Dialogues in Health 2 (2023) 100119

Contents lists available at ScienceDirect

Dialogues in Health

journal homepage: www.elsevier.com/locate/dialog

Multiple socioeconomic risks and cognitive impairment among older men and women in India

T. Muhammad [b,*], Manacy Pai [a], Manish Kumar [c], T.V. Sekher [b]

[a] Department of Sociology, Kent State University, Kent, OH 44242, USA
[b] Department of Family and Generations, International Institute for Population Sciences, Mumbai, Maharashtra 400088, India
[c] Population Research Centre, Dharwad, Karnataka, India

ARTICLE INFO

Keywords:
Socioeconomic risk
Cognitive impairment
Older adult
India

ABSTRACT

Introduction: Socioeconomic status (SES) is negatively associated with innumerable health outcomes, including cognitive functioning. Yet much remains undiscovered about SES patterns in later-life cognition in low-and middle-income countries (LMICs). The purpose of this study was to examine the association between separate and combined socioeconomic risks and cognitive impairment among older adults in India. Further, given gender disparities in later life cognitive functioning and SES, the study examines the associations between socioeconomic risks and cognitive impairment separately, for older men and women.

Methods: Data come from the 2017–18, first wave of the Longitudinal Aging Study in India (LASI), with 31,464 older adults aged 60 years and above. Cognitive impairment was assessed using multiple broad measures of memory, orientation, arithmetic function, and visuo-spatial construction skills. We present descriptive statistics along with cross-tabulation of the outcome variable. Additionally, binary logistic regression analysis was used to test the association between outcome and explanatory variables. SES is measured using education, paid work status, and household wealth measured using monthly per-capita consumption expenditure (MPCE).

Results: A proportion of 7.14% of the older men and 20.03% of older women reported cognitive impairment. The odds of cognitive impairment were higher among uneducated older men and women, and older men and women in lowest wealth quintile. Surprisingly, older women without current or prior work history report lower odds of cognitive impairment compared to their peers in labor force. While odds of cognitive impairment are higher among non-working older men, this association is not statistically significant. In older men, the odds of cognitive impairment were 5.34, 7.14, and 13.05 times higher with one, two, and three risk factors, respectively, compared with those with no risk exposure. A similar trend was observed for women but with comparatively lower odds.

Conclusions: Our findings underscore the need to distinguish between varying elements of SES to construct "upstream" health policies and programs that redistribute resources. In particular, the findings support the use of multiple SES indicators in identifying older adults most susceptible to cognitive deficits, and planning gender-based interventions to improve cognitive health in late life.

1. Introduction

Although cognitive decline generally is expected with increasing age [1], this decline is far from uniformly distributed [2]. Specifically, lower SES, including lower education and income, is a critical non-biological correlate of cognitive decline in later life [3]. Cognitive decline can lead to Alzheimer's Disease and other forms of dementia, seriously affecting the quality of life for older adults and their families, and rendering financial and health liabilities of massive proportions for society at large [4].

The estimated proportion of cognitively impaired individuals is likely to reach 75.6 million in 2030 and 135.5 million by 2050 [5]. Although the age at which cognitive impairment becomes discernible at the population level remains contested [6–9], it is generally accepted that cognitive performance starts to decline after age 40 and declines more precipitously among those age 65 and older [9]. Moreover, there is a consensus that cognitive impairment, in a sizeable proportion of cases, can be delayed and perhaps, even averted [10]. Although changes in cognition are intimately tied to etiological changes in the brain, social

Abbreviations: LASI, Longitudinal Aging Study in India; SES, Socioeconomic status; SRH, Self Rated Health; ADL, Activities of Daily Living; IADL, Instrumental Activities of Daily Living; AOR, Adjusted Odds Ratio; CI, Confidence Interval; MPCE, Monthly Per capita Consumption Expenditure.

* Corresponding author.
E-mail addresses: muhammad@iips.net (T. Muhammad), mpai@kent.edu (M. Pai), tvsekher@iipsindia.ac.in (T.V. Sekher).

http://dx.doi.org/10.1016/j.dialog.2023.100119
Received 2 September 2022; Received in revised form 22 January 2023; Accepted 21 February 2023
Available online 26 February 2023

and environmental factors exert an enormous influence on later life cognitive functioning.

Existing research, indeed, finds a strong association between several modifiable risk factors including, education [11,12], occupation [13], income [14], and wealth [15] and later life cognitive health. Multiple studies also have demonstrated the effect of these variables on cognitive impairment among older adults in lower and middle income countries (LMICs) [16–18]. In fact, one recent study reported that relative to objective socioeconomic markers, subjective SES may better predict cognitive functioning among older adults in India [19].

As an an important indicator of SES and extensively studied correlate of cognition, education is protective against cognitive decline [19–23], and this is regardless of how cognitive health is measured. Conversely, two studies find that higher education does not protect against cognitive decline [23] or may even result in a steeper decline in cognition [24]. Indeed, studies document that while more education prolongs the onset of cognitive decline, once it starts, the progression is much faster among those with more education [25,26]. Like education, paid work [27,28] also is found to benefit later life cognitive capabilities. Workplaces are where most individuals learn new skills, practice problem-solving, form new networks, and interact with others outside of one's immediate social circle – all experiences that require the use of several high-ordered neural networks that help preserve cognitive reserve [29] and protect against cognitive deficits [30]. Given that most adults spend a substantial amount of their life working for pay, understanding the relationship between paid work and later life cognition becomes important [31].

In addition to education and employment, later life cognitive health also is associated with household wealth status. For one, income can facilitate stable access to better quality of health care, including regular screenings, consults with health providers, and essential medical procedures, and medications [32]. This is particularly useful in preventing or prolonging the progression of a disease, including cognitive decline. Additionally, because persons belonging to higher wealth quintiles may be better equipped to cope with life stressors, and given the association between stress and cognition, the ability to mitigate the impact of life stressors may, in turn, protect against cognitive decline. Prior studies, including a study based on Indian older adults, do find a positive link between higher income and improved cognitive performance [31–35].

Existing literature also directs attention to gender disparities in later life cognitive health. In developing countries like India and China, studies have found that older men outperform older women in terms of cognitive abilities [34,35]. Conversely, in developed countries, gender differences are minimal in terms of overall prevalence of cognitive impairment and dementia [36,37]. SES appears to significantly contribute to the gender differences in the prevalence of cognitive impairment in the elderly population [17]. Traditional cultural attitudes, gender socialization, constrained family finances, and myriad other factors, including distance from school, lack of security in and outside school, and early marriage and child bearing have limited the educational, employment, and income opportunities for women, especially of older cohorts [38]. Gender disparity in socioeconomic resources early in life, in turn, likely mean gender disparity in cognitive resources in later life [39].

Only a handful of studies have explored the link between SES and cognitive health among older adults in India. This is surprising given that cognitive impairment, including dementia is an emerging pandemic in India. Approximately 5.3 million older Indians have dementia and this number is likedy to double by 2030 and triple by 2050 [40]. India also happens to have a large proportion of individuals without formal education, a massive informal economy with little to no assurance of social security in later life, low economic mobility, and decentralized health care systems. Such social and environmental conditions form fertile ground for cognitive impairments among older Indians. Considering this, the purpose of the present study is to examine the association between both separate and combined SES risks and cognitive impairment among older adults in India. Further, considering the existing gender disparities both, in later life cognitive health [41], and in social and economic status and resources [42,43], we assess the associations between SES and cognitive impairment separately, for older men and women.

1.1. Working hypotheses

1) Education, wealth and paid work status of older individuals are positively associated with their cognitive abilities.
2) Older adults with a higher composite SES score have lower chances of cognitive impairment.

