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Association of objective and subjective socioeconomic status with cognitive impairment among older adults: A population-based study in a developing country

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052501
Article Type:	Original research
Date Submitted by the Author:	19-Apr-2021
Complete List of Authors:	Muhammad, T; International Institute for Population Sciences, Department of Population Policies and Programs Sekher, T.V; International Institute for Population Sciences, Department of Population Policies and Programs Srivastava, Shobhit; International Institute for Population Sciences
Keywords:	Old age psychiatry < PSYCHIATRY, Delirium & cognitive disorders < PSYCHIATRY, MENTAL HEALTH, Economics < TROPICAL MEDICINE

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Association of objective and subjective socioeconomic status with cognitive impairment among older adults: A population-based study in a developing country

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Abstract

Objective: The present study aims to explore the late-life cognitive impairment as a function of older individuals' objective and subjective socio-economic status.

Design: A cross-sectional study was conducted using a large representative survey data.

Setting and participant: The present study uses data of the Longitudinal Aging Study in India (LASI's) baseline wave (Wave 1) conducted during 2017-18. The total sample size for the present study was 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: The outcome variable was cognitive impairment among older adults. Descriptive statistics along with cross-tabulation were presented in the present study. Chi square test was used to evaluate the significance level of differences in cognitive impairment for subjective and objective SES. Additionally, binary logistic regression analysis was used to fulfil the objectives.

Results

It was found that about 41.7 per cent and 43.4 per cent of older adults belonged to low subjective and objective SES respectively. Older adults with lower subjective (17.8 per cent) and objective SES (16.6 per cent) status had higher chances of cognitive impairment. It was also revealed that older adults with lower subjective SES [AOR: 2.04; $p<0.05$] and objective SES [AOR: 1.32; $p<0.05$] had significantly higher odds of cognitive impairment in comparison to their counterparts with a stronger subjective SES-cognitive impairment association. Further it was revealed that the older adults who belonged to lower subjective as well as objective SES were 2.45 times more likely to suffer from cognitive impairment compared to older adults from higher subjective as well as objective SES [AOR: 2.45; $p<0.05$].

Conclusion

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The results also suggest that more attention should be placed on subjective SES indicators when investigating socioeconomic influences on cognitive functioning among older adults in India.

Keywords: *Subjective; Objective; Socioeconomic status; Cognitive impairment; Older adult*

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Strengths and limitations:

- The study utilizes a large nationally representative sample of the older population
- The major limitation is the cross-sectional design of the study eliminating the drawing of causal inferences among variables.
- It is important to consider that some individuals may become cognitively impaired because they are illiterate and could not respond to several measures with accuracy

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Introduction

Cognitive impairment, including dementia as an outcome of decline in cognitive ability, increases considerably with the rapidly growing population of older adults [1]. Worldwide, almost 80% of the general public are concerned about developing dementia at some point in time and 1 in 4 people think that they can do nothing to prevent such a cognitive decline [2].

Various indices of economic hardship, including lack of education, poor household economy, unemployment, and employment frustration, are linked with poor physical health conditions resulting in cognitive deficits [3–5]. Similarly, evidence suggests an aggregate or cumulative effect of socio-economic risk factors on cognitive impairment in later years of life [6–8]. Persons with higher cumulative socioeconomic status (SES) demonstrated an advantage in cognitive functioning [9]. A growing body of literature suggests that people who accumulated more wealth may be able to more easily translate it into better environmental circumstances or less stressful living conditions, further contributing to better cognitive health in later life [7, 10, 11]. Studies reported improvements in mental well-being for older people after the introduction of an income supplemental program [12, 13]. Measured by a test of processing speed, associations of educational attainment and current poverty index were found with late-life cognitive impairment in multiple studies [7, 14, 15]. Furthermore, a major contributing factor may include poor literacy resulting in an inability to benefit from strategies for early prevention of cognitive impairment [16].

Two Approaches to SES: Subjective and objective SES measures

Objective SES, which is commonly indicated by household wealth index and individual educational attainment [17]. Although these indicators are highly correlated [18], they reflect more of one's power or prestige [19]. In comparison, the subjective SES captures individuals'

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perceptions of their position in the social hierarchy, thus representing a psychological process [20].

In this regard, people make judgments of where they belong in the social hierarchy relative to others based on cognitive averaging of their economic status, education, occupation, and other objective indicators using different reference groups [17]. There is a growing body of research documenting that if people perceive themselves to be subordinate to others, they report lower self-esteem and greater stress, and they are likely to suffer from diseases more often than people who do not regard themselves to be of lower status [21]. Hence, subjective SES as a rank-based judgment that is composed of an evaluative judgment of where the objective resources would place a person in rank within a specific context, which is derived mainly via the social comparison process.

Evidence for the association between poor socioeconomic indicators with worse mental health outcomes is abundant in the geriatric research. Many previous studies in India and other countries have reinforced that illiteracy and poor financial status were strongly associated with worse cognitive function at the individual level [1, 22, 23]. However, the difference in the role that subjective and objective socioeconomic factors play in contributing to declining in late life cognition is poorly understood in the context of developing countries. Therefore, we in this study aim to explore the late-life cognitive impairment as a function of older individuals' objective and subjective SES using a large representative survey information of older adults aged 60 and above in India.

Data, Variables, and Methods

Data Source

Data for this study was utilized from the recent release of Longitudinal Ageing Study in India (LASI) wave 1 [24]. LASI is a full-scale national survey of scientific investigation of the

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health, economic, and social determinants and consequences of population aging in India, conducted in 2017-18. The LASI is a nationally representative survey of over 72000 older adults aged 45 and above across all states and union territories of India [24]. The main objective of the survey is to study the health status and the social and economic well-being of older adults in India. LASI adopted a multistage stratified area probability cluster sampling design to arrive at the eventual units of observation: older adults age 45 and above and their spouses irrespective of age. The survey adopted a three-stage sampling design in rural areas and a four-stage sampling design in urban areas. In each state/UT, the first stage involved the selection of Primary Sampling Units (PSUs), that is, sub-districts (Tehsils/Talukas), and the second stage involved the selection of villages in rural areas and wards in urban areas in the selected PSUs [24]. In rural areas, households were selected from selected villages in the third stage. However, sampling in urban areas involved an additional stage. Specifically, in the third stage, one Census Enumeration Block (CEB) was randomly selected in each urban area [24]. In the fourth stage, households were selected from this CEB. The detailed methodology, with the complete information on the survey design and data collection, was published in the survey report [24]. The present study is conducted on eligible respondents aged 60 years and above. The total sample size for the present study is 31,464 older adults aged 60 years and above.

Variable description

Outcome variable

Cognitive impairment was measured through five broad domains (memory, orientation, arithmetic function, executive function, and object naming). The cognitive impairment in our study is based on the different cognitive measures including: immediate (0–10 points) and delayed word recall (0–10 points); orientation related to time (0-4 points), and place (0-4

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points); arithmetic ability based on serial 7s (0–5 points), computation (0-2) and backward counting from 20 (0–2 points); executive functioning based on paper folding (0-3) and pentagon drawing (0-1); and object naming (0-2). The overall score ranges between 0 and 43, and a higher score indicate better cognitive functioning. In our study, the respondents who received assistance during the cognition module were excluded from the analysis. The lowest 10th percentile is used as a proxy measure of poor cognitive functioning [24].

Control variables

The control variables were divided into four sections namely socio-economic status (SES), individual factors, health factors and household factors.

Socio-economic status

The main explanatory variables were subjective socio-economic status and objective socio-economic status among older adults.

1. The subjective socio-economic status was assessed using ladder technique and the question used to assess the variable was "Think of the ladder with 10 stairs as representing where people stand in our society. At the top of the ladder are the people who are the best off – those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off – who have the least money, least education, and the worst jobs or no jobs. The higher up you are on this ladder, the closer you are to the people at the very top and the lower you are, the closer you are to the people at the very bottom of your society". A score of 0-10 was hence generated using this technique and variable subjective socio-economic status was coded as 0-3 as "low", 4-7 as "middle" and 8-10 as "high" [25].
2. The monthly per capita expenditure (MPCE) quintile was assessed using household consumption data. Sets of 11 and 29 questions on the expenditures on food and non-food

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items, respectively, were used to canvas the sample households. Food expenditure was collected based on a reference period of seven days, and non-food expenditure was collected based on reference periods of 30 days and 365 days. Food and non-food expenditures have been standardized to the 30-day reference period. The monthly per capita consumption expenditure (MPCE) is computed and used as the summary measure of consumption [24]. The variable was then divided into five quintiles i.e., from poorest to richest. The variable objective socio-economic status was coded as low which includes poorest and poorer, middle which includes middle and high which includes richer and richest [26].

Individual factors

Age was coded as young old (60-69 years), old-old (70-79 years), and oldest-old (80+ years). Sex was coded as male and female. Educational status was coded as no education/primary not completed, primary, secondary and higher. Working status was coded as currently working, retired, and not working [27]. Marital status was coded as currently married, widowed and others. Others included divorced/separated/never married. Living arrangement was coded as living alone, living with spouse, living with spouse and children and living with others [28]. Social participation was coded as no and yes. Social participation was measured through the 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 frequent (every day), rare (more than once a week, once a week, one to three times in a month), and never. The question through which physical activity was assessed was "How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health centre or gym, cycling, or digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads"? [24].

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Health factors

The probable major depression among the older adults with symptoms of dysphoria, calculated using the CIDI-SF (Short Form Composite International Diagnostic Interview) score of 3 or more. This scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [24]. The lowest 10th percentile is used as a proxy measure for major depression among older adults. Self-rated health was coded as good which includes excellent, very good, and good whereas poor includes fair and poor [29]. Difficulty in ADL (Activities of Daily Living) was coded as no and yes. Activities of Daily Living (ADL) is a term used to refer to normal daily self-care activities (such as movement in bed, changing position from sitting to standing, feeding, bathing, dressing, grooming, personal hygiene, etc.) The ability or inability to perform ADLs is used to measure a person's functional status, especially in the case of people with disabilities and the ones in their older ages [27]. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as no and yes. Activities of daily living that are not necessarily related to the fundamental functioning of a person, but they let an individual live independently in a community. These tasks are necessary for independent functioning in the community. Respondents were asked if they were having any difficulties that were expected to last more than three months, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places [30]. Morbidity was coded as no morbidity, 1 and 2+ [30].

Household factors

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Religion was coded as Hindu, Muslim, Christian, and Others [31]. Caste was recoded as Scheduled Tribe, Scheduled Caste, Other Backward Class, and others [31]. The Scheduled Caste include "untouchables"; a group of the population that is socially segregated and financially/economically by their low status as per Hindu caste hierarchy. The Scheduled Tribes (STs) and Scheduled Castes (SCs) are among the most disadvantaged and discriminated socio-economic groups in India. The OBC is the group of people who were identified as "educationally, economically and socially backward". The OBC's are considered low in the traditional caste hierarchy but are not considered untouchables. The "other" caste category is identified as having higher social status [32]. Place of residence was coded as rural and urban. The regions of India were coded as North, Central, East, Northeast, West, and South [28].

Statistical analysis

Descriptive statistics along with cross-tabulation were presented in the present study. Chi square test was used to evaluate the significance level of differences in cognitive impairment for subjective and objective SES [33, 34]. Additionally, binary logistic regression analysis [35] was used to establish the association between the outcome variable (cognitive impairment) and socio-economic status.

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

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

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, and ϵ represents the residual in the model. Variance inflation factor (VIF) was generated in STATA 14 [36] to

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check the multicollinearity and it was found that there was no evidence of multicollinearity in the variables used [37, 38].

Moreover, interaction effects [30, 39–42] were observed for subjective SES and objective SES with cognitive impairment among older adults in India. Model-1 (figure-1) represents the unadjusted effects whereas model-2 (figure-2) represents the adjusted effects. Model-3 (figure-3) represents interaction effects which are adjusted for individual characteristics, health factors and household factors.

Patient and Public Involvement

No patient involved

Results

Table-1 represents socio-economic and demographic profile of older adults in India. It was found that about 41.7 per cent of older adults belong to low subjective SES and nearly seven per cent belong to higher subjective SES. Additionally, about 43.4 per cent of older adults belonged to low objective SES and about 35.6 percent belonged to higher objective SES.

About 26.4 per cent of older adults got retired and 30.8 per cent were currently working. Nearly 36.2 per cent of older adults were widowed. Almost 5.7 per cent of older adults were living alone and 68.3 per cent were living with their children and spouse. Only 4.5 per cent of older adults reported they socially participate. Nearly, 69.3 per cent of older adults were never involved in any physical activity. About 8.7 per cent of older adults suffered from major depression. Nearly, 48.6 per cent of older adults reported poor self-rated health. About 24.4 percent and 48.7 per cent of older adults reported difficulty in ADL and IADL.

[Insert table-1 here]

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Figure-1 reveals percentage of older adults with cognitive impairment by their subjective and objective socio-economic status. It was found that lower the subjective (17.8 per cent) and objective SES (16.6 per cent) status of an older adults higher the percentage of cognitive impairment among them.

[Insert figure-1 here]

Figure-2 represents the plots for logistic regression estimates for cognitive impairment among older adults in India. In model-1 which is an unadjusted model it was found that the older adults who belonged to lower subjective SES had significantly higher odds for cognitive impairment [UOR: 3.83; $p<0.05$] in reference to older adults who belonged to higher subjective SES. Moreover, older adults who belonged to lower objective SES had 50% significantly higher likelihood to suffer from cognitive impairment [UOR: 1.50; $P<0.05$] in comparison to older adults who belonged to higher objective SES.

[Insert figure-2 here]

Similarly, in model-2 (figure-3) which is an adjusted model, it was revealed that the older adults who belonged to lower subjective SES had significantly higher odds for cognitive impairment [AOR: 2.04; $p<0.05$] in reference to older adults who belonged to higher subjective SES. Moreover, older adults who belonged to lower objective SES had 32% significantly higher likelihood to suffer from cognitive impairment [AOR: 1.32; $p<0.05$] in comparison to older adults who belonged to higher objective SES. The estimates for other covariates can be viewed in *supplementary file* (table-S1).

[Insert figure-3 here]

In model-3 (figure-4) which reveals the interaction results for cognitive impairment. It was found that older adults who belong to lower subjective as well as objective SES were 2.45

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times significant more likely to suffer from cognitive impairment in reference to older adults from higher subjective as well as objective SES [AOR: 2.45; $p<0.05$].

[Insert figure-4 here]

Discussion

This study using a large representative information on older population in India was in parallel to multiple earlier studies in India and other developing countries which found that older individuals with higher SES experience cognitive impairment compared with people with lower SES [1, 43–45]. This association has been identified in case of both objective and subjective measures of SES. Moreover, studies have amassed empirical evidence on the positive relationship between SES as measured by objective indices of material resources along with subjective measures and psychological well-being [46, 47]. Similarly, the interactive effect in our study found that older adults with lower levels of subjective and objective SES were at greater risk of cognitive impairment.

However, subjective SES was identified to have a much stronger association with cognitive impairment in the unadjusted and adjusted regression estimates in comparison to objective SES. With respect to this strong association, there can be some possible explanations. At first, obviously, subjective SES was more meaningful than household wealth index. Higher economic status does not necessarily mean more available resources, if compared with higher individual circumstances, but positive social comparison does. In addition, people with greater household economic status may endure more pressures and mental stress, which in turn may affect their mental health status and cognitive ability [48]. This could be mainly due to the subjectivity character of subjective SES. This potential explanation can also be attributed to different perceptions towards wealth and social statuses among older population in India.

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The finding underscores the need for further longitudinal investigation of subjective SES-related measurement strategies to obtain a better understanding of the SES-cognitive functioning link especially in poor resource settings. The effects of country affluence on population health have been demonstrated. Several cross-country comparisons have documented considerable variations in the strength of subjective SES-health relationship between affluent and low-income countries with a stronger association in the later ones [49, 50].

There are several limitations of the present study to be considered. The major limitation is the cross-sectional design of the study eliminating the drawing of causal inferences among variables. Indeed, it is important to consider that some individuals may become cognitively impaired because they are illiterate and could not respond to several measures with accuracy. Finally, there may also be floor or ceiling effects for SES because we have only three categories for both SES measures. Notwithstanding these limitations, there were several advantages in this study. At first, this may be the first study to identify the association between both objective and subjective SES indicators and cognitive impairment based on a comprehensive measure with a score of 0 to 43 among the older Indian population. The large sample of the present study that is free from selection bias includes all SES groups of Indian population that credits to the representativeness and generalizability of the findings. Further, the findings of the present study provide empirical support to the body of literature that highlights the vulnerability of older adults who have low subjective and objective socioeconomic status to the worse mental health outcomes.

Conclusion

In conclusion, the findings of the study highlight the importance of subjective SES measure in assessing mental health outcomes in developing countries. The results also suggest that

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more attention should be placed on subjective SES indicators when investigating socioeconomic influences on cognitive functioning among older adults in India.

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Abbreviations:

OSES: Objective socio-economic status

SSES: Subjective socio-economic status

SES: Socio-economic status

AOR: Adjusted odds ratio

CI: Confidence interval

LASI: Longitudinal Ageing Study in India

PSUs: Primary Sampling Units

CEB: Census Enumeration Block

MPCE: Monthly per capita expenditure

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Contributor statement

Conceived and designed the research paper: SS, MT and TVS; analysed the data: SS and MT; Contributed agents/materials/analysis tools: SS; Wrote the manuscript: SS and MT; Refined the manuscript: SS, MT and TVS.

Competing interest

The authors declare that there is no competing interest

Funding

No funding was received for the study

Data sharing statement

The study uses a secondary data which is available on reasonable request through https://www.iipsindia.ac.in/content/lasi-wave-i

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Table-1. Socio-economic and demographic profile of older adults in India.

Background characteristics	Sample	Percentage
Socio-economic status		
Subjective SES		
Low	13,127	41.7
Medium	16,142	51.3
High	2,195	7.0
Objective SES		
Low	13,660	43.4
Medium	6,590	21.0
High	11,213	35.6
Individual characteristics		
Age		
Young-old	18,410	58.5
Old-old	9,501	30.2
Oldest-old	3,553	11.3
Sex		
Male	14,931	47.5
Female	16,533	52.6
Education		
Not educated/primary not completed	21,381	68.0
Primary	3,520	11.2
Secondary	4,371	13.9
Higher	2,191	7.0
Working status		
Working	9,680	30.8
Retired	13,470	42.8
Not working	8,314	26.4
Marital status		
Currently married	19,391	61.6
Widowed	11,389	36.2
Others	684	2.2
Living arrangement		
Living alone	1,787	5.7
Living with spouse	6,397	20.3
Living with children and spouse	21,475	68.3
Living with others.	1,805	5.7
Social participation		
No	30,053	95.5
Yes	1,411	4.5
Physical activity		
Frequent	5,651	18.0
Rarely	4,023	12.8
Never	21,790	69.3
Health factors		
Depression*		
No	27,995	91.3
Yes	2,657	8.7
Self-rated health*		
Good	15,850	51.4

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	Poor	14,961	48.6
Difficulty in ADL			
	No	23,802	75.7
	Yes	7,662	24.4
Difficulty in IADL			
	No	16,130	51.3
	Yes	15,334	48.7
Morbidity			
	No morbidity	14,773	47.0
	1	9,171	29.2
	2+	7,520	23.9
	Household factors		
Religion			
	Hindu	25,871	82.2
	Muslim	3,548	11.3
	Christian	900	2.9
	Others	1,145	3.6
Caste			
	Scheduled Caste	5,949	18.9
	Scheduled Tribe	2,556	8.1
	Other Backward Class	14,231	45.2
	Others	8,729	27.7
Place of residence			
	Rural	22,196	70.6
	Urban	9,268	29.5
Region			
	North	3,960	12.6
	Central	6,593	21.0
	East	7,439	23.6
	Northeast	935	3.0
	West	5,401	17.2
	South	7,136	22.7
Total		31,464	100.0

**if Sample may be less due to missing cases.*

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Figure-1. Percentage of older adults with cognitive impairment by their subjective and objective socio-economic status.

