Early life factors associated with old age physical frailty: evidence from India

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ARTICLE INFO

ABSTRACT

Background: Physical frailty is one of the most important phenotypes used to understand the vulnerable nature of older adults. The paper examined the association of childhood factors, including birth order, childhood socio-economic status, and other exposures with old age physical frailty. The study further explored the gender dimensions of physical frailty prevalence.

Methods: Data from the Longitudinal Ageing Study in India (LASI, 2017-18), wave-1 were used. The sample size for the study was 24,513 older adults aged 60 years and above (12,510 females and 12,003 males). Physical frailty was assessed using the measurement approach proposed by Fried and colleagues.

Results: The results indicated significant gender difference in the prevalence of physical frailty with 39.03% of older women and 32.49% of men being frail. Older adults with lower levels of mothers' (adjusted odds ratio (aOR): 1.26; 95% confidence interval (CI):1.01–1.58) or fathers' education (aOR: 1.33; 95% CI:1.18–1.50) or poor childhood health status (aOR: 1.48; 95% CI:1.27–1.71) had higher odds of physical frailty. Compared to older women with a well-off childhood financial condition, women with average childhood financial status had 38% (aOR: 1.38, 95% CI:1.01-1.89) higher odds of reporting physical frailty. In contrast, older men with poor childhood financial status had lower odds (aOR: 0.73; 95% CI:0.56-0.96) of physical frailty than older men with well-off childhood financial status.

Conclusion: Early life disadvantages in health, financial condition and lack of parental education had significant positive associations with old age physical frailty. The findings suggest the importance of childhood factors in policy and practice in terms of addressing old age physical frailty.

1. Introduction

With the rapid demographic transition taking place in the Indian context, the discussion of the health and wellbeing of older adults is a recurring one. Ageing is associated with a decline in physical ability that increases the vulnerability among older adults. Physical frailty is one of the most important phenotypes used to understand the vulnerable nature of older adults [1]. Literature highlight that physical frailty is characterised by the decline in reserves and function across multiple physiologic systems of individuals [2]. Available studies also emphasised the importance of various socioeconomic, demographic, health and behavioural factors in determining physical frailty [3,4]. The vitality of assessing physical frailty among older adults is that it helps to predict

frailty-related complications, including diseases and disability [5,6]. It also helps to study the effect of physical frailty on mortality and other outcomes such as incidence of fall, social frailty, hospitalization, and healthcare expenditure [6–9]. Therefore, physical frailty phenotype is also considered as one of the crucial clinical tools in geriatric care. However, the inadequate evidence on the associated factors of physical frailty limits the designing of interventions and strategies to prevent or cure frailty in old age [1]. Therefore, studying physical frailty and its associated factors among older population may offer better strategies to work towards healthy ageing.

It is established that physical frailty is a gradual process of losing the functional capacity that starts with a pre-frail condition to ultimate frailty and may subsequently result in other complications [10]. A

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review indicates that studies on old-age physical frailty in developing countries are limited despite rapid population ageing with higher health risks [11]. Since geriatric healthcare resources are limited in developing countries, preparation with counter-frailty intervention shall be a challenging policy task. It was also established that there is a higher degree of subjectivity in the experience of physical frailty among older adults, and each person will have their own unique clinical intervention needs [10]. There are ample possibilities of various interventions to treat physical frailty. Studies indicated that physical exercise, supplementation of vitamin D, and physical therapy could be used for managing physical frailty among older adults [12,13]. It is also important to identify the physical frailty among older adults at an earlier stage to provide timely intervention, which may help achieve healthy ageing. The unique healthcare needs of frail older adults require appropriate intervention that satisfies both individuals and their families.

Researchers explored various factors that cause physical frailty among older adults. Besides socioeconomic and demographic factors, studies emphasised the critical role of biological factors, including the early childhood aspects in determining the physical frailty in old age through their mediating effect over the life span of individuals [14,15]. The World Health Organisation [16] underlines the need for a holistic approach to understand the health status of older adults as health in old age is determined mainly by the cumulative impact of individuals' lifetime behaviour and exposures. Therefore, it is argued that a life course approach to physical frailty may offer a better understanding. A study conducted in Finland revealed that physical frailty in old age is partly programmed through early life factors such as birth weight and childhood socioeconomic status [17]. A previous study confirmed that there is a partial effect on parental characteristics such as their education in determining physical frailty [18]. However, most of the available literature considered modifiable variables related to physical frailty that account for the effect of the post-childhood period of individuals. These studies mainly considered socioeconomic, demographic, behavioural, environmental, and social exposures [14].

The present paper aimed to explore the role of a set of potential related variables related to the early childhood, including birth order, childhood health and socioeconomic status, and other exposures. There are study evidence that indicates the gender differential in physical frailty prevalence among older adults [19,20]. Generally, in comparison to males, females have the advantage of higher survival with the high risk of health burden. This health and survival paradox needs to be studied further to remove the gender gap in health outcomes [20]. Therefore, the current study also explored the gender dimensions of physical frailty among older adults in India. Based on the above mentioned literature, a conceptual framework has been developed and summarized in Fig. 1.