2. Methods

2.1. Sample and data

Data come from wave 1 of the Longitudinal Aging Study in India (LASI), which was collected during 2017–18. LASI is a nationally representative survey of over 72,000 community-dwelling individuals age 45 and above across all states and union territories of India. The objective of this survey was to investigate the health, economic, social, and psychological aspects of population aging in India. The survey adopted a three-stage sampling design in rural and a four-stage sampling design in urban areas. Detailed information on the survey design, sampling frame, and data collection is published elsewhere and available in the LASI wave-1 Report [48]. The survey agencies that conducted the field survey for the data collection have collected prior consent from the respondents. The Indian Council of Medical Research (ICMR) extended the necessary guidelines and ethics approval for undertaking the LASI survey. The total sample size for the present study is 31,464 older adults aged 60 years and above (men-15,098 and women-16,366). However, 1438 individuals who received assistance during cognition module and 3851 respondents who had some missing information on cognitive functions (total 5289 individuals) were dropped during the multivariable analyses (Fig. 1). Thus, the final sample for the multivariable analysis was 26,175 older adults age 60 years and above.

2.2. Measures of variables

2.2.1. Outcome variable

LASI collected data on several different domains of cognition, including memory, orientation, arithmetic functioning, and visuospatial

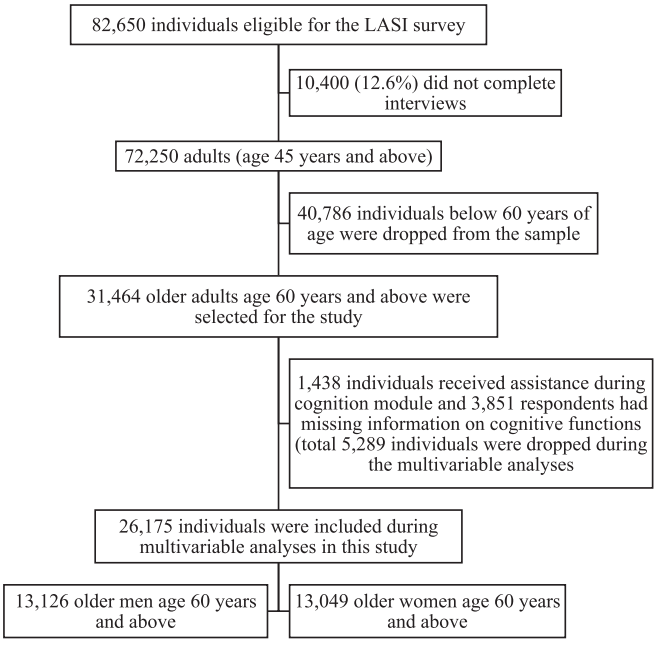

Fig. 1. The CONSORT diagram showing the inclusion/exclusion critera of the study sample.

constructional ability. The survey adapted these measures from the Mini-Mental State Examination (MMSE) [45], the cognitive modules of the Health and Retirement (HRS), the China Health and Retirement Longitudinal Study (CHARLS), and the Mexican Health and Aging Study (MHAS) [46,47]. Cognitive functions in the present study are based on the scoring of the following cognitive sub-domains: immediate word recall (0–10 points), and delayed word recall (0–10 points); orientation related to time (0–4 points), and place (0–4 points); arithmetic ability based on serial 7 s' subtraction task (0–5 points), a task involving two computations (0–2) and backward counting from 20 (0–2 points) [46,48]; visuospatial and constructional skills based on paper folding (folding a piece of paper according to instructions) (0–3) and pentagon drawing (drawing intersecting circles) (0–1); and object naming (0–2) [47]. The overall composite score ranges between 0 and 43, with a higher score indicating higher cognitive functioning. The lowest 10th percentile is used as a proxy measure of poor cognitive functioning [48,49]. Respondents who had to rely on proxies to complete the cognition moduel were excluded from the present study.

2.2.2. Explanatory variables

SES was measured using respondents' educational status, paid work status, and household wealth. Educational status was coded as no education/ primary not completed, primary, secondary and higher. Paid work status was coded as never worked (for at least three months during lifetime), currently working, currently not working, and retired. The monthly per capita consumption expenditure (MPCE) quintile was assessed using household consumption data. Sets of 11 and 29 questions on the expenditures on food and non-food items, respectively, were used to canvas the sample households. Food and non-food expenditures have been standardized to the 30-day reference period. The MPCE is computed and used as the summary measure of consumption [48]. The variable is then divided into five quintiles i.e., from poorest to richest. These three important socioeconomic components- educational status, paid work status, and the MPCE quintiles were combined to derive a more robust composite SES risk score.

2.2.3. Other covariates

Age was coded as 60–69, 70–79, and 80+ years. Sex was coded as male and female. Social engagement was measured using the following question "Are you a member of any of the organizations, religious groups, clubs, or societies? The response was coded as no and yes. Physical activity status was coded as yes (that includes responses of 'every day', 'more than once a week', 'once a week', 'one to three times in a month'), and no to the following question: "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"? Tobacco use and alcohol consumption were recoded as yes or no [50].

Self-rated health was coded as good which includes excellent, very good, and good whereas poor includes fair and poor [51].

Activities of daily living (ADL), which include daily self-care activities (walking across a room, dressing, bathing, eating, getting in and out of bed, and toileting) are used to measure functional limitations [52]. Difficulty in ADL was coded as 0, 1, 2, and 3+ according to the number of difficulties. IADLs may not require hands-on–assistance, yet they are instrumental in ensuring independent living and as such, "aging in place." Respondents were asked to indicate the difficulty they encounter when performing the following seven activities: grocery shopping, preparing meals, making phone calls, taking medication, doing household chores, managing finances, and getting onself to otherwise unfamiliar location [53]. Difficulty in instrumental activities of daily living (IADL) was recoded as 0, 1, 2, and 3 + according to the number of difficulties.

Given the close ties between mental distress and cognition [54–56] The probable major depression, among older adults with symptoms of dysphoria, was calculated using the Short Form Composite International Diagnostic Interview (CIDI-SF) with a score of 3 or more indicating a probable diagnosis of depression. The CIDI-SF scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [48].

Religion was coded as Hindu, Muslim, Christian, and Others. Given the documented link between poorer health and lower SES among certain castes [57] we also included respondent's self-reported social group, and coded as Scheduled Tribe (ST), Scheduled Caste (SC), Other Backward Class (OBC) and Others. Considering that a higher proportion of older adults live in rural areas [58], place of residence is considered and was coded as rural and urban. The regions of India were coded as North, Central, East, Northeast, West, and South.

2.3. Models and data analysis procedure

We present descriptive statistics along with cross-tabulation of the outcome variable in the study. Chi-square test was conducted to examine the significance of the associations among the variables and *p*-values are reported. Additionally, binary logistic regression analysis [59] was used to establish the association between the outcome (cognitive impairment) and explanatory variables.

The binary logistic regression model is usually put into a more compact form as follows:

$$\text{Logit}\,[\mathrm{P}(\mathrm{Y}=1)] = \beta_0 + \beta * X$$

The parameter β_0 estimates the log odds of cognitive impairment for the reference group, while β estimates the maximum likelihood, the differential log odds of cognitive impairment associated with a set of predictors X, as compared to the reference group. The survey weights were applied during the analysis to account for sample clustering and present population estimates.

Binary logistic regression was run between SES risk factors and cognitive impairment to find out the unadjusted estimates. Further, three models of logistic regression were employed to examine the adjusted associations of each socioeconomic risk factor with cognitive impairment. Model 1 was adjusted for age, marital status, and living arrangement; Model 2 was adjusted for behavioral factors (community involvement, physical activity, tobacco use, and alcohol consumption); and Model 3 was additionally adjusted for health variables including SRH, functional difficulties of ADL and IADL and depression as well as household/ community variables such as religion, caste, place of residence, region.