Figure-2. Plots for logistic regression estimates (unadjusted) for cognitive impairment among older adults in India

Figure-3. Plots for logistic regression estimates (adjusted) for cognitive impairment among older adults in India

Figure-3. Plots for logistic regression estimates (interaction effects) for cognitive impairment among older adults in India

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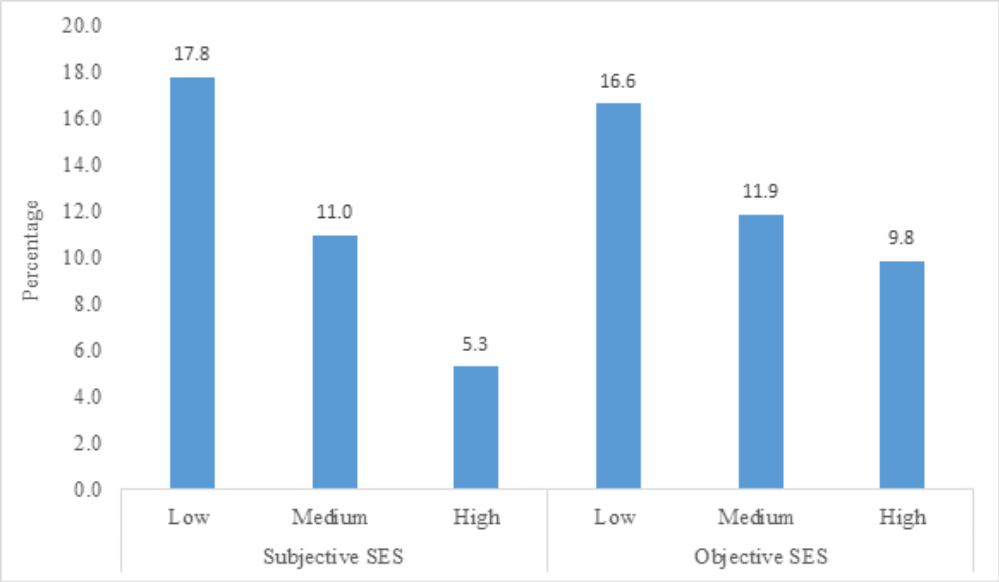
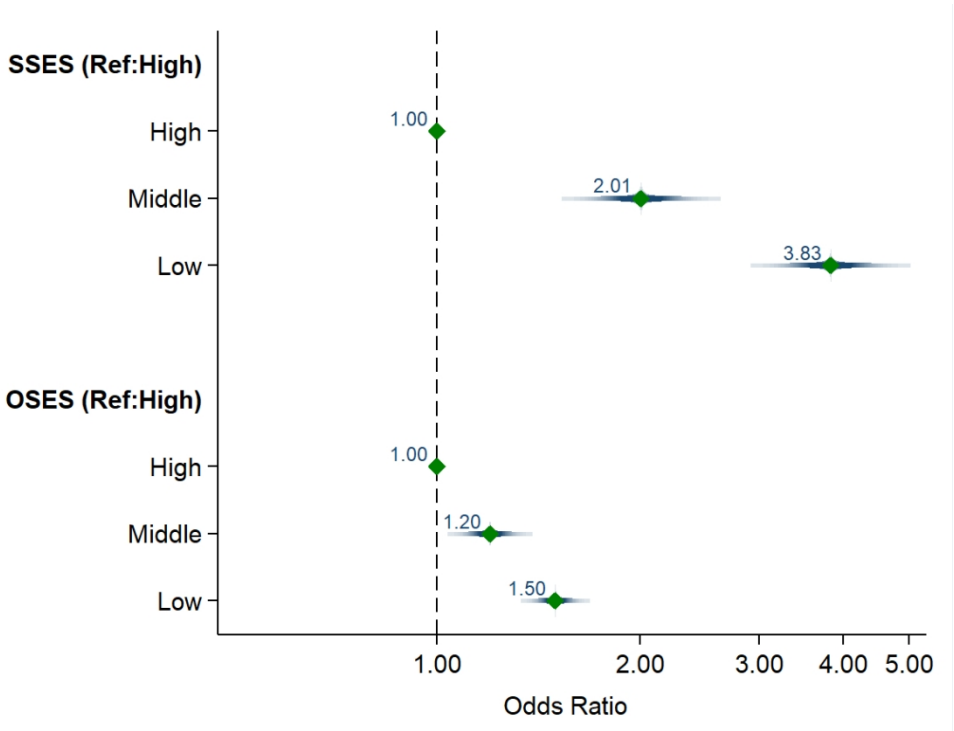


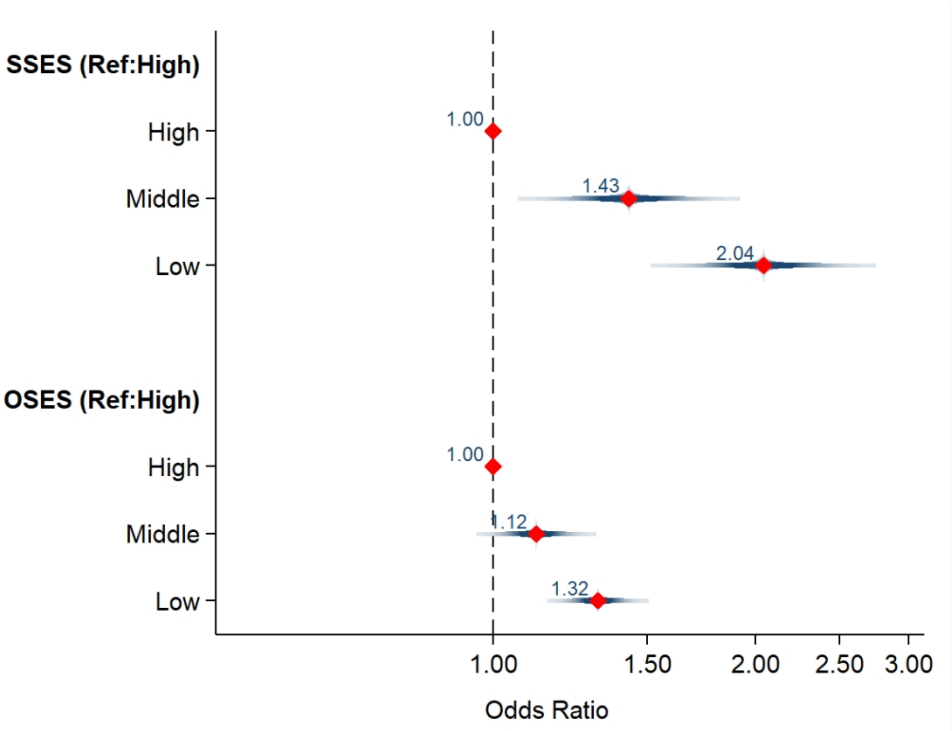
Percentage of older adults with cognitive impairment by their subjective and objective socio-economic status.

102x80mm (144 x 144 DPI)



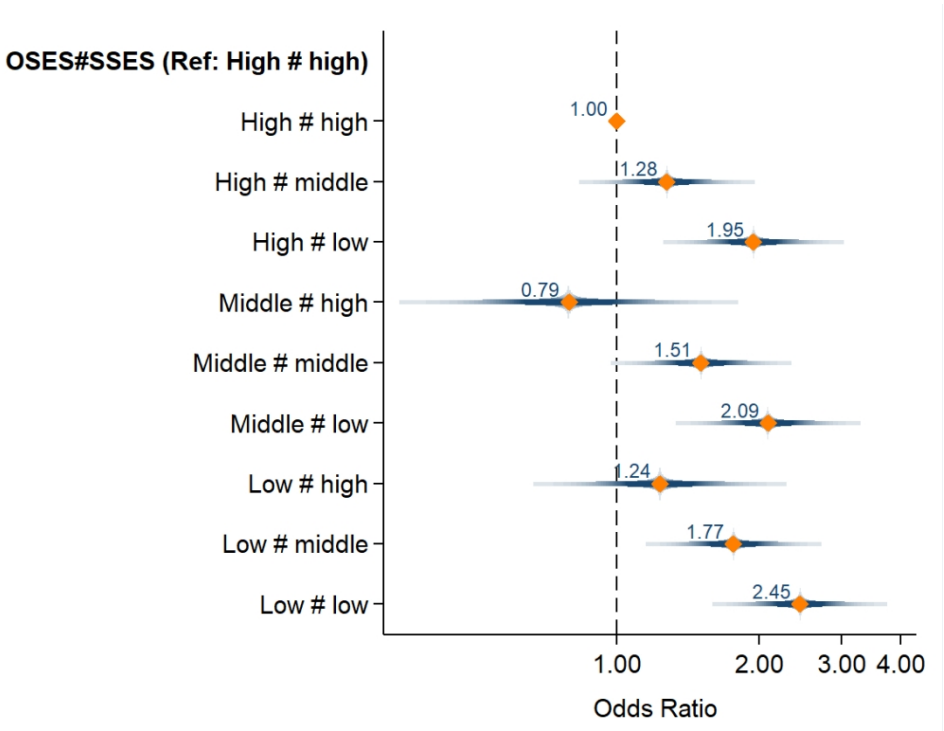
Plots for logistic regression estimates (unadjusted) for cognitive impairment among older adults in India

423x308mm (72 x 72 DPI)



Plots for logistic regression estimates (adjusted) for cognitive impairment among older adults in India

423x308mm (72 x 72 DPI)



Plots for logistic regression estimates (interaction effects) for cognitive impairment among older adults in India

423x308mm (72 x 72 DPI)

Supplementary material

Table-S1. Logistic regression estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1	Model-2	Model-3
	UOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Socio-economic status			
Subjective SES			
High	Ref.	Ref.	
Medium	2.01*(1.63,2.47)	1.43*(1.14,1.79)	
Low	3.83*(3.11,4.71)	2.04*(1.63,2.56)	
Objective SES			
High	Ref.	Ref.	
Medium	1.20*(1.07,1.34)	1.12(0.99,1.26)	
Low	1.50*(1.37,1.64)	1.32*(1.19,1.46)	
Subjective SES # Objective SES			
High # high			Ref.
High # middle			1.28(0.92,1.77)
High # low			1.95*(1.39,2.72)
Middle # high			0.79(0.42,1.48)
Middle # middle			1.51*(1.08,2.11)
Middle # low			2.09*(1.49,2.95)
Low # high			1.24(0.77,1.98)
Low # middle			1.77*(1.28,2.45)
Low # low			2.45*(1.77,3.39)
Individual characteristics			
Age			
Young-old		Ref.	Ref.
Old-old		1.61*(1.46,1.78)	1.61*(1.46,1.78)
Oldest-old		2.95*(2.58,3.37)	2.95*(2.58,3.37)
Sex			
Male		Ref.	Ref.
Female		2.1*(1.88,2.34)	2.1*(1.88,2.34)
Education			
Not educated/primary not completed		22.4*(10.58,47.41)	22.4*(10.58,47.41)
Primary		3.83*(1.75,8.36)	3.83*(1.75,8.36)
Secondary		1.94(0.86,4.38)	1.94(0.86,4.38)
Higher		Ref.	Ref.
Working status			
Working		Ref.	Ref.
Retired		1.17*(1.03,1.33)	1.17*(1.03,1.33)
Not working		1.34*(1.17,1.54)	1.34*(1.17,1.54)
Marital status			
Currently married		Ref.	Ref.
Widowed		1.37*(1.23,1.53)	1.37*(1.23,1.53)
Others		1.34*(1.01,1.79)	1.34*(1.01,1.79)
Living arrangement			
Living alone		Ref.	Ref.
Living with spouse		1.18(0.95,1.46)	1.18(0.95,1.46)
Living with children and spouse		1.04(0.87,1.24)	1.04(0.87,1.24)
Living with others.		1.29*(1.03,1.61)	1.29*(1.03,1.61)
Social participation			
No		1.65*(1.3,2.09)	1.65*(1.3,2.09)

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Yes	Ref.	Ref.
Physical activity		
Frequent	Ref.	Ref.
Rarely	1.06(0.89,1.26)	1.06(0.89,1.26)
Never	1.35*(1.17,1.55)	1.35*(1.17,1.55)
Health factors		
Depression		
No	Ref.	Ref.
Yes	1.09(0.93,1.27)	1.09(0.93,1.27)
Self-rated health		
Good	Ref.	Ref.
Poor	1.27*(1.16,1.39)	1.27*(1.16,1.39)
Difficulty in ADL		
No	Ref.	Ref.
Yes	1.41*(1.26,1.56)	1.41*(1.26,1.56)
Difficulty in IADL		
No	Ref.	Ref.
Yes	1.37*(1.24,1.5)	1.37*(1.24,1.5)
Morbidity		
No morbidity	Ref.	Ref.
1	0.81*(0.74,0.9)	0.81*(0.74,0.9)
2+	0.73*(0.65,0.82)	0.73*(0.65,0.82)
Household factors		
Religion		
Hindu	Ref.	Ref.
Muslim	1.02(0.89,1.17)	1.02(0.89,1.17)
Christian	0.97(0.81,1.17)	0.97(0.81,1.17)
Others	0.83(0.68,1.02)	0.83(0.68,1.02)
Caste		
Scheduled Caste	Ref.	Ref.
Scheduled Tribe	1.48*(1.28,1.73)	1.48*(1.28,1.73)
Other Backward Class	0.81*(0.72,0.91)	0.81*(0.72,0.91)
Others	0.82*(0.72,0.94)	0.82*(0.72,0.94)
Place of residence		
Rural	Ref.	Ref.
Urban	0.54*(0.48,0.6)	0.54*(0.48,0.6)
Region		
North	Ref.	Ref.
Central	0.81*(0.7,0.95)	0.81*(0.7,0.95)
East	0.86*(0.75,1)	0.86*(0.75,1)
Northeast	1.07(0.89,1.28)	1.07(0.89,1.28)
West	1.26*(1.08,1.49)	1.26*(1.08,1.49)
South	0.87(0.75,1.01)	0.87(0.75,1.01)

#: Interaction; Ref: Reference: UOR: Unadjusted Odds Ratio; AOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Model-2 and Model-3 were adjusted for Individual, Health and Household factors

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	Yes
Introduction		
Background/rationale	2	Yes
Objectives	3	Yes
Methods		
Study design	4	Yes
Setting	5	Yes
Participants	6	Yes
Variables	7	Yes
Data sources/ measurement	8*	Yes
Bias	9	Yes
Study size	10	Yes
Quantitative variables	11	Yes
Statistical methods	12	Yes
Results		
Participants	13*	Yes
Descriptive data	14*	Yes
Outcome data	15*	Yes
Main results	16	Yes
Other analyses	17	Yes
Discussion		
Key results	18	Yes
Limitations	19	Yes
Interpretation	20	Yes
Generalisability	21	Yes
Other information		
Funding	22	Yes

*Give information separately for exposed and unexposed groups.

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BMJ Open

Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052501.R1
Article Type:	Original research
Date Submitted by the Author:	26-Jan-2022
Complete List of Authors:	Muhammad, T; International Institute for Population Sciences, Department of Population Policies and Programs Sekher, T.V; International Institute for Population Sciences, Department of Population Policies and Programs Srivastava, Shobhit; International Institute for Population Sciences
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Old age psychiatry < PSYCHIATRY, Delirium & cognitive disorders < PSYCHIATRY, MENTAL HEALTH, Economics < TROPICAL MEDICINE

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Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

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Abstract

Objective: The present study explored how various markers of objective and subjective socio-economic status (SES) are associated with cognitive impairment among older Indian adults.

Design: A cross-sectional study was conducted using a large representative survey data.

Setting and participant: The present study uses data from the Longitudinal Aging Study in India (2017-18). The total sample size was 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: The outcome variable was cognitive impairment measured through five broad domains (memory, orientation, arithmetic function, executive function, and object naming). Descriptive statistics and cross-tabulations were presented. Chi square test was used to evaluate the significance level of differences in cognitive impairment by subjective (ladder) and objective SES measures (monthly per-capita consumption expenditure (MPCE) quintile, education and caste status). Additionally, multivariable linear and logistic regression analyses were conducted to fulfil the objectives.

Results

About 41.7% and 43.4% of older adults belonged to low subjective (ladder) and objective (MPCE) SES respectively. Older adults with lower subjective SES [aOR: 2.04; $p<0.05$] and objective SES (measured by MPCE quintile) [aOR: 1.32; $p<0.05$] had significantly higher odds of having cognitive impairment in comparison to their counterparts, with a stronger subjective SES-cognitive impairment association. Older adults with lower education or belonged to lower caste hierarchy had higher odds of cognitive impairment than their counterparts. Further interaction analyses revealed that older adults who belonged to lower subjective as well as objective (poorest MPCE quintile, Scheduled Castes and lowest education) SES had 2.45 (CI: 1.77, 3.39), 4.56 (CI: 2.97,6.98) and 54.41 (CI: 7.61,388.93)

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significantly higher odds of cognitive impairment compared to older adults from higher subjective as well as objective SES.

Conclusion

The findings suggest that more attention should be placed on subjective SES indicators when investigating the socioeconomic influences on the cognitive functioning among older adults.

Keywords: *Subjective; Objective; Socioeconomic status; Cognitive impairment; Older adults, India*

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Strengths and limitations:

- The study utilizes a large nationally representative sample of older persons from both rural and urban areas of India
- The major limitation is the cross-sectional design of the study eliminating the opportunity for drawing of causal inferences among variables.
- It is important to consider that some individuals may become cognitively impaired because they are illiterate and could not respond with accuracy to several measures

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Introduction

Cognitive impairment, including dementia as an outcome of decline in cognitive ability, increases considerably with the rapidly growing population of older adults [1]. Worldwide, almost 80% of the general public are concerned about developing dementia at some point in time and 1 in 4 people think that they can do nothing to prevent such a cognitive decline [2].

Various indices of economic hardship, including lack of education, poor household economy, unemployment, and employment frustration, are linked with poor physical health conditions resulting in cognitive deficits [3–5]. Similarly, evidence suggests an aggregate or cumulative effect of socio-economic risk factors on cognitive impairment in later years of life [6–8]. Persons with higher cumulative socioeconomic status (SES) demonstrated an advantage in cognitive functioning [9]. A growing body of literature suggests that people who accumulated more wealth may be able to more easily translate it into better environmental circumstances or less stressful living conditions, further contributing to better cognitive health in later life [7, 10, 11]. Studies reported improvements in mental well-being for older people after the introduction of an income supplemental program [12, 13]. Measured by a test of processing speed, associations of educational attainment and current poverty index were found with late-life cognitive impairment in multiple studies [7, 14, 15]. Furthermore, a major contributing factor may include poor literacy resulting in an inability to benefit from strategies for early prevention of cognitive impairment [16].

Two Approaches to SES: Subjective and objective SES measures

Objective SES is commonly indicated by household wealth index and individual educational attainment, and caste status in particular Indian context [17–19]. Although these indicators are highly correlated [20], they reflect more of one's power or prestige [21]. In

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comparison, the subjective SES captures individuals' perceptions of their position in the social hierarchy, thus representing a psychological process [22].

In this regard, people make judgments of where they belong in the social hierarchy relative to others based on cognitive averaging of their economic status, education, occupation, and other objective indicators using different reference groups [23]. There is a growing body of research documenting that if people perceive themselves to be subordinate to others, they report lower self-esteem and greater stress, and they are likely to suffer from diseases more often than people who do not regard themselves to be of lower status [24]. Hence, subjective SES as a rank-based judgment that is composed of an evaluative judgment whereas the objective resources would place a person in rank within a specific context, which is derived mainly via the social comparison process.

Evidence for the association between poor socioeconomic indicators with worse mental health outcomes is abundant in the geriatric research. Many previous studies in India and other countries have reinforced that illiteracy, lower social status and poor financial status were strongly associated with worse cognitive function at the individual level [1, 25, 26]. Similarly, the association of subjective SES and physical and mental health of older adults is explored in a couple of studies in Asian countries [27, 28]. However, the difference in the role that subjective and objective socioeconomic factors play in contributing to declining in late life cognition is poorly understood in the context of developing countries. Therefore, in this study, we aim to explore the late-life cognitive impairment as a function of older individuals' objective and subjective SES using a large representative survey information of older adults aged 60 and above in India. A conceptual framework based on the abovementioned theoretical background is summarised in Figure-1.

Data, Variables, and Methods

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Data Source

Data for this study was utilized from the recent release of Longitudinal Ageing Study in India (LASI) wave 1 [29]. LASI is a full-scale national survey of scientific investigation of the health, economic, and social determinants and consequences of population aging in India, conducted in 2017-18. The LASI is a nationally representative survey of over 72000 older adults aged 45 and above across all states and union territories of India. The survey adopted a three-stage sampling design in rural areas and a four-stage sampling design in urban areas. In each state/UT, the first stage involved the selection of Primary Sampling Units (PSUs), that is, sub-districts (Tehsils/Talukas), and the second stage involved the selection of villages in rural areas and wards in urban areas in the selected PSUs [29]. In rural areas, households were selected from selected villages in the third stage. However, sampling in urban areas involved an additional stage. Specifically, in the third stage, one Census Enumeration Block (CEB) was randomly selected in each urban area [29]. In the fourth stage, households were selected from this CEB. The detailed methodology, with the complete information on the survey design and data collection is published elsewhere and in the survey report [29, 30]. The present study is conducted on eligible respondents aged 60 years and above (31,464 older individuals from both rural and urban areas).

