal logistic regression.**

***Results*: The findings of this study suggest that the prevalence of frailty and pre-frailty was 29.2 and 58.8 per cent, respectively. The prevalence of frailty was higher among women (37.3%), illiterate (37%) and rural residents (31%). It ranged between 14.5 per cent in Uttarakhand and 41.3 per cent in Arunachal Pradesh. Frailty was strongly associated with depression [OR: 2.09, Confidence Interval (CI): 1.98–2.21] and activities of daily living (ADL) difficulty (OR: 1.75, CI: 1.64–1.86). Higher odds were reported for fracture (OR: 1.24, CI: 1.01–1.51) and multimorbidity (OR: 1.18, CI: 1.04–1.33) among frailty.**

***Interpretation & conclusions*: The heterogeneity of frailty prevalence across States indicates the need for population-specific strategies. A sharp age-related increase in prevalence highlights the need for preventive measures. Furthermore, the high prevalence of frailty among women, illiterate and rural residents indicates the target population for receiving preventive interventions. Lastly, a heterogeneity in frailty prevalence across different States indicates the scope for region-specific programmes.**

Key words ADL - depression - frailty - geriatric syndrome - LASI - older adults - pre-frailty

Frailty is a geriatric syndrome which results from age-related changes impacting multiple physiological systems[1]. The degree of frailty depends on several factors, including age, gender and the burden of disease[2]. Frailty is thought to be an independent risk factor for poor health outcomes such as falls, hospitalizations, disability and early death[3,4].

Estimating the burden of frailty is important, especially in low- and middle- income countries, as these countries are projected to host 80 per cent of the older population by 2050[5]. However, these countries report a wide variation in frailty occurrence; for example, the prevalence of frailty in China was reported at 3.9 per cent in 2017, while Cuba reported one of the highest prevalence at 51.4 per cent in 2009[6]. Using Fried's frailty criteria[7], frailty prevalence in older Indian adults was estimated to be around 30 per cent based on the Longitudinal Ageing Study in India (LASI) dataset[8] and between 20 and 29 per cent in studies carried out in different regions of India between 2016-2020[9-11].

The Indian population over 60 yr age reached 138 million in 2021[12]. This number is projected to increase to 194 million within the next 10 years. As a consequence, 40-55 million people over 60 years of age may experience frailty in the near future. Significant clinical and public health concerns are associated with the growing frailty number. Frailty indicates increased vulnerability; therefore, frailty assessment in clinical settings can help optimize patient care[13], whereas at the population level, frailty estimates can support public health service planning. In view of a growing global interest in healthy ageing and preserving functional ability with age, gaining a deeper understanding of frailty, its prevalence and risk factors is helpful[14].

India is a heterogeneous country with a varying level of development and distribution of health risks; therefore, the national estimates do not represent the regional variation[15]. Hence, this study aimed to estimate the prevalence of frailty as well as pre-frailty by demographic characteristics and geographical regions in India. This paper also examined the association of frailty status with selected health outcomes using the data from the LASI wave-1.

Material & Methods

Data & sample: This study is based on the secondary analysis of the available dataset, which was collected for the LASI wave-1 from 2017 to 2019. It is a nationally representative survey of Indian men and women of age ≥45 yr. The LASI dataset was obtained from the Gateway to Global ageing data, a hosting population survey data on ageing around the world. The manuscript has received clearance from the institutional ethics committee. Other details are available in the report published on the website[16].

The LASI survey adopted a stratified multi-stage area probability cluster sampling design covering 72,262 individuals across all Indian States (except Sikkim) and Union Territories. Within each State, a three-stage sampling design for rural areas and a four-stage sampling design for urban areas was adopted. The rural sample was selected using multistage sampling at sub-districts, village and household levels. In contrast, the urban sample was taken by randomly selected sub-districts, cities, Census Enumeration Block and households. Data was collected by trained interviewers who received 35 days of training (including five days of field training). The survey provides vital demographic information, biomarkers, chronic as well as symptoms-based health conditions, functional and mental health, household economic status, health insurance and healthcare utilization, family and social network, work, employment, retirement and life expectations. In addition, other details pertaining to the sample size, survey design and instruments, data collection, fieldwork, and processing and response rate are also publicly available in the LASI user guide[16].