For a better understanding of the associations between multiple risk factors of SES and cognitive impairment, we combined education status, paid work status, and household wealth status. We regressed the composite SES risk score on cognitive impairment stratified by sex of the respondents. Separate models were run for total, male and female samples after adjusting for age, marital status, living arrangements, community involvelment, tobacco use, alcohol consumption, physical activity, SRH, functional difficulties of ADL and IADL, depression, caste, religion, place of residence and regions.

Regression diagnostics such as mean variance inflation factor (VIF) and the concordance statistic (c-statistic) or area under the receiver operating characteristic curve (AUROC) were used to determine the validity of the assumptions in the multivariable models. It was observed that there was no multicollinearity and the mean VIF of less than two and c-statistic of more than 0.8 suggested good fit models.

3. Results

Table 1 represents the socioeconomic profile of the older adults in India. 11.29% of the respondents were aged 80 years and above. A proportion of 38.37% of the respondents were not in a marital union and 5.68% lived alone. Also, a proportion of 56.52% of older adults had no formal education, 29.87% of the older adults were currently employed and 21.70% were from the poorest and poorer MPCE quintiles. Also, a proportion of 72.7% of older women had no formal education, 22.49% belonged to the lowest MPCE quintile and 46.82% reported having had no paid work history. The respective percentages in men were 38.6, 20.83, and 3.81%.

Table 1
Socio-economic and health profile of sample population (Column percent distribution), LASI, 2017–18.

Background factors	Total (N = 31,464)	Male (N = 15,098)	Female (N = 16,366)
	wc %	wc %	wc %
Age (in years)			
60–69	18,974 (58.51)	8961 (57.82)	10,013 (59.13)
70–79	9101 (30.2)	4545 (31.14)	4556 (29.35)
80+	3389 (11.29)	1592 (11.04)	1797 (11.52)
Marital status			
Currently in union	19,920 (61.63)	12,398 (81.09)	7522 (44.06)
Not in union	11,544 (38.37)	2700 (18.91)	8844 (55.94)
Living arrangement			
Alone	1622 (5.68)	365 (2.52)	1257 (8.53)
With spouse	6215 (20.33)	3739 (26.03)	2476 (15.19)
Others	23,627 (73.99)	10,994 (71.45)	12,633 (76.28)
Educational status			
No education	16,889 (56.52)	5479 (38.6)	11,410 (72.7)
Primary	5840 (17.5)	3361 (22.36)	2479 (13.12)
Secondary/higher	8735 (25.98)	6258 (39.05)	2477 (14.18)
Working status			
Never worked	8784 (26.43)	759 (3.83)	8025 (46.84)
Currently not working	10,990 (36.45)	5979 (40.88)	5011 (32.45)
Currently working	8997 (29.87)	6044 (42.05)	2953 (18.87)
Retired	2693 (7.25)	2316 (13.24)	377 (1.84)
Community involvement			
No	28,888 (95.31)	13,558 (94.08)	15,330 (96.41)
Yes	2128 (4.69)	1289 (5.92)	839 (3.59)
Physical activity			
No	21,653 (68.9)	9085 (59.08)	12,568 (77.65)
Yes	9545 (31.1)	5853 (40.92)	3692 (22.35)
Tobacco use			
No	19,034 (59.83)	6511 (40)	12,523 (77.52)
Yes	12,178 (40.17)	8435 (60)	3743 (22.48)
Alcohol consumption			
No	25,855 (85.41)	10,270 (71.97)	15,585 (97.4)
Yes	5364 (14.59)	4679 (28.03)	685 (2.6)
SRH			
Good	23,685 (75.79)	11,691 (77.75)	11,994 (74.03)
Poor	7113 (24.21)	3087 (22.25)	4026 (25.97)
ADL[1]			
0	24,642 (76.23)	12,293 (79.13)	12,349 (73.64)
1	2740 (9.61)	1172 (9.17)	1568 (10)
2	1459 (5.72)	541 (4.3)	918 (6.98)
3+	2495 (8.45)	1008 (7.39)	1487 (9.39)
Background factors	wc %	wc %	wc %
IADL[2]			
0	17,449 (51.64)	9733 (61.16)	7716 (43.14)
1	3414 (10.94)	1631 (11.57)	1783 (10.39)
2	2442 (7.85)	968 (6.67)	1474 (8.9)
3+	7990 (29.57)	2670 (20.61)	5320 (37.57)
Depression			
No	28,482 (91.33)	13,757 (92.5)	14,725 (90.29)
Yes	2170 (8.67)	931 (7.5)	1239 (9.71)
MPCE quintile			
Poorest	6484 (21.7)	3035 (20.83)	3449 (22.49)
Poorer	6477 (21.71)	3068 (21.32)	3409 (22.06)
Middle	6416 (20.95)	3064 (21.6)	3352 (20.35)
Richer	6170 (19.19)	2990 (19.22)	3180 (19.16)
Richest	5917 (16.45)	2941 (17.02)	2976 (15.93)
Religion			
Hindu	10,313 (82.2)	4884 (82.04)	5429 (82.39)
Muslim	11,886 (11.3)	5781 (11.72)	6105 (10.88)
Others	9265 (6.5)	4433 (6.25)	4832 (6.73)
Caste			
SC/ST	23,037 (27.1)	11,078 (26.5)	11,959 (27.5)
OBC	3731 (45.2)	1804 (45.86)	1927 (44.66)
Others	4696 (27.7)	2216 (27.63)	2480 (27.84)

Table 1 (*continued*)

Background factors	wc %	wc %	wc %
Place of residence			
Urban	10,739 (29.45)	5021 (27.95)	5718 (30.82)
Rural	20,725 (70.55)	10,077 (72.05)	10,648 (69.18)
Region			
North	5812 (12.59)	2799 (12.34)	3013 (12.81)
Central	4262 (20.95)	2155 (22.49)	2107 (19.57)
East	5757 (23.64)	2863 (24.59)	2894 (22.78)
Northeast	3752 (2.97)	1782 (2.9)	1970 (3.04)
South	7578 (22.68)	3546 (21.41)	4032 (23.83)
West	4303 (17.17)	1953 (16.28)	2350 (17.97)

Notes: The percentages are weighted to account for the population estimates and the counts are un-weighted; wc %: weighted column percentage; LASI: Longitudinal Aging Study in India; SRH: Self-Rated Health; ADL: Activities of daily living; IADL: Instrumental activities of daily living.

[1] Number of ADL difficulties.

[2] Number of IADL difficulties; MPCE: Monthly per capita consumption expenditure.

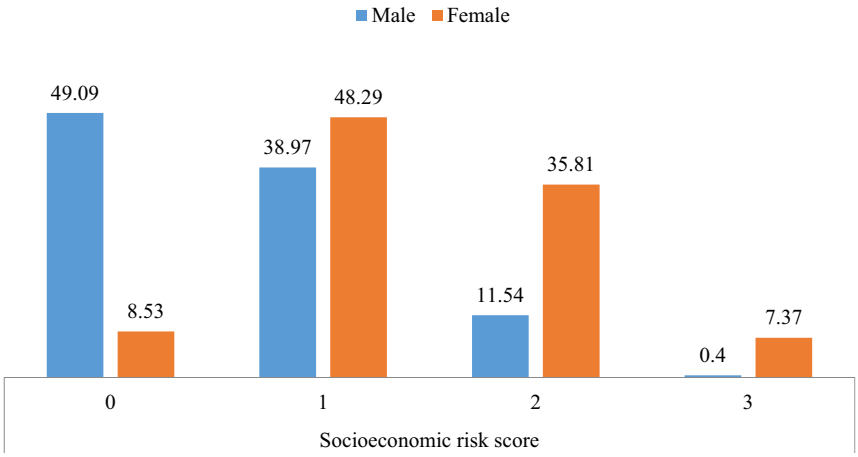

Fig. 2. Percentage distribution of older adults by socioeconomic risk score, LASI, 2017–18. Notes: Socioeconomic risk score indicates the number of combined socioeconomic risk factors (no formal education, lowest quintile of household wealth, and no lifetime formal jobs).

