

ORIGINAL ARTICLE

The prevalence of frailty and its relationship with sociodemographic factors, regional healthcare disparities, and healthcare utilization in the aging population across India

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Abstract

Objective: To estimate frailty prevalence and its relationship with the socio-economic and regional factors and health care outcomes.

Methods: In this study, participants from the harmonized Diagnostic Assessment of Dementia for the Longitudinal Aging Study in India (LASI-DAD) were included. The frailty index (FI) was calculated using a 32-variable deficit model, with a value of $\geq 25\%$ considered as frail. Data on demographic (including caste and religion) and socioeconomic profiles and health care utilization were obtained. The state-wise health index maintained by the government based on various health-related parameters was used to group the participants' residential states into high-, intermediate-, and low-performing states. Multivariable and zero-inflated negative binomial regression was used to assess the relationship of frailty index with sociodemographic characteristics, health index, and health care expenditure or hospitalization.

Results: Among the 3953 eligible participants, the prevalence of frailty was 42.34% (men = 34.99% and women = 49.35%). Compared to high-performing states, intermediate- and low-performing states had a higher proportion of frail individuals (49.7% vs. 46.8% vs. 34.5%, $P < 0.001$). In the adjusted analysis, frailty was positively associated with age, female sex, rural locality, lower education level, and caste (scheduled caste and other backward classes). After adjusting for the socio-economic profile, FI was inversely associated with the composite health index of a state ($P < 0.001$). FI was also significantly correlated with total 1-year health care expenditure and hospitalization ($P < 0.001$ and 0.020, respectively).

Conclusion: There is a high prevalence of frailty among older Indian adults that is associated with sociodemographic factors and regional health care performance. Furthermore, frailty is associated with increased health care utilization and expenditure.

Sunny Singhal and Sumitabh Singh have contributed equally to this article.

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KEYWORDS

low-middle income country, social class, South-Asia

1 | INTRODUCTION

Population aging, that is, increase in the number and proportion of older adults has shifted the focus of public health policies toward older adults.¹ Frailty, a multifactorial clinical syndrome characterized by a decrease in the homeostatic or physiological reserve, is associated with increased vulnerability to adverse health outcomes,² such as falls,³ disability,⁴ institutionalization,⁵ and death.⁶ It is a multidimensional syndrome caused by deficits in physical, psychological, and/or social domains.⁷ It is also a better predictor of biological age than chronological age,⁸ and measuring its prevalence in the community can play a key role in identifying the true burden of aging. Along with physiological health, frailty has also been linked to social determinants of health, and people who are socially disadvantaged are known to face a higher burden of frailty.⁹

India, the country with the second largest geriatric population globally,¹⁰ has a unique and complex social structure. Cowling et al¹¹ reported differences in the social determinants of health across different states, castes, sexes, and urbanicity in the Indian population. This study states that the population belonging to underdeveloped states, those of the scheduled castes/scheduled tribes, those living in rural areas, and women face the highest inequities. This inequality was then translated into differences in life expectancy within different castes, religions, and regions.¹² To improve population health and reduce regional disparities, a composite health index is calculated for each Indian state based on 23 indicators grouped into domains of health outcomes (neonatal mortality rate, tuberculosis [TB], and HIV cases, etc.), governance and information (medical officer occupancy rate, etc.), and key inputs or processes (number of vacant health care providers, etc.). However, it lacks geriatric specific outcomes.¹³

South Asians and, in particular, Indians differ from other populations in terms of socioeconomic status, health care behavior, attitude, education status, and genotype.^{14–16} At the population level, there is vast heterogeneity within the Indian population as there are several regional, sociodemographic, and economic differences affecting health-related characteristics of older people.¹⁷ However, very few studies have investigated the prevalence of frailty in Indian older adults, and these studies are limited due to their small sample sizes and designs, therefore lacking generalizability.^{18,19} Hence, a national sample, representative on the population level, is required to accurately estimate the burden of frailty. Further investigation of the association between frailty and sociodemographic factors, health care availability, utilization, and financing will help us in administering a targeted approach when managing the geriatric population of this largely diverse country.

To bridge this critical knowledge gap, we designed the present study with the following aims: (1) to construct a frailty index and report its prevalence among older Indian population; (2) to determine the association between frailty status and determinants of socioeconomic inequalities (income, education status, urbanicity, caste, and religion) and regional health care performance; and (3) to determine the correlation between the frailty index and health care-related outcomes (total health care expenditure and total number of nights spent in the hospital in the last 12 months).