This study included individuals aged ≥60 yr. Out of 72,262 individuals in the original dataset, 31,477 fulfilled the selected age criteria in this study. Further, this study considered individuals with complete records of their handgrip strength (HGS), walk test, height and weight. Therefore, the final sample included in the analysis was 26,058 individuals over 60 yr age from across the country.

Study variables:

Frailty: In this study, the dependent variable was assessed using Fried's frailty phenotype criteria[7], which included deficits in five domains: shrinking [Body mass index (BMI) < 18.5 kg], slowness (gait speed <0.8 m/s assessed using a 4 m walk test), weakness [Handgrip Strength (HGS)] below the 20th percentile within three BMI categories including <18.5, 18.5-24.9 and ≥25 kg/m^2 for men (HGS below 16.25, 19 and 20.75 kg, respectively) and women (HGS below 10.75, 12 and 13 kg, respectively), low physical activity (never performing sports or activities that are vigorous and moderately energetic) and low endurance (a frequent experience of tiredness and resting in bed during the day). Based on Fried's phenotype criteria, individuals with one to two conditions were categorized as pre-frail and those with ≥3 as frail. The absence of all conditions indicated a robust state.

Demographic variables: Age was converted into three categories, which were 60–69, 70–79 and ≥80 yr. Responses on education were recoded into three categories: illiterate, up to high school (primary, middle school, secondary and higher secondary) and graduate and more (degree/certificate/diploma, postgraduate/professional). Marital status was recoded as with partner (married/live-in relationship) and single (separated/divorced/widowed/never married). The place of residence variable was used as available in the LASI dataset (1=rural, 2=urban).

Clinical outcomes: In this study, multimorbidity, hospitalization, falls in the last two years of the study period, pain, fractures in the last two years, acute illness, difficulty in ADL and depression were the health events. Multimorbidity was defined as the presence of three or more chronic conditions and hospitalization was, one or more hospital admissions within 12 months prior to data collection. Fall, chronic pain and fracture were dichotomous variables in the original dataset and were used as is. Respondents who reported one or more acute illnesses (jaundice, tuberculosis, malaria, diarrhoea, urinary tract infection, anaemia, dengue *etc*.,) over the previous year were considered to have an acute illness. ADL activities, which include walking, sitting, getting up from a chair, climbing a single flight of stairs, crouching/kneeling/stooping, extending arms, pushing or pulling large objects, lifting or carrying weights over 5 kg and picking up a coin from the table, were recorded as yes (1) and no (0); adding responses to all functions gave a score between 0 and 9. A score of 0 was considered as no difficulty in performing ADL, while a score of ≥1 was considered as difficulty in performing ADL. Depression was assessed using a short form of the Centre for Epidemiologic Studies Depression (CESD) Scale. Responses were summed and gave a score between 0 and 30. Following the scale cut-offs, scores of ≥10 were considered as the presence of depression.

Statistical analysis: In this study the frailty prevalence was described using descriptive statistics. Chi-square analysis was carried out to study the association of frailty with demographic factors and selected health outcomes (hospitalization, multimorbidity, fall, chronic pain, acute illness, fracture, ADL, depression). Ordinal logistic regression was used to generate adjusted and crude odds. All variables were put in a single model which was adjusted for gender, age, education and place of residence, as these factors influence the selected health outcomes and frailty. The results with $P<0.05$ were considered as significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY).

Results

Sample characteristics: A total of 26,058 respondents above 60 yr age were included in the analysis. The age of the respondents ranged between 60 to 111 yr, with a mean of 68.47±7.13 yr. Overall, the prevalence of pre-frailty and frailty was calculated as 58.5 and 29.2 per cent, respectively. Table I describes the prevalence of frailty States across demographic subgroups. The frailty prevalence increased with increasing age. Increasing education reduced frailty prevalence. Women showed a higher frailty prevalence (37.3%) as compared to men. Those with a partner had a lower prevalence (22.3%) of frailty than those without a partner.