2. Methods

2.1. Data and sample

The study utilized the recently released data from the Longitudinal Ageing Study in India (LASI) wave 1, a national level survey conducted during 2017-2018. The survey was funded by the Ministry of Health and Family Welfare, Government of India, the National Institute of Ageing, United Nations Population Fund-India and the International Institute for Population Sciences (IIPS), Mumbai, executed the survey in collaboration with the Harvard TH Chan School of Public Health (HSPH) and the University of Southern California (USC) and several other institutions [21]. The LASI is a longitudinal prospective study of 72,250 individuals aged 45 years and above, including their spouses (no age criteria) from 35 Indian states and union territories (excluding Sikkim). The LASI provides national-level estimates of health outcomes, socioeconomic and demographic profiles of the study sample [22]. The present study considered the older adults aged 60 years and above from the LASI dataset (31464 older individuals). In the current study, we have extensively used bio-markers data from LASI. The biomarkers data were available for 28576 older adults. After excluding the missing cases, 24,
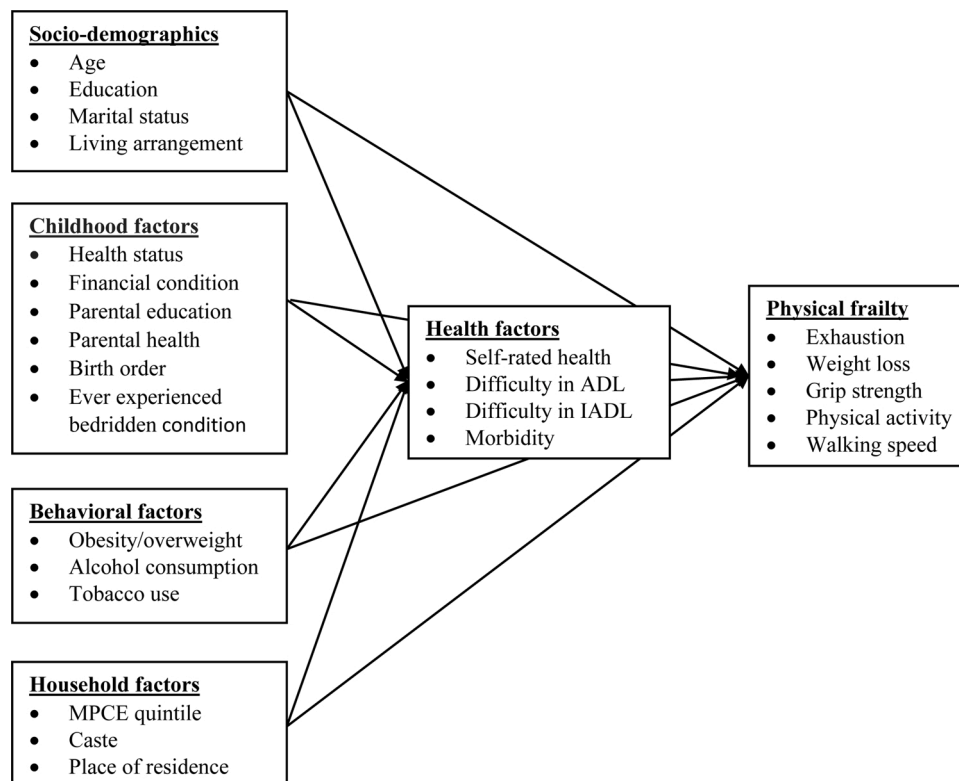

Fig. 1. Conceptual framework.

513 older adults (12,510 females and 12,003 males) were considered for the analysis.

2.2. Measures

2.2.1. Outcome measure

To measure the physical frailty among older adults, we adopted the concept developed by Fried and colleagues [2]. Accordingly, a composite physical frailty index was developed by constituting five major components; i) self-rated exhaustion, ii) unintentional weight loss, iii) weak grip strength, iv) self-reported low physical activity, and v) slow walking speed. Exhaustion was assessed using two questions from the Center for Epidemiologic Studies Depression (CES-D) scale: in the past week, how often do you feel "everything you did was an effort," and "feel tired or low in energy", answered with "three or more days = 1" and "less than three days = 0". Unintentional weight loss was assessed using the question: "Do you think that you have lost weight in the last 12 months because there was not enough food at your household?", with responses "Yes = 1" and "No = 0." LASI measured handgrip strength in kilograms using a handheld Smedley's Hand Dynamometer. The final handgrip strength score (in kg) was calculated as the average score (in kg) of two successive trials in the dominant hand, and was adjusted for the gender and body mass index. In LASI, respondents were asked about their physical activity: "How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health center or gym, cycling, or digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads: everyday, more than once a week, once a week, one to three times a month, or hardly ever or never?", The low physical activity was defined as: "One to three times a month or hardly ever or never = 1" and "once a week or more than once a week= 0". Finally, LASI asked respondents to walk 4-metres twice, and slowness was assessed by averaging the time (in seconds) taken in completing the 4 meters (stratified by gender and height). All the other components of the physical frailty index were based on self-reported responses. The total frailty index score lies between 0 and 6. We classified individuals as "frail" if the index score was three or higher and as "non frail", otherwise.