2 | MATERIALS AND METHODS

2.1 | Settings and study design

The data were obtained from the harmonized Diagnostic Assessment of Dementia for the Longitudinal Aging Study in India (LASI-DAD). The Longitudinal Aging Study in India (LASI) is an ongoing cohort study funded by the National Institute on Aging (R01AG042778) and the Government of India. It is a nationally representative survey of the Indian population aged 45 years and older. LASI-DAD is a part of the LASI, which includes a subsample of selected LASI respondents aged 60 years and above and is designed to collect data on late-life cognition. It includes a subsample of selected LASI respondents aged 60 years and above from 18 states and union territories of India, thus representing 89% of the Indian population. Data are collected through a comprehensive geriatric assessment, including detailed cognitive interviews with both the respondents and caregivers. The LASI-DAD uses a two-stage stratified random sampling with oversampling of those at a high risk of cognitive impairment. In the first stage, LASI participants were stratified based on their state of residence and risk of cognitive impairment. In the second stage, an equal number of participants were randomly drawn from the two groups (high-risk and low-risk cognitive impairment) such that the sample size from each state was proportional to that included in the parent LASI study. Sample weights were created to account for this sampling strategy and nonresponders. Post-stratification weights were computed using a raking algorithm that aligned the sample distributions of key demographic variables (age, sex, literacy, and urbanicity) to their population benchmarks (taken from the 2011 Indian Census). These post-stratification weights allowed the LASI-DAD to represent the population aged 60 years and above at the national level, although the sample was drawn from only 18 of the 28 states. The complete protocol for the LASI-DAD has been published elsewhere.²⁰

2.2 | Construction of the LASI-frailty index

There are various approaches to measure frailty.²¹ We used the deficit accumulation model, which defines frailty as the accumulation of various deficits across different physiologic systems.²² Its questionnaire-based structure makes it ideal for use in community surveys and does not require significant training of interviewers.

Searle et al²³ previously defined a standard procedure for selecting deficits and creating a frailty index (FI). Based on their definition, the variables selected must be associated with adverse health outcomes and may include symptoms, signs, disabilities, activities of daily living (ADL), self-rated health, and comorbidities. The prevalence of impairment should generally increase with chronological age; however, it should not saturate too early. The variables included should cover a range of physiological systems and should avoid overweighing an individual system. Hence, the variables were excluded if the respective health domains were better represented by another available variable. The values for the variables must be present in more than 95% of the sample. Furthermore, the prevalence of the deficit should be more than 1% but less than 80% in the complete sample. Finally, the final constructed LASI-FI must include at least 30–40 variables.

2.3 | Scoring of the LASI-FI

Only those participants with available values for $\geq 90\%$ of the LASI-FI variables were included in the final analysis. Each variable was scored from 0 to 1, with 0 indicating the absence and 1 indicating the presence of a deficit. A score of 0.5 was given in some deficits for an intermediate response. An individual's FI was calculated as the sum of the scores of individual deficits divided by the total number of deficits with non-missing values. For simplification, FI was multiplied by 100. As used in the Rockwood Frailty model, an individual was considered frail if the FI was ≥ 25 and prefrail if FI was 8–25.²⁴

2.4 | Covariates

Information on sociodemographic factors (age, sex, education, urbanicity, caste, and religion) and state of residence was obtained from the LASI-DAD study, whereas information on the annual household income, total health care expenditure of the last 12 months, and the total number of nights spent being hospitalized in the last 12 months was obtained for the respective participants from the main LASI study.

2.5 | Health index

As mentioned previously, the health index is an annual report card that measures the performance of the health care sector of various

states. The health-index report released in June 2019, analyzed the states' performance for the year 2017–2018.¹³ As the first wave of LASI-DAD data collection was also done during the same period, this report card was selected for our study. The six states having the highest health index were grouped as high-performing states, followed by six states that were intermediate-performing states, and, last, six states that were low-performing states.

2.6 | Statistical analysis

Statistical analyses were performed using the STATA software (release 12.1, Stata Corp). Statistical significance was set at $P < 0.05$. We used the LASI-DAD post-stratification sampling weight to adjust for nonresponse and complex sampling design. The Chi-squared test was used to compare categorical variables while Wilcoxon rank-sum test was used to compare continuous variables with frail categories.