Frailty prevalence across different States of India: The burden of frailty for each State (except Sikkim) was calculated. Figure and Supplementary Figure, depicts the frailty prevalence across different Indian States. Fourteen States showed a higher prevalence than the national average. Arunachal Pradesh reported the highest frailty prevalence of 41.3 per cent, while a minimum of 14.5 per cent was reported in Uttarakhand. Himachal Pradesh, Nagaland and Pondicherry reported a lower than 20 per cent prevalence of frailty (Supplementary Table I). In the States of Madhya Pradesh, Bihar and Mizoram, the frailty prevalence was above 30 per cent in both rural and urban residents (Supplementary Table II). Although, frailty prevalence was higher among rural residents in most of the States, Rajasthan and Kerala reported higher prevalence in urban areas. Pre-frailty is also an alarming state, and Delhi reported the highest pre-frailty prevalence of 66.7 per cent, while a minimum of 53.5 per cent was reported in Telangana.

Association of health events with frailty status: Association of health events with frailty status persisted after adjustment for age, gender, education and place of residence (Table II). The highest odds were observed for depression [odds ratio (OR): 2.09, confidence interval (CI): 1.98–2.21] and ADL difficulty (OR: 1.75, CI: 1.64–1.86), indicating a strong association of frailty with psychological and functional outcomes. Frail respondents were at an increased risk of fractures, acute illnesses, multimorbidity and hospitalization.

Table I. Prevalence of frailty across demographic and health variables

Variable	n	Robust, n(%)	Pre-frail, n(%)	Frail, n(%)
Age, (mean ±SD)				
68.47±7.13	26,058	65.41(4.84)	67.5(6.34)	71.68(8.22)
Age (yr)				
60–69	16,211	2,565(15.8)	10,333(63.7)	3,313(20.4)
70–79	7,454	528(7.1)	4,089(54.9)	2,837(38.1)
80–89	2055	47(2.3)	811(39.5)	1,197(58.2)
90–99	311	1(0.3)	73(23.5)	237(76.2)
100 & above	27	0	5(18.5)	22(81.5)**
Gender				
Male	12,643	2,125 (16.8)	7,920(62.6)	2,598(20.5)
Female	13,415	1,016 (7.6)	7,391(55.1)	5,008(37.3)**
Education				
Illiterate	13,824	1,137(8.2)	7,572(54.8)	5,115(37)**
Up to high school	11,065	1,729(15.6)	6,998(63.2)	2,338(21.1)
Graduate & more	1,169	275(23.5)	741(63.4)	153(13.1)
Marital status				
With partner	16,985	2,550(15)	10,650(62.7)	3,785(22.3)
Single	9,073	591(6.5)	4,661(51.4)	3,821(42.1)**
Place of residence				
Rural	17,385	1,977(11.4)	10,021(57.6)	5,387(31)**
Urban	8,673	1,164(13.4)	5,290(61)	2,219(25.6)
Depression				
Yes	11,690	831(7.1)	6,389(54.7)	4,470(38.2)**
No	14,368	2,310(16.1)	8,922(62.1)	3,136(21.8)
ADL difficulty				
Yes	18,845	1,696(9)	10,735(57)	6,414(34)**
No	7,213	1,445(20)	4,576(63.4)	1,192(16.5)
Multimorbidity				
Yes	1,313	102(7.8)	771(58.7)	440(33.5)**
No	24,745	3,039(12.3)	14,540(58.8)	7,166(29)
Hospitalization				
Yes	9,751	1,240(12.7)	5,669(58.1)	2,842(29.1)
No	16,307	1,901(11.7)	9,642(59.1)	4,764(29.2)*
Fractures of bones/joints				
Yes	921	85(9.2)	492(53.4)	344(37.4)**
No	25,137	3,056(12.2)	14,819(59)	7,262(28.9)
Acute illnesses				
Yes	7,209	719(10)	4,091(56.7)	2,399(33.3)**
No	18,848	2,422(12.9)	11,220(59.5)	5,206(27.6)
Fall				
Yes	2,675	285(10.7)	1,516(56.7)	874(32.7)**
No	21,029	2,639(12.5)	12,551(59.7)	5,839(27.8)
Pain				
Yes	10,445	1,086(10.4)	5,974(57.2)	3,385(32.4)**
No	15,611	2,055(13.2)	9,336(59.8)	4,220(27)