2.2.2. Exposure variables

The main set of related variables consists of childhood factors. It includes variables; birth order (1 or 2, 3 or 4 and 5 and above), mother's schooling (yes and no), father's schooling (yes and no), parental medical history (whether the mother was diagnosed with chronic diseases and whether the father was diagnosed with chronic diseases including hypertension, diabetes, heart disease, stroke, cancer, Alzheimer's disease, Parkinson's, and psychotic disorder), childhood health status (poor and good), whether bedridden for one month during childhood (yes and no) and childhood financial condition (well-off, average and poor). We expect these related variables to significantly determine physical frailty during old age [17]. Additionally, we have used seven socioeconomic and demographic variables found in the literature [23]. It includes age (60–69 years, 70–79 years and 80 years and above), gender (male and female), education (no schooling, up to 5 years, 6–10 years, and more than 10 years), socioeconomic position (scheduled tribes (ST), scheduled castes (SC), other backward class (OBC) and others), marital status (in a union and not in a union), monthly per capita consumption expenditure (MPCE) quintiles (poorest, poorer, middle, richer and richest), and place of residence (rural and urban). In the Indian context, the socioeconomic position is based on the socioeconomic status and the population is categorised to castes. This categorisation is often used as a norm for many government service/product delivery mechanisms. The information on the MPCE quintile was provided in the LASI dataset and was measured using the expenditure on 11 food and 29 non-food items, after standardising the expenditure to a 30 day reference period [22]. Finally, seven health and behavioural variables were considered [14, 24–27]. It includes current self-reported health (SRH) (good and poor),

activities of daily living (ADL) (low and high), instrumental activities of daily living (IADL) (low and high), current morbidity (none, one disease, and two or more diseases), BMI (underweight, normal, overweight and obese), smoking (yes and no) and alcohol drinking (yes and no).

The ADL was measured using six basic questions on disabilities, including dressing, walking, bathing, eating, using the toilet, and getting out of bed. Similarly, IADL was measured using seven questions on difficulties in performing, cooking, shopping, making telephone calls, taking medications, doing work around the house/gardening. Both ADL and IADL were classified as low if the difficulty was reported among at least one of the respective disability forms [28]. Current morbidity was measured based on chronic ailments diagnosed, including hypertension, diabetes, cancer, chronic lung disease, chronic heart disease, stroke, arthritis, neurological/psychiatric problems, high cholesterol, thyroid, gastrointestinal problems, skin disease, and any other diseases [29]. For BMI categorization, the height and weight variables were used and measured using the standard formula.

2.3. Statistical analysis

We used descriptive statistics and gender-wise bivariate analysis to find the preliminary results. In the multivariate analysis, we applied two binary logistic regression models. In the first model, we estimated the significant determinants of physical frailty using eight early childhood-related variables. In the second model, we added the remaining socio-economic, demographic, health and behavioural variables. Since the study focuses on the gender difference in physical frailty, we estimated the logistic regression models for overall, male and female samples separately. As women are expected to report highest level of physical frailty, this would offer better gender-based policy recommendation. The results are presented in the form of adjusted odds ratio (aOR) with 95% confidence interval (CI). No multicollinearity was found among independent variables used in the study models. For all the statistical tests, p values <0.05 was considered statistically significant. All the analyses were performed using the sample weights provided in the dataset.

3. Results

The characteristics of the study population are given in Table 1. A large share of the study participants was characterized by the birth order 1 to 2. Only a small share of the parents of the study participants had formal education. Among older men, 24.43% and 8.18% of their fathers and mothers had schooling, respectively, whereas 21.89% and 7.36% of the fathers and mothers of older women had a formal education. Older men had a childhood bedridden experience and poor childhood health than older women. 44.64% and 42.75% of men and women reported poor childhood financial conditions. Nearly three-fourths of older women had no formal schooling (73.03%). More than half of older women were not in a union (52.67%), whereas only 17.77% of men were not in a union. A large share of the study participants were rural residents. Older women (23.43%) reported poor SRH than men (20.43%). Similarly, a high prevalence of disability (in ADL and IADL) and multimorbidity were reported among older women than men.

The prevalence estimates of physical frailty by age and gender are given in Figs. 2 and 3. Of the total study sample, 35.85% reported physical frailty. On the basis of age category, the prevalence of physical frailty was 27.35%, 44.39%, and 63.34% among older adults aged 60-69 years, 70-79 years, and 80 years above, respectively. Overall physical frailty was higher among older women (39.03%) than men (32.49%).

The results of bivariate analysis are presented in Table 2. Older women had a high prevalence of physical frailty irrespective of the difference in birth order, parental education and medical history than men. Older women with poor childhood health had a higher prevalence of physical frailty than older men (female = 48.92% and male = 40.22%). Those who had childhood bedridden experience had high

Table 1
Descriptive Statistics.