As the clustering effect (Intra-class correlation = 0.09) on frailty due to state was negligible in LASI data, we used multivariable linear regression modeling to establish the relationship among the FI, composite health index, and other socioeconomic factors. Model 1 shows the unadjusted relationship between the FI and composite health index. In model 2, age and sex were added to the regression model. Household income was added to model 3, and locality and years of education were further added to model 4. Finally, model 5 included religion and caste.

Count regression analysis was used to evaluate the relationship of health care expenditure and number of hospitalized nights with FI. A zero-inflated negative binomial regression (ZINB) was chosen for both due to over-dispersion and evidence of excess zeros. ZINB is a mixture model in which the outcome distribution consists of two parts. The first part is a logistic model for predicting excessive zeroes (zero and not zero) and the second part is a negative binomial model to account for the over-dispersed counts. Thus, ZINB provides two sets of coefficients and corresponding P values for models relating to the logistic and counts parts.²⁵ Further, the performance of the ZINB model was tested against Negative Binomial (NB) model using the Akaike information criterion (AIC) and Bayesian information criterion (BIC).

3 | RESULTS

A total of 32 variables were included in the final LASI-FI (Table S1). Figure S1 shows the process for selecting variables for the LASI-FI. Despite having missing data accounting for 7.8%, body mass index (BMI) was included in the final index, considering its significant role in predicting adverse outcomes in older adults.²⁶ Of the 4096 subjects, 143 (3.5%) were excluded due to having missing values for more than 10% of the LASI-FI variables. Thus, 3953 subjects were finally included in the study.

Table 1 provides a description of the characteristics of the study population. The mean age of the population was 69.8 ± 0.2 years, and

individuals with frailty were older compared to non-frail individuals. The mean FI of the population was 23.5 ± 0.3 (women = 25.7 ± 0.4 and men = 21.2 ± 0.4). It increased with age and was higher in female patients (Figure 1). The prevalence of frailty, pre-frailty, and non-frailty were 42.34%, 47.64%, and 10.02%, respectively. In addition to older age and female sex, lower income, lower education, and rural locality were also associated with a high prevalence of frailty. As regard to caste, frailty was highest in the scheduled tribes (STs), followed by the scheduled castes (SCs), other backward classes (OBCs), and least

in other or no caste. Similarly, regarding religion, the prevalence of frailty was highest among Hindus, followed by Muslims and other religions. Both health care expenditure and hospitalization duration were higher among individuals with frailty, but only differences in health care expenditure were statistically significant.

As shown in Figure 2, the highest prevalence was observed in Odisha (74.06%), whereas the lowest was observed in Maharashtra (25.36%). The prevalence of frailty and FI variables are presented in Table S2. The FI was higher in low-performing states, followed

TABLE 1 Frailty status and baseline characteristics of the Diagnostic Assessment of Dementia for the Longitudinal Aging Study in India population.

	Total, n	Frail, n (proportion ^a)	Non-frail, n (proportion ^a)	P value
Total	3953	1769 (42.3)	2184 (57.7)	
Age, y				
Mean $\pm$ SE ^b	69.8 $\pm$ 0.2	72.1 $\pm$ 0.3	68.0 $\pm$ 0.2	<0.001
60–69 y	2245	817 (32.4)	1428 (67.6)	<0.001
70–79 y	1242	615 (49.9)	627 (50.1)	
≥ 80 y	466	337 (71.0)	129 (29.0)	
Sex				
Female	2130	1089 (49.3)	1041 (50.7)	<0.001
Male	1823	680 (35.0)	1143 (65.0)	
Annual household income (USD)				
Mean $\pm$ SE ^b	2832.4 $\pm$ 369.2	1741.1 $\pm$ 101.8	3635.6 $\pm$ 634.3	<0.001
Education				
Years of education ^b	3.8 $\pm$ 0.1	2.2 $\pm$ 0.1	5.0 $\pm$ 0.2	<0.001
Less than lower secondary	2964	1517 (49.6)	1447 (50.4)	<0.001
Upper secondary and vocational training	826	221 (21.7)	605 (78.3)	
Tertiary	163	31 (16.0)	132 (84.0)	
Locality				
Urban	1499	523 (35.5)	976 (64.5)	<0.001
Rural	2454	1246 (50.9)	1208 (49.1)	
Caste				
No caste or other caste	1335	507 (34.0)	828 (66.0)	<0.001
Scheduled caste	720	366 (47.7)	354 (52.3)	
Scheduled tribe	202	106 (53.0)	96 (47.0)	
Other backward class	1677	782 (45.2)	895 (54.8)	
Religion				
Hindu	3132	1417 (42.8)	1715 (57.2)	0.521
Muslim	505	223 (41.3)	282 (58.7)	
Other	316	129 (38.5)	187 (61.5)	
Total expenditure on health care in last 12 mo (USD)				
Mean $\pm$ SE ^b	118.1 $\pm$ 18.0	153.9 $\pm$ 38.8	91.8 $\pm$ 12.9	0.010
Number of nights spent in the hospital in last 12 mo				
Mean $\pm$ SE ^b	0.66 $\pm$ 0.10	0.84 $\pm$ 0.20	0.53 $\pm$ 0.09	0.069