The prevalence of number of socioeconomic risk factors among older participants is presented in Fig. 2. A proportion of 48.29% of older women had at least one risk factor compared to 38.97% of older men, 35.81% of older women had two risks compared to 11.54% of older men, and 7.37% of older women had three risks compared to less than 0.4% of their older male counterparts.

Fig. 3 presents the prevalence of cognitive impairment by socioeconomic risk score among older participants. Older men and women with the SES score of three had the highest prevalence of cognitive impairment (23.51% and 30.71%, respectively) in this study, while older men and women with zero SES risk had the lowest prevalence of cognitive impairment (1.87% and 3.80%, respectively).

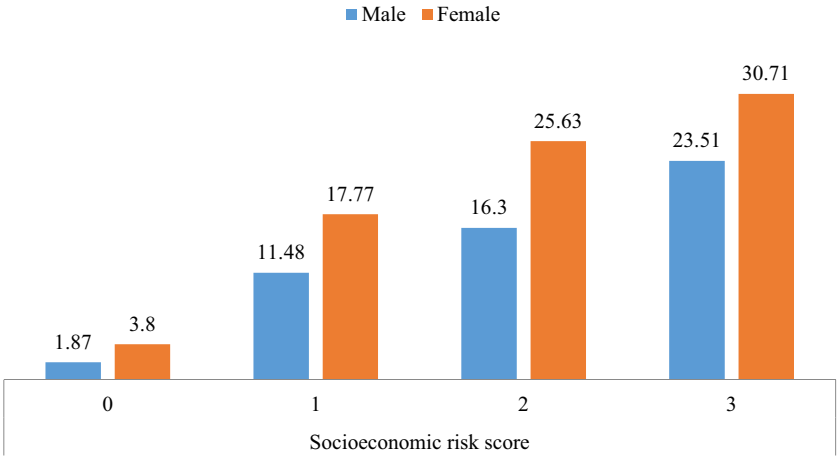

Fig. 3. Prevalence of cognitive impairment by socioeconomic risk score among older participants, LASI, 2017–18. Notes: Socioeconomic risk score indicates the number of combined socioeconomic risk factors (no formal education, lowest quintile of household wealth, and no lifetime formal jobs).

Table 2 presents the prevalence of cognitive impairment among older adults in India. A proportion of 7.14% of the older men and 20.03% of older women had cognitive impairment in the study. A total of 23.28% of older adults without any formal education, 16.40% of older adults without any paid work history, and 18.55% of those from the poorest MPCE quintile reported cognitive impairment.

Table 3 represents the logistic regression estimates of cognitive impairment among older adults. After controlling for age, marital status, living arrangements, community involvement, tobacco use, alcohol consumption, physical activity, SRH, functional difficulties of ADL and IADL, depression, caste, religion, place of residence and regions, the odds of cognitive impairment were 6.54 and 6.59 times higher among older men [AOR: 6.54, CI: 4.95–8.64] and women [AOR: 6.59, CI: 4.90–8.86], respectively, with no formal education relative to their peers with primary or higher education (unadjusted model). Older women, without any prior or current employment, had significantly reduced odds of cognitive impairment [UOR: 0.69, CI: 0.59–0.81] compared to their counterparts with paid work experience, and the significance was retained even after controlling for conceptually relevant covariates mentioned above. The odds of cognitive impairment were significantly higher among older men [AOR: 1.57, CI: 1.22–2.03] and women [AOR: 1.62, CI: 1.38–1.90] in households of the lowest MPCE quintile relative to their peers in higher household MPCE quintiles (unadjusted model). Although the magnitude of the effect size tended to decrease upon addition of potential confounders, the association between household MPCE quintiles and cognitive impairment remained statistically significant in the adjusted model.

Table 4 represents the multiple SES risk factors shown as a composite risk score associated with cognitive impairment among older adults. The odds are adjusted for age, marital status, living arrangements, community involvement, tobacco use, alcohol consumption, physical activity, SRH, functional difficulties of ADL and IADL, depression, caste, religion, place of residence and regions (Supplementary, Table S1). Higher SES risk score substantially increased the odds of cognitive impairment in older ages among both, men and women. In older men, the likelihood of cognitive impairment was 5.34, 7.14, and 13.05 times higher with one, two, and three risk factors, respectively, compared with peers with no risk exposure. A similar pattern was observed for older women, though with comparatively lower odds.

4. Discussion

The purpose of the present study was to examine the association between separate and combined socioeconomic risks and cognitive impairment in older Indians aged 60 years and over. As expected both separate and combined socioeconomic risks were adversely associated with cognitive functioning. And both older men and women with the greatest number of socioeconomic risks were the most vulnerable to cognitive impairment.

Consistent with previous studies, including ones based on samples of older Indians [20,60–62], our study found a significant positive association between education and cognitive functioning for both, older men and women. Education may develop neural networks, which strengthen resilience to brain neurodegeneration [63–66], and facilitate cognitive functions by promoting cognitive reserve [29,67] which recruits existing and/or alternative neural networks to compensate for the neuropathological processes [29,67]. Aside from the neurological mechanisms, higher education also is linked with more positive views of science, more health knowledge and health promoting behaviors, and fewer risky health activities [68,69], all of which reduce the risk of chronic health conditions and increase the odds of higher cognition [70–74].

Given that income and household wealth are significantly associated with household-level consumption [75], we used the mean MPCE quintile as the proximate measure of household wealth. Few have investigated the effects of household wealth on cognitive health. In our study, we found that MPCE quintiles are significantly linked with cognition for both men and women. This matches findings in the limited body of research that

Table 2
Bivariate estimates (prevalence/ row percentage) of cognitive impairment by background characteristics among older participants (n = 26,175), LASI, 2017–18.

Background variables	Total	Male	Female	p-value
	wr %	wr %	wr %	
Age (in years)				<0.001
60–69	10.03	5.15	14.61	
70–79	16.77	8.33	25.43	
80+	27.76	15.67	40.87	
Marital status				<0.001
Currently in union	9.68	6.42	15.23	
Not in union	20.77	10.34	24.29	
Living arrangement				<0.001
Alone	19.07	5.70	22.83	
With spouse	11.92	8.35	17.28	
Others	13.73	6.77	20.03	
Educational status				<0.001
No education	23.28	15.79	27.13	
Primary	5.80	4.38	8.03	
Secondary/higher	0.86	0.97	0.60	
Working status				<0.001
Never worked	16.40	8.64	16.99	
Currently not working	17.60	9.78	27.25	
Currently working	9.98	6.46	17.53	
Retired	2.24	1.59	6.76	
Community involvement				<0.001
No	14.12	7.48	20.45	
Yes	5.24	2.12	10	
Physical activity				<0.001
No	15.7	8.37	21.12	
Yes	9.50	5.45	16.54	
Tobacco use				0.004
No	14.21	5.89	18.4	
Yes	12.82	7.98	26.08	
Alcohol consumption				<0.001
No	14.17	6.47	19.77	
Yes	10.63	8.90	31.96	
SRH				<0.001
Good	12.20	6.38	18.11	
Poor	18.62	9.96	26.08	
ADL[1]				<0.001
0	11.24	5.99	16.73	
1	15.88	9.27	22.01	
2	19.14	8.42	25.49	
3+	33.44	18.62	44.27	
Background variables	wr %	wr %	wr %	p-value
IADL[2]				<0.001
0	8.43	4.0.70	13.56	
1	10.66	5.68	15.90	
2	13.19	7.96	16.85	
3+	25.84	16.40	30.65	
Depression				<0.001
No	13.23	7.15	19.32	
Yes	18.26	6.99	26.56	
MPCE quintile				<0.001
Poorest	18.55	9.81	26.56	
Poorer	15.75	8.53	22.74	
Middle	12.46	5.97	18.97	
Richer	10.88	6.06	15.66	
Richest	9.81	5.05	14.66	
Religion				0.107
Hindu	13.37	6.89	19.66	
Muslim	14.62	7.53	22.09	
Others	15.72	9.61	21.40	
Caste				<0.001
SC/ST	19.74	11.53	27.73	
OBC	12.03	5.85	18.12	
Others	10.80	5.24	16.17	
Place of residence				<0.001
Urban	6.69	2.40	10.30	
Rural	16.67	8.97	24.70	
Region				<0.001
North	13.02	5.84	20.04	
Central	14.27	8.51	20.8	
East	14.78	7.26	22.97	