Total	Women 12591 (100)	Men 11922 (100)
Physical Frailty		
Non-frail	7677 (60.97)	8049 (67.51)
Frail	4914 (39.03)	3873 (32.49)
Birth order		
1-2	7016 (55.72)	6944 (58.25)
2-4	3493 (27.74)	3434 (28.80)
5 and above	2082 (16.54)	1544 (12.95)
Mother's schooling		
Yes	927 (7.36)	975 (8.18)
No	11664 (92.64)	10947 (91.82)
Father's schooling		
Yes	2757 (21.89)	2913 (24.43)
No	9834 (78.11)	9009 (75.57)
Mother ever diagnosed by chronic disease		
No	10857 (86.23)	10433 (87.51)
Yes	1734 (13.77)	1489 (12.49)
Father ever diagnosed by chronic disease		
No	11059 (87.83)	10300 (86.40)
Yes	1532 (12.17)	1622 (13.60)
Childhood health status		
Good	11092 (88.09)	10482 (87.92)
Poor	1499 (11.91)	1440 (12.08)
Bedridden during childhood		
No	11951 (94.53)	11150 (93.53)
Yes	640 (5.08)	772 (6.47)
Childhood financial condition		
Well off	1207 (9.59)	910 (7.63)
Average	6001 (47.66)	5690 (47.73)
Poor	5383 (42.75)	5322 (44.64)
Age		
60-69 years	7741 (61.48)	7161 (60.06)
70-79 years	3686 (29.28)	3567 (29.92)
80 years above	1164 (9.25)	1194 (10.01)
Education		
No schooling	9195 (73.03)	4506 (37.79)
Up to 5 years	1667 (13.24)	2734 (22.93)
6-10 years	1334 (10.59)	3116 (26.14)
Above 10 years	395 (3.14)	1566 (13.14)
Social background		
General	3409 (27.08)	3222 (27.02)
Other Backwards Classes	5592 (44.42)	5384 (45.16)
Scheduled Tribes/Scheduled Castes	3589 (28.51)	3316 (27.81)
Marital status		
In a union	5959 (47.33)	9804 (82.23)
Not in a union	6632 (52.67)	2118 (17.77)
MPCE Quintile		
Poorest	2794 (22.19)	2489 (20.87)
Poorer	2781 (22.09)	2572 (21.57)
Middle	2626 (20.86)	2492 (20.90)
Richer	2341 (18.59)	2354 (19.75)
Richest	2049 (16.27)	2015 (16.90)
Residence		
Urban	3523 (27.98)	3025 (25.37)
Rural	9068 (72.02)	8897 (74.63)
Self-rated health status		
Good	9576 (76.57)	9487 (79.57)
Poor	3015 (23.43)	2435 (20.43)
Activities of Daily Living		
High	9711 (77.13)	9755 (81.82)
Low	2880 (22.87)	2167 (18.18)
Instrumental Activities of Daily Living		
High	5744 (45.62)	7609 (63.83)
Low	6847 (54.38)	4313 (36.17)
Morbidity		
None	4639 (36.85)	4632 (38.85)
One disease	3952 (31.39)	3845 (32.25)
Multi-morbidity	4000 (31.77)	3445 (28.90)
Body Mass Index		
Underweight	3222 (25.59)	3360 (28.18)
Normal	6156 (48.89)	6440 (54.02)
Overweight	2264 (17.98)	1795 (15.05)
Obese	949 (7.54)	327 (2.75)
Ever smoked		

Table 1 (*continued*)

Total	Women 12591 (100)	Men 11922 (100)
No	9686 (76.92)	4627 (38.81)
Yes	2905 (23.08)	7295 (61.19)
Ever drank alcohol		
No	12264 (97.40)	8566 (71.85)
Yes	327 (2.60)	3356 (28.15)

MPCE: Monthly Per-capita Consumption Expenditure
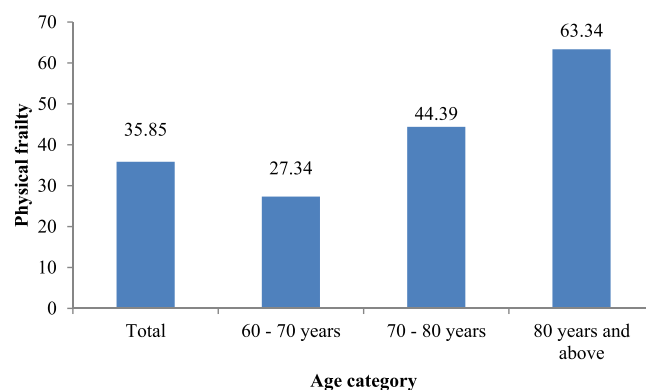
Fig. 2. Physical frailty prevalence by age.
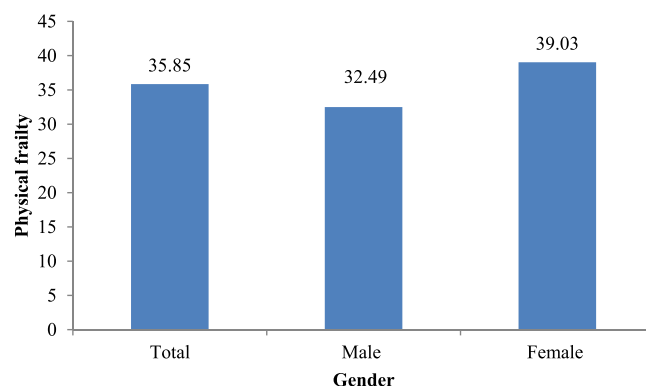
Fig. 3. Physical frailty prevalence by gender.

physical frailty prevalence. Interestingly, older men had higher physical frailty with well-off childhood financial conditions (36.42%) than older women with well-off childhood financial conditions (34.31%).

