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Assessing the role of depressive symptoms in the association between social engagement and cognitive functioning among older adults: analysis of cross-sectional data from the Longitudinal Aging Study in India (LASI)

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ABSTRACT

Objective The present study aimed to examine the confounding effects of depressive symptoms and the role of gender in the association between social engagement and cognitive functioning among older Indian adults.

Design Large-scale cross-sectional survey data were analysed.

Setting and participants Data from the Longitudinal Aging Study in India (2017–2019) were used in the analysis. The sample included 23 584 individuals aged 60 years and above (11 403 men and 12 181 women).

Outcome measures The outcome variable was cognitive functioning, which was based on various measures including immediate and delayed word recall, orientation, executive functioning, arithmetic ability and object naming. Social engagement measure consists of marital status, living arrangement, availability of confidant, and participation in indoor games, and social and cultural functions. The Center for Epidemiological Studies-Depression Scale was used to assess depressive symptoms.

Results Significant gender differences in mean cognition scores (men: 25.8, women: 21.1; on a scale of 0–43) were observed. Two-way stratification between social engagement and depressive symptoms was significantly associated with cognitive functioning after controlling for selected explanatory factors. Older men with a low level of social engagements had significantly poor cognitive functioning (β=−1.12; 95% CI: −1.53 to −0.72) compared with men with a high level of social engagements. On the other hand, women with a higher level of social engagement performed poorly on cognitive tests (β=−1.54; 95% CI: −2.11 to −0.98) compared with men with higher social engagements. Three-way stratification between social engagement, gender and depressive symptoms suggests that social engagement's buffering effects are lower in women than in men. The Karlson-Holm-Breen method identified a significant confounding effect of depressive symptoms on the relationship between social engagement and cognitive functioning.

Conclusion The positive association of social engagement with cognitive functioning was significantly confounded by depressive symptoms, suggesting the need for maintaining social relations that help improve mental health and cognitive functioning among older adults.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The study used data of a large, nationally representative sample of older adults.
⇒ Internationally validated scales of cognition and depressive symptoms were used.
⇒ In a sample with a large proportion of illiterate people, assessment of cognitive functioning might be subject to measurement error.
⇒ The inability to establish a causal relationship between the variables of interest is the main limitation of the study.

INTRODUCTION

With the growth of ageing population, global challenges in mental health are on the rise. It includes the decline in late-life cognitive abilities which are generally associated with poor quality of life,[1] functional disabilities,[2] multimorbidity[3] and higher mortality risk.[4] India is currently facing rapid population ageing, with an expected increase in the number of individuals aged 60 years and above from 104 million in 2011 to 319 million by 2050[5]; consequently, the disease burden of cognitive impairment in the country is also expected to increase.

Social engagement is an umbrella concept usually referring to various factors such as social relationships, social and emotional connectedness with other people, and

participation in social activities, which provide a sense of belonging, social identity and fulfilment.[6 7] In the absence of effective pharmacological treatment for persons with cognitive impairment, especially for the long-term benefits, various methods such as improving social engagement and active participation in social activities are considered.[8] Multiple cross-sectional studies investigating the association between social environment and cognition in older adults showed that greater social functioning was positively associated with cognitive performances.[9 10] Moreover, several longitudinal studies among older adults have also indicated that greater engagements with relatives,[11 12] rich social networks[12 13] and frequent participation in social activities[14] exert protective effects against cognitive decline. Therefore, in the long run, individuals who present trajectories of high and increasing social engagements experience lower levels of cognitive limitation.[15]

Several interventional studies reported the protective effects of improved social behaviours on preventing or delaying dementia among older adults with diagnosed cognitive impairment.[16 17] Most of the available research on social capital and engagement as to enhance cognitive reserve and protect cognitive health has been conducted in developed countries.[18–21] Little is known about the relationship between social engagement and cognitive functioning in developing countries like India, where the cultural and structural contexts of social engagement differ from developed countries. In India, traditionally, older adults are more likely to live with their children in multigenerational households where cultural norms emphasise family ties and the virtue of filial piety,[22 23] and a higher proportion of older people experience psychological distress and mental illnesses.[24–26]

Similarly, depressive disorders are highly prevalent among older adults in low/middle-income countries (LMICs)[27–29] and in India in particular.[30] Previously, various studies have found the beneficial effects of greater social engagements (with varying measurements and definitions) against depressive symptoms.[31 32] A cross-sectional study by Jang and Chiriboga[31] found that a higher level of participation in social activities was associated with the decline in depressive symptoms after controlling for the effects of demographic and health-related factors. Multiple longitudinal studies have also reported similar findings.[33–37] Also, increased participation in social activities and meaningful engagement by older adults may improve their mood, which benefits their emotional functioning and reduces depressive symptoms,[38] which is linked to cognitive functioning.[39] According to the 'depression reduction hypothesis', depressive symptoms interfere with cognitive health; therefore, as evident from multiple longitudinal studies, practical strategies to reduce depressive symptoms will possibly improve cognitive functioning.[40] Two facts justify such a hypothesis: first, greater depressive symptoms are related to poor cognitive functioning among older adults.[41 42] Second, depressed older adults who engage in social activities may experience the decline in depressive symptoms and improve cognitive functioning