Variable description

Outcome variable

Cognitive impairment was measured through five broad domains (memory, orientation, arithmetic function, executive function, and object naming). It is followed from the cognitive module of the Health and Retirement Study (HRS), based on different cognitive measures including: immediate (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 7s (0–5 points),

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computation (0-2) and backward counting from 20 (0–2 points); executive functioning based on paper folding (0-3) pentagon drawing (0-1); and object naming (0-2). The overall score ranged between 0 and 43, and a higher score indicated better cognitive functioning. The lowest 10th percentile is used as a proxy measure of poor cognitive functioning [29]. Further, for the analytical purpose, the score was reversed to assess the cognitive impairment among older adults and thus after reversing, the higher score indicated higher levels of cognitive impairment. In our study, the respondents who received assistance during the cognition module were excluded from the analysis.

SES exposures

The main explanatory variables were subjective SES (ladder SES) and objective SES (household MPCE quintile, education and caste) among older adults.

The subjective SES was assessed using the Macarthur scale [31], with a ladder technique and the question used to assess the variable was "Think of the ladder with 10 stairs as representing where people stand in our society. At the top of the ladder are the people who are the best off – those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off – who have the least money, least education, and the worst jobs or no jobs. The higher up you are on this ladder, the closer you are to the people at the very top and the lower you are, the closer you are to the people at the very bottom of your society". The scale is used to measure the subjective SES across different populations in India and other countries [32, 33]. A score of 0-10 was generated as per the number of rungs marked by the respondents and the variable of subjective SES was coded as 0-3 as "low", 4-7 as "middle" and 8-10 as "high" [34].

The monthly per capita consumption expenditure (MPCE) quintile was assessed using household consumption data. The MPCE was used as one of the measures of objective SES.

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Sets of 11 and 29 questions on the expenditures on food and non-food items, respectively, were used to canvas the consumption pattern of the sample households. Food expenditure was collected based on a reference period of seven days, and non-food expenditure was collected based on reference periods of 30 days and 365 days. 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 [29]. The variable was then divided into five quintiles i.e., from poorest to richest. The variable was coded as low which includes poorest and poorer, middle which includes middle and high which includes richer and richest [35]. Another objective SES measure was educational status of older adults. As documented in multiple studies, brain functioning and cognitive processing are modulated by formal education of individuals and the illiterate population who received no formal education due to several socio-cultural and economic reasons are at greater risk for cognitive impairment and dementias [36]. The educational status in the current study was coded as no education/primary not completed, primary, secondary and higher. Finally, caste system in India is a social hierarchy that is passed down through families and groups of people dictate the professions and social prestige merely by their caste status [19]. As an objective SES measure, caste in the study was recoded as Scheduled Tribes, Scheduled Castes, Other Backward Classes, and others based on specific administrative classification [19]. The Scheduled Caste includes “untouchables”; a group of the population that is socially segregated and financially/economically marginalized by their low status as per Hindu caste hierarchy. The Scheduled Tribes (STs) and Scheduled Castes (SCs) are among the most disadvantaged and discriminated socio-economic groups in India [37]. The OBC is the group of people who were identified as “educationally, economically and socially backward”. The OBCs are considered low in the traditional caste hierarchy but are not considered

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untouchables. The "other" caste category is identified as having higher social status and refers to many of the forward/upper castes in the country [38].

Other covariates

Individual factors: Age was used as continuous variable. Sex was coded as male and female. Working status was coded as currently working, retired, and not working. Marital status was coded as currently married, widowed and others. Others included divorced/separated/never married. Living arrangement was coded as living alone, living with spouse, living with spouse and children and living with others [39]. Social participation was coded as 'no' and 'yes'. Social participation was measured through the 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 frequent (every day), rare (more than once a week, once a week, one to three times in a month), and never. The question through which physical activity was assessed was "How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health centre or gym, cycling, or digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads"? [29].

Health factors: The probable major depression among the older adults with symptoms of dysphoria, calculated using the CIDI-SF (Short Form Composite International Diagnostic Interview) score of 3 or more. This scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [29]. The lowest 10th percentile is used as a proxy measure for major depression among older adults. Self-rated health was coded excellent, very good, good, fair and poor [40]. Difficulty in ADL (Activities of Daily Living) was coded as 'no' and 'yes'. Activities of Daily Living (ADL) is a term used to refer to normal daily self-care activities

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(such as movement in bed, changing position from sitting to standing, feeding, bathing, dressing, grooming, personal hygiene, etc.) The ability or inability to perform ADLs is used to measure a person's functional status, especially in the case of people with disabilities and the ones in their older ages [41]. Difficulty in IADL (Instrumental Activities of Daily Living) was coded as 'no' and 'yes'. Activities of daily living that are not necessarily related to the fundamental functioning of a person, but they let an individual live independently in a community, by undertaking certain tasks. Respondents were asked if they were having any difficulties that were expected to last more than three months, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places [40]. Morbidity was coded as no morbidity, 1 and 2+ [40]. The variable morbidity was created using the data on chronic diseases which include hypertension, chronic heart diseases, stroke, any chronic lung disease, diabetes, cancer or malignant tumor, any bone/joint disease, neurological/psychiatric disease, or high cholesterol.

Household factors: Religion was coded as Hindu, Muslim, Christian, and Others. Place of residence was coded as rural and urban. The geographical regions of India were categorized as North, Central, East, Northeast, West, and South.

Statistical analysis

Descriptive statistics along with cross-tabulation were presented in the study. Additionally, binary logistic and linear regression analysis [42, 43] were used to establish the association between the outcome variable (cognitive impairment) and socio-economic status. The results were presented in the form of odds ratio (OR) and standardized regression coefficients (beta) with 95% confidence interval (CI). Variance inflation factor (VIF) was generated in STATA

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14 [44] to check the multicollinearity and it was found that there was no evidence of multicollinearity in the variables used [45, 46].

Moreover, interaction effects [40, 47] were observed for subjective SES and multiple objective SES measures with cognitive impairment among older adults in India. Model-1 represents the unadjusted effects whereas model-2 represents the adjusted effects. The analysis was controlled for age, sex, working status, marital status, living arrangement, social participation, physical activity, depression, self-rated health, difficulty in ADL and IADL, morbidity, religion, place of residence and regions. Models-3, 4 and 5 represent interaction effects which are adjusted for individual characteristics, health factors and household factors.

Patient and Public Involvement

No patient involved

Results

Table-1 represents socio-economic and demographic profile of Indian older adults included in this study. The mean age of the study population was 69.2 years (standard deviation: 7.5). It was found that about 41.7 per cent of older adults belong to low subjective SES and only seven per cent belong to higher subjective SES. Additionally, about 43.4 per cent of older adults belonged to low objective SES and about 35.6 percent belonged to higher objective SES. About 13.1% (n=3250) older adults were cognitively impaired in reference to 86.9% (n=21580) who were not cognitively impaired.

About 26.4 per cent of older adults got retired from employment and 30.8 per cent were currently working. Nearly 36.2 per cent of older adults were widowed. Only 5.7 per cent of older adults were living alone and 68.3 per cent were living with their children and spouse. Only 4.5 per cent of older adults reported that they socially participate. Nearly, 69.3 per cent of older adults were never involved in any physical activity. About 8.7 per cent of older

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adults suffered from major depression. Nearly, 15.0 per cent of older adults reported poor self-rated health. About 24.4 percent and 48.7 per cent of older adults reported difficulty in ADL and IADL.

[Insert table-1 here]

Figure-2 presents the percentage distribution of subjective SES (ladder SES) that ranges from 1 to 10, representing lowest to highest rank. A proportion of 8.2% of older adults marked their SES in the bottom of the ladder (lowest), whereas, a proportion of only 1.1% marked their SES at the top of the ladder (highest).

[Insert figure-2 here]

Figure-3 reveals that lower the subjective SES (17.8 per cent; $p<0.001$) of an older adult, higher the prevalence of cognitive impairment.

[Insert figure-3 here]

Figure-4 reveals that lower the objective SES (measured by MPCE quintile) (16.6 per cent; $p<0.001$) of an older adult, higher the prevalence of cognitive impairment. With regard to other objective SES measures, older adults with no education/primary not completed had highest prevalence of cognitive impairment (19.9%; $p<0.001$). Similarly, older adults from Scheduled Tribe category had highest prevalence of cognitive impairment (22.1%; $p<0.001$).

[Insert figure-4 here]

Table-2a represents the logistic regression estimates of cognitive impairment among older adults. In model-2 which is adjusted model, it was revealed that older adults who belonged to lower subjective SES had significantly higher odds of cognitive impairment [aOR: 2.04; $p<0.05$] in reference to older adults who belonged to higher subjective SES. Moreover, older adults who belonged to lower objective SES (MPCE quintile) had 32% significantly higher

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odds of suffering from cognitive impairment [aOR: 1.32; p<0.05] in comparison to older adults who belonged to higher objective SES (MPCE quintile). Older adults who were not educated/ with minimum education had significantly higher odds of cognitive impairment in reference to older adults with higher education [aOR: 22.4; p<0.05]. Older adults who belonged to the Scheduled Castes and Scheduled Tribes had 22% [aOR: 1.22; p<0.05] and 80% [aOR: 1.80; p<0.05] significantly higher odds of cognitive impairment in reference to older adults from other (higher) caste category, respectively.

[Insert Table-2a]

In model-3, 4 and 5 (Table-2b) which reveals the interaction results for cognitive impairment. It was found that older adults who belong to lower subjective as well as objective SES were 2.45 times significant more likely to suffer from cognitive impairment in reference to older adults from higher subjective as well as objective SES (MPCE quintile) [aOR: 2.45; p<0.05]. In reference to older adults with high ladder SES and higher education, older adults with high ladder SES and no education/primary not completed [aOR: 24.14; p<0.05], middle ladder SES and no education/primary not completed [aOR: 37.07; p<0.05] and low ladder SES and no education/primary not completed [aOR: 54.41; p<0.05] had significantly higher odds for cognitive impairment. Older adults from low ladder SES and belonged to the Scheduled Castes [aOR: 2.88; p<0.05], low ladder SES and belonged to the Scheduled Tribes [aOR: 4.56; p<0.05] and low ladder SES and belonged to the Other Backward Classes [aOR: 2.15; p<0,05] had significantly higher odds of cognitive impairment in reference to older adults from high ladder SES and other (higher) caste category.

[Insert Table-2b]

Discussion

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This study using a large representative data on older population in India was in parallel to multiple earlier studies in India and other developing countries which found that older individuals with lower SES experience cognitive impairment compared with people with higher SES [1, 48–50]. This association has been identified in case of both objective and subjective measures of SES. Studies have illustrated empirical evidence on the positive relationship between SES as measured by objective indices of material resources and subjective measures, and psychological well-being [51, 52]. Similarly, the interactive effect in our study found that older adults with lower levels of subjective and objective SES were at a greater risk of having cognitive impairment.

However, subjective SES was identified to have a much stronger association with cognitive impairment in the unadjusted and adjusted regression estimates in comparison to objective SES measured by household MPCE quintile. With respect to this strong association, there can be some possible explanations. At first, obviously, subjective SES was more meaningful than household wealth index. Higher economic status does not necessarily mean more resources at disposal, if compared with higher individual circumstances, but positive social comparison does. In addition, people with greater household economic status may endure more pressures and mental stress, which in turn may affect their mental health status and cognitive ability [53]. This could be mainly due to the subjectivity character of subjective SES. This potential explanation can also be attributed to different perceptions towards wealth and social status among older population in India.

Furthermore, considering the education-cognitive function association, the current findings suggest that higher education is a protective factor against cognitive impairment in older individuals. A hypothesized mechanism is that education is transformed to personal experience and self-perceptions about own social standing, which in turn translate into health and disease. Similarly, the current findings suggest that older adults with no education and

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low levels of subjective SES had greater odds of cognitive impairment compared to those with higher education and higher subjective SES. This finding agrees with the previous evidence on the moderating role of education in the relationship between subjective SES and cognitive function. Also, as documented in earlier research [22], subjective SES is a means through which education may influence health outcomes among older people. Nevertheless, proper path analysis using longitudinal data and conducting moderation as well as mediation analyses is needed to test these claims.

Finally, older adults belonging to the lower caste groups (with low social status) were found to be more likely to be cognitively impaired in the study in comparison to those belong to higher castes. Importantly, in a previous study, it was observed that indicators of subjective SES differ across socio-demographic groups including race, and interpretations may vary when perceiving themselves on the existing social hierarchy [24]. Previous studies in India have demonstrated that the socioeconomic disadvantages such as lower income and lack of education were associated with belonging to lower castes (scheduled tribes and other backward classes) [18, 19, 54, 55]. Further, lower caste status being a factor of less opportunities in economic spectrum also contributes to poorer health, health inequalities and mortality burden in India [17, 38, 56]. It is however demonstrated that since individuals may estimate their SES relative to others in a specific community or social group, the social disadvantage may not necessarily negatively influence their mental wellbeing [51]. This suggests that the SES could be better captured by assessing the interactions between subjective and objective measures of SES.

The current study provides crucial clues about what measure of SES highly reflect on the mental health in old age by underlining the importance of the cumulative dimension of subjective SES and different traditional measures including wealth status, education and caste, and showing the underperformance of traditional measure of wealth status compared to

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subjective SES. Considering the current findings and the existing evidence [51], separate SES-related ladders that evaluate subjective perceptions of individuals' economic status (MPCE), education and social status (caste hierarchy in Indian context) may be suggested in wellbeing research. This is because subjective SES may reflect individuals' present social circumstances and an assessment of their past experiences and future prospects. As suggested in previous studies, subjective perception of one's SES might also encompass his/her household resources, life chances and opportunities, and thus captures a broad range of aspects of social stratification than traditional measures of SES do [23, 31, 57]. The finding further underscores the need for future longitudinal investigation of subjective SES-related measurement strategies to obtain a better understanding of the SES-cognitive functioning link especially in poor resource settings. The effects of country affluence on population health have been demonstrated. Several cross-country comparisons have documented considerable variations in the strength of subjective SES-health relationship between affluent and low-income countries with a stronger association in the later ones [58, 59].

There are several limitations of the present study to be considered. The major limitation is the cross-sectional design of the study eliminating the opportunity for drawing of causal inferences among variables. Indeed, it is important to consider that some individuals may become cognitively impaired because they are illiterate and could not respond to several measures with accuracy. Finally, there may also be floor or ceiling effects for SES because we have only three categories for both SES measures. Notwithstanding these limitations, there were several advantages in this study. At first, this may be the first study to identify the association between both objective and subjective SES indicators and cognitive impairment based on a comprehensive measure with a score of 0 to 43 among the older Indian population. The large sample of the present study that is free from selection bias includes all SES groups of Indian population that credits to the representativeness and generalizability of

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the findings. In addition to including multiple SES groups, this study also includes participants living both in rural and urban areas which enhance the generalizability of the results. Further, the findings of the present study provide empirical support to the body of literature that highlights the vulnerability of older adults who have low subjective and objective SES to the worse mental health outcomes. Finally, future research may focus on longitudinal associations of various socioeconomic markers with mental health outcomes among middle aged and older adults in India.

Conclusion

In conclusion, the findings of the study highlight the importance of subjective SES measure and its interaction with objective (traditional) measures of SES including wealth, education and caste status in assessing the mental health outcomes in developing countries. The results also suggest that more attention should be placed on subjective SES indicators when investigating socioeconomic influences on cognitive functioning among older adults in India.

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Abbreviations:

OSES: Objective socio-economic status

SSES: Subjective socio-economic status

SES: Socio-economic status

aOR: Adjusted odds ratio

CI: Confidence interval

LASI: Longitudinal Ageing Study in India

PSU Primary Sampling Unit

CEB: Census Enumeration Block

MPCE: Monthly per capita expenditure

ADL: Activities of daily living

IADL: Instrumental activities of daily living

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Declarations

Ethics approval

The necessary guidelines and ethics for undertaking the LASI survey were approved by the Indian Council of Medical Research (ICMR). ICMR approved the study. There was no number/ID of the approval(s) mentioned in the LASI report (https://www.iipsindia.ac.in/sites/default/files/LASI_India_Report_2020_compressed.pdf). All methods were carried out in accordance with relevant guidelines and regulations by the Indian Council of Medical Research (ICMR).

Contributor statement

Conceived and designed the research paper: TM and TVS; analysed the data: SS and TM; Contributed agents/materials/analysis tools: TVS; Wrote the manuscript: TM and SS; Refined the manuscript: TM, SS and TVS.

Competing interest

The authors declare that there is no competing interest

Funding

No funding was received for the study

Data sharing statement

The study uses a secondary data which is available on request through https://www.iipsindia.ac.in/content/lasi-wave-i

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Table-1. Socio-economic and demographic profile of older adults in India.

Background characteristics	Sample	Percentage
Socio-economic status		
Subjective SES		
Ladder SES		
Low	13,127	41.7
Medium	16,142	51.3
High	2,195	7.0
Objective SES		
MPCE quintile		
Low	13,660	43.4
Medium	6,590	21.0
High	11,213	35.6
Education		
Not educated/primary not completed	21,381	68.0
Primary	3,520	11.2
Secondary	4,371	13.9
Higher	2,191	7.0
Caste		
Scheduled Castes	5,949	18.9
Scheduled Tribes	2,556	8.1
Other Backward Classes	14,231	45.2
Others	8,729	27.7
Individual characteristics		
Age in years (mean (sd))		69.2 (7.5)
Sex		
Male	14,931	47.5
Female	16,533	52.6
Working status		
Working	9,680	30.8
Retired	13,470	42.8
Not working	8,314	26.4
Marital status		
Currently married	19,391	61.6
Widowed	11,389	36.2
Others	684	2.2
Living arrangement		
Living alone	1,787	5.7
Living with spouse only	6,397	20.3
Living with children and spouse	21,475	68.3
Living with others.	1,805	5.7
Social participation		
No	30,053	95.5
Yes	1,411	4.5
Physical activity		
Frequent	5,651	18.0
Rarely	4,023	12.8
Never	21,790	69.3
Health factors		
Depression*		

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	No	27,995	91.3
	Yes	2,657	8.7
Self-rated health*			
	Excellent	964	3.1
	Very good	4,192	13.6
	Good	10,693	34.7
	Fair	10,331	33.5
	Poor	4,630	15.0
Difficulty in ADL			
	No	23,802	75.7
	Yes	7,662	24.4
Difficulty in IADL			
	No	16,130	51.3
	Yes	15,334	48.7
Morbidity			
	No morbidity	14,773	47.0
	1	9,171	29.2
	2+	7,520	23.9
Household factors			
Religion			
	Hindu	25,871	82.2
	Muslim	3,548	11.3
	Christian	900	2.9
	Others	1,145	3.6
Place of residence			
	Rural	22,196	70.6
	Urban	9,268	29.5
Region			
	North	3,960	12.6
	Central	6,593	21.0
	East	7,439	23.6
	Northeast	935	3.0
	West	5,401	17.2
	South	7,136	22.7
Total		31,464	100.0

**if Sample may be less due to missing cases; sd: standard deviation*

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Table-2a. Regression estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1		Model-2	
	OR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Socio-economic status				
Subjective SES				
Ladder SES				
High	Ref.		Ref.	
Medium	2.01*(1.63,2.47)	0.107	1.43*(1.14,1.79)	0.102
Low	3.83*(3.11,4.71)	0.172	2.04*(1.63,2.56)	0.157
Objective SES				
MPCE quintile				
High	Ref.		Ref.	
Medium	1.20*(1.07,1.34)	0.011	1.12(0.99,1.26)	0.020
Low	1.50*(1.37,1.64)	0.032	1.32*(1.19,1.46)	0.051
Education				
Not educated/primary not completed	58.91*(27.97,124.07)	0.694	22.40*(10.58,47.41)	0.514
Primary	6.45*(2.96,14.03)	0.204	3.83*(1.75,8.36)	0.142
Secondary	2.55*(1.13,5.73)	0.108	1.94(0.86,4.38)	0.072
Higher	Ref.		Ref.	
Caste				
Scheduled Castes	1.03(0.91,1.16)	0.005	1.22*(1.06,1.39)	0.027
Scheduled Tribes	1.38*(1.22,1.55)	0.029	1.80*(1.55,2.09)	0.067
Other Backward Classes	0.86*(0.78,0.96)	-0.038	0.98(0.87,1.1)	-0.005
Others	Ref.		Ref.	

Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; aCoef: adjusted coefficients; CI: Confidence Interval; SES: Socio-economic status; Model-2 was adjusted for Individual, Health and Household factors

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Table-2b. Interaction estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-3 aOR (95% CI)	Model-4 aOR (95% CI)	Model-5 aOR (95% CI)	Model-3 Standardized beta	Model-4 Standardized beta	Model-5 Standardized beta
Ladder SES # MPCE quintile						
High # high	Ref.					
High # middle	1.28(0.92,1.77)			0.085		
High # low	1.95*(1.39,2.72)			0.102		
Middle # high	0.79(0.42,1.48)			0.008		
Middle # middle	1.51*(1.08,2.11)			0.084		
Middle # low	2.09*(1.49,2.95)			0.092		
Low # high	1.24(0.77,1.98)			0.011		
Low # middle	1.77*(1.28,2.45)			0.125		
Low # low	2.45*(1.77,3.39)			0.160		
Ladder SES # Education						
High # higher		Ref.				
High # secondary		2.12(0.22,20.49)			0.021	
High # primary		8.91*(1.1,72.16)			0.037	
High # Not educated/primary not completed		24.14*(3.34,174.63)			0.168	
Middle # higher		1.57(0.18,13.48)			0.032	
Middle # secondary		3.06(0.41,22.74)			0.116	
Middle # primary		5.82(0.8,42.55)			0.167	
Middle # Not educated/primary not completed		37.07*(5.19,264.9)			0.568	
Low # higher		2.11(0.13,34.01)			0.020	
Low# secondary		4.68(0.6,36.81)			0.079	
Low # primary		8.65*(1.17,64.2)			0.129	

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Low # Not educated/primary not completed	54.41*(7.61,388.93)	0.602
Ladder SES # Caste		
High # Others	Ref.	
High # Other Backward Class	1.39(0.83,2.32)	0.003
High # Scheduled Caste	1.69(0.82,3.48)	0.016
High # Scheduled Tribe	1.04(0.52,2.07)	-0.005
Middle # Others	1.53*(1.01,2.32)	0.081
Middle # Other Backward Class	1.60*(1.06,2.41)	0.081
Middle # Scheduled Caste	1.89*(1.23,2.89)	0.078
Middle # Scheduled Tribe	2.72*(1.77,4.2)	0.105
Low # Others	2.27*(1.49,3.46)	0.083
Low # Other Backward Class	2.15*(1.42,3.26)	0.111
Low # Scheduled Caste	2.88*(1.89,4.39)	0.108
Low # Scheduled Tribe	4.56*(2.97,6.98)	0.132

#: Interaction; Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; aCoef: adjusted coefficients; CI: Confidence Interval; SES: Socio-economic status; Model-3, 4 and 5 were adjusted for Individual, Health and Household factors

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Figure legend: -

Figure 1. Conceptual framework

Figure-2. The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

Figure-3. Percentage of older adults with cognitive impairment by their subjective socio-economic status.

Figure-4. Percentage of older adults with cognitive impairment by their objective socio-economic status.

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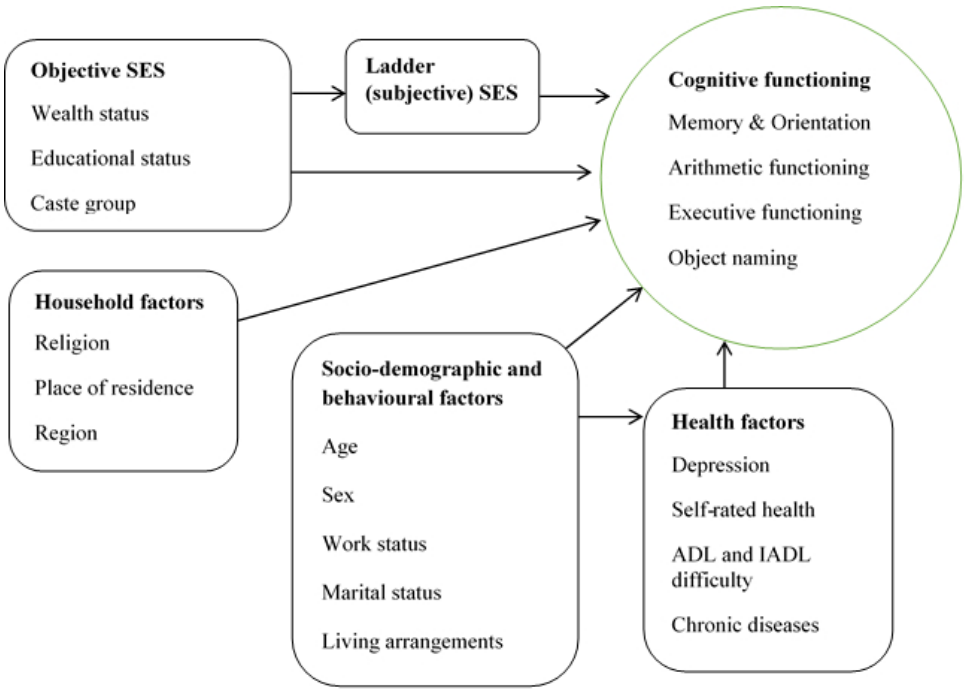

Conceptual framework

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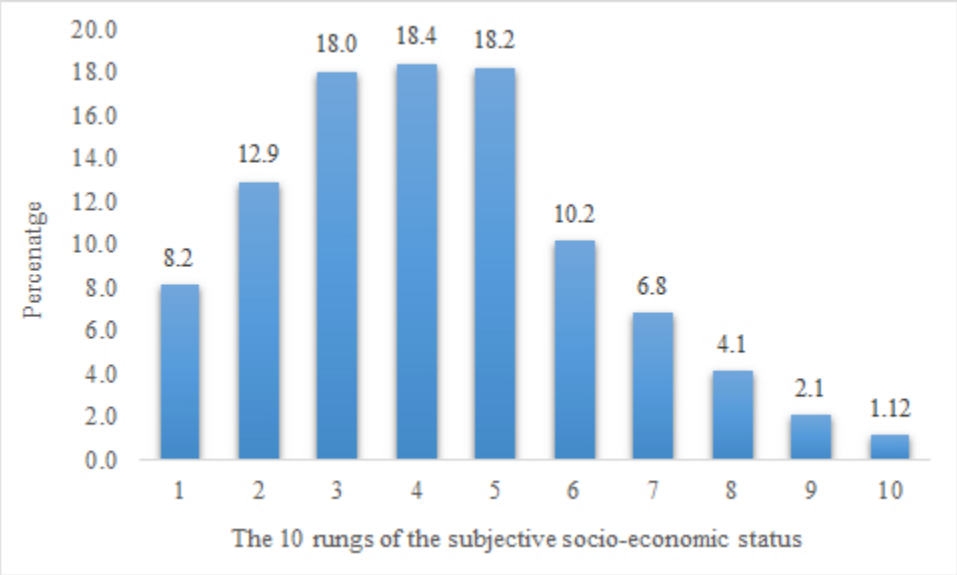
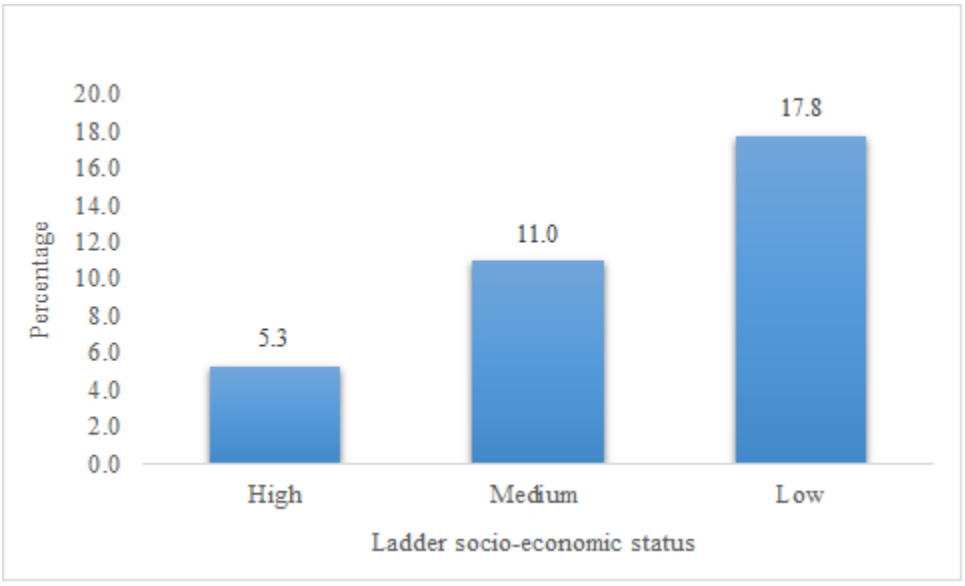


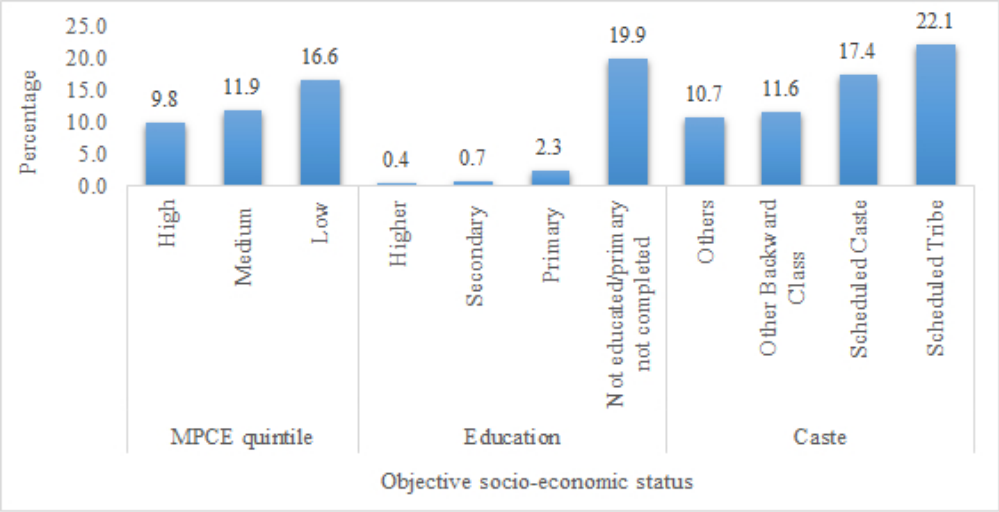
The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

127x77mm (96 x 96 DPI)



Percentage of older adults with cognitive impairment by their subjective socio-economic status.

127x77mm (96 x 96 DPI)



Percentage of older adults with cognitive impairment by their objective socio-economic status.

148x77mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	1-2
Introduction		
Background/rationale	2	5
Objectives	3	6
Methods		
Study design	4	7
Setting	5	7
Participants	6	7
Variables	7	7-8
Data sources/ measurement	8*	7
Bias	9	-
Study size	10	7
Quantitative variables	11	7-8
Statistical methods	12	11-12
Results		
Participants	13*	12-13
Descriptive data	14*	12-13
		12-13
Outcome data	15*	
Main results	16	12-14
Other analyses	17	12-14
Discussion		
Key results	18	15-18
Limitations	19	17
Interpretation	20	15-18
Generalisability	21	15-18
Other information		
Funding	22	20

*Give information separately for exposed and unexposed groups.

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Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052501.R2
Article Type:	Original research
Date Submitted by the Author:	06-Jun-2022
Complete List of Authors:	Muhammad, T; International Institute for Population Sciences, Department of Population Policies and Programs Sekher, T.V; International Institute for Population Sciences, Department of Population Policies and Programs Srivastava, Shobhit; International Institute for Population Sciences
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Old age psychiatry < PSYCHIATRY, Delirium & cognitive disorders < PSYCHIATRY, MENTAL HEALTH, Economics < TROPICAL MEDICINE

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Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

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Abstract

Objective: This study explored how various markers of objective and subjective socio-economic status (SES) are associated with cognitive impairment among older Indian adults.

Design: A cross-sectional study was conducted using a large nationally representative survey data.

Setting and participant: This study used data from the Longitudinal Aging Study in India (2017-18). The total sample size was 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: The outcome variable was cognitive impairment measured through broad domains of memory, orientation, arithmetic function, and visuo-spatial and constructive skills. We estimated descriptive statistics and presented cross-tabulations of the outcome. Chi square test was used to evaluate the significance level of differences in cognitive impairment by subjective (ladder) and objective SES measures (monthly per-capita consumption expenditure (MPCE) quintile, education and caste status). Multivariable linear and logistic regression analyses were conducted to fulfil the objectives.

Results

A proportion of 41.7% and 43.4% of older adults belonged to low subjective (ladder) and objective (MPCE) SES, respectively. Older adults with low subjective SES [aOR: 2.04; $p<0.05$] and objective SES (measured by MPCE quintile) [aOR: 1.32; $p<0.05$] had significantly higher odds of having cognitive impairment in comparison to their counterparts, with a stronger subjective SES-cognitive impairment association. Older adults with lower education or belonged to lower caste hierarchy had higher odds of cognitive impairment than their counterparts. Interaction analyses revealed that older adults who belonged to lower subjective and objective (poorest MPCE quintile, Scheduled Castes and lowest education) SES had 2.45 (CI: 1.77, 3.39), 4.56 (CI: 2.97,6.98) and 54.41 (CI: 7.61,388.93) significantly

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higher odds of cognitive impairment compared to older adults from higher subjective and objective SES.

Conclusion

Our findings suggest that more attention should be placed on subjective SES indicators when investigating the socioeconomic influences on the cognitive functioning among older adults.

Keywords: *Subjective; Objective; Socioeconomic status; Cognitive impairment; Older adults, India*

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Strengths and limitations:

- The study utilizes a large nationally representative sample of older persons from both rural and urban areas of India
- The cross-sectional design of the study eliminates the opportunity for drawing of causal inferences among variables.
- Some individuals may become cognitively impaired because they are illiterate and could not respond with accuracy to several measures

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Introduction

Cognitive impairment, including dementia as an outcome of decline in cognitive ability, increases considerably with the rapidly growing population of older adults [1]. Worldwide, almost 80% of the general public are concerned about developing dementia at some point in time and 1 in 4 people think that they can do nothing to prevent such a cognitive decline [2].

Various indices of economic hardship, including lack of education, poor household economy, unemployment, and employment frustration, are linked with poor physical health conditions resulting in cognitive deficits [3–5]. Similarly, evidence suggests an aggregate or cumulative effect of socio-economic risk factors on cognitive impairment in later years of life [6–8]. Persons with higher cumulative socioeconomic status (SES) demonstrated an advantage in cognitive functioning [9]. A growing body of literature suggests that people who accumulated more wealth may be able to more easily translate it into better environmental circumstances or less stressful living conditions, further contributing to better cognitive health in later life [7, 10, 11]. Studies reported improvements in mental well-being for older people after the introduction of an income supplemental program [12, 13]. Measured by a test of processing speed, associations of educational attainment and current poverty index were found with late-life cognitive impairment in multiple studies [7, 14, 15]. Furthermore, a major contributing factor may include poor literacy resulting in an inability to benefit from strategies for early prevention of cognitive impairment [16].

Two approaches to SES: Subjective and objective SES measures

Objective SES is commonly indicated by household wealth index and individual educational attainment, and caste status in particular Indian context [17–19]. Although these indicators are highly correlated [20], they reflect more of one's power or prestige [21]. In

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comparison, the subjective SES captures individuals' perceptions of their position in the social hierarchy, thus representing a psychological process [22].

In this regard, people make judgments of where they belong in the social hierarchy relative to others based on cognitive averaging of their economic status, education, occupation, and other objective indicators using different reference groups [23]. There is a growing body of research documenting that if people perceive themselves to be subordinate to others, they report lower self-esteem and greater stress, and they are likely to suffer from diseases more often than people who do not regard themselves to be of lower status [24]. Hence, subjective SES as a rank-based judgment that is composed of an evaluative judgment whereas the objective resources would place a person in rank within a specific context, which is derived mainly via the social comparison process.

Evidence for the association between poor socioeconomic indicators with worse mental health outcomes is abundant in the geriatric research. Many previous studies in India and other countries have reinforced that illiteracy, lower social status and poor financial status were strongly associated with worse cognitive function at the individual level [1, 25, 26]. Similarly, the association of subjective SES and physical and mental health of older adults is explored in a couple of studies in Asian countries [27, 28]. However, the difference in the role that subjective and objective socioeconomic factors play in contributing to declining in late life cognition is poorly understood in the context of developing countries. Therefore, in this study, we aimed to explore the late-life cognitive impairment as a function of older individuals' objective and subjective SES using a large representative survey information of older adults aged 60 and above in India. A conceptual framework based on the abovementioned theoretical background is summarised in Figure-1.

Data, variables, and methods

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Data Source

We utilized data from the recent release of Longitudinal Ageing Study in India (LASI) wave 1 [29]. LASI is a full-scale national survey of scientific investigation of the health, economic, and social determinants and consequences of population aging in India, conducted in 2017-18. The LASI is a nationally representative survey of over 72000 older adults aged 45 and above across all states and union territories (UTs) of India. The survey adopted a three-stage sampling design in rural areas and a four-stage sampling design in urban areas. In each state/UT, the first stage involved the selection of Primary Sampling Units (PSUs), that is, sub-districts (Tehsils/Talukas), and the second stage involved the selection of villages in rural areas and wards in urban areas in the selected PSUs [29]. In rural areas, households were selected from selected villages in the third stage. However, sampling in urban areas involved an additional stage. Specifically, in the third stage, one Census Enumeration Block (CEB) was randomly selected in each urban area [29]. In the fourth stage, households were selected from this CEB. The detailed methodology, with the complete information on the survey design and data collection is published elsewhere and in the survey report [29, 30]. The present study is conducted on eligible respondents aged 60 years and above (31,464 older individuals from both rural and urban areas).

The necessary guidelines and ethics for undertaking the LASI survey were approved by the Indian Council of Medical Research (ICMR). The agencies that conducted the field survey for the data collection had collected prior informed consent (signed and oral) for both the interviews and biomarker tests from the eligible respondents in accordance with the Human Subjects Protection. All methods in this study were carried out in accordance with relevant guidelines and regulations by the ICMR.

Variable description

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Outcome variable

Cognitive impairment was measured through broad domains of memory, orientation, arithmetic function, and visuo-spatial and constructive skills. It is followed from the cognitive module of the Health and Retirement Study (HRS), the China Health and Retirement Longitudinal Study (CHARLS), and the Mexican Health and Aging Study (MHAS), based on different cognitive measures including: immediate (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 7s (0–5 points), computation (0-2) and backward counting from 20 (0–2 points); visuo-spatial and constructive skills based on paper folding (0-3) pentagon drawing (0-1); and object naming (0-2). The overall score ranged between 0 and 43, and a higher score indicated better cognitive functioning. The lowest 10th percentile was used as a proxy measure of poor cognitive functioning [29]. Further, for the analytical purpose, the score was reversed to assess the cognitive impairment among older adults and thus after reversing, the higher score indicated higher levels of cognitive impairment. In our study, the respondents who received assistance during the cognition module were excluded from the analysis.

SES exposures

The main explanatory variables were subjective SES (ladder SES) and objective SES (household MPCE quintile, education and caste) among older adults.

The subjective SES was assessed using the Macarthur scale [31], with a ladder technique and the question used to assess the variable was "Think of the ladder with 10 stairs as representing where people stand in our society. At the top of the ladder are the people who are the best off – those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off – who have the least money, least education, and the worst jobs or no jobs. The higher up you are on this ladder, the closer you are to the

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people at the very top and the lower you are, the closer you are to the people at the very bottom of your society". The scale is used to measure the subjective SES across different populations in India and other countries [32, 33]. A score of 0-10 was generated as per the number of rungs marked by the respondents and the variable of subjective SES was coded as 0-3 as "low", 4-7 as "middle" and 8-10 as "high" [34].

The monthly per capita consumption expenditure (MPCE) quintile was assessed using household consumption data. The MPCE was used as one of the measures of objective SES. Sets of 11 and 29 questions on the expenditures on food and non-food items, respectively, were used to canvas the consumption pattern of the sample households. Food expenditure was collected based on a reference period of seven days, and non-food expenditure was collected based on reference periods of 30 days and 365 days. 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 [29]. The variable was then divided into five quintiles i.e., from poorest to richest. However, for the purpose of this study, the MPCE quintile variable was recoded as 'low' (poorest and poorer), 'middle' and 'high' (richer and richest) [35].

Another objective SES measure was educational status of older adults. As documented in multiple studies, brain functioning and cognitive processing are modulated by formal education of individuals and the illiterate population who received no formal education due to several socio-cultural and economic reasons are at greater risk for cognitive impairment and dementias [36]. The educational status in the current study was coded as no education/primary not completed, primary, secondary and higher. Finally, caste system in India is a social hierarchy that is passed down through families and groups of people dictate the professions and social prestige merely by their caste status [19]. As an objective SES measure, caste in the study was recoded as Scheduled Tribes, Scheduled Castes, Other

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Backward Classes, and Others based on specific administrative classification [19]. The Scheduled Caste includes a group of the population that is socially segregated and financially/economically marginalized by their low status as per Hindu caste hierarchy. The Scheduled Tribes and Scheduled Castes are among the most disadvantaged socio-economic groups and have substantially lower wealth than the "forward" caste groups in India [37]. The Other Backward Classes refer to the group of people who were identified as "educationally, economically and socially backward" and occupy positions in the middle [38]. The 'Others' caste category denotes the groups having higher social status and refers to a large number of the forward castes and comparatively advantaged populations in the country [38].