Table 3 presents the logistic regression estimates of the physical frailty of the overall, women and men sample models. It was found that birth order was not a significant related variable of old age physical frailty in any of the models. In model 1, older adults whose mothers have no education had 26% (adjusted odds ratio (aOR): 1.26; 95% confidence interval (CI):1.01-1.58) higher odds of physical frailty. Similarly, older adults whose fathers have no education were more likely (aOR: 1.33; 95% CI:1.18–1.50) to report physical frailty. In model 1, It was also found that older adults who reported poor childhood health had a higher likelihood of physical frailty (aOR: 1.48; 95% CI:1.27–1.71). In model 2, compared to older women with a well-off childhood financial condition, women with average childhood financial status had 38% (aOR: 1.38, 95% CI:1.01–1.89) higher odds of reporting physical frailty. In contrast, in model 1, older men with poor childhood financial status had lower odds (aOR: 0.73; 95% CI:0.56–0.96) of physical frailty than older men with well-off childhood financial status. Parental medical history and childhood bedridden experience had no significant association with physical frailty.

Table 2

Prevalence rates of physical frailty in women and men with different characteristics.

	Women =n (%)	Men =n (%)	P value
Birth order			
1-2	2808 (40.28)	2328 (33.29)	<0.01
2-4	1286 (37.06)	1118 (32.34)	<0.01
5 and above	789 (38.13)	453 (29.18)	<0.01
Mother's schooling			
Yes	298 (32.37)	225 (22.91)	<0.01
No	4584 (39.56)	3675 (33.34)	<0.01
Father's schooling			
Yes	902 (32.95)	795 (27.10)	<0.01
No	3980 (40.73)	3105 (34.23)	<0.01
Mother ever diagnosed by chronic disease			
No	4277 (39.65)	3400 (32.37)	<0.01
Yes	605 (35.13)	499 (33.29)	<0.01
Father ever diagnosed by chronic disease			
No	4349 (39.59)	3372 (32.51)	<0.01
Yes	533 (35.01)	528 (32.31)	<0.01
Childhood health status			
Good	4154 (37.69)	3316 (31.42)	<0.01
Poor	729 (48.92)	583 (40.22)	<0.01
Bedridden during childhood			
No	4586 (38.62)	3624 (32.28)	<0.01
Yes	296 (46.61)	275 (35.45)	<0.01
Childhood financial condition			
Well off	411 (34.31)	334 (36.42)	<0.01
Average	2436 (40.86)	1813 (31.66)	<0.01
Poor	2035 (38.05)	1752 (32.70)	<0.01
Age			
60-69 years	2306 (29.98)	1765 (24.48)	<0.01
70-79 years	1774 (48.43)	1444 (40.22)	<0.01
80 years above	803 (69.41)	690 (57.43)	<0.01
Education			
No schooling	3761 (41.17)	1644 (36.24)	<0.01
Up to 5 years	600 (36.22)	1033 (37.54)	<0.03
6-10 years	405 (30.58)	849 (27.07)	<0.01
Above 10 years	116 (29.69)	373 (23.65)	<0.02
Social background			
General	1353 (39.94)	971 (29.92)	<0.01
Other Backwards Classes	2150 (38.70)	1839 (33.93)	<0.01
Scheduled Tribes/Scheduled Castes	1379 (38.68)	1090 (32.64)	<0.01
Marital status			
In a union	1908 (32.22)	2953 (29.92)	<0.01
Not in a union	2975 (45.15)	946 (44.37)	0.06
MPCE Quintile			
Poorest	1159 (41.75)	871 (34.78)	<0.01
Poorer	1035 (37.46)	855 (33.03)	<0.01
Middle	1007 (38.61)	796 (31.74)	<0.01
Richer	904 (38.87)	702 (29.61)	<0.01
Richest	777 (38.16)	675 (33.25)	<0.01
Residence			
Urban	1299 (37.11)	957 (31.44)	<0.01
Rural	3583 (39.78)	2942 (32.84)	<0.01
Self-rated health status			
Good	3217 (33.81)	2643 (27.68)	<0.01
Poor	1665 (55.59)	1256 (51.23)	<0.01
Activities of Daily Living			
High	3212 (33.29)	2782 (28.32)	<0.01
Low	1671 (58.39)	1118 (51.23)	<0.01
Instrumental Activities of Daily Living			
High	1719 (30.11)	1924 (25.12)	<0.01
Low	3164 (46.51)	1975 (45.49)	0.29
Morbidity			
None	1540 (33.41)	1324 (28.39)	<0.01
One disease	1542 (39.28)	1275 (32.95)	<0.01
Multi-morbidity	1800 (45.30)	1300 (37.48)	<0.01
Body Mass Index			
Underweight	1480 (46.22)	1408 (41.62)	<0.01
Normal	2239 (36.61)	1918 (29.58)	<0.01
Overweight	784 (34.87)	494 (27.37)	<0.01
Obese	379 (40.21)	79 (23.95)	<0.01
Ever smoked			
No	3708 (38.53)	1530 (32.85)	<0.01
Yes	1174 (40.68)	2369 (32.26)	<0.01
Ever drank alcohol			