P<0.05, **<0.001. ADL, activities of daily living; SD, standard deviation

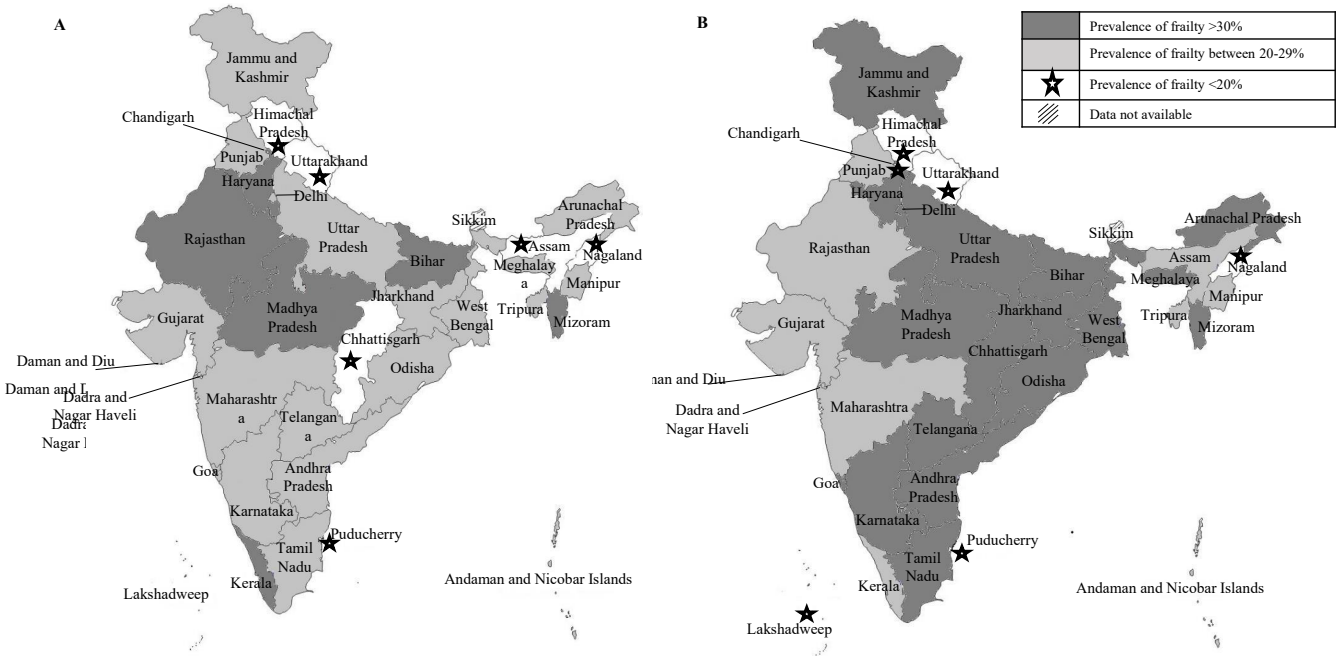

Figure. Crude prevalence of frailty **(A)** in urban areas and **(B)** in rural areas across different States of India. Note: These maps were exclusively generated by the authors using secondary data collected for the Longitudinal Ageing Study in India (LASI). Source: Map outline generated using *d-maps.com* (*https://d-maps.com/continent.php?num_con=13&lang=en*).

Discussion

This study examined the frailty prevalence and its association with adverse health outcomes among older adults. The findings of the study suggest that nearly 30 per cent of older Indians were frail, and almost double that proportion (58%) were in a pre-frail state, which means that one-third of the older adults have deficits in more than three factors included in the frailty assessment. Overall, the prevalence of frailty was higher among rural residents (31%) as compared to urban residents (25.6%). We observed an extensive regional variation in frailty prevalence (Figure), which is perhaps due to the regional disparities in healthcare, different lifestyles, cultural differences and the socio-economic development of the regions[17,18]. This is supported by other similar studies showing that rural residents in India with low education and income, and less access to health services have poorer health and an increased risk of becoming physically frail[19]. Further exploration of these findings will help address the need of the ageing population in India. Since the LASI dataset is comparable with a parallel European survey called SHARE[20], a Chinese survey called CHARLS[21] and a Japanese survey known as NSJE[22], we compared the results and found that the overall prevalence of frailty in these countries ranged from 7-8.7 per cent, which is much lower than the results obtained in this study. These differences may be attributed to variations in the population's age distribution, socio-economic development and the measurement of frailty[23]. Nonetheless, these numbers indicate the increased vulnerability of older adults in India.