Other covariates

Individual factors: The following socio-demographic variables were included in the analysis according to the previous literature [39–42]. Age was used as continuous variable. Sex was coded as male and female. Working status was coded as currently working, retired, and not working. Marital status was coded as currently married, widowed and others. Others included divorced/separated/never married. Living arrangement was coded as living alone, living with spouse, living with spouse and children and living with others. Social participation was coded as 'no' and 'yes'. Social participation was measured through the question "Are you a member of any of the organizations, religious groups, clubs, or societies?" The response was coded as 'no' and 'yes' [43]. Physical activity status was coded as frequent (every day), rare (more than once a week, once a week, one to three times in a month), and never. The question through which physical activity was assessed was "How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health centre or gym, cycling, or digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads"? [44].

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Health factors: Health status covariates that were shown to associate with cognitive impairment include depression [42], functional difficulty [45] and morbidity [46]. The probable major depression among older adults with symptoms of dysphoria was calculated using the Short Form Composite International Diagnostic Interview (CIDI-SF). This scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [29]. On a scale of 0-10, the respondents who had three or more symptoms were considered as depressed [47]. Self-rated health was coded excellent, very good, good, fair and poor [43]. Difficulty in activities of daily living (ADL) was coded as 'no' and 'yes'. ADL refers to normal daily self-care activities (such as movement in bed, changing position from sitting to standing, feeding, bathing, dressing, grooming, personal hygiene, etc.) The ability or inability to perform ADLs is used to measure a person's functional status, especially in case of people with disabilities and the ones in their older ages [48]. Difficulty in instrumental ADL (IADL) was coded as 'no' and 'yes'. Respondents were asked if they were having any difficulties that were expected to last more than three months, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places [43]. Morbidity was coded as no morbidity, 1 and 2+ [43]. This variable was created using the data on chronic diseases which include hypertension, chronic heart diseases, stroke, any chronic lung disease, diabetes, cancer or malignant tumor, any bone/joint disease, neurological/psychiatric disease, or high cholesterol.

Household/community-related factors: Taking cue from earlier research, we also added the following characteristics [39, 49, 50]. Religion was coded as Hindu, Muslim, Christian, and Others. Place of residence was coded as rural and urban. The geographical regions of India were categorized as North, Central, East, Northeast, West, and South.

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Statistical analysis

We estimated descriptive statistics and presented cross-tabulations of the outcome in the study. Additionally, multivariable logistic and linear regression analysis [51, 52] were conducted to establish the association between the outcome variable (cognitive impairment) and socio-economic status. The results were presented in the form of odds ratio (OR), adjusted OR (aOR) and standardized regression coefficients (beta) with 95% confidence interval (CI). Variance inflation factor (VIF) was generated in STATA 14 [53] to check the multicollinearity and it was found that there was no evidence of multicollinearity in the variables used [54, 55].

Moreover, interaction effects [43, 56] were observed for subjective SES and multiple objective SES measures with cognitive impairment among older adults in India. Model-1 represents the unadjusted effects whereas model-2 represents the adjusted effects. The analysis was controlled for age, sex, working status, marital status, living arrangement, social participation, physical activity, depression, self-rated health, difficulty in ADL and IADL, morbidity, religion, place of residence and regions. Models-3, 4 and 5 represent interaction effects which are adjusted for individual, health and household/community related factors.

Patient and Public Involvement

No patient involved

Results

Table-1 represents socio-economic and demographic profile of Indian older adults included in this study. The mean age of the study population was 69.2 years (standard deviation: 7.5). It was found that about 41.7 per cent of older adults belong to low subjective SES and only seven per cent belong to higher subjective SES. Additionally, about 43.4 per cent of older adults belonged to low objective SES and about 35.6 percent belonged to higher objective

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SES. About 13.1% (n=3250) older adults were cognitively impaired in reference to 86.9% (n=21580) who were not cognitively impaired.

About 26.4 per cent of older adults got retired from employment and 30.8 per cent were currently working. Nearly 36.2 per cent of older adults were widowed. Only 5.7 per cent of older adults were living alone and 68.3 per cent were living with their children and spouse. Only 4.5 per cent of older adults reported that they socially participate. Nearly, 69.3 per cent of older adults were never involved in any physical activity. About 8.7 per cent of older adults suffered from major depression. Nearly, 15.0 per cent of older adults reported poor self-rated health. About 24.4 percent and 48.7 per cent of older adults reported difficulty in ADL and IADL.

[Insert table-1 here]

Figure-2 presents the percentage distribution of subjective SES (ladder SES) that ranges from 1 to 10, representing lowest to highest rank. A proportion of 8.2% of older adults marked their SES in the bottom of the ladder (lowest), whereas a proportion of only 1.1% marked their SES at the top of the ladder (highest).

[Insert figure-2 here]

Figure-3 reveals that lower the subjective SES (17.8 per cent; $p<0.001$) of an older adult, higher the prevalence of cognitive impairment.

[Insert figure-3 here]

Figure-4 reveals that lower the objective SES (measured by MPCE quintile) (16.6 per cent; $p<0.001$) of an older adult, higher the prevalence of cognitive impairment. With regard to other objective SES measures, older adults with no education/primary not completed had

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highest prevalence of cognitive impairment (19.9%; p<0.001). Similarly, older adults from Scheduled Tribe category had highest prevalence of cognitive impairment (22.1%; p<0.001).

[Insert figure-4 here]

Table-2a represents the logistic regression estimates of cognitive impairment among older adults. In model-2 which is adjusted model, it was revealed that older adults who belonged to lower subjective SES had significantly higher odds of cognitive impairment [aOR: 2.04; p<0.05] in reference to older adults who belonged to higher subjective SES. Moreover, older adults who belonged to lower objective SES (MPCE quintile) had 32% significantly higher odds of suffering from cognitive impairment [aOR: 1.32; p<0.05] in comparison to older adults who belonged to higher objective SES (MPCE quintile). Older adults who were not educated/ with minimum education had significantly higher odds of cognitive impairment in reference to older adults with higher education [aOR: 22.4; p<0.05]. Older adults who belonged to the Scheduled Castes and Scheduled Tribes had 22% [aOR: 1.22; p<0.05] and 80% [aOR: 1.80; p<0.05] significantly higher odds of cognitive impairment in reference to older adults from other (higher) caste category, respectively. Table-S1 represents the regression estimates for cognitive impairment among older adults in India. In table S2, model-1 was controlled for subjective SES and individual, health and household factors; model-2 was controlled for MPCE quintile and individual, health and household factors; model-3 was controlled for education and individual, health and household factors and model-4 were controlled for caste and individual, health and household factors. Table S2 represents sensitivity analysis estimates (aORs) of cognitive impairment among older adults and the outcome variable i.e., cognitive impairment was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups).

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[Insert Table-2a]

In model-3, 4 and 5 (Table-2b) which reveals the interaction results for cognitive impairment. It was found that older adults who belong to lower subjective as well as objective SES were 2.45 times significant more likely to suffer from cognitive impairment in reference to older adults from higher subjective as well as objective SES (MPCE quintile) [aOR: 2.45; p<0.05]. In reference to older adults with high ladder SES and higher education, older adults with high ladder SES and no education/primary not completed [aOR: 24.14; p<0.05], middle ladder SES and no education/primary not completed [aOR: 37.07; p<0.05] and low ladder SES and no education/primary not completed [aOR: 54.41; p<0.05] had significantly higher odds for cognitive impairment. Older adults from low ladder SES and belonged to the Scheduled Castes [aOR: 2.88; p<0.05], low ladder SES and belonged to the Scheduled Tribes [aOR: 4.56; p<0.05] and low ladder SES and belonged to the Other Backward Classes [aOR: 2.15; p<0,05] had significantly higher odds of cognitive impairment in reference to older adults from high ladder SES and other (higher) caste category. Table S3 represents sensitivity analysis estimates (interaction models) for cognitive impairment among older adults and the outcome variable i.e., cognitive impairment was adjusted for education.

[Insert Table-2b]

Discussion

This study using a large representative data on older population in India was in parallel to multiple earlier studies in India and other developing countries which found that older individuals with lower SES experience cognitive impairment compared with people with higher SES [1, 57–59]. This association has been identified in case of both objective and subjective measures of SES. Studies have illustrated empirical evidence on the positive relationship between SES as measured by objective indices of material resources and

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subjective measures, and psychological well-being [60, 61]. Similarly, the interactive effect in our study found that older adults with lower levels of subjective and objective SES were at a greater risk of having cognitive impairment.

However, subjective SES was identified to have a much stronger association with cognitive impairment in the unadjusted and adjusted regression estimates in comparison to objective SES measured by household MPCE quintile. With respect to this strong association, there can be some possible explanations. At first, obviously, subjective SES was more meaningful than household wealth index. Higher economic status does not necessarily mean more resources at disposal, if compared with higher individual circumstances, but positive social comparison does. In addition, people with greater household economic status may endure more pressures and mental stress, which in turn may affect their mental health status and cognitive ability [62]. This could be mainly due to the subjectivity character of subjective SES. This potential explanation can also be attributed to different perceptions towards wealth and social status among older population in India.

Furthermore, considering the education-cognitive function association, the current findings suggest that higher education is a protective factor against cognitive impairment in older individuals. A hypothesized mechanism is that education is transformed to personal experience and self-perceptions about own social standing, which in turn translate into health and disease. Similarly, the current findings suggest that older adults with no education and low levels of subjective SES had greater odds of cognitive impairment compared to those with higher education and higher subjective SES. This finding agrees with the previous evidence on the moderating role of education in the relationship between subjective SES and cognitive function. Also, as documented in earlier research [22], subjective SES is a means through which education may influence health outcomes among older people. Nevertheless,

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proper path analysis using longitudinal data and conducting moderation as well as mediation analyses is needed to test these claims.

Finally, older adults belonging to the lower caste groups (with low social status) were found to be more likely to be cognitively impaired in the study in comparison to those belong to higher castes. Importantly, in a previous study, it was observed that indicators of subjective SES differ across socio-demographic groups including race, and interpretations may vary when perceiving themselves on the existing social hierarchy [24]. Previous studies in India have demonstrated that the socioeconomic disadvantages such as lower income and lack of education were associated with belonging to lower castes (scheduled tribes and other backward classes) [18, 19, 63, 64]. Further, lower caste status being a factor of less opportunities in economic spectrum also contributes to poorer health, health inequalities and mortality burden in India [17, 38, 65]. It is however demonstrated that since individuals may estimate their SES relative to others in a specific community or social group, the social disadvantage may not necessarily negatively influence their mental wellbeing [60]. This suggests that the SES could be better captured by assessing the interactions between subjective and objective measures of SES.

The current study provides crucial clues about what measure of SES highly reflect on the mental health in old age by underlining the importance of the cumulative dimension of subjective SES and different traditional measures including wealth status, education and caste, and showing the underperformance of traditional measure of wealth status compared to subjective SES. Considering the current findings and the existing evidence [60], separate SES-related ladders that evaluate subjective perceptions of individuals' economic status (MPCE), education and social status (caste hierarchy in Indian context) may be suggested in wellbeing research. This is because subjective SES may reflect individuals' present social circumstances and an assessment of their past experiences and future prospects. As suggested

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in previous studies, subjective perception of one's SES might also encompass his/her household resources, life chances and opportunities, and thus captures a broad range of aspects of social stratification than traditional measures of SES do [23, 31, 66]. The finding further underscores the need for future longitudinal investigation of subjective SES-related measurement strategies to obtain a better understanding of the SES-cognitive functioning link especially in poor resource settings. The effects of country affluence on population health have been demonstrated. Several cross-country comparisons have documented considerable variations in the strength of subjective SES-health relationship between affluent and low-income countries with a stronger association in the later ones [67, 68].

There are several limitations of the present study to be considered. The major limitation is the cross-sectional design of the study eliminating the opportunity for drawing of causal inferences among variables. Indeed, it is important to consider that some individuals may become cognitively impaired because they are illiterate and could not respond to several measures with accuracy. Importantly, due to lack of evidence of algorithm for combing various cognitive tests in the Indian context, we weight all tests equally and use an additive measure for overall cognitive functioning in the current study. Some of the tests may be far better than others in screening for or assessing the degree of cognitive dysfunction or dementia, and thus, the current approach may be misleading and should be addressed in future studies. In addition, there is a possibility of some of the covariates included in the analysis potentially being on the pathway from, say, objective SES to cognition. For example, in case of objective SES measured by caste, this is generally determined at birth, which could then influence individuals' life course in multiple ways, including how often they partake in physical activity or social activity, eventually resulting in collider stratification bias in the multivariable models in the current study. Finally, there may also be floor or ceiling effects for SES because we have only three categories for both SES measures.

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Notwithstanding these limitations, there were several advantages in this study. At first, this may be the first study to identify the association between both objective and subjective SES indicators and cognitive impairment based on a comprehensive measure with a score of 0 to 43 among the older Indian population. The large sample of the present study that is free from selection bias includes all SES groups of Indian population that credits to the representativeness and generalizability of the findings. In addition to including multiple SES groups, this study also includes participants living both in rural and urban areas which enhance the generalizability of the results. Further, the findings of the present study provide empirical support to the body of literature that highlights the vulnerability of older adults who have low subjective and objective SES to the worse mental health outcomes. Finally, future research may focus on longitudinal associations of various socioeconomic markers with mental health outcomes among middle aged and older adults in India.

Conclusion

The current findings highlight the importance of subjective SES measure and its interaction with objective (traditional) measures of SES including wealth, education and caste status in assessing the mental health outcomes in developing countries. The results also suggest that more attention should be placed on subjective SES indicators when investigating socioeconomic influences on cognitive functioning among older adults in India.

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Abbreviations:

SES: Socio-economic status

aOR: Adjusted odds ratio

CI: Confidence interval

LASI: Longitudinal Ageing Study in India

PSU Primary Sampling Unit

CEB: Census Enumeration Block

MPCE: Monthly per capita consumption expenditure

ADL: Activities of daily living

IADL: Instrumental activities of daily living

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Declarations

Ethics approval

The necessary guidelines and ethics for undertaking the LASI survey were approved by the Indian Council of Medical Research (ICMR). ICMR approved the study. There was no number/ID of the approval(s) mentioned in the LASI report (https://www.iipsindia.ac.in/sites/default/files/LASI_India_Report_2020_compressed.pdf). All methods were carried out in accordance with relevant guidelines and regulations by the Indian Council of Medical Research (ICMR).

Contributor statement

Conceived and designed the research paper: TM and TVS; analysed the data: SS and TM; Contributed agents/materials/analysis tools: TVS; Wrote the manuscript: TM and SS; Refined the manuscript: TM, SS and TVS.

Competing interest

The authors declare that there is no competing interest

Funding

No funding was received for the study

Data sharing statement

The study uses a secondary data which is available on request through

https://www.iipsindia.ac.in/content/lasi-wave-i

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Table-1. Socio-economic and demographic profile of older adults in India.

Background characteristics	Sample	Percentage
Socio-economic status		
Subjective SES		
Ladder SES		
Low	13,127	41.7
Medium	16,142	51.3
High	2,195	7.0
Objective SES		
MPCE quintile		
Low	13,660	43.4
Medium	6,590	21.0
High	11,213	35.6
Education		
Not educated/primary not completed	21,381	68.0
Primary	3,520	11.2
Secondary	4,371	13.9
Higher	2,191	7.0
Caste		
Scheduled Castes	5,949	18.9
Scheduled Tribes	2,556	8.1
Other Backward Classes	14,231	45.2
Others	8,729	27.7
Individual characteristics		
Age in years (mean (sd))		69.2 (7.5)
Sex		
Male	14,931	47.5
Female	16,533	52.6
Working status		
Working	9,680	30.8
Retired	13,470	42.8
Not working	8,314	26.4
Marital status		
Currently married	19,391	61.6
Widowed	11,389	36.2
Others	684	2.2
Living arrangement		
Living alone	1,787	5.7
Living with spouse only	6,397	20.3
Living with children and spouse	21,475	68.3
Living with others.	1,805	5.7
Social participation		
No	30,053	95.5
Yes	1,411	4.5
Physical activity		
Frequent	5,651	18.0
Rarely	4,023	12.8
Never	21,790	69.3
Health factors		
Depression*		

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	No	27,995	91.3
	Yes	2,657	8.7
Self-rated health*			
	Excellent	964	3.1
	Very good	4,192	13.6
	Good	10,693	34.7
	Fair	10,331	33.5
	Poor	4,630	15.0
Difficulty in ADL			
	No	23,802	75.7
	Yes	7,662	24.4
Difficulty in IADL			
	No	16,130	51.3
	Yes	15,334	48.7
Morbidity			
	No morbidity	14,773	47.0
	1	9,171	29.2
	2+	7,520	23.9
Household/community-related factors			
Religion			
	Hindu	25,871	82.2
	Muslim	3,548	11.3
	Christian	900	2.9
	Others	1,145	3.6
Place of residence			
	Rural	22,196	70.6
	Urban	9,268	29.5
Region			
	North	3,960	12.6
	Central	6,593	21.0
	East	7,439	23.6
	Northeast	935	3.0
	West	5,401	17.2
	South	7,136	22.7
Total		31,464	100.0

**if Sample may be less due to missing cases; sd: standard deviation*

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Table-2a. Regression estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1		Model-2	
	OR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Socio-economic status				
Subjective SES				
Ladder SES				
High	Ref.		Ref.	
Medium	2.01*(1.63,2.47)	0.107	1.43*(1.14,1.79)	0.102
Low	3.83*(3.11,4.71)	0.172	2.04*(1.63,2.56)	0.157
Objective SES				
MPCE quintile				
High	Ref.		Ref.	
Medium	1.20*(1.07,1.34)	0.011	1.12(0.99,1.26)	0.020
Low	1.50*(1.37,1.64)	0.032	1.32*(1.19,1.46)	0.051
Education				
Not educated/primary not completed	58.91*(27.97,124.07)	0.694	22.40*(10.58,47.41)	0.514
Primary	6.45*(2.96,14.03)	0.204	3.83*(1.75,8.36)	0.142
Secondary	2.55*(1.13,5.73)	0.108	1.94(0.86,4.38)	0.072
Higher	Ref.		Ref.	
Caste				
Scheduled Castes	1.03(0.91,1.16)	0.005	1.22*(1.06,1.39)	0.027
Scheduled Tribes	1.38*(1.22,1.55)	0.029	1.80*(1.55,2.09)	0.067
Other Backward Classes	0.86*(0.78,0.96)	-0.038	0.98(0.87,1.1)	-0.005
Others	Ref.		Ref.	

Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Model-2 was adjusted for Individual, Health and Household factors

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Table-2b. Interaction estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-3		Model-4		Model-5	
	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Ladder SES # MPCE quintile						
High # high	Ref.					
High # middle	1.28(0.92,1.77)	0.085				
High # low	1.95*(1.39,2.72)	0.102				
Middle # high	0.79(0.42,1.48)	0.008				
Middle # middle	1.51*(1.08,2.11)	0.084				
Middle # low	2.09*(1.49,2.95)	0.092				
Low # high	1.24(0.77,1.98)	0.011				
Low # middle	1.77*(1.28,2.45)	0.125				
Low # low	2.45*(1.77,3.39)	0.160				
Ladder SES # Education						
High # higher			Ref.			
High # secondary			2.12(0.22,20.49)	0.021		
High # primary			8.91*(1.1,72.16)	0.037		
High # Not educated/primary not completed			24.14*(3.34,174.63)	0.168		
Middle # higher			1.57(0.18,13.48)	0.032		
Middle # secondary			3.06(0.41,22.74)	0.116		
Middle # primary			5.82(0.8,42.55)	0.167		
Middle # Not educated/primary not			37.07*(5.19,264.9)	0.568		

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completed				
Low # higher	2.11(0.13,34.01)	0.020		
Low# secondary	4.68(0.6,36.81)	0.079		
Low # primary	8.65*(1.17,64.2)	0.129		
Low # Not educated/primary not completed	54.41*(7.61,388.93)	0.602		
Ladder SES # Caste				
High # Others			Ref.	
High # Other Backward Class			1.39(0.83,2.32)	0.003
High # Scheduled Caste			1.69(0.82,3.48)	0.016
High # Scheduled Tribe			1.04(0.52,2.07)	-0.005
Middle # Others			1.53*(1.01,2.32)	0.081
Middle # Other Backward Class			1.60*(1.06,2.41)	0.081
Middle # Scheduled Caste			1.89*(1.23,2.89)	0.078
Middle # Scheduled Tribe			2.72*(1.77,4.2)	0.105
Low # Others			2.27*(1.49,3.46)	0.083
Low # Other Backward Class			2.15*(1.42,3.26)	0.111
Low # Scheduled Caste			2.88*(1.89,4.39)	0.108
Low # Scheduled Tribe			4.56*(2.97,6.98)	0.132

#: Interaction; Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Model-3, 4 and 5 were adjusted for Individual, Health and Household factors

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Figure legend: -

Figure-1: Conceptual Framework

Figure-2 The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

Figure-3 Percentage of older adults with cognitive impairment by their subjective socio-economic status.