Table 2 (*continued*)

	Women =n (%)	Men =n (%)	P value
No	4763 (39.09)	2860 (33.17)	<0.01
Yes	119 (36.70)	1039 (30.75)	<0.01
Total	**4914 (39.03)**	**3873 (32.49)**	**<0.01**

MPCE: Monthly Per-capita Consumption Expenditure

In model 2, the results indicate that oldest old age group (80+) had a higher likelihood of physical frailty (aOR: 3.19; 95% CI:2.60-3.91). In comparison to male older adults with no education, male older adults with higher education had lower odds of physical frailty (aOR: 0.79; 95% CI:0.62–0.99). However, the result was not significant among women older adults. Compared to older adults living in a marital union, older adults who were not in a union were higher likely to become physically frail (aOR: 1.33; 95% CI:1.18–1.49). Older men in rural areas were less likely (aOR: 0.81; 95% CI:0.69–0.96) to report physical frailty than urban men. Similarly, older adults with poor SRH, disability, morbidity and those who were underweight had a higher likelihood of physical frailty. It was also found that behavioural factors such as smoking and drinking, household economic status, and socioeconomic position had no significant role in predicting physical frailty in older men and women.

4. Discussion

The paper examined the prevalence of physical frailty among older adults in India using a nationally representative large-scale sample data of LASI- wave 1 and the association of various early childhood, socioeconomic, and health-related factors in determining physical frailty among older adults. The study also explored the gender differentials in physical frailty prevalence and the above associations. Physical frailty is an important indicator of geriatric health that may be used for managing health and wellbeing of older adults. The study results confirmed that there is a significant relationship between various childhood and current socioeconomic factors and physical frailty. The results also emphasise the importance of health and behavioral factors in determining the frailty status of older adults. Previous studies have identified that the significance of early childhood factors becomes lesser when post-childhood-related variables are mediated [17].

The main findings of the study revealed that potential early child-hood factors including birth order, parental medical history and bedridden experience during childhood had no significant effect in determining old age physical frailty. Similar evidence was observed in a cohort study which established that early childhood factors had a partial effect on physical frailty [17]. Therefore, the study evidence is in line with the WHO's conceptualization of healthy ageing. Accordingly, ageing is a random process and is considered as the consequence of complicated factors related to past living experiences, socioeconomic and behavioural influences. Health in old age is associated with individuals' intrinsic capacity and functionality. Though ageing has genetic influences, the pattern of individuals' intrinsic capacity is largely determined by the cumulative impact of behaviours and exposures a person had during lifetime [16]. The evidence indicates that the effect of birth order becomes insignificant when other childhood and adulthood socioeconomic status are mediated [17].

Further, it was found that parental education significantly affected physical frailty in old age. A previous study observed that parental education is an important determinant of health status among middle-aged adults and the detrimental effect becomes more if both the individuals and their parents had lower levels of education [30]. Moreover, studies also established the importance of parental education to determine health status at the early stages of individuals [31]. Our study also revealed that childhood health status is a significant related variable of old age physical frailty as found in past studies [32]. It was found that the childhood financial condition had a significant effect on physical

Table 3

Results of logistic regression models.