One of the objectives was to measure frailty across demographic characteristics. We observed an exponential increase in frailty prevalence with increasing age, from 20.4 per cent in persons aged 60-69 yr to 58.2 per cent in those aged 80–89 yr and 81.5 per cent in those aged ≥100 yr. Therefore, early intervention and strategies to reduce frailty at higher ages are needed urgently. The results further identified female gender, rural residence and low literacy status as risk factors for frailty. Though literacy levels have no direct influence on the pathophysiology of frailty, it can, however, affect the lifestyle of such individuals, which may be closely related to the progression of frailty[24].

It is well-documented that frailty is a state of increased vulnerability to adverse health outcomes[3]. Frailty increased the acute illness, risk of fractures, multiple morbidities, chances of hospitalization, depression and ADL disability in this population. Several studies have shown that depression and

Table II. Association of adverse health outcomes with frailty

Variable	Odds (95% C.I.)	
	Unadjusted odds	Adjusted odds
ADL difficulty		
Yes	2.57 (2.43–2.72)**	1.75(1.64–1.86)**
No	Reference	
Depression		
Yes	2.29(2.18–2.4)**	2.09(1.98–2.21)**
No	Reference	
Fracture of bones/joints		
Yes	1.45(1.27–1.64)**	1.24(1.01–1.51)*
No	Reference	
Multimorbidity		
Yes	1.31(1.18–1.46)**	1.18(1.04–1.33)*
No	Reference	
Acute illness		
Yes	1.31(1.25–1.39)**	1.13(1.06–1.2)**
No	Reference	
Pain		
Yes	1.30(1.24–1.36)**	0.98(0.93–1.04)
No		
Fall		
Yes	1.25(1.15–1.35)**	1.02(0.94–1.12)
No	Reference	
Hospitalization		
Yes	0.97(0.92–1.02)	1.11(1.05–1.18)**
No	Reference	
Age		
	1.09(1.09–1.1)**	1.09(1.09–1.1)**
Gender		
Female	2.33(2.24–2.47)**	2.11(1.99–2.24)**
Male	Reference	
Education		
Illiterate	3.65(3.24–4.12)**	2.12(1.86–2.43)**
Up to high school	1.69(1.50–1.91)**	1.44(1.27–1.64)**
Graduate or above	Reference	
Place of residence		
Rural	1.27(1.21–1.32)**	1.08(1.02–1.15)*
Urban	Reference	

P *<0.05; **<0.001. Adjusted odds: adjusted for age, gender, education and place of residence. CI, confidence interval

frailty are closely related; in fact, they appear to interact reciprocally. A meta-analysis[25], including 24 studies, explained the reciprocal relationship between depression and frailty. The authors reported that each of these two conditions may be a risk factor for the development of the other and each of these is associated with an increased incidence and prevalence of the other[25]. Another important observation in this dataset was the higher odds of ADL disability (OR: 1.75, CI: 1.64–1.86) in the frailty category. The frailty status is thought to be a significant predictor of disability in ADL and instrumental activities of daily living (IADL) among community-dwelling, middle-aged and older individuals. A recently published systematic review[26] reported a high incident ADL disability risk (pooled OR: 9.82 , 95% CI: 4.71–20.46) for frailty. Disabilities in ADL or IADL contribute significantly to the quality of life as these represent considerable inconveniences in everyday life. Therefore, screening for frailty during routine check-ups in a clinical setting will help optimize patient care. Such screening also provides an opportunity to identify the population at-risk who can be advised for prevention intervention.

This study had some limitations. This paper is based on the analysis of cross-sectional data, where no causal relationship could be established. Hence, the direction of association between frailty and adverse outcomes could not be determined. However, several longitudinal studies have shown an increased incidence of adverse health outcomes among frail older adults[27,28]. Another limitation could be the inclusion of only community-dwelling individuals in the survey; institutionalized older adults reportedly have a higher frailty and worse health outcomes[29,30]. Hence, the interpretation of these results is limited to community-dwelling older adults.