Note: All bold P values are <0.05 denoting significant results.

Abbreviation: USD, United States dollars.

^aWeighted proportions.

^bWeighted means $\pm$ standard error (SE).

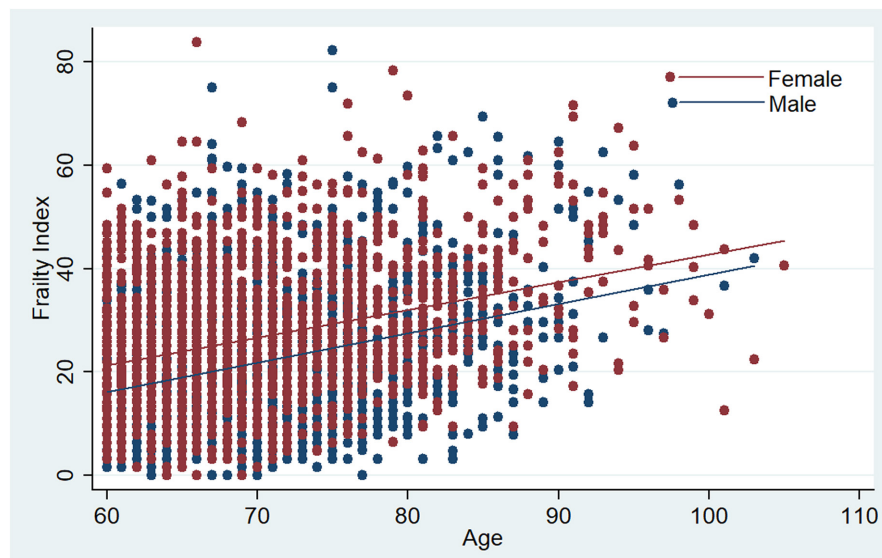


FIGURE 1 Scatter plot with fit-line plot showing variation of frailty index with age in male participants (blue dots and line) and female participants (maroon dots and line).