Figure-4 Percentage of older adults with cognitive impairment by their objective socio-economic status.

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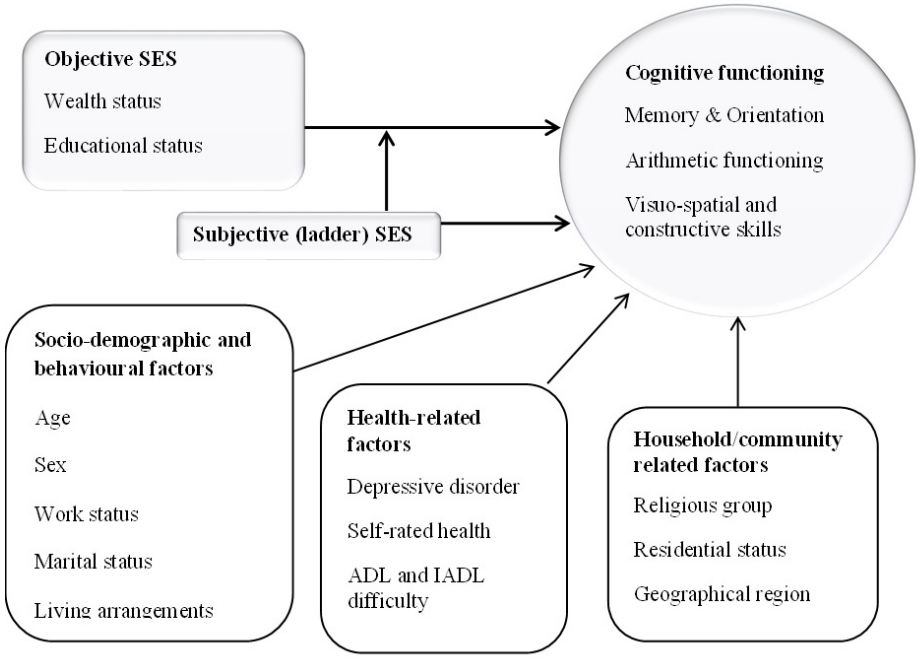

Figure-1: Conceptual Framework

179x134mm (144 x 144 DPI)

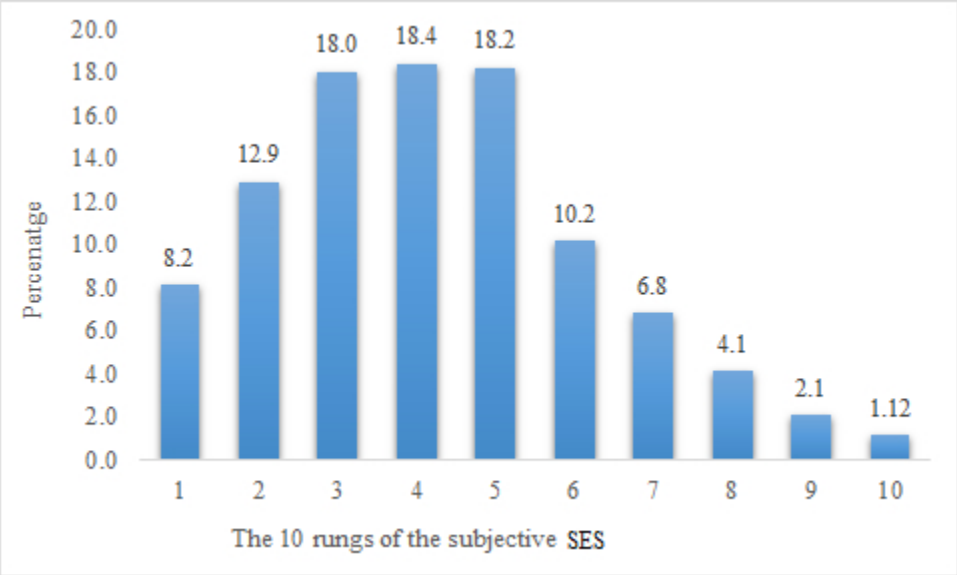

Figure-2 The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

85x51mm (144 x 144 DPI)

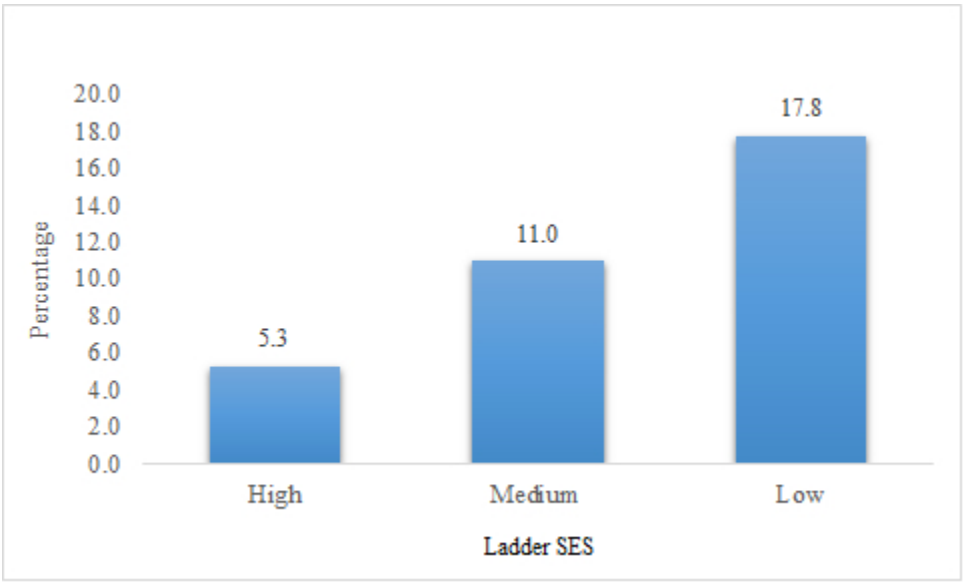

Figure-3 Percentage of older adults with cognitive impairment by their subjective socio-economic status.

85x51mm (144 x 144 DPI)

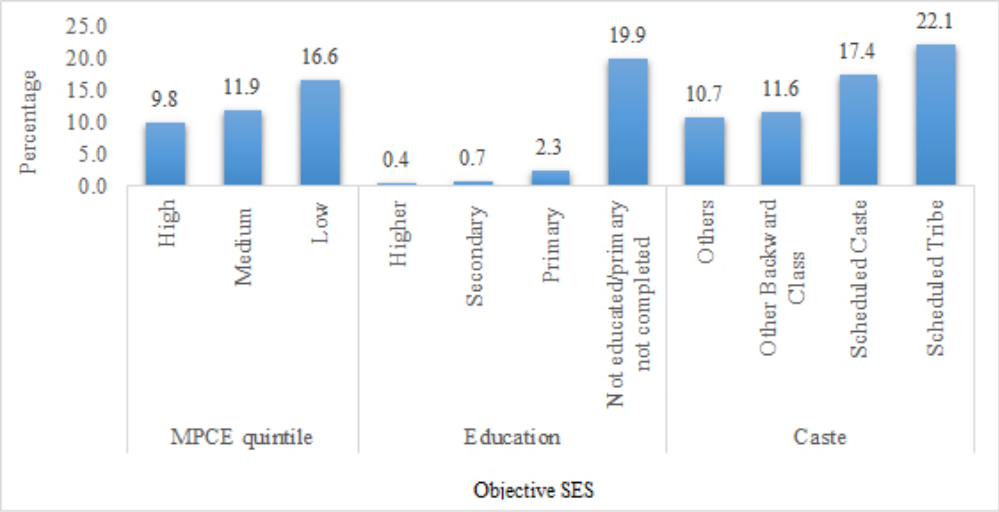

Figure-4 Percentage of older adults with cognitive impairment by their objective socio-economic status.

148x77mm (96 x 96 DPI)

Table-S1. Regression estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1		Mode-2		Model-3		Model-4	
	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Subjective SES								
Ladder SES								
Low	Ref.							
Medium	1.76*(1.42, 2.18)	0.17						
High	3.16*(2.54, 3.93)	0.30						
Objective SES								
MPCE quintile								
Low			Ref.					
Medium			1.3*(1.16,1.46)	0.06				
High			1.76*(1.6,1.94)	0.15				
Education								
Not educated/primary not completed					31.13*(14.74, 65.73)	0.58		
Primary					4.75*(2.18,10.35)	0.17		
Secondary					2.19(0.97,4.94)	0.09		
Higher					Ref.			
Caste								
Scheduled Castes							1.88*(1.66, 2.15)	0.13
Scheduled Tribes							2.75*(2.38, 3.18)	0.17
Other Backward Classes							1.26*(1.13, 1.42)	0.08
Others							Ref.	

Ref: Reference; aOR: Adjusted Odds Ratio;; CI: Confidence Interval; SES: Socio-economic status; MPCE: Monthly per capita consumption expenditure;

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Model-1 was control for Subjective SES and Individual, Health and Household factors; Model-2 was controlled for MPCE quintile and Individual, Health and Household factors; Model-3 was controlled for education and Individual, Health and Household factors and Model-4 was controlled for caste and Individual, Health and Household factors.

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Table-S2. Sensitivity analysis estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1 OR (95% CI)	Model-2 aOR (95% CI)
Socio-economic status		
Subjective SES		
Ladder SES		
High	Ref.	Ref.
Medium	1.44*(1.21,1.7)	1.53*(1.28,1.82)
Low	1.81*(1.52,2.16)	2.04*(1.69,2.46)
Objective SES		
MPCE quintile		
High	Ref.	Ref.
Medium	1.06(0.95,1.18)	1.14*(1.01,1.27)
Low	1.17*(1.08,1.28)	1.28*(1.16,1.42)
Education		
Not educated/primary not completed	0.72*(0.63,0.82)	0.21*(0.18,0.25)
Primary	0.81*(0.69,0.95)	0.43*(0.36,0.51)
Secondary	0.87(0.75,1.01)	0.61*(0.52,0.71)
Higher	Ref.	Ref.
Caste		
Scheduled Castes	1.03(0.91,1.16)	1.26*(1.11,1.44)
Scheduled Tribes	1.21*(1.08,1.37)	1.71*(1.47,1.98)
Other Backward Classes	0.84*(0.76,0.92)	0.98(0.88,1.09)
Others	Ref.	Ref.

Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Cognitive impairment was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups); Model-2 was adjusted for Individual, Health and Household related factors

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Table-S3. Sensitivity analysis estimates (Interaction models) for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-3	Model-4	Model-5
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Ladder SES # MPCE quintile			
High # high	Ref.		
High # middle	1.44*(1.14,1.83)		
High # low	1.97*(1.52,2.57)		
Middle # high	1.14(0.73,1.76)		
Middle # middle	1.68*(1.3,2.17)		
Middle # low	2.16*(1.64,2.85)		
Low # high	1.08(0.72,1.62)		
Low # middle	1.89*(1.48,2.42)		
Low # low	2.51*(1.95,3.23)		
Ladder SES # Education			
High # higher		Ref.	
High # secondary		0.6*(0.39,0.94)	
High # primary		0.54*(0.32,0.92)	
High # Not educated/primary not completed		0.19*(0.12,0.3)	
Middle # higher		1.52*(1.09,2.13)	
Middle # secondary		0.93(0.67,1.28)	
Middle # primary		0.67*(0.48,0.94)	
Middle # Not educated/primary not completed		0.34*(0.25,0.47)	
Low # higher		1.84*(1.15,2.95)	
Low# secondary		1.34(0.94,1.93)	
Low # primary		0.87(0.61,1.25)	
Low # Not educated/primary not completed		0.47*(0.34,0.65)	
Ladder SES # Caste			
High # Others			Ref.
High # Other Backward Class			1.33(0.92,1.94)
High # Scheduled Caste			2.04*(1.14,3.62)
High # Scheduled Tribe			0.97(0.52,1.8)
Middle # Others			1.72*(1.3,2.26)
Middle # Other Backward Class			1.73*(1.3,2.29)
Middle # Scheduled Caste			2.23*(1.65,3.03)
Middle # Scheduled Tribe			2.49*(1.82,3.42)

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Low # Others	2.19*(1.63,2.96)
Low # Other Backward Class	2.16*(1.61,2.89)
Low # Scheduled Caste	2.89*(2.13,3.92)
Low # Scheduled Tribe	4.99*(3.65,6.83)

#: Interaction; Ref: Reference; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status;
Cognitive impairment was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups); Model-3, 4 and 5 were adjusted for Individual, Health and Household related factors

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	1-2
Introduction		
Background/rationale	2	5
Objectives	3	6
Methods		
Study design	4	7
Setting	5	7
Participants	6	7
Variables	7	7-8
Data sources/ measurement	8*	7
Bias	9	-
Study size	10	7
Quantitative variables	11	7-8
Statistical methods	12	11-12
Results		
Participants	13*	12-13
Descriptive data	14*	12-13
		12-13
Outcome data	15*	
Main results	16	12-14
Other analyses	17	12-14
Discussion		
Key results	18	15-18
Limitations	19	17
Interpretation	20	15-18
Generalisability	21	15-18
Other information		
Funding	22	20

*Give information separately for exposed and unexposed groups.

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BMJ Open

Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2021-052501.R3
Article Type:	Original research
Date Submitted by the Author:	16-Jul-2022
Complete List of Authors:	Muhammad, T; International Institute for Population Sciences, Department of Population Policies and Programs Sekher, T.V; International Institute for Population Sciences, Department of Population Policies and Programs Srivastava, Shobhit; International Institute for Population Sciences
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Health policy, Public health
Keywords:	Old age psychiatry < PSYCHIATRY, Delirium & cognitive disorders < PSYCHIATRY, MENTAL HEALTH, Economics < TROPICAL MEDICINE

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Association of objective and subjective socioeconomic markers with cognitive impairment among older adults: cross-sectional evidence from a developing country

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Abstract

Objective: This study explored how various markers of objective and subjective socio-economic status (SES) are associated with cognitive impairment among older Indian adults.

Design: A cross-sectional study was conducted using large nationally-representative survey data.

Setting and participant: This study used data from the Longitudinal Aging Study in India (2017-18). The sample included 31,464 older adults aged 60 years and above.

Primary and secondary outcome measures: Outcome variable was cognitive impairment, measured through broad domains of memory, orientation, arithmetic function, and visuo-spatial and constructive skills. We estimated descriptive statistics and presented cross-tabulations of the outcome. Chi-square test was used to evaluate the significance level of differences in cognitive impairment by subjective (ladder) and objective SES measures (monthly per-capita consumption expenditure (MPCE) quintile, education and caste status). Multivariable linear and logistic regression analyses were conducted to fulfil the objectives.

Results

A proportion of 41.7% and 43.4% of older adults belonged to low subjective (ladder) and objective (MPCE) SES, respectively. Older adults with low subjective [aOR: 2.04; $p<0.05$] and objective SES [aOR: 1.32; $p<0.05$] had higher odds of having cognitive impairment in comparison to their counterparts, with a stronger subjective SES-cognitive impairment association. Older adults with lower education or belonged to lower caste had higher odds of cognitive impairment than their counterparts. Interaction analyses revealed that older adults who belonged to lower subjective and objective (poorest MPCE quintile, Scheduled Castes and lowest education) SES had 2.45 (CI: 1.77, 3.39), 4.56 (CI: 2.97,6.98) and 54.41 (CI:

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7.61,388.93) higher odds of cognitive impairment than those from higher subjective and objective SES.

Conclusion

Subjective measures of SES were linked to cognitive outcomes, even more strongly than objective measures of SES; considering the relative ease of obtaining such measures, subjective SES measures are a promising target for future study on socioeconomic indicators of cognitive impairment.

Keywords: *Subjective; Objective; Socioeconomic status; Cognitive impairment; Older adults, India*

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Strengths and limitations:

- The study utilizes a large nationally representative sample of older persons from both rural and urban areas of India
- The cross-sectional design of the study eliminates the opportunity for drawing of causal inferences among variables.
- Some individuals may become cognitively impaired because they are illiterate and could not respond with accuracy to several measures

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Introduction

Cognitive impairment, including dementia as an outcome of decline in cognitive ability, increases considerably with the rapidly growing population of older adults [1]. Worldwide, almost 80% of the general public are concerned about developing dementia at some point in time and 1 in 4 people think that they can do nothing to prevent such a cognitive decline [2].

Various indices of economic hardship, including lack of education, poor household economy, unemployment, and employment frustration, are linked with poor physical health conditions resulting in cognitive deficits [3–5]. Similarly, evidence suggests an aggregate or cumulative effect of socio-economic risk factors on cognitive impairment in later years of life [6–8]. Persons with higher cumulative socioeconomic status (SES) demonstrated an advantage in cognitive functioning [9]. A growing body of literature suggests that people who accumulated more wealth may be able to more easily translate it into better environmental circumstances or less stressful living conditions, further contributing to better cognitive health in later life [7, 10, 11]. Studies reported improvements in mental well-being for older people after the introduction of an income supplemental program [12, 13]. Measured by a test of processing speed, associations of educational attainment and current poverty index were found with late-life cognitive impairment in multiple studies [7, 14, 15]. Furthermore, a major contributing factor may include poor literacy resulting in an inability to benefit from strategies for early prevention of cognitive impairment [16].

Two approaches to SES: Subjective and objective SES measures

Objective SES is commonly indicated by household wealth index and individual educational attainment, and caste status in particular Indian context [17–19]. Although these indicators are highly correlated [20], they reflect more of one's power or prestige [21]. In

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comparison, the subjective SES captures individuals' perceptions of their position in the social hierarchy, thus representing a psychological process [22].

In this regard, people make judgments of where they belong in the social hierarchy relative to others based on cognitive averaging of their economic status, education, occupation, and other objective indicators using different reference groups [23]. There is a growing body of research documenting that if people perceive themselves to be subordinate to others, they report lower self-esteem and greater stress, and they are likely to suffer from diseases more often than people who do not regard themselves to be of lower status [24]. Hence, subjective SES as a rank-based judgment that is composed of an evaluative judgment whereas the objective resources would place a person in rank within a specific context, which is derived mainly via the social comparison process.

Evidence for the association between poor socioeconomic indicators with worse mental health outcomes is abundant in the geriatric research. Many previous studies in India and other countries have reinforced that illiteracy, lower social status and poor financial status were strongly associated with worse cognitive function at the individual level [1, 25, 26]. Similarly, the association of subjective SES and physical and mental health of older adults is explored in a couple of studies in Asian countries [27, 28]. However, the difference in the role that subjective and objective socioeconomic factors play in contributing to declining in late life cognition is poorly understood in the context of developing countries. Therefore, in this study, we aimed to explore the late-life cognitive impairment as a function of older individuals' objective and subjective SES using a large representative survey information of older adults aged 60 and above in India. A conceptual framework based on the abovementioned theoretical background is summarised in Figure-1.

Data, variables, and methods

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Data Source

We utilized data from the recent release of Longitudinal Ageing Study in India (LASI) wave 1 [29]. LASI is a full-scale national survey of scientific investigation of the health, economic, and social determinants and consequences of population aging in India, conducted in 2017-18. The LASI is a nationally representative survey of over 72000 older adults aged 45 and above across all states and union territories (UTs) of India. The survey adopted a three-stage sampling design in rural areas and a four-stage sampling design in urban areas. In each state/UT, the first stage involved the selection of Primary Sampling Units (PSUs), that is, sub-districts (Tehsils/Talukas), and the second stage involved the selection of villages in rural areas and wards in urban areas in the selected PSUs [29]. In rural areas, households were selected from selected villages in the third stage. However, sampling in urban areas involved an additional stage. Specifically, in the third stage, one Census Enumeration Block (CEB) was randomly selected in each urban area [29]. In the fourth stage, households were selected from this CEB. The detailed methodology, with the complete information on the survey design and data collection is published elsewhere and in the survey report [29, 30]. The present study is conducted on eligible respondents aged 60 years and above (31,464 older individuals from both rural and urban areas).

The necessary guidelines and ethics for undertaking the LASI survey were approved by the Indian Council of Medical Research (ICMR). The agencies that conducted the field survey for the data collection had collected prior informed consent (signed and oral) for both the interviews and biomarker tests from the eligible respondents in accordance with the Human Subjects Protection. All methods in this study were carried out in accordance with relevant guidelines and regulations by the ICMR.