The findings of this study highlight the regional variation in frailty prevalence with higher physical frailty prevalent among community-dwelling older adults, women, less educated and rural residents. A sharp age-related increase in prevalence was also observed. The findings highlight the urgent need for action from public health practitioners and clinicians. Routine screening and optimizing patient care are inevitable, as frailty is strongly associated with frequent adverse health outcomes. Public health practitioners will be better equipped to identify and reduce risks and vulnerabilities by focusing on preventive measures. It is recommended to design interventions that are specific to each region in order to reduce frailty and its consequences.

***Acknowledgment*:** Authors acknowledge the support from Rashtriya Uchchatar Shiksha Abhiyan (RUSA) for statistical analysis.

***Financial support & sponsorship*:** None.

***Conflicts of Interest*:** None.

***Use of artificial intelligence (AI)-assisted technology for manuscript preparation*:** The authors confirm that there was no use of AI-assisted technology for assisting in the writing of the manuscript and no images were manipulated using AI.

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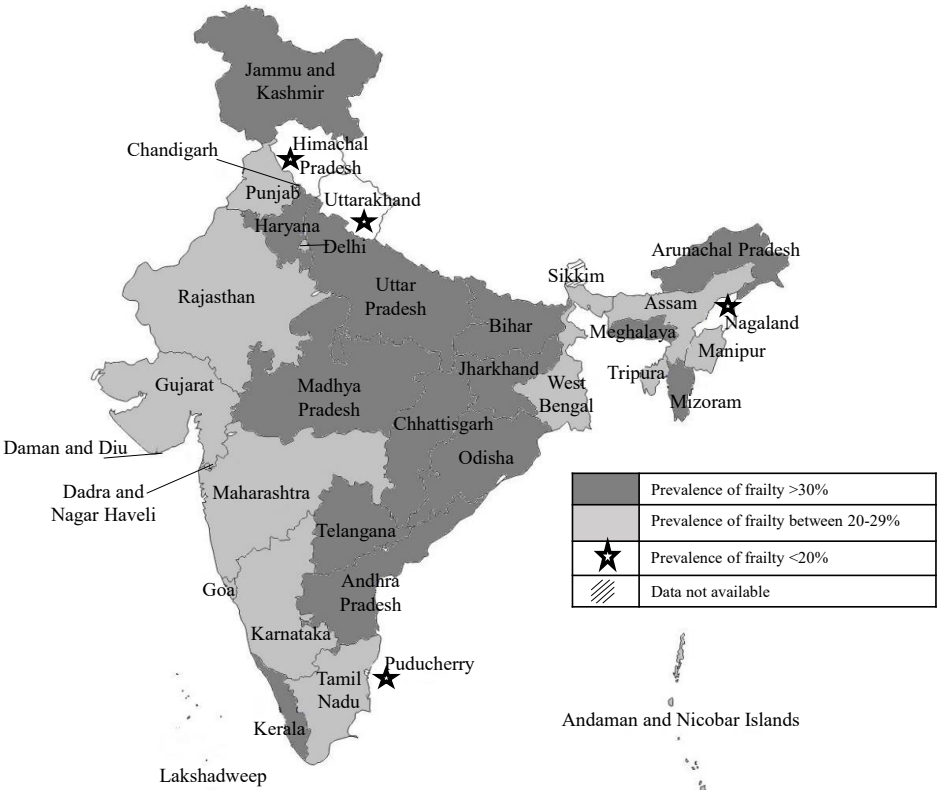

Supplementary Figure. Crude prevalence of frailty across States of India. Note: These maps were exclusively generated by the authors using secondary data collected for the Longitudinal Ageing Study in India (LASI). Source: Map outline generated using *d-maps.com* (*https://d-maps.com/continent.php?num_con=13&lang=en*).