	Full sample		Women sample		Men sample	
	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)
Birth order (Ref: 1-2)						
3-4	0.91 (0.82–1.00)	0.93 (0.84–1.04)	0.88 (0.77–1.01)	0.90 (0.78–1.04)	0.95 (0.82–1.10)	0.97 (0.83–1.14)
5 and above	0.90 (0.78–1.05)	0.90 (0.76–1.08)	0.94 (0.77–1.15)	0.96 (0.77–1.20)	0.82 (0.66–1.02)	0.86 (0.69–1.08)
Mother's schooling (Ref: Yes)						
No	1.26* (1.01–1.58)	1.12 (0.84–1.50)	1.05 (0.73–1.49)	0.92 (0.61–1.38)	1.48* (1.14–1.93)	1.37 (0.99–1.90)
Father's schooling (Ref: Yes)						
No	1.33* (1.18–1.50)	1.16* (1.01–1.34)	1.35* (1.14–1.59)	1.30* (1.07–1.57)	1.30* (1.09–1.54)	1.04 (0.86–1.27)
Mother ever diagnosed by chronic disease (Ref: No)						
Yes	0.99 (0.86–1.14)	0.98 (0.84–1.16)	0.89 (0.73–1.09)	0.86 (0.69–1.07)	1.08 (0.89–1.32)	1.15 (0.93–1.42)
Father ever diagnosed by chronic disease (Ref: No)						
Yes	0.95 (0.83–1.10)	0.89 (0.76–1.05)	0.92 (0.75–1.14)	0.80 (0.63–1.01)	1.01 (0.84–1.21)	0.99 (0.82–1.21)
Childhood health status (Ref: good)						
Poor	1.48* (1.27–1.71)	1.54* (1.31–1.81)	1.52* (1.25–1.85)	1.63* (1.31–2.03)	1.43* (1.13–1.81)	1.42* (1.14–1.78)
Whether bedridden during childhood (Ref: No)						
Yes	1.14 (0.93–1.40)	1.11 (0.88–1.40)	1.29 (0.98–1.70)	1.24 (0.96–1.60)	1.06 (0.78–1.43)	1.03 (0.74–1.43)
Childhood financial condition (Ref: Well off)						
Average	0.93 (0.76–1.14)	1.16 (0.91–1.48)	1.16 (0.87–1.54)	1.38* (1.01–1.89)	0.73* (0.57–0.95)	0.91 (0.67–1.23)
Poor	0.85 (0.69–1.03)	0.98 (0.77–1.24)	0.97 (0.73–1.29)	1.04 (0.77–1.41)	0.73* (0.56–0.96)	0.85 (0.62–1.15)
Age category (Ref: 60-69 years)						
70-79 years		1.77* (1.58–1.99)		1.86* (1.59–2.18)		1.74* (1.50–2.02)
80 years and above		3.19* (2.60–3.91)		4.07* (3.13–5.31)		2.62* (1.98–3.46)
Gender (Ref: male)						
Female		1.02 (0.90–1.17)				
Education (Ref: No schooling)						
Up to 5 years		0.99 (0.87–1.13)		0.85 (0.70–1.03)		1.12 (0.94–1.34)
6-10 years		0.80* (0.68–0.95)		0.80 (0.57–1.12)		0.84* (0.70–1.00)
Above 10 years		0.79* (0.62–0.99)		0.89 (0.57–1.38)		0.77 (0.60–1.00)
Social class (Ref: General)						
Other Backward Classes		0.96 (0.85–1.09)		0.88 (0.75–1.04)		1.08 (0.91–1.28)
Scheduled Castes/Scheduled Tribes		0.93 (0.80–1.08)		0.88 (0.72–1.07)		0.99 (0.81–1.21)
Marital status (Ref: In a union)						
Not in a union		1.33* (1.18–1.49)		1.22* (1.05–1.41)		1.51* (1.26–1.81)
MPCE Quintile (Ref: Poorest)						
Poorer		0.91 (0.80–1.04)		0.86 (0.72–1.03)		0.95 (0.78–1.15)
Middle		0.95 (0.82–1.10)		0.90 (0.75–1.10)		0.98 (0.79–1.21)
Richer		0.89 (0.77–1.03)		0.88 (0.72–1.08)		0.87 (0.70–1.08)
Richest		1.02 (0.85–1.21)		0.92 (0.72–1.18)		1.12 (0.90–1.40)
Residential status (Ref: Urban)						
Rural		0.91 (0.81–1.02)		0.99 (0.85–1.17)		0.81* (0.69–0.96)
Self-Rated Health (ref: Good)						
Poor		1.99* (1.77–2.22)		1.87* (1.61–2.17)		2.10* (1.79–2.46)
Activities of Daily Living (high)						

(continued on next page)

Table 3 (*continued*)

	Full sample		Women sample		Men sample	
	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)	[a]OR, Model 1 (95% CI)	[a]OR, Model 2 (95% CI)
Low		1.82* (1.59–2.08)		1.96* (1.66–2.32)		1.67* (1.36–2.04)
Instrumental Activities of Daily Living (high)						
Low		1.42* (1.27–1.58)		1.29* (1.12–1.50)		1.61* (1.38–1.89)
Morbidity (Ref: None)						
One disease		1.20* (1.07–1.35)		1.24* (1.06–1.45)		1.16 (0.98–1.37)
Multimorbidity		1.35* (1.19–1.53)		1.46* (1.23–1.74)		1.26* (1.06–1.51)
Body Mass Index (Ref: Underweight)						
Normal		0.70* (0.63–0.78)		0.74* (0.63–0.86)		0.65* (0.56–0.76)
Overweight		0.68* (0.57–0.80)		0.76* (0.62–0.94)		0.59* (0.46–0.76)
Obesity		0.82 (0.58–1.17)		1.08 (0.77–1.52)		0.49* (0.26–0.91)
Ever smoked (Ref: No)						
Yes		0.93 (0.84–1.03)		0.98 (0.85–1.13)		0.89 (0.77–1.03)
Ever drank alcohol (Ref: No)						
Yes		0.98 (0.85–1.13)		0.93 (0.67–1.29)		0.97 (0.83–1.13)
Constant	0.40* (0.30–0.54)	0.25* (0.16–0.38)	0.46* (0.29–0.73)	0.25* (0.14–0.44)	0.36* (0.25–0.50)	0.27* (0.16–0.46)
Sample	**24,513**		**12,510**		**12,003**	

[a] OR: Adjusted Odds Ratio; MPCE: Monthly Per-capita Consumption Expenditure; CI: Confidence Interval;
* $p < 0.05$

frailty among older women. A longitudinal study confirmed that the functional health problems during the mid and old age may arise due to economic disadvantage in the childhood. The study also emphasised the importance of mediating factors such as educational attainment to reduce functional health problems [33]. Therefore, the contradictory findings of the role of childhood financial condition in older men is possibly due to the role of other mediating factors as male participants are noted for better entitlements such as education.