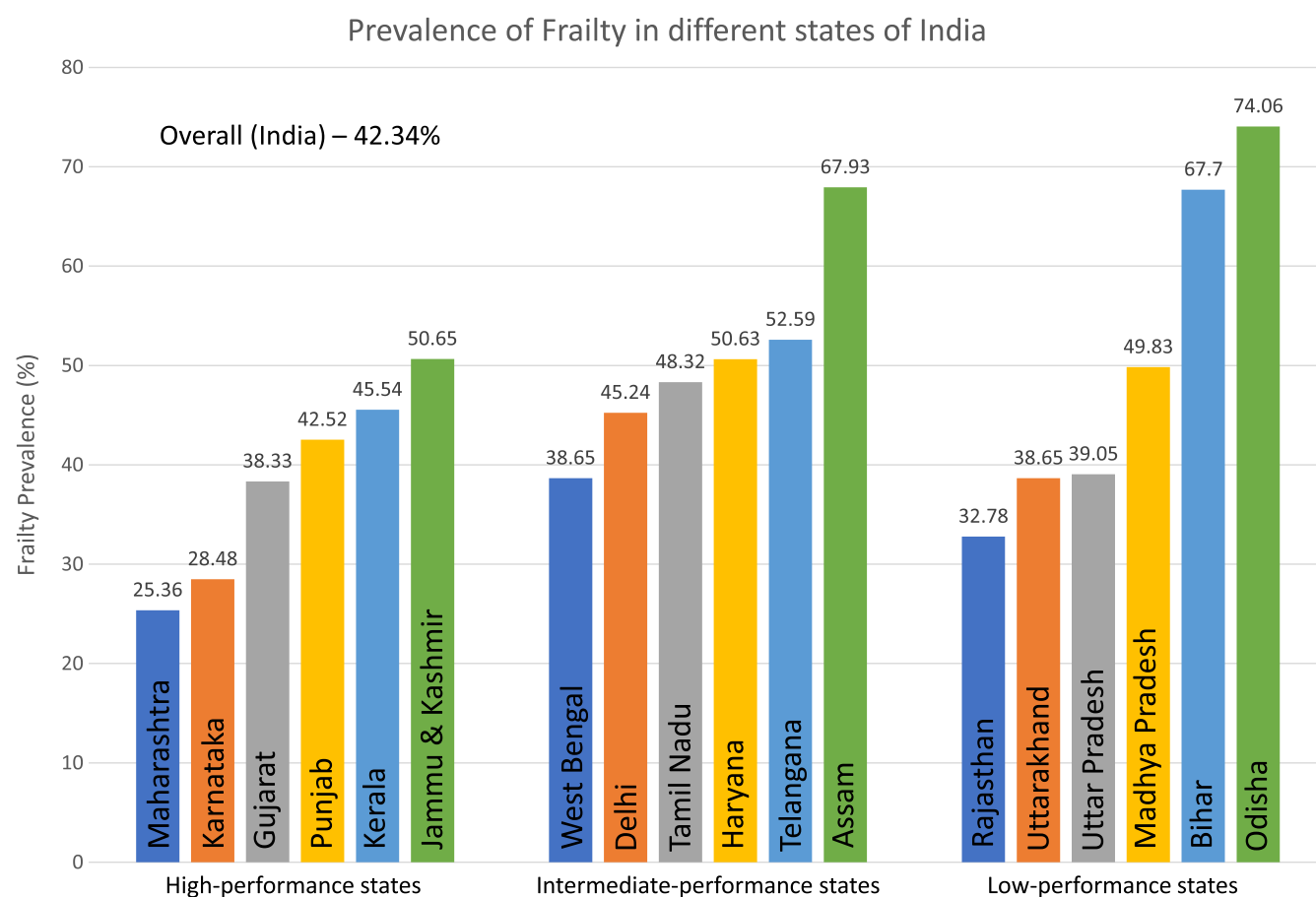


FIGURE 2 Prevalence of frailty in different states of India distributed as per the health index.

by intermediate- and high-performing states (Figure S2). The results from the multivariable linear regression analysis of the FI on health index and socioeconomic variables are shown in Table 2. From model 1 (unadjusted model), we see that the FI is inversely associated with the state's composite health, that is, frailty increases with

poor performance of state on health index. After further adjustment for demographic and socioeconomic factors (age, sex, income, education, locality, caste, and religion) in models 2, 3, 4, and 5, the health index remained significantly associated with the FI. Similarly, older age, female sex, lower annual income, rural residence, and

TABLE 2 Multivariable linear regression analysis of the frailty index^a, on the composite health index of the states and various socio-economic variables.

	Model 1 ^b	Model 2 ^b	Model 3 ^b	Model 4 ^b	Model 5 ^b
R ²	0.022	0.164	0.168	0.214	0.217
Composite Health Index	-0.147 (-0.190, -0.104)	-0.145 (-0.184, -0.106)	-0.144 (-0.183, -0.104)	-0.086 (-0.127, -0.046)	-0.086 (-0.128, -0.044)
Age, y		0.582 (0.513, 0.651)	0.578 (0.510, 0.647)	0.535 (0.468, 0.603)	0.539 (0.471, 0.607)
Sex (reference population - male)		4.992 (4.022, 5.963)	4.896 (3.929, 5.864)	3.333 (2.326, 4.329)	3.449 (2.445, 4.454)
Female					
Annual household income (per 1000 USD)			-0.059 (-0.085, -0.034)	-0.030 (-0.051, -0.009)	-0.032 (-0.051, -0.011)
Locality (reference population - urban)				2.163 (1.131, 3.194)	2.044 (0.986, 3.103)
Rural					
Years of education				-0.526 (-0.634, -0.417)	-0.490 (-0.603, -0.378)
Religion (reference population - Hindu)					0.254 (-1.286, 1.795)
Muslim					
Other					0.283 (-1.494, 2.060)
Caste (reference population - no caste or other caste)					1.657 (0.223, 3.090)
Scheduled caste					
Scheduled tribe					1.144 (-0.968, 3.256)
Other backward class					1.439 (0.322, 2.557)