Table 2 (*continued*)

Background variables	wr %	wr %	wr %	p-value
Northeast	15.35	8.48	22.19	
South	10.97	6.52	14.70	
West	15.02	6.44	22.27	
Total	13.66	7.14	20.03	

Notes: The percentages are weighted to account fo ther population estimates; wr %: weighted row percentage; LASI: Longitudinal Aging Study in India; p-values are based on Chi-square test; SRH: Self-Rated Health; ADL: Activities of daily living; IADL: Instrumental activities of daily living.

[1] Number of ADL difficulties.

[2] Number of IADL difficulties; MPCE: Monthly per capita consumption expenditure.

Table 4
Logistic regression analysis of the association of multiple socioeconomic risk factors with cognitive impairment (adjusted odds ratio) among participants, LASI, 2017–18.

Risk score*	Total, *n* = 26,175	Male, *n* = 13,126	Female, n = 13,049
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
0	Ref.	Ref.	Ref.
1	6.132*** (4.840–7.769)	5.344*** (3.949–7.233)	4.728*** (3.034–7.368)
2	9.598*** (7.522–12.25)	7.139*** (5.011–10.17)	7.002*** (4.488–10.92)
3	13.77*** (9.918–19.13)	13.05*** (5.463–31.18)	9.347*** (5.691–15.35)

Notes: LASI: Longitudinal Aging Study in India; * Risk score indicates the number of combined SES risk factors (no formal education, lowest quintile of household MPCE and no lifetime formal jobs); The analysis is adjusted for all the socio-demographic, behavioral and health variables mentioned in Table 3.

has reported that wealth is more consequential for later life cognition than income for both, men and women [15,76,77]. Wealth becomes an increasingly important indicator of SES with age, given that education typically is acquired much earlier in the life course, employment may also become a distant experience for many, and income may be relatively unstable and may not necessarily account for the overall financial solvency among older adults [78,79].

In terms of work status, interestingly, we observed lower odds of cognitive impairment for older women without any current or prior paid work experience and this was both, in unadjusted and fully adjusted models. This is surprising because paid work, which is a source of not just economic assets, but social (e.g. social support) and psychological resources (e.g., mastery and self-esteem) [80], improves mental health [81], which ultimately is consequential for cognitive functioning. That said, employed women often are faced with work-family conflict given the often competing demands attached to paid work and their roles as spouse, parent, and caregiver [82–85]. Given gender socialization, Indian women often shoulder the responsibility of providing direct care to their parents and parents-in-laws [86]. Not to mention, most women continue to do the bulk of kin-keeping, including offering emotional and instrumental support for adult offsprings [87,88]. As such, older women without current or prior employment may have dodged the bullet in terms of work-family conflict and work stress, which may have rendered them with lower odds of cognitive deficits. Nevertheless, this finding is somewhat counterintuitive. It is possible that, though not consequential for objective cognitive functioning, the cognitive health relevance of paid work status and experience for older women may be captured through "subjective" appraisals of their cognitive performance (especially, short-term memory). To that end, one direction for future exploration would be to assess gender differentials in the association between paid work status and "subjective" cognitive health. In fact, increasing research has emerged on subjective cognitive functioning [89] and decline [90].

In contrast, non-working men are report cognitive impairment, although, the association was insignificant. Kim et al. in their recent study also failed to find a statistically significant association between work status and cognitive impairment among men [13]. It is difficult to explain this finding, but we speculate that the association between employment and cognition is muddier and work characteristics may help clarify the complexities surrounding it. For instance, white-collar jobs with higher occupational prestige, flexible hours, creative freedom, low supervision, supportive colleagues, and lower work stress may protect against chronic distress over time, maintaining cognitive health [91]. Poor work conditions and low occupational prestige, alternatively, may lead to cognitive distress [59]. Future research with longitudinal data that support such an investigation into work characteristics is needed to make a more definitive statement on the link between paid work and later life cognition. Our findings offer the springboard for such a future endeavor.

Our work also supports the evidence suggestive of an aggregate or cumulative effect of socio-economic risk factors on cognitive impairment among older adults [16,92]. Simply put, those who endure multiple socioeconomic insults also endure the highest risk of cognitive deficit later in life; and this is consistent with what other studies find [31,93,94]. Further, the stronger association of higher SES risk score with increased risk of cognitive impairment is more pronounced among older women than men. Customary gender roles and gender-based unequal investments in the human capital of children have caused older cohorts of women in India to amass noticeably fewer socioeconomic resources relative to their older male peers [95]. Such gender disparities, in consequence, may contribute to cognitive health disparities in later life. Therefore, in a poor and gender-stratified society like India, policy interventions targeting the vulnerable populations and educating them could have a profound effect on the future prevalence of cognitive impairment.

The present study has several strengths. *First*, the study population consisted of a large, nationally representative sample of older persons age 60 years and above. *Second*, unlike previous studies that either only assess separate or composite measures of SES, we rely on both given that there are advantages and disadvantages associated with both approaches. Separate measures are easier to interpret and different measures of SES may operate in different ways [96], but they may not offer a complete SES profile. Composite measures of SES may provide a more complete picture of an individual's economic capacity, yet they fail to account for the uniqueness associated with each individual dimension of SES. Our approach pays heed to prominent scholars of the present century who suggest broadening how we measure economic development, growth, and even mobility to truly decipher the connections between social inequities and health [97,98] *Third*,

Table 3
Logistic regression estimates of cognitive impairment with socioeconomic risk factors by sex among older participants (n = 26,175), LASI, 2017–18.

Socioeconomic risk factors		Unadjusted	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
			Model 1	Model 2	Model 3
Male	Education- No	8.393*** (6.447–10.93)	7.950*** (6.089–10.38)	7.751*** (5.914–10.16)	6.537*** (4.945–8.641)
	MPCE Quintile- Poorest	1.574*** (1.221–2.029)	1.635*** (1.273–2.101)	1.556*** (1.211–1.999)	1.404** (1.083–1.820)
	Work status- Never worked	1.251 (0.726–2.154)	1.212 (0.684–2.148)	1.346 (0.756–2.394)	1.148 (0.595–2.215)
Female	Education- No	8.920*** (6.797–11.71)	8.570*** (6.465–11.36)	8.507*** (6.408–11.29)	6.588*** (4.901–8.855)
	MPCE Quintile- Poorest	1.621*** (1.380–1.903)	1.624*** (1.356–1.946)	1.602*** (1.338–1.917)	1.498*** (1.252–1.792)
	Work status- Never worked	0.694*** (0.592–0.813)	0.657*** (0.556–0.776)	0.658*** (0.558–0.775)	0.845* (0.713–1.002)

Notes: LASI: Longitudinal Aging Study in India; Model 1 is adjusted for age, marital status, and living arrangement; Model 2 is adjusted for behavioral factors (community involvement, physical activity, tobacco use, and alcohol consumption); Model 3 is additionally adjusted for health variables including SRH, functional difficulties of ADL and IADL and depression as well as household/ community variables such as religion, caste, place of residence, region.

we utilized the otherwise underutilized measure of household wealth using detailed measures of household expenditures. This is important given that household wealth is a more reliable measure of SES among older adults [79], especially in LMICs, like India. Lastly, we were able to adjust for various conceptually relevant health and behavioral covariates and sociodemographic factors contributing to a more robust analysis on the association between SES risks and cognition in later life.