Supplementary Table I. Prevalence of frailty across Indian States

State	Robust (%)	Pre-frailty (%)	Frailty (%)
Arunachal	4.8	53.9	41.3
Telangana	5.4	53.5	41
Mizoram	6.3	54.6	39.1
Meghalaya	2.5	60.5	37
Bihar	9.1	55.2	35.7
Haryana	7.2	58	34.8
Madhya Pradesh	9.3	57	33.7
Odisha	13.1	54.3	32.6
Uttar Pradesh	10.8	56.8	32.4
Chhattisgarh	10.8	58.1	31.1
Kerala	8	61	31
Jammu & Kashmir	9.4	59.8	30.8
Daman & Diu	10.2	59.2	30.6
Jharkhand	12	57.6	30.4
Andhra Pradesh	8.7	60.9	30.4
Karnataka	12.4	57.7	29.9
West Bengal	6.6	63.8	29.7
Delhi	4.2	66.7	29.1
Rajasthan	12.6	58.4	29
Goa	13.7	58.2	28.1
Tamil Nadu	18.7	53.7	27.6
Gujarat	11.7	60.8	27.5
Dadra & Nagar Haveli	12.1	60.7	27.2
Assam	16.1	57	26.9
Tripura	8.1	65.5	26.4
Manipur	8.6	65.4	25.9
Maharashtra	17.1	57.3	25.6
Andaman & Nicobar	11.9	63.3	24.8
Lakshadweep	10.4	67.1	22.6
Punjab	13.9	64.7	21.4
Chandigarh	14.9	64.7	20.4
Himachal Pradesh	21.8	60.3	17.9
Puducherry	24.5	57.7	17.8
Nagaland	25.5	58.8	15.7
Uttarakhand	24.8	60.7	14.5

Supplementary Table II. Prevalence of frailty according to place of residence (urban/rural) across Indian States.

State	Rural			Urban		
	Robust (%)	Pre-frail (%)	Frail (%)	Robust (%)	Pre-frail (%)	Frail (%)
Andaman & Nicobar	12.5	61.8	25.7	10.8	65.9	23.4
Andhra Pradesh	7.8	58.9	33.3	11.8	67.7	20.4
Arunachal	4.3	52.6	43.1	8.1	62.2	29.7
Assam	15.3	56.2	28.4	21.3	61.8	16.9
Bihar	9.2	55.2	35.5	7.9	55.2	37
Chandigarh	0	100	0	15	64.4	20.6
Chhattisgarh	9.3	55.7	35	17.3	68.5	14.2
Dadra & Nagar Haveli	9.6	61.6	28.8	17.1	58.9	24
Daman & Diu	9.9	59.5	30.5	10.3	59.1	30.6
Delhi	0	50	50	4.3	66.9	28.8
Goa	10.2	56.8	33	15.9	59.1	25
Gujarat	11.3	59.9	28.8	12.1	61.8	26
Haryana	7	58.2	34.8	7.5	57.5	34.9
Himachal Pradesh	21	60.1	18.9	30	62	8
Jammu & Kashmir	8.9	59	32.1	10.9	62	27
Jharkhand	11.6	55.8	32.7	13.6	65.4	20.9
Karnataka	11.2	57.8	31	15.2	57.4	27.5
Kerala	9	62.3	28.7	6.8	59.7	33.5
Lakshadweep	9.9	70.4	19.8	10.5	66.3	23.3
Madhya Pradesh	8.9	56.9	34.2	10.3	57.5	32.2
Maharashtra	18	54.5	27.5	16.2	60.5	23.3
Manipur	4.6	67.6	27.8	17	61	22
Meghalaya	2.7	58.1	39.3	1.8	73.2	25
Mizoram	8	55.8	36.3	4.5	53.4	42.1
Nagaland	24.6	59.3	16.1	28.3	57.2	14.5
Odisha	12.7	53.8	33.5	15.3	57.3	27.4
Puducherry	20.1	62.2	17.7	26.4	55.7	17.9
Punjab	14.8	64.6	20.6	11.4	64.9	23.7
Rajasthan	12.5	59.1	28.4	13	55.4	31.6
Tamil Nadu	13.6	53.6	32.9	22.7	53.9	23.5
Telangana	3.6	50.6	45.8	9.9	60.5	29.6
Tripura	7	66.5	26.5	12.3	60.5	27.2
Uttar Pradesh	10.1	55.8	34.1	13.5	60.8	25.6
Uttarakhand	25.1	59.2	15.6	23.6	65.9	10.6
West Bengal	8.3	58.4	33.2	4.7	69.1	26.1