Variable description

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Outcome variable

Cognitive impairment was measured through broad domains of memory, orientation, arithmetic function, and visuo-spatial and constructive skills. It is followed from the cognitive module of the Health and Retirement Study (HRS), the China Health and Retirement Longitudinal Study (CHARLS), and the Mexican Health and Aging Study (MHAS), based on different cognitive measures including: immediate (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 7s (0–5 points), computation (0-2) and backward counting from 20 (0–2 points); visuo-spatial and constructive skills based on paper folding (0-3) pentagon drawing (0-1); and object naming (0-2). The overall score ranged between 0 and 43, and a higher score indicated better cognitive functioning. The lowest 10th percentile was used as a proxy measure of poor cognitive functioning [29]. Further, for the analytical purpose, the score was reversed to assess the cognitive impairment among older adults and thus after reversing, the higher score indicated higher levels of cognitive impairment. In our study, the respondents who received assistance during the cognition module were excluded from the analysis.

SES exposures

The main explanatory variables were subjective SES (ladder SES) and objective SES (household wealth quintile, education and caste status) among older adults.

The subjective SES was assessed using the Macarthur scale [31], with a ladder technique and the question used to assess the variable was "Think of the ladder with 10 stairs as representing where people stand in our society. At the top of the ladder are the people who are the best off – those who have the most money, most education, and best jobs. At the bottom are the people who are the worst off – who have the least money, least education, and the worst jobs or no jobs. The higher up you are on this ladder, the closer you are to the

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people at the very top and the lower you are, the closer you are to the people at the very bottom of your society". The scale is used to measure the subjective SES across different populations in India and other countries [32, 33]. A score of 0-10 was generated as per the number of rungs marked by the respondents and the variable of subjective SES was coded as 0-3 as "low", 4-7 as "middle" and 8-10 as "high" [34].

The monthly per capita consumption expenditure (MPCE) quintile was assessed using household consumption data. The MPCE was used as one of the measures of objective SES. Sets of 11 and 29 questions on the expenditures on food and non-food items, respectively, were used to canvas the consumption pattern of the sample households. Food expenditure was collected based on a reference period of seven days, and non-food expenditure was collected based on reference periods of 30 days and 365 days. 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 [29]. The available categories of the variable comprised of five quintiles i.e., poorest, poorer, middle, richer and richest. Since keeping the actual categories would produce large number of categories during the interaction analysis, MPCE was further recoded into three categories for easy interpretability and better understanding while applying the interaction terms. Thus, the MPCE quintile was further recoded as 'low' (poorest and poorer), 'middle' and 'high' (richer and richest) [35].

Another objective SES measure was educational status of older adults. As documented in multiple studies, brain functioning and cognitive processing are modulated by formal education of individuals and the illiterate population who received no formal education due to several socio-cultural and economic reasons are at greater risk for cognitive impairment and dementias [36]. The educational status in the current study was coded as no education/primary not completed, primary, secondary and higher. Finally, caste system in India is a social hierarchy that is passed down through families and groups of people dictate

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the professions and social prestige merely by their caste status [19]. As an objective SES measure, caste in the study was recoded as Scheduled Tribes, Scheduled Castes, Other Backward Classes, and Others based on specific administrative classification [19]. The Scheduled Caste includes a group of the population that is socially segregated and financially/economically marginalized by their low status as per Hindu caste hierarchy. The Scheduled Tribes and Scheduled Castes are among the most disadvantaged socio-economic groups and have substantially lower wealth than the "forward" caste groups in India [37]. The Other Backward Classes refer to the group of people who were identified as "educationally, economically and socially backward" and occupy positions in the middle [38]. The 'Others' caste category denotes the groups having higher social status and refers to a large number of the forward castes and comparatively advantaged populations in the country [38].

Other covariates

Individual factors: The following socio-demographic variables were included in the analysis according to the previous literature that have shown their associations with the cognitive outcomes [39–42]. Age was used as continuous variable. Sex was coded as male and female. Working status was coded as currently working, retired, and not working. Marital status was coded as currently married, widowed and others. Others included divorced/separated/never married. Living arrangement was coded as living alone, living with spouse, living with spouse and children and living with others. Social participation was coded as 'no' and 'yes'. Social participation was measured through the question "Are you a member of any of the organizations, religious groups, clubs, or societies?" The response was coded as 'no' and 'yes' [43]. Physical activity status was coded as frequent (every day), rare (more than once a week, once a week, one to three times in a month), and never. The question through which physical activity was assessed was "How often do you take part in sports or vigorous activities, such as running or jogging, swimming, going to a health centre or gym, cycling, or

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digging with a spade or shovel, heavy lifting, chopping, farm work, fast bicycling, cycling with loads"? [44].

Health-related factors: Health-related covariates that were shown to associate with cognitive impairment and are considered as possible confounders of the SES-cognition relationship in the current analyses include depression [42], self-rated health [45], functional difficulty [46] and morbidity [47]. The probable major depression among older adults with symptoms of dysphoria was calculated using the Short Form Composite International Diagnostic Interview (CIDI-SF). This scale estimates a probable psychiatric diagnosis of major depression and has been validated in field settings and widely used in population-based health surveys [29]. On a scale of 0-10, the respondents who had three or more symptoms were considered as depressed [48]. Self-rated health was available in five-point scale, representing excellent, very good, good, fair and poor [49]. Difficulty in activities of daily living (ADL) was coded as 'no' and 'yes'. ADL refers to normal daily self-care activities (such as movement in bed, changing position from sitting to standing, feeding, bathing, dressing, grooming, personal hygiene, etc.) The ability or inability to perform ADLs is used to measure a person's functional status, especially in case of people with disabilities and the ones in their older ages [50]. Difficulty in instrumental ADL (IADL) was coded as 'no' and 'yes'. Respondents were asked if they were having any difficulties that were expected to last more than three months, such as preparing a hot meal, shopping for groceries, making a telephone call, taking medications, doing work around the house or garden, managing money (such as paying bills and keeping track of expenses), and getting around or finding an address in unfamiliar places [43]. Morbidity was coded as no morbidity, 1 and 2+ [43]. This variable was created using the data on chronic diseases which include hypertension, chronic heart diseases, stroke, any chronic lung disease, diabetes, cancer or malignant tumor, any bone/joint disease, neurological/psychiatric disease, or high cholesterol.

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Household/community-related factors: Taking cue from earlier research, we also added the following characteristics as control variables in order to improve the precision of the results [39, 51, 52]. Religion was coded as Hindu, Muslim, Christian, and Others. Place of residence was coded as rural and urban. The geographical regions of India were categorized as North, Central, East, Northeast, West, and South.

Statistical analysis

We estimated descriptive statistics and presented cross-tabulations of the outcome in the study. Additionally, multivariable logistic and linear regression analysis [53, 54] were conducted to establish the association between the outcome variable (cognitive impairment) and socio-economic status. The results were presented in the form of odds ratio (OR), adjusted OR (aOR) and standardized regression coefficients (beta) with 95% confidence interval (CI). Variance inflation factor (VIF) was generated in STATA 14 [55] to check the multicollinearity and it was found that there was no evidence of multicollinearity in the variables used [56, 57].

Moreover, interaction effects [43, 58] were observed for subjective SES and multiple objective SES measures with cognitive impairment among older adults in India. Model-1 represents the unadjusted effects whereas model-2 represents the adjusted effects. The analysis was controlled for age, sex, working status, marital status, living arrangement, social participation, physical activity, depression, self-rated health, difficulty in ADL and IADL, morbidity, religion, place of residence and regions. Models-3, 4 and 5 represent interaction effects which are adjusted for individual, health and household/community related factors.

Patient and Public Involvement

No patient involved

Results

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Table-1 represents socio-economic and demographic profile of Indian older adults included in this study. The mean age of the study population was 69.2 years (standard deviation: 7.5). It was found that about 41.7% of older adults belong to low subjective SES and only 7% belong to higher subjective SES. Additionally, about 43.4% of older adults belonged to low objective SES and about 35.6% belonged to higher objective SES. About 13.1% (n=3250) older adults were cognitively impaired in reference to 86.9% (n=21580) who were not cognitively impaired.

About 26.4% of older adults got retired from employment and 30.8% were currently working. Nearly 36.2% of older adults were widowed. Only 5.7% of older adults were living alone and 68.3% were living with their children and spouse. Only 4.5% of older adults reported that they socially participate. Nearly, 69.3% of older adults were never involved in any physical activity. About 8.7% of older adults suffered from major depression. Nearly, 15.0% of older adults reported poor self-rated health. About 24.4% and 48.7% of older adults reported difficulty in ADL and IADL.

[Insert table-1 here]

Figure-2 presents the percentage distribution of subjective SES (ladder SES) that ranges from 1 to 10, representing lowest to highest rank. A proportion of 8.2% of older adults marked their SES in the bottom of the ladder (lowest), whereas a proportion of only 1.1% marked their SES at the top of the ladder (highest).

[Insert figure-2 here]

Figure-3 reveals that lower the subjective SES (17.8%; $p<0.001$) of an older adult, higher the prevalence of cognitive impairment.

[Insert figure-3 here]

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Figure-4 reveals that lower the objective SES (measured by MPCE quintile) (16.6%; p<0.001) of an older adult, higher the prevalence of cognitive impairment. With regard to other objective SES measures, older adults with no education/primary not completed had highest prevalence of cognitive impairment (19.9%; p<0.001). Similarly, older adults from Scheduled Tribe category had highest prevalence of cognitive impairment (22.1%; p<0.001).

[Insert figure-4 here]

Table-2a represents the logistic regression estimates of cognitive impairment among older adults. In model-2 which is adjusted model, it was revealed that older adults who belonged to lower subjective SES had significantly higher odds of cognitive impairment [aOR: 2.04; p<0.05] in reference to older adults who belonged to higher subjective SES. Moreover, older adults who belonged to lower objective SES (MPCE quintile) had 32% significantly higher odds of suffering from cognitive impairment [aOR: 1.32; p<0.05] in comparison to older adults who belonged to higher objective SES (MPCE quintile). Older adults who were not educated/ with minimum education had significantly higher odds of cognitive impairment in reference to older adults with higher education [aOR: 22.4; p<0.05]. Older adults who belonged to the Scheduled Castes and Scheduled Tribes had 22% [aOR: 1.22; p<0.05] and 80% [aOR: 1.80; p<0.05] significantly higher odds of cognitive impairment in reference to older adults from other (higher) caste category, respectively. Table-S1 represents the regression estimates for cognitive impairment among older adults in India. In table S2, model-1 included subjective SES and individual, health and household factors; model-2 included MPCE quintile and individual, health and household factors; model-3 included education and individual, health and household factors and model-4 included caste and individual, health and household factors. These separate models for each aspect of SES also showed the similar pattern and odds of cognitive impairment were even greater in case of older adults who were not educated/with minimum education. Table S2 represents sensitivity

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analysis estimates (aORs) of cognitive impairment among older adults when the outcome variable i.e., cognitive impairment, was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups). The results showed no changes in the observed associations and the pattern remained same for all the subjective and objective SES measures, except education.

[Insert Table-2a]

In model-3, 4 and 5 (Table-2b) which reveals the interaction results for cognitive impairment. It was found that older adults who belong to lower subjective as well as objective SES were 2.45 times significant more likely to suffer from cognitive impairment in reference to older adults from higher subjective as well as objective SES (MPCE quintile) [aOR: 2.45; p<0.05]. In reference to older adults with high ladder SES and higher education, older adults with high ladder SES and no education/primary not completed [aOR: 24.14; p<0.05], middle ladder SES and no education/primary not completed [aOR: 37.07; p<0.05] and low ladder SES and no education/primary not completed [aOR: 54.41; p<0.05] had significantly higher odds for cognitive impairment. Older adults from low ladder SES and belonged to the Scheduled Castes [aOR: 2.88; p<0.05], low ladder SES and belonged to the Scheduled Tribes [aOR: 4.56; p<0.05] and low ladder SES and belonged to the Other Backward Classes [aOR: 2.15; p<0,05] had significantly higher odds of cognitive impairment in reference to older adults from high ladder SES and other (higher) caste category. Table S3 represents sensitivity analysis estimates (interaction models) for cognitive impairment among older adults after adjusting for education, and the results indicated towards similar findings.

[Insert Table-2b]

Discussion

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This study using a large representative data on older population in India was in parallel to multiple earlier studies in India and other developing countries which found that older individuals with lower SES experience cognitive impairment compared with people with higher SES [1, 59–61]. This association has been identified in case of both objective and subjective measures of SES. Studies have illustrated empirical evidence on the positive relationship between SES as measured by objective indices of material resources and subjective measures, and psychological well-being [62, 63]. Similarly, the interactive effect in our study found that older adults with lower levels of subjective and objective SES were at a greater risk of having cognitive impairment.

However, subjective SES was identified to have a much stronger association with cognitive impairment in the unadjusted and adjusted regression estimates in comparison to objective SES measured by household MPCE quintile. With respect to this strong association, there can be some possible explanations. At first, obviously, subjective SES was more meaningful than household wealth index. Higher economic status does not necessarily mean more resources at disposal, if compared with higher individual circumstances, but positive social comparison does. In addition, people with greater household economic status may endure more pressures and mental stress, which in turn may affect their mental health status and cognitive ability [64]. This could be mainly due to the subjectivity character of subjective SES. This potential explanation can also be attributed to different perceptions towards wealth and social status among older population in India.

Furthermore, considering the education-cognitive function association, the current findings suggest that higher education is a protective factor against cognitive impairment in older individuals. A hypothesized mechanism is that education is transformed to personal experience and self-perceptions about own social standing, which in turn translate into health and disease. Similarly, the current findings suggest that older adults with no education and

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low levels of subjective SES had much greater odds of cognitive impairment compared to those with higher education and higher subjective SES. This finding agrees with the previous evidence on the moderating role of education in the relationship between subjective SES and cognitive function. Also, as documented in earlier research [22], subjective SES is a means through which education may influence health outcomes among older people. Nevertheless, proper path analysis using longitudinal data and conducting moderation as well as mediation analyses is needed to test these claims.

Finally, older adults belonging to the lower caste groups (with low social status) were found to be more likely to be cognitively impaired in the study in comparison to those belong to higher castes. Importantly, in a previous study, it was observed that indicators of subjective SES differ across socio-demographic groups including race, and interpretations may vary when perceiving themselves on the existing social hierarchy [24]. Previous studies in India have demonstrated that the socioeconomic disadvantages such as lower income and lack of education were associated with belonging to lower castes (scheduled tribes and other backward classes) [18, 19, 65, 66]. Further, lower caste status being a factor of less opportunities in economic spectrum also contributes to poorer health, health inequalities and mortality burden in India [17, 38, 67]. It is however demonstrated that since individuals may estimate their SES relative to others in a specific community or social group, the social disadvantage may not necessarily negatively influence their mental wellbeing [62]. This suggests that the SES could be better captured by assessing the interactions between subjective and objective measures of SES.

The current study provides crucial clues about what measure of SES highly reflect on cognitive health in old age by underlining the importance of the cumulative dimension of subjective SES and different traditional measures including wealth status, education and caste. Similarly, although no statistical test was performed which assesses whether the

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difference in magnitude of the association detected by separate models is non-zero and statistically significant, the current findings revealed a greater strength of correlation between subjective SES and cognitive impairment, compared to objective SES measure. The findings also showed the underperformance of traditional measure of wealth status compared to subjective SES. Considering the current findings and the existing evidence [62], separate SES-related ladders that evaluate subjective perceptions of individuals' economic status (MPCE), education and social status (caste hierarchy in Indian context) may be suggested in wellbeing research. This is because subjective SES may reflect individuals' present social circumstances and an assessment of their past experiences and future prospects. As suggested in previous studies, subjective perception of one's SES might also encompass his/her household resources, life chances and opportunities, and thus captures a broad range of aspects of social stratification than traditional measures of SES do [23, 31, 68]. The finding further underscores the need for future longitudinal investigation of subjective SES-related measurement strategies to obtain a better understanding of the SES-cognitive functioning link especially in poor resource settings. The effects of country affluence on population health have been demonstrated. Several cross-country comparisons have documented considerable variations in the strength of subjective SES-health relationship between affluent and low-income countries with a stronger association in the later ones [69, 70].

There are several limitations of the present study to be considered. The major limitation is the cross-sectional design of the study eliminating the opportunity for drawing of causal inferences among variables. Indeed, it is important to consider that the cognitive measure used in this study included elements that are acquired through years of education and several elements are compounded by literacy levels. Hence, a large number of individuals who are illiterate may be mis-categorized as cognitively impaired because they cannot respond with accuracy to several measures, and therefore, reliable cognitive assessment tools should be

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developed and validated among poorly educated older people in Indian context. In this regard, much greater odds of cognitive impairment among illiterate population with large confidence interval even after controlling for several covariates in the main and sensitivity analyses, with separate models for each aspect of SES, may also be a result of a very different sample of older adults with higher education (7%) from those without education (68%). Importantly, due to lack of evidence of algorithm for combing various cognitive tests in the Indian context, we weight all tests equally and use an additive measure for overall cognitive functioning in the current study. Some of the tests may be far better than others in screening for or assessing the degree of cognitive dysfunction or dementia, and thus, the current approach may be misleading and should be addressed in future studies.

In addition, there is a possibility of some of the covariates included in the current analysis potentially being on the pathway between the key explanatory variables and outcome variable. For example, the objective SES, measured by caste, which is generally determined at birth could influence individuals' life course in multiple ways, such as their participation in physical or social activities. This may eventually result in collider stratification that leads to biased estimates in the multivariable models in the current study. Finally, there may also be floor or ceiling effects for SES because we have only three categories for both SES measures of ladder and MPCE quintiles.

Notwithstanding these limitations, there were several advantages in this study. At first, this may be the first study to identify the association between both objective and subjective SES indicators and cognitive impairment based on a comprehensive measure with a score of 0 to 43 among the older Indian population. The large sample of the present study that is free from selection bias includes all SES groups of Indian population that credits to the representativeness and generalizability of the findings. In addition to including multiple SES groups, this study also includes participants living both in rural and urban areas which

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enhance the generalizability of the results. Further, the findings of the present study provide empirical support to the body of literature that highlights the vulnerability of older adults who have low subjective and objective SES to the worse cognitive health outcomes. Finally, future research may focus on longitudinal associations of various socioeconomic markers with mental health outcomes among middle aged and older adults in India.

Conclusion

Subjective measures of SES were linked to cognitive outcomes, potentially even more strongly than were the objective measures of SES. Thus, considering the relative ease of obtaining such measures, subjective SES measures are a promising target for future study on socioeconomic indicators of cognitive impairment. The current findings also highlight the importance of subjective SES measure and its interaction with objective (traditional) measures of SES including wealth, education and caste status in assessing the mental health outcomes in developing countries. The results also suggest that more attention should be placed on subjective SES indicators when investigating socioeconomic influences on cognitive functioning among older adults in India.

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Abbreviations:

SES: Socio-economic status

aOR: Adjusted odds ratio

CI: Confidence interval

LASI: Longitudinal Ageing Study in India

PSU Primary Sampling Unit

CEB: Census Enumeration Block

MPCE: Monthly per capita consumption expenditure

ADL: Activities of daily living

IADL: Instrumental activities of daily living

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Declarations

Ethics approval

The necessary guidelines and ethics for undertaking the LASI survey were approved by the Indian Council of Medical Research (ICMR). ICMR approved the study. There was no number/ID of the approval(s) mentioned in the LASI report (https://www.iipsindia.ac.in/sites/default/files/LASI_India_Report_2020_compressed.pdf). All methods were carried out in accordance with relevant guidelines and regulations by the Indian Council of Medical Research (ICMR).

Contributor statement

Conceived and designed the research paper: TM and TVS; analysed the data: SS and TM; Contributed agents/materials/analysis tools: TVS; Wrote the manuscript: TM and SS; Refined the manuscript: TM, SS and TVS.

Competing interest

The authors declare that there is no competing interest

Funding

No funding was received for the study

Data sharing statement

The study uses a secondary data which is available on request through

https://www.iipsindia.ac.in/content/lasi-wave-i

Acknowledgements

The authors are thankful to the International Institute for Population Sciences, Mumbai, for providing the LASI survey data for undertaking this study.

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Table-1. Socio-economic and demographic profile of older adults in India.