4.1. Study limitations

These contributions, however, need to be considered in light of several limitations. *First*, the cross-sectional design of the study precludes us from making any causal or temporal inferences. *Second*, although it may be less of a problem in the case of educational level, reverse causation, especially pertaining to characteristics of household wealth and older adults' lifetime work status, is plausible. *Third*, our study does not assess work conditions and occupational status (e.g., prestige), both of which would offer a detailed glimpse into the association between work and cognition among older adults. This may be a worthwhile direction for future research, so would examining paid work histories and their impact of cognitive health. On one hand, multiple employment transitions, especially, moving across industries, could lead to tremendous stress, which could hurt cognitive health over time. On the other hand, new jobs, which may mean learning new skills, new tasks, and meeting new people, could trigger intellectual and sensory stimulation, positively shaping cognitive functioning. Assessing life long experiences related to paid work may, in fact, shed more light on the complexities in the linkages between work, occupations, careers and cognition [99]. *Finally,* our study is limited to the more conventional measures of SES. A worthwhile undertaking for future research would be to broaden the measurement of SES, to include environmental disadvantages (e.g., air pollution) and neighborhood adversities (e.g., disproportionate instances of covid-19 pandemic), in gauging social-structural inequities in cognitive health [100–102].

5. Conclusion

Although it remains a widely accepted empirical fact that SES is a "fundamental cause" of health, much remains to be discovered about how varying components of SES either similarly or differentially operate to generate patterns of morbidity and mortality. An inquiry of this nature is missing, especially, in LMICs, such as India. Our study, while not a definitive statement, offers a springboard for future work on SES related inequities in cognitive health among older Indians. The present study adds new insight to the existing literature on the combined effects of SES risk factors on cognitive impairment in community-dwelling older men and women. Morover, the findings highlight the importance of taking into account different and distinct measures of SES in identifying the most vulnerable older adults and planning gender specific interventions to improve cognitive health in late life. These findings underscore the need to distinguish between varying elements of SES to construct "upstream" health policies, programs, and interventions that redistribute resources and improve later life cognitive health.

Ethics approval and consent to participate

The study was approved by the Indian Council of Medical Research (ICMR) Ethics Committee in January 2017 and written or oral informed consent was obtained from the participants. All methods were carried out in accordance with relevant guidelines and regulations and in accordance with the World Medical Association Declaration of Helsinki.

Consent for publication

Not applicable.

Funding

The analysis received no funding.

Contributor statement

TM: Conceptualization, data curation, formal analysis, investigation, methodology, software, supervision, writing- original draft and writing – review & editing; MP: Conceptualization, supervision, validation, writing – original draft and writing – review & editing; MK: Conceptualization, writing – original draft and writing – review & editing; TVS: Conceptualization, supervision, validation, writing – original draft and writing – review & editing.

Data availability

The data are available at The Gateway to Global Aging Data (www.g2aging.org).

Declaration of Competing Interest

The authors declare that they have no competing interests.

Acknowledgements

The Longitudinal Aging Study in India Project is funded by the Ministry of Health and Family Welfare, Government of India, the National Institute on Aging (R01 AG042778, R01 AG030153), and United Nations Population Fund, India.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dialog.2023.100119.

References

[1] Harada CN, Natelson Love MC, Triebel K. Normal cognitive aging. Clin Geriatr Med. 2013;29:737–52.
[2] de Frias CM, Lövdén M, Lindenberger U, et al. Revisiting the dedifferentiation hypothesis with longitudinal multi-cohort data. Intelligence. 2007;35:381–92.
[3] Adams P, Hurd MD, Mcfadden D, et al. Healthy, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status, 112; 2003; 3–56.
[4] Mattap SM, Mohan D, McGrattan AM, et al. The economic burden of dementia in low- and middle-income countries (LMICs): a systematic review. BMJ Glob Health. 2022;7:e007409.
[5] WHO. Dementia fact sheet N°362. WHO; 2022..
[6] Finch CE. The neurobiology of middle-age has arrived. Neurobiol Aging. 2009;30:515–20. discussion 530-533.
[7] Nilsson L-G, Sternäng O, Rönnlund M, et al. Challenging the notion of an early-onset of cognitive decline. Neurobiol Aging. 2009;30:521–4. discussion 530-533.
[8] Salthouse TA. When does age-related cognitive decline begin? Neurobiol Aging. 2009;30:507–14.
[9] Singh-Manoux A, Kivimaki M, Glymour MM, et al. Timing of onset of cognitive decline: results from Whitehall II prospective cohort study. BMJ (Online). 2012. https://doi.org/10.1136/bmj.d7622. Epub ahead of print.
[10] Baumgart M, Snyder HM, Carrillo MC, et al. Summary of the evidence on modifiable risk factors for cognitive decline and dementia: a population-based perspective. Alzheimers Dement. 2015;11:718–26.
[11] Opdebeeck C, Martyr A, Clare L. Cognitive reserve and cognitive function in healthy older people: a meta-analysis. Aging Neuropsychol Cogn. 2016. https://doi.org/10.1080/13825585.2015.1041450. Epub ahead of print.
[12] Lövdén M, Fratiglioni L, Glymour MM, et al. Education and cognitive functioning across the life span. Psychol Sci Public Interest. 2020. https://doi.org/10.1177/1529100620920576. Epub ahead of print.
[13] Kim HJ, Min JY, Min KB. The association between longest-held lifetime occupation and late-life cognitive impairment: Korean longitudinal study of aging (2006–2016). Int J Environ Res Public Health. 2020. https://doi.org/10.3390/ijerph17176270. Epub ahead of print.
[14] Danielewicz AL, Wagner KJP, d'Orsi E, et al. Is cognitive decline in the elderly associated with contextual income? Results of a population-based study in southern Brazil. Cad Saúde Pública. 2016. https://doi.org/10.1590/0102-311x00112715. Epub ahead of print.