The findings indicated that the risk of physical frailty increased with age, which is consistent with literature evidence [34]. However, an experimental study conducted in the Korean context revealed that, through a multicomponent intervention that consists of physical exercise, nutritional and depression management may significantly improve physical functioning and frailty even in the advanced age [35]. Therefore, we recommend for counter-frailty intervention for older adults. Education had a protective effect against physical frailty. Previous studies have observed that lower levels of education increased the risk of physical frailty [34,36]. A multi-country study conducted in European context showed that the difference in physical frailty is subject to the inequality in educational attainment and the mediated effect of education with other potential factors may partially determine frailty [37]. As documented, health education intervention and promotion of nutritional and other health behaviour management may be considered as a possible policy interventions in mitigating physical frailty in older adults [38]. Similarly, being in a union had a protective effect against physical frailty, and older adults who were not in a union had a higher likelihood of physical frailty [39]. Rural male older adults were less likely to become physically frail than their urban counterparts. Contradictory finding was available in another context [40]. A study representing various countries from three continents indicated mixed evidence of physical frailty prevalence by the area of residence. It was also concluded that there is a potential possibility of various contextual factors in determining physical frailty including the culture and health system characteristics [41].

Older adults who reported poor SRH had a higher likelihood of physical frailty. A previous cohort study indicates that poor SRH is a significant related variable of physical frailty, and individuals reported to have a consistent poor SRH were at high risk of physical frailty [42]. The current study also found that the prevalence of morbidity leads to an increased risk of frailty, which is consistent with evidence from previous studies. Generally, older adults are prone to multiple morbid conditions and the literature emphasised that the prevalence of multimorbidity increases the susceptibility to physical frailty [43]. Similarly, the disabled older adults were at a higher risk of physical frailty. Theoretically, it was established that individual level physical frailty is the combination of physical, psychological, and social components. Disability is one of the influencing factors associated with the incidence of physical frailty among older adults [3]. As found in previous studies, underweighted older adults had a higher likelihood of physical frailty. The mediated effect of being underweight through the physical frailty incidence may lead to premature morbidity and other post frailty challenges [39,44]. Thus, it was suggested that according to the physical and psycho-social needs of frail older individuals, interdisciplinary caregiving initiatives such as palliative care interventions can be developed [45], which is expected to reduce cost of care and patient dissatisfaction. The findings however, indicated no significant effect of behavior factors and household socioeconomic status in determining physical frailty. However, previous evidence showed a significant effect of these factors in predicting physical frailty in other study contexts [46], suggesting the necessity of further investigation.

Another important finding is that there exists a significant gender differential in the prevalence of physical frailty. Older women in comparison to older men had a higher likelihood of physical frailty which may affect their health and wellbeing. Similar findings were also confirmed in previous studies [20,36]. This may be attributed to the disadvantageous socioeconomic position of women and their perception and rating of health as poorer than men [47]. Another study reported significant gender differences in frailty and indicated that the

determinants of gender-specific physical frailty is more complex one, and therefore suggested that the tools for treating physical frailty should be different for men and women [19].

The study is not free from limitations, and there is potential for future research. The study measured physical frailty with a widely accepted approach. However, the subjectivity of individuals in reporting each frailty component may lead to errors in constructing the frailty phenotype recommended by Fried and colleagues. It is to be noted that some of the main related variables in the current study used self-reported information though they are acceptable based on literature recommendations. The self-reporting of health and other individual data is likely subject to some level of reporting bias [48], which may affect the accuracy of estimates. Existing studies showed that physical frailty might be used to understand geriatric health further. Physical frailty significantly predicts mortality, social frailty, and other life-threatening complications [8]. Studies on physical frailty may be extended to these dimensions in future research.

5. Conclusion

The findings of the study revealed that childhood health and financial condition and parental education had significant associations with physical frailty among older adults. The study also revealed a significant gender difference in the prevalence of physical frailty, and female older adults had a higher risk of physical frailty. Increasing age, poor SRH, disability symptoms, morbidity condition, and underweight had increased the likelihood of physical frailty. Education and being in a marital union had a protective effect against physical frailty among older adults. Thus, the large number of widowed older women in India calls for special attention in this context. The findings also suggest the importance of childhood factors in policy and practice in terms of addressing old age physical frailty. Since each individual has unique experience of physical frailty, intervention should be person-centered that promises the better health and wellbeing for older adults. Additional research is needed to explore the possibility of various counter-frailty interventions.

Ethical approval

The present study used secondary survey data and the data is open for research. The ethical approval for conducting the Longitudinal Ageing Study is India was guided by the Indian Council of Medical Research.

Funding

Declaration of Competing Interests

None.

Acknowledgements

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