Note: Model 1 was an unadjusted model; model 2 was adjusted for age and sex; model 3 was further adjusted for income; model 4 was further adjusted for locality and education; and model 5 was further adjusted for caste and religion.

^aThe frailty index ranges from 0 to 100.

^bThe values reported are the regression coefficients (frailty index score) (95% confidence intervals) and are survey weighted.

lower level of education were significantly associated with higher FI scores. Compared to no/other castes, belonging to SC or OBC was also associated with a higher FI.

Figure 3 shows the fit-line plot between the frailty index and health care-related outcomes. Table 3 shows the results of ZINB model of frailty index predicting number of nights spent in the hospital and health care expenditure in last 1 year. The FI was found to be significantly correlated with both total health care expenditure ($P < 0.001$) and total hospitalization duration ($P = 0.020$). Increased frailty was found to be associated with increased odds of both having hospitalization and/or health care expenditure in 1 year (logit model). Similarly, increased frailty was also associated with increased nights of hospitalization and amount of health care expenditure (count model). This correlation remained significant after adjusting for age and sex (adjusted $P < 0.05$ for both). As compared to NB model, the ZINB model had the lowest AIC (NB = 56988.38 and ZINB = 55619.96) and BIC coefficients (NB = 57007.23 and ZINB = 55651.36) for health care expenditure. Similarly, the ZINB model had the lowest AIC (NB = 4390.443 and ZINB = 4373.584) and BIC coefficients (NB = 4409.263 and ZINB = 4404.951) for hospitalization nights. Thus, indicating ZINB to be a better performing or more suitable model for both variables.

4 | DISCUSSION

4.1 | Prevalence of frailty

In our study, the weighted prevalence of frailty and pre-frailty in Indian older adults was 42.34% and 47.64%, respectively. The prevalence of frailty was relatively high, which is comparable to that obtained from other Indian studies. The World Health Organization Study on Global Ageing and Adult Health (WHO-SAGE study), which is the only other study with national sampling from six Indian states, reported a similar prevalence of frailty (44.5%).²⁷ A few regional studies from eastern and southern India have reported a prevalence of frailty of as high as 59%.^{28,29} Although one study reported a lower prevalence (26.1%), the study participants only belonged to an urban locality.¹⁹ Another study conducted in an outpatient setting also reported a similar prevalence of 44%.¹⁸ However, besides the WHO-SAGE study, all other community-based studies included participants from a single state only and hence lacked generalizability. Although the study population of the WHO-SAGE included participants from all regions, it included only one state from one region. In our study, we included multiple states from one region to capture