[15] Cagney KA, Lauderdale DS. Education, wealth, and cognitive function in later life. J Gerontol B Psychol Sci Soc Sci. 2002;57:163–72.
[16] Lee Y, Back JH, Kim J, et al. Multiple socioeconomic risks and cognitive impairment in older adults. Dement Geriatr Cogn Disord. 2010;29:523–9.
[17] Zhang M, Gale SD, Erickson LD, et al. Cognitive function in older adults according to current socioeconomic status. Aging Neuropsychol Cogn. 2015;22:534–43.
[18] Muhammad T, Srivastava S, Sekher TV. Assessing socioeconomic inequalities in cognitive impairment among older adults: a study based on a cross-sectional survey in India. BMC Geriatr. 2022;22:389.
[19] Muhammad T, Sekher TV, Srivastava S. Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country. BMJ Open. 2022;12:e052501.
[20] Zahodne LB, Stern Y, Manly JJ. Differing effects of education on cognitive decline in diverse elders with low versus high educational attainment. Neuropsychology. 2015. https://doi.org/10.1037/neu0000141. Epub ahead of print.
[21] Dotson VM, Kitner-Triolo MH, Evans MK, et al. Effects of race and socioeconomic status on the relative influence of education and literacy on cognitive functioning. J Int Neuropsychol Soc. 2009;15:580–9.
[22] O'Donovan G, Hamer M, Sarmiento OL, et al. Education in early life markedly reduces the probability of cognitive impairment in later life in Colombia. Sci Rep. 2020. https://doi.org/10.1038/s41598-020-74822-2. Epub ahead of print.
[23] Christensen H, Hofer SM, Mackinnon AJ, et al. Age is no kinder to the better educated: absence of an association investigated using latent growth techniques in a community sample. Psychol Med. 2001. https://doi.org/10.1017/S0033291799002834. Epub ahead of print.
[24] Ardila A, Ostrosky-Solis F, Rosselli M, et al. Age-related cognitive decline during normal aging: the complex effect of education. Arch Clin Neuropsychol. 2000. https://doi.org/10.1016/S0887-6177(99)00040-2. Epub ahead of print.
[25] Scarmeas N, Albert SM, Manly JJ, et al. Education and rates of cognitive decline in incident Alzheimer's disease. J Neurol Neurosurg Psychiatry. 2006;77:308–16.
[26] Wilson RS, Li Y, Aggarwal NT, et al. Education and the course of cognitive decline in Alzheimer disease. Neurology. 2004;63:1198–202.
[27] Van Der Elst W, Van Boxtel MPJ, Jolles J. Occupational activity and cognitive aging: a case-control study based on the Maastricht aging study. Exp Aging Res. 2012. https://doi.org/10.1080/0361073X.2012.672137. Epub ahead of print.
[28] Boots EA, Schultz SA, Almeida RP, et al. Occupational complexity and cognitive reserve in a middle-aged cohort at risk for Alzheimer's disease. Arch Clin Neuropsychol. 2015. https://doi.org/10.1093/arclin/acv041. Epub ahead of print.
[29] Stern Y. Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol. 2012;11:1006–12.
[30] Xue B, Pai M, Luo M. Working beyond SPA and the trajectories of cognitive and mental health of UK pensioners: do gender, choice, and occupational status matter? Eur J Ageing. 2022;19:423–36.
[31] Nguyen CT, Couture MC, Alvarado BE, et al. Life course socioeconomic disadvantage and cognitive function among the elderly population of seven capitals in latin America and the Caribbean. J Aging Health. 2008. https://doi.org/10.1177/0898264308315430. Epub ahead of print.
[32] Finkelstein DM, Harding JF, Paulsell D, et al. Economic well-being and health: the role of income support programs in promoting health and advancing health equity. Health Aff. 2022;41:1700–6.
[33] Selvamani Y, Singh P. Socioeconomic patterns of underweight and its association with self-rated health, cognition and quality of life among older adults in India; 2018; 1–17.
[34] Lee J, Shih R, Feeney K, et al. Gender disparity in late-life cognitive functioning in India: findings from the longitudinal aging study in India, 69; 2014; 603–11.
[35] Lei X, Hu Y, McArdle JJ, et al. Gender differences in cognition among older adults in China. J Hum Resour. 2012;47:951–71.
[36] Rocca WA, Petersen RC, Knopman DS, et al. Trends in the incidence and prevalence of Alzheimer's disease, dementia, and cognitive impairment in the United States. Alzheimers Dement. 2011;7:80–93.
[37] Fitzpatrick AL, Kuller LH, Ives DG, et al. Incidence and prevalence of dementia in the cardiovascular health study. J Am Geriatr Soc. 2004;52:195–204.
[38] Singh N. Higher education for women in India–choices and challenges. Forum on public policy online; 2007. https://eric.ed.gov/?id=EJ1099426. 2007, accessed 28 December 2022.
[39] Stern PC, Carstensen LL. Aging NRCouncilC on FD for CR on. The aging mind: opportunities in cognitive research. Washington, D.C. 2000.
[40] Alzheimer's & Related Disorders Society of India. The Dementia India Report: prevalence, impact, costs and services for Dementia: Executive Summary. In: Shaji KS, Jotheeswaran AT, Girish N, editors. Srikala Bharath, Amit Dias, Meera Pattabiraman and Mathew Varghese. New Delhi: ARDSI; 2010.
[41] Singh PK, Jasilionis D, Oksuzyan A. Gender difference in cognitive health among older Indian adults: a cross-sectional multilevel analysis. SSM Popul Health. 2018;5:180–7.
[42] Aging and the socioeconomic life of older adults in India: an empirical exposition - Sanjeev Bakshi, Prasanta Pathak; 2016. https://doi.org/10.1177/2158244015624130 [accessed 28 December 2022].
[43] Irudaya Rajan S. Demographic ageing and employment in India. Working paper; 31 March 2010. https://www.ilo.org/asia/publications/WCMS_140676/lang–en/index.htm. Accessed 28 December 2022.
[45] Juva K, Mäkelä M, Erkinjuntti T, et al. Functional assessment scales in detecting dementia. Age Ageing. 1997;26:393–400.
[46] Blankson AN, McArdle JJ. A brief report on the factor structure of the cognitive measures in the HRS/AHEAD studies.*J*. Aging Res. 1997;2014:5. https://doi.org/10.1155/2014/7985142014.
[47] Saenz JL, Adar SD, Zhang YS, et al. Household use of polluting cooking fuels and late-life cognitive function: a harmonized analysis of India, Mexico, and China. Environ Int. 2021;156:106722.
[48] International Institute for Population Sciences (IIPS), NPHCE, MoHFW, et al. Longitudinal ageing study in India (LASI) wave 1. Mumbai, India; 2020..
[49] Pandav R, Fillenbaum G, Ratcliff G, et al. Sensitivity and specificity of cognitive and functional screening instruments for dementia: the indo-U.S. dementia epidemiology study. J Am Geriatr Soc. 2002;50:554–61.
[50] Srivastava S, Joseph KJV, Dristhi D, et al. Interaction of physical activity on the association of obesity-related measures with multimorbidity among older adults: a population-based cross-sectional study in India. BMJ Open. 2021;11:e050245.
[51] Srivastava S, Purkayastha N, Chaurasia H, et al. Socioeconomic inequality in psychological distress among older adults in India: a decomposition analysis. BMC Psychiatry. 2021;21:1–15.
[52] Muhammad T, Srivastava S. Why rotational living is bad for older adults? Evidence from a cross-sectional study in India. J Popul Ageing. 2020;1. https://doi.org/10.1007/s12062-020-09312-4. Epub ahead of print.
[53] Srivastava S, Muhammad T. Violence and associated health outcomes among older adults in India: a gendered perspective. SSM Popul Health. 1 December 2020;12. https://doi.org/10.1016/j.ssmph.2020.100702. Epub ahead of print.
[54] Ma Y, Kvarta MD, Adhikari BM, et al. Association between brain similarity to severe mental illnesses and comorbid cerebral, physical, and cognitive impairments. Neuroimage. 2023;265:119786.
[55] Solfrizzi V, D'Introno A, Colacicco AM, et al. Incident occurrence of depressive symptoms among patients with mild cognitive impairment - the Italian longitudinal study on aging. Dement Geriatr Cogn Disord. 2007;24:55–64.
[56] Petersen RC, Lopez O, Armstrong MJ, et al. Practice guideline update summary: mild cognitive impairment: report of the guideline development, dissemination, and implementation subcommittee of the American academy of neurology. Neurology. 2018;90:126–35.
[57] Nayar KR. Social exclusion, caste & health: a review based on the social determinants framework. Indian J Med Res. 2007;126:355–63.
[58] Arora S, Wong CG. Examining the cognitive performance of older adults in urban and rural regions of India. Alzheimers Dement. 2022;18:e063767.
[59] Osborne J, King JE. Binary logistic regression. Best practices in quantitative methods. SAGE Publications, Inc. 2011. p. 358–84.
[60] Wu MS, Lan TH, Chen CM, et al. Socio-demographic and health-related factors associated with cognitive impairment in the elderly in Taiwan. BMC Public Health. 2011;11. https://doi.org/10.1186/1471-2458-11-22. Epub ahead of print.
[61] Kumar H, Arokiasamy P, Selvamani Y. Socioeconomic disadvantage, chronic diseases and their association with cognitive functioning of adults in India: a multilevel analysis. J Popul Ageing. 2020;13:285–303.
[62] Sattler C, Toro P, Schönknecht P, et al. Cognitive activity, education and socioeconomic status as preventive factors for mild cognitive impairment and Alzheimer's disease. Psychiatry Res. 2012;196:90–5.
[63] Jansen MG, Geerligs L, Claassen JAHR, et al. Positive effects of education on cognitive functioning depend on clinical status and neuropathological severity. Front Hum Neurosci. 2021;15. https://doi.org/10.3389/fnhum.2021.723728. accessed 28 December 2022.
[64] Chen Y, Lv C, Li X, et al. The positive impacts of early-life education on cognition, leisure activity, and brain structure in healthy aging. Aging (Albany NY). 2019;11:4923–42.
[65] Noble KG, Grieve SM, Korgaonkar MS, Engelhardt LE, Griffith EY, Williams LM, et al. Hippocampal volume varies with educational attainment across the life-span. *Frontiers in*. human. 2012; neuroscience, 6:307. https://doi.org/10.3389/fnhum.2012.00307.
[66] Steffener J. Education and age-related differences in cortical thickness and volume across the lifespan. Neurobiol Aging. 2021;102:102–10.
[67] Stern Y. How can cognitive reserve promote cognitive and neurobehavioral health? Arch Clin Neuropsychol. 2021;36:1291–5.
[68] Margerison-Zilko C, Cubbin C. Socioeconomic disparities in tobacco-related health outcomes across racial/ethnic groups in the United States: national health interview survey 2010. Nicotine Tob Res. 2013;15:1161–5.
[69] Cutler DM, Lleras-Muney A. Understanding differences in health behaviors by education.*Journal of*. health. 2010; economics, 29(1):1–28. https://doi.org/10.1016/j.jhealeco.2009.10.003.
[70] Dye L, Boyle NB, Champ C, et al. The relationship between obesity and cognitive health and decline. Proc Nutr Soc. 2017;76:443–54.
[71] Yohannes AM, Chen W, Moga AM, et al. Cognitive impairment in chronic obstructive pulmonary disease and chronic heart failure: a systematic review and meta-analysis of observational studies. J Am Med Dir Assoc. 2017;18(451) e1-451.e11.
[72] Leto L, Feola M. Cognitive impairment in heart failure patients. J Geriatr Cardiol. 2014;11:316–28.
[73] Levine DA, Galecki AT, Langa KM, et al. Trajectory of cognitive decline after incident stroke. JAMA. 2015;314:41–51.
[74] Taylor CA, Bouldin ED, Greenlund KJ, et al. Comorbid chronic conditions among older adults with subjective cognitive decline, United States, 2015–2017. Innov Aging. 2020;4 igz045.
[75] Coskun Y, Sencer Atasoy B, Morri G, et al. Wealth effects on household final consumption: stock and housing market channels. Int J Financ Stud. 2018;6:57.
[76] Lang IA, Llewellyn DJ, Langa KM, et al. Neighborhood deprivation, individual socioeconomic status, and cognitive function in older people: analyses from the English longitudinal study of ageing. J Am Geriatr Soc. 2008;56:191–8.
[77] Llewellyn DJ, Lang IA, Langa KM, et al. Cognitive function and psychological well-being: findings from a population-based cohort. Age Ageing. 2008;37:685–9.
[78] Shavers VL. Measurement of socioeconomic status in health disparities research. J Natl Med Assoc. 2007;99:1013–23.
[79] Demakakos P, Biddulph JP, Bobak M, et al. Wealth and mortality at older ages: a prospective cohort study. J Epidemiol Community Health. 2016;70:346–53.