Background characteristics	Sample	Percentage
Socio-economic status		
Subjective SES		
Ladder SES		
Low	13,127	41.7
Medium	16,142	51.3
High	2,195	7.0
Objective SES		
MPCE quintile		
Low	13,660	43.4
Medium	6,590	21.0
High	11,213	35.6
Education		
Not educated/primary not completed	21,381	68.0
Primary	3,520	11.2
Secondary	4,371	13.9
Higher	2,191	7.0
Caste		
Scheduled Castes	5,949	18.9
Scheduled Tribes	2,556	8.1
Other Backward Classes	14,231	45.2
Others	8,729	27.7
Individual characteristics		
Age in years (mean (sd))		69.2 (7.5)
Sex		
Male	14,931	47.5
Female	16,533	52.6
Working status		
Working	9,680	30.8
Retired	13,470	42.8
Not working	8,314	26.4
Marital status		
Currently married	19,391	61.6
Widowed	11,389	36.2
Others	684	2.2
Living arrangement		
Living alone	1,787	5.7
Living with spouse only	6,397	20.3
Living with children and spouse	21,475	68.3
Living with others.	1,805	5.7
Social participation		
No	30,053	95.5
Yes	1,411	4.5
Physical activity		
Frequent	5,651	18.0
Rarely	4,023	12.8
Never	21,790	69.3
Health factors		
Depression*		

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	No	27,995	91.3
	Yes	2,657	8.7
Self-rated health*			
	Excellent	964	3.1
	Very good	4,192	13.6
	Good	10,693	34.7
	Fair	10,331	33.5
	Poor	4,630	15.0
Difficulty in ADL			
	No	23,802	75.7
	Yes	7,662	24.4
Difficulty in IADL			
	No	16,130	51.3
	Yes	15,334	48.7
Morbidity			
	No morbidity	14,773	47.0
	1	9,171	29.2
	2+	7,520	23.9
Household/community-related factors			
Religion			
	Hindu	25,871	82.2
	Muslim	3,548	11.3
	Christian	900	2.9
	Others	1,145	3.6
Place of residence			
	Rural	22,196	70.6
	Urban	9,268	29.5
Region			
	North	3,960	12.6
	Central	6,593	21.0
	East	7,439	23.6
	Northeast	935	3.0
	West	5,401	17.2
	South	7,136	22.7
Total		31,464	100.0

**if Sample may be less due to missing cases; sd: standard deviation*

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Table-2a. Regression estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-1		Model-2	
	OR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Socio-economic status				
Subjective SES				
Ladder SES				
High	Ref.		Ref.	
Medium	2.01*(1.63,2.47)	0.107	1.43*(1.14,1.79)	0.102
Low	3.83*(3.11,4.71)	0.172	2.04*(1.63,2.56)	0.157
Objective SES				
MPCE quintile				
High	Ref.		Ref.	
Medium	1.20*(1.07,1.34)	0.011	1.12(0.99,1.26)	0.020
Low	1.50*(1.37,1.64)	0.032	1.32*(1.19,1.46)	0.051
Education				
Not educated/primary not completed	58.91*(27.97,124.07)	0.694	22.40*(10.58,47.41)	0.514
Primary	6.45*(2.96,14.03)	0.204	3.83*(1.75,8.36)	0.142
Secondary	2.55*(1.13,5.73)	0.108	1.94(0.86,4.38)	0.072
Higher	Ref.		Ref.	
Caste				
Scheduled Castes	1.03(0.91,1.16)	0.005	1.22*(1.06,1.39)	0.027
Scheduled Tribes	1.38*(1.22,1.55)	0.029	1.80*(1.55,2.09)	0.067
Other Backward Classes	0.86*(0.78,0.96)	-0.038	0.98(0.87,1.1)	-0.005
Others	Ref.		Ref.	

Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Model-2 was adjusted for Individual, Health and Household factors

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Table-2b. Interaction estimates for cognitive impairment among older adults in India, 2017-18

Background characteristics	Model-3		Model-4		Model-5	
	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Ladder SES # MPCE quintile						
High # high	Ref.					
High # middle	1.28(0.92,1.77)	0.085				
High # low	1.95*(1.39,2.72)	0.102				
Middle # high	0.79(0.42,1.48)	0.008				
Middle # middle	1.51*(1.08,2.11)	0.084				
Middle # low	2.09*(1.49,2.95)	0.092				
Low # high	1.24(0.77,1.98)	0.011				
Low # middle	1.77*(1.28,2.45)	0.125				
Low # low	2.45*(1.77,3.39)	0.160				
Ladder SES # Education						
High # higher			Ref.			
High # secondary			2.12(0.22,20.49)	0.021		
High # primary			8.91*(1.1,72.16)	0.037		
High # Not educated/primary not completed			24.14*(3.34,174.63)	0.168		
Middle # higher			1.57(0.18,13.48)	0.032		
Middle # secondary			3.06(0.41,22.74)	0.116		
Middle # primary			5.82(0.8,42.55)	0.167		
Middle # Not educated/primary not			37.07*(5.19,264.9)	0.568		

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completed				
Low # higher	2.11(0.13,34.01)	0.020		
Low# secondary	4.68(0.6,36.81)	0.079		
Low # primary	8.65*(1.17,64.2)	0.129		
Low # Not educated/primary not completed	54.41*(7.61,388.93)	0.602		
Ladder SES # Caste				
High # Others			Ref.	
High # Other Backward Class			1.39(0.83,2.32)	0.003
High # Scheduled Caste			1.69(0.82,3.48)	0.016
High # Scheduled Tribe			1.04(0.52,2.07)	-0.005
Middle # Others			1.53*(1.01,2.32)	0.081
Middle # Other Backward Class			1.60*(1.06,2.41)	0.081
Middle # Scheduled Caste			1.89*(1.23,2.89)	0.078
Middle # Scheduled Tribe			2.72*(1.77,4.2)	0.105
Low # Others			2.27*(1.49,3.46)	0.083
Low # Other Backward Class			2.15*(1.42,3.26)	0.111
Low # Scheduled Caste			2.88*(1.89,4.39)	0.108
Low # Scheduled Tribe			4.56*(2.97,6.98)	0.132

#: Interaction; Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Model-3, 4 and 5 were adjusted for Individual, Health and Household factors

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Figure legend: -

Figure-1: Conceptual Framework

Figure-2 The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

Figure-3 Percentage of older adults with cognitive impairment by their subjective socio-economic status.

Figure-4 Percentage of older adults with cognitive impairment by their objective socio-economic status.

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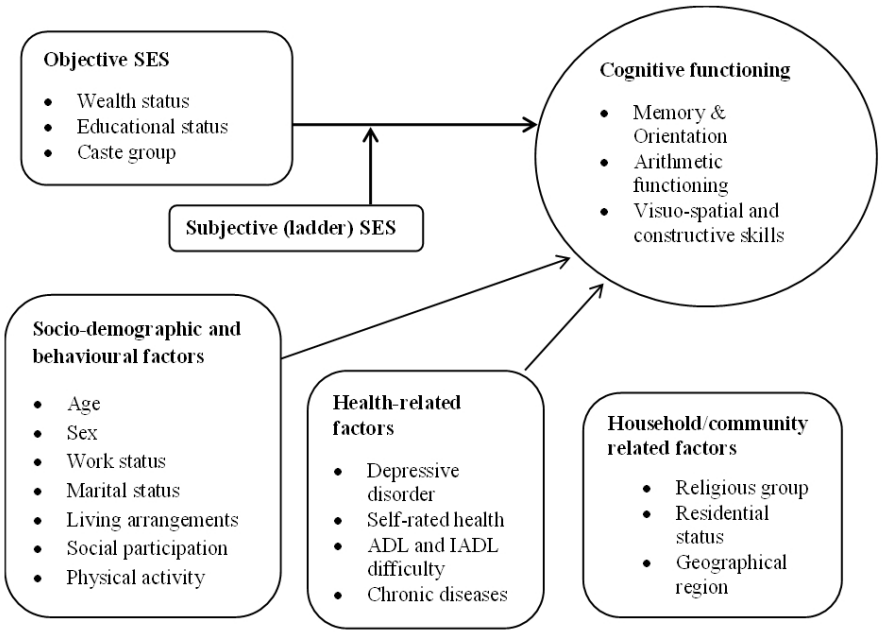

Conceptual Framework

186x150mm (144 x 144 DPI)

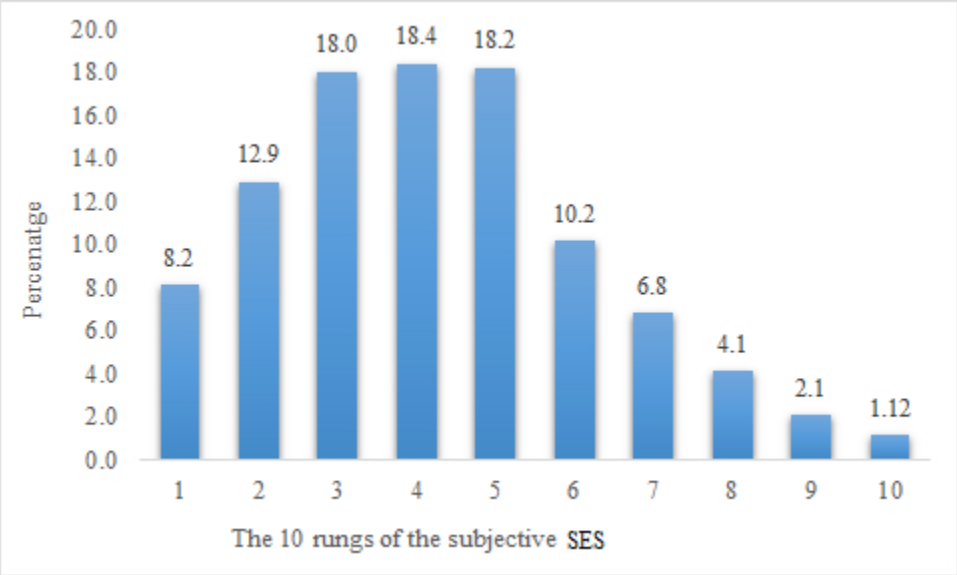

Figure-2 The distribution of the subjective socio-economic status (1-10: lowest to highest rank)

85x51mm (144 x 144 DPI)

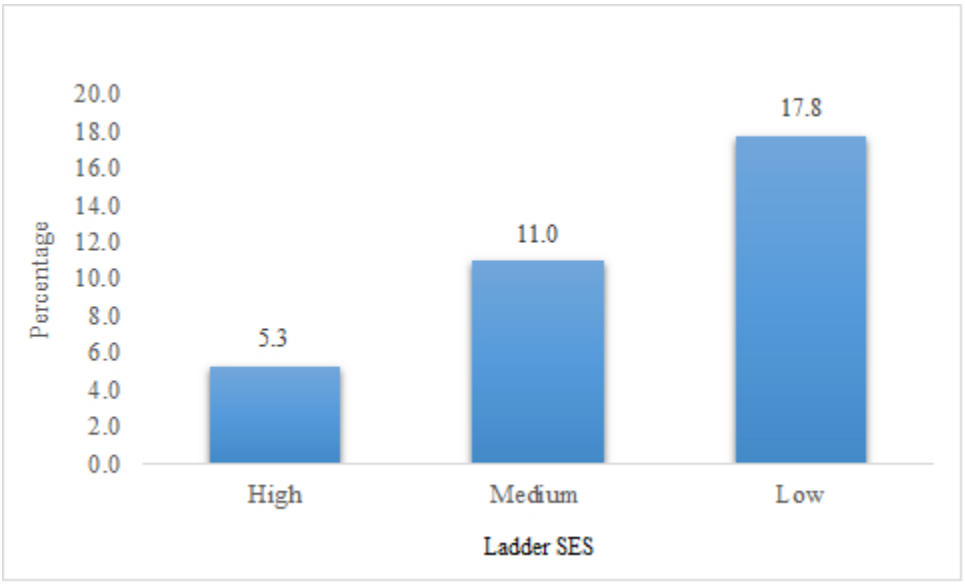

Figure-3 Percentage of older adults with cognitive impairment by their subjective socio-economic status.

85x51mm (144 x 144 DPI)

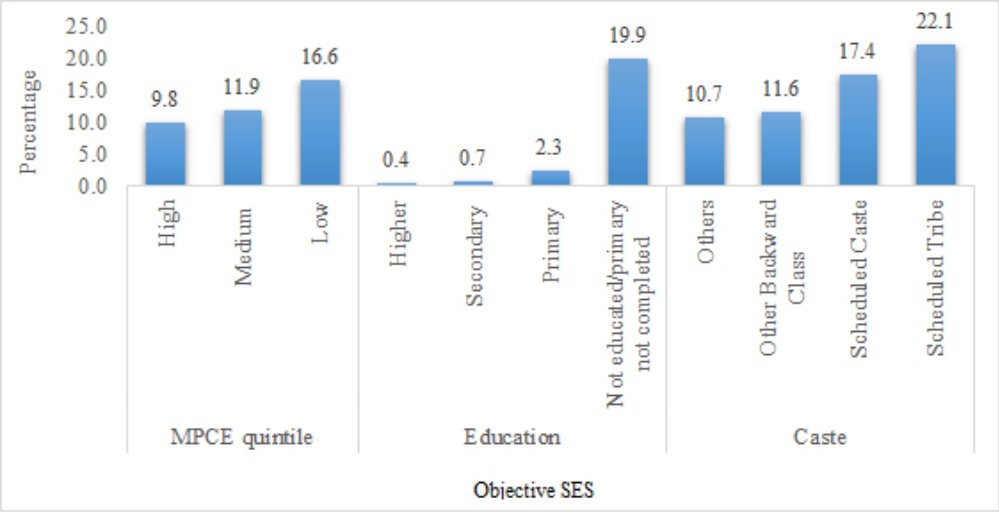

Figure-4 Percentage of older adults with cognitive impairment by their objective socio-economic status.

148x77mm (96 x 96 DPI)

Table-S1. Regression estimates for cognitive impairment by each aspect of SES among older adults in India, 2017-18

Background characteristics	Model-1		Mode-2		Model-3		Model-4	
	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta	aOR (95% CI)	Standardized beta
Subjective SES								
Ladder SES								
Low	Ref.							
Medium	1.76*(1.42, 2.18)	0.17						
High	3.16*(2.54, 3.93)	0.30						
Objective SES								
MPCE quintile								
Low			Ref.					
Medium			1.3*(1.16,1.46)	0.06				
High			1.76*(1.6,1.94)	0.15				
Education								
Not educated/primary not completed					31.13*(14.74, 65.73)	0.58		
Primary					4.75*(2.18,10.35)	0.17		
Secondary					2.19(0.97,4.94)	0.09		
Higher					Ref.			
Caste								
Scheduled Castes							1.88*(1.66, 2.15)	0.13
Scheduled Tribes							2.75*(2.38, 3.18)	0.17
Other Backward Classes							1.26*(1.13, 1.42)	0.08
Others							Ref.	

Ref: Reference; aOR: Adjusted Odds Ratio;; CI: Confidence Interval; SES: Socio-economic status; MPCE: Monthly per capita consumption expenditure;

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Model-1 included SES and Individual, Health and Household factors; Model-2 included MPCE quintile and Individual, Health and Household factors; Model-3 included education and Individual, Health and Household factors and Model-4 included caste and Individual, Health and Household factors.

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Table-S2. Sensitivity analysis estimates for cognitive impairment after adjusting for education among older adults in India, 2017-18

Background characteristics		Model-1 OR (95% CI)	Model-2 aOR (95% CI)
Socio-economic status			
Subjective SES			
Ladder SES			
	High	Ref.	Ref.
	Medium	1.44*(1.21,1.7)	1.53*(1.28,1.82)
	Low	1.81*(1.52,2.16)	2.04*(1.69,2.46)
Objective SES			
MPCE quintile			
	High	Ref.	Ref.
	Medium	1.06(0.95,1.18)	1.14*(1.01,1.27)
	Low	1.17*(1.08,1.28)	1.28*(1.16,1.42)
Education			
	Not educated/primary not completed	0.72*(0.63,0.82)	0.21*(0.18,0.25)
	Primary	0.81*(0.69,0.95)	0.43*(0.36,0.51)
	Secondary	0.87(0.75,1.01)	0.61*(0.52,0.71)
	Higher	Ref.	Ref.
Caste			
	Scheduled Castes	1.03(0.91,1.16)	1.26*(1.11,1.44)
	Scheduled Tribes	1.21*(1.08,1.37)	1.71*(1.47,1.98)
	Other Backward Classes	0.84*(0.76,0.92)	0.98(0.88,1.09)
	Others	Ref.	Ref.

Ref: Reference: OR: Unadjusted Odds Ratio; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Cognitive impairment was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups); Model-2 was adjusted for Individual, Health and Household related factors

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Table-S3. Sensitivity analysis estimates (Interaction models) for cognitive impairment after adjusting for education among older adults in India, 2017-18

Background characteristics	Model-3	Model-4	Model-5
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Ladder SES # MPCE quintile			
High # high	Ref.		
High # middle	1.44*(1.14,1.83)		
High # low	1.97*(1.52,2.57)		
Middle # high	1.14(0.73,1.76)		
Middle # middle	1.68*(1.3,2.17)		
Middle # low	2.16*(1.64,2.85)		
Low # high	1.08(0.72,1.62)		
Low # middle	1.89*(1.48,2.42)		
Low # low	2.51*(1.95,3.23)		
Ladder SES # Education			
High # higher		Ref.	
High # secondary		0.6*(0.39,0.94)	
High # primary		0.54*(0.32,0.92)	
High # Not educated/primary not completed		0.19*(0.12,0.3)	
Middle # higher		1.52*(1.09,2.13)	
Middle # secondary		0.93(0.67,1.28)	
Middle # primary		0.67*(0.48,0.94)	
Middle # Not educated/primary not completed		0.34*(0.25,0.47)	
Low # higher		1.84*(1.15,2.95)	
Low# secondary		1.34(0.94,1.93)	
Low # primary		0.87(0.61,1.25)	
Low # Not educated/primary not completed		0.47*(0.34,0.65)	
Ladder SES # Caste			
High # Others			Ref.
High # Other Backward Class			1.33(0.92,1.94)
High # Scheduled Caste			2.04*(1.14,3.62)
High # Scheduled Tribe			0.97(0.52,1.8)
Middle # Others			1.72*(1.3,2.26)
Middle # Other Backward Class			1.73*(1.3,2.29)
Middle # Scheduled Caste			2.23*(1.65,3.03)
Middle # Scheduled Tribe			2.49*(1.82,3.42)

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Low # Others	2.19*(1.63,2.96)
Low # Other Backward Class	2.16*(1.61,2.89)
Low # Scheduled Caste	2.89*(2.13,3.92)
Low # Scheduled Tribe	4.99*(3.65,6.83)

#: Interaction; Ref: Reference; aOR: Adjusted Odds Ratio; CI: Confidence Interval; SES: Socio-economic status; Cognitive impairment was adjusted for education (lowest 10th percentile of each educational category was considered cognitively impaired, i.e, with a cut-off score of 14 for no educated/primary not completed, 21 for primary, 24 for secondary and 27 for higher education groups); Model-3, 4 and 5 were adjusted for Individual, Health and Household related factors

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S1 Checklist. STROBE checklist of items that should be included in reports of cross-sectional studies

	Item No	Recommendation	Section, paragraph Response
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Title (Page 1-2; Line 1-2)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract: Objectives, study design, participants, outcome measures, results, conclusion. Author summary: What did the researchers do and find? (Page 2-3; Line 31-62)
Introduction			
Background/ rationale	2	Explain the scientific background and rationale for the investigation being reported	Author summary: Why was this study done? In the Introduction section (Page 5-6)
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction: final paragraph. (Page 6; Line 42-46)
Methods			
Study design	4	Present key elements of study design early in the paper	Abstract: Design, setting, and participants. Introduction: final paragraph. Methods: Data Source (Page 2-3; Line 31-62)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Abstract: Design, setting, and participants (Page 2; Line 34-37). Methods: Data Source, study selection, and inclusion criteria (Page-2 Line 38-44)
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Abstract: Design, setting, and participants (Page 2; 36-37). Methods: Study selection and inclusion criteria (Page 7; Line 38-44)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Methods: Study Variables (Page 7-12)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods: Data Source, study selection, and inclusion criteria (Page 7-12)
Bias	9	Describe any efforts to address potential sources of bias	Discussion: Final paragraph (Page 15-20)
Study size	10	Explain how the study size was arrived at	Methods: Data Source, study selection, and inclusion criteria (Page 7)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods: Statistical analysis (Page 12).
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Methods: Statistical analysis (Page 12)
		(*b*) Describe any methods used to examine subgroups and interactions	Methods: Statistical analysis (Page 12)
		(*c*) Explain how missing data were addressed	Methods: Study selection and inclusion criteria, Study Variables, Statistical analysis (Page 7-12)
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Methods: Data Source (Page 7-12), Statistical analysis (Page 12)
		(*e*) Describe any sensitivity analyses	Supplementary file

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Results			
Participants	13	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Table 1 (Page 28-29)
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	Figure-1 Page-33
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 (Page 28-29)
		(b) Indicate number of participants with missing data for each variable of interest	Method, Table 1 (Page 28-29)
Outcome data	15*	Report numbers of outcome events or summary measures	Table 1 (Page 28-29)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Table-2a and Table-2b (Page 30-32)
		(*b*) Report category boundaries when continuous variables were categorized	None
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not Applicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not Applicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	Discussion (Page 16-20)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion (Page 19-20)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion (Page 16-20)
Generaliseability	21	Discuss the generalisability (external validity) of the study results	Discussion (Page 16-20)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Provided during the submission process and in Declaration (Page 22)

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