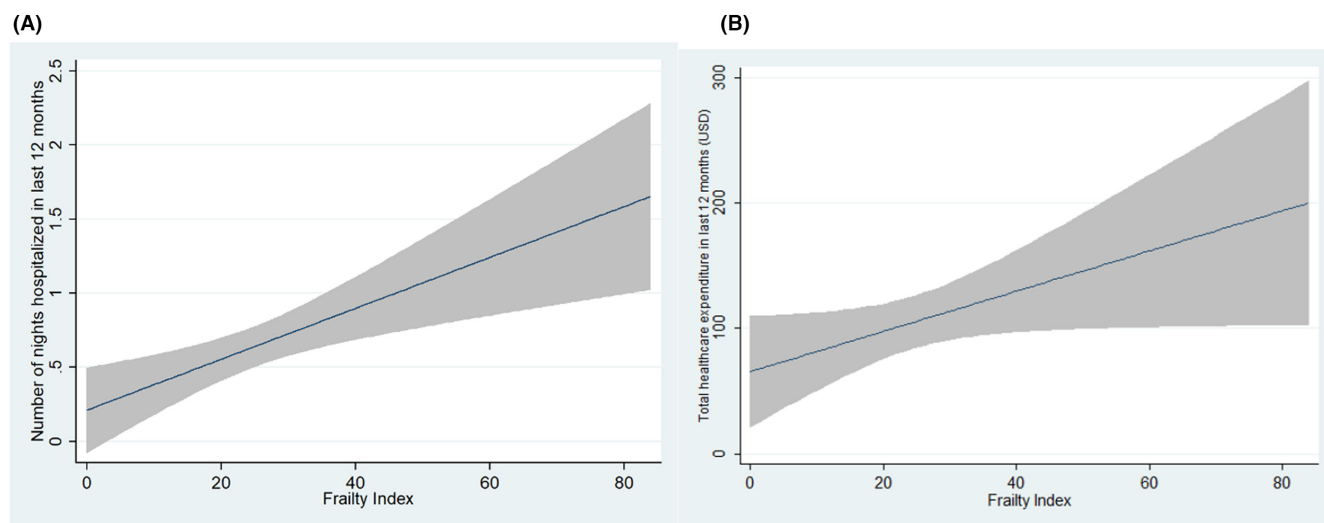


FIGURE 3 Fit-line plot showing the relationship between frailty index and (A) number of nights spent in the hospital in last 1 year and (B) total health care expenditure in last 1 year.

	Total health care expenditure in last 1 y	Number of nights spent in the hospital in last 1 y
Logistic portion of model (yes/no)		
Coefficient	-0.006	-0.012
95% confidence interval	-0.011 to (-)0.001	-0.021 to (-)0.003
P value	0.029	0.009
Counts portion of model (amount/events)		
Coefficient	0.013	0.012
95% confidence interval	0.008 to 0.017	0.001 to 0.023
P value	<0.001	0.027

TABLE 3 Zero Inflated Negative Binomial (ZINB) Regression analysis results for health care expenditure and hospitalization nights in last 1 year.

Note: All bold P values are < 0.05 denoting significant results.

intra-regional heterogeneity. Furthermore, the FI used in the WHO-SAGE study lacks variables from the cognitive domain,²⁷ which is a major component of geriatric health. By including variables assessing cognitive function, we aimed to create a more robust FI.

Although the prevalence of frailty varies with the study tool used, earlier studies have also shown that frailty is more prevalent in low-middle-income countries (such as India) than in high-income countries.^{30–32} Socioeconomic inequalities (lower education and wealth)^{33,34} and health care disparities (poor accessibility, quality, and increased cost)^{35,36} may explain the increased prevalence of frailty in such countries. Ethnicity also plays an important role in frailty. An earlier study conducted in the United Kingdom showed a higher prevalence of frailty among South Asians (including Indians) compared to White and Black ethnic groups,³⁷ which can be related to their high cardiovascular risk profile.³⁸

4.2 | Relationship of frailty with sociodemographic factors

In our study, there was an increase in the prevalence of frailty with age, as demonstrated by frailty being more prevalent in the oldest old (≥ 80 years). Frailty was more prevalent among women than men. A higher proportion of people who were frail also undertook fewer years of education; there was a decrease in the prevalence of frailty with an increase in the years of education. These findings are consistent with those of the WHO-SAGE study, where the oldest old and female participants showed higher levels of frailty than younger old and male participants. In addition, the mean frailty score demonstrated a strong inverse relationship with education, with lower levels of education showing higher levels of frailty.³⁹

Individuals living in rural areas were more likely to be frail than those residing in urban areas. The frailty gap among urban–rural inhabitants can be explained by differences in their wealth index, education, physical activity, community engagement.⁴⁰ Caste also showed significant variability in being frail, with a higher proportion of frail individuals belonging to SC, followed by ST. The WHO-SAGE data demonstrated similar results, although they determined frailty based on the phenotypic model.⁴¹ Further studies are required to understand the reason for this difference in the prevalence of frailty among various caste groups. Religion of participants was not found to be significantly associated with frailty. However, larger sample size of other religious minorities (Sikhs, Christians, etc.) may be required for better understanding.