[80] Wickrama KAS, Lorenz FO, Conger RD, et al. Linking occupational conditions to physical health through marital, social, and intrapersonal processes. J Health Soc Behav. 1997;38:363–75.
[81] Thoits PA. Mechanisms linking social ties and support to physical and mental health. J Health Soc Behav. 2011;52:145–61.
[82] Erving CL, Wright C, Lara J. An intersectional analysis of women's social role engagement and mental health. J Marriage Fam. 2022;84:1387–407.
[83] Sinha S. Multiple roles of working women and psychological well-being. Ind Psychiatry J. 2017;26:171–7.
[84] Jahan Priyanka T, Akter Mily M, Asadujjaman MD, et al. Impacts of work-family role conflict on job and life satisfaction: a comparative study among doctors, engineers and university teachers. PSU Res Rev. 1 January 2022. https://doi.org/10.1108/prr-10-2021-0058. ahead-of-print Epub ahead of print.
[85] Verbrugge LM. Multiple roles and physical health of women and men. J Health Soc Behav. 1983;24:16–30.
[86] Singh P, Pattanaik F. Unfolding unpaid domestic work in India: women's constraints, choices, and career. Palgrave Commun. 2020;6:1–13.
[87] Sharma N, Chakrabarti S, Grover S. Gender differences in caregiving among family - caregivers of people with mental illnesses. World J Psychiatry. 2016;6:7–17.
[88] Ugargol AP, Bailey A. Family caregiving for older adults: gendered roles and caregiver burden in emigrant households of Kerala, India. Asian Popul Stud. 2018;14:194–210.
[89] Mueller A, Zucchetto JM, Siedlecki KL. The relationship between social support and subjective cognitive functioning across adulthood. Int J Aging Hum Dev. 2023;96:174–200.
[90] Ha J-H, Pai M. Subjective memory problems and availability of emotional support. Res Aging. 2018;40:978–1007.
[91] Heinz AJ, Meffert BN, Halvorson MA, et al. Employment characteristics, work environment, and the course of depression over 23 years: does employment help foster resilience? Depress Anxiety. 2018;35:861–7.
[92] Zhang Z, Gu D, Hayward MD. Early life influences on cognitive impairment among oldest old Chinese. J Gerontol B Psychol Sci Soc Sci. 2008;63:25–33.
[93] Nutakor JA, Dai B, Zhou J, et al. Association between socioeconomic status and cognitive functioning among older adults in Ghana. Int J Geriatr Psychiatry. 2020:2–31.
[94] Horvat P, Richards M, Malyutina S, et al. Life course socioeconomic position and mid-late life cognitive function in Eastern Europe. J Gerontol B Psychol Sci Soc Sci. 2014;69:470–81.
[95] The roots of gender inequality in developing countries. Ann Rev Econ. 2015. https://www.annualreviews.org/doi/10.1146/annurev-economics-080614-115404.
[96] Braveman PA, Cubbin C, Egerter S, et al. Socioeconomic status in health research: one size does not fit all. JAMA. 2005;294:2879–88.
[97] Coccia M. Theories of Development. In: Farazmand A, editor. Global Encyclopedia of Public Administration, Public Policy, and Governance. Cham: Springer; 2019. https://doi.org/10.1007/978-3-319-31816-5_939-1.
[98] Coccia M. An introduction to theories of national and regional economic development. https://papers.ssrn.com/abstract=3316027; 2019. accessed 14 January 2023.
[99] Ersoezlue E, Rauchmann B-S, Schneider-Axmann T, et al. Lifelong experiences as a proxy of cognitive reserve moderate the association between connectivity and cognition in Alzheimer's disease. Neurobiol Aging. 2023;122:33–44.
[100] Khanna SK, Khanna N, Malav MK, et al. Profiling cognitive impairment in mild COVID-19 patients: a case-control study at a secondary healthcare centre in the hilly region of North India. Ann Indian Acad Neurol. 2022;25:1099.
[101] Dakua M, Karmakar R, Barman P. Exposure to indoor air pollution and the cognitive functioning of elderly rural women: a cross-sectional study using LASI data, India. BMC Public Health. 2022;22:2272.
[102] Rani R, Arokiasamy P, MeITeI WB, Sikarwar A. Association between indoor air pollution and cognitive function of older adults in India: a cross-sectional multilevel analysis. Journal of Public Health. 2021. 1-1.