4.3 | Relationship of frailty with health index of states

On comparing the FI with the health index of the states, we found it to be inversely correlated, that is, states with a better health index were more likely to have a lower FI. On further classification of the states based on the health index, states with a better health index (high-performing states) had a lower prevalence of frailty among

older adults as compared to those with a lower health index (intermediate- and low-performing states). This higher prevalence of frailty in low-performing states could be due to a multitude of reasons, such as poor allocation and utilization of health care resources and improper implementation of health policies for older individuals. As frailty is strongly associated with mortality in older adults,⁶ the FI and health index can help identify states that have more vulnerable older adults, thus improving the focus on geriatric health care.

However, it is also important to note that the health outcomes used to develop the health index are primarily pediatric (neonatal, under-5 mortality rate, etc.), maternal (institutional deliveries and total fertility rate), or infection-related (TB and HIV) and do not have any chronic disease, disability, or other geriatric-related outcome.⁴² This can explain the high prevalence of frailty in some high-performing states and, similarly, the low prevalence in some low-performance states (Figure 2). Furthermore, because of improvements in health and medical care, deaths from infections and maternal and perinatal causes are decreasing, whereas chronic non-infectious diseases are becoming more common causes of morbidity and mortality.⁴³ We need to develop better data systems that can measure such geriatric-related outcomes (eg, FI) to understand the health risks faced by older people. These data systems can be used for health care policy and decision making to target appropriate prevention and intervention services and strengthen further research.

4.4 | Health care outcomes and frailty index

As seen in the ZINB model (Table 3), the odds and amount of both health care-related expenditures and duration of hospitalization increases with increased frailty. This finding was simulated by previous studies,⁴⁴ particularly the ESTHER study,⁴⁵ where frailty was found to be an important and significant factor for an increase in health care costs independent of age and comorbidity. Although it is a well-known fact that frailty increases the risk of hospitalization among older adults,^{46,47} our study further strengthens the fact that increasing frailty, as determined by an increase in the FI, leads to an increased length of hospital stay.

4.5 | Strengths and limitations

The major strength of this study is its strong sampling strategy. As mentioned earlier, the LASI-DAD is a nationally representative weighted survey that recruited subjects from 18 different states and represented 89% of the population, thereby increasing the generalizability and applicability of our study. As this was designed to be a longitudinal study, this index can also be used for future analysis. Furthermore, our study provides an understanding of how regional health care differences can be associated with frailty in older adults, which was previously unexplored. Last, sociodemographic factors, such as caste and religion, which play an important role in determining the health status of an individual,⁴⁸ were also included in this study.

This study had a few limitations. First, because we used cross-sectional data, causation could not be established. However, as data from subsequent waves become available, we will use this model for further validation. Second, we used the deficit accumulation model to measure frailty. However, it is known to overestimate prevalence as compared to the phenotypic model.^{30,31} As other data (grip strength and gait speed) from the LASI-DAD are being collected, we will, in the future, need to compare prevalence between the two models for better understanding.

5 | CONCLUSION

India has a high prevalence of frailty among older individuals, and this is associated with various demographic and socio-economic factors. Frailty is also inversely associated with the health care performance of a state. Furthermore, it is associated with increased hospitalization duration and health care expenditure. Using frailty as either a health care variable or outcome in a state's policymaking strategy can help improve the assessment and delivery of health services to older adults.

AUTHOR CONTRIBUTIONS

S. Singhal and S. Singh conceptualized the study and its methodology. Data acquisition and project supervision was done by A. B. D., S. D., J. B., J. L., and P.H. S. Singhal, S. Singh, G. C. D., and A. D. U. performed the study analysis and wrote the original draft. All authors reviewed and gave approval for the final version.

FUNDING INFORMATION

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

The original cohort data for LASI (<https://www.iipsindia.ac.in/content/LASI-data>) and LASI-DAD population (<https://g2aging.org/downloads>) is publicly available and can be accessed through the aforementioned weblinks.

ETHICS APPROVAL

This study is based on anonymous data obtained from the LASI (Longitudinal Aging Study of India) and the LASI-DAD (Longitudinal Aging Study of India – Harmonized Diagnostic Assessment of Dementia). Both the original LASI and LASI-DAD study were approved by the human ethics committee of the All India Institute of Medical Sciences (New Delhi) (IEC-284/06.05.2016, RP-33/2016), the Indian Council of Medical Research (New Delhi), and the International Institute of Population Sciences (Mumbai).

CONSENT FOR PUBLICATION

Participants provided consent for the anonymous publication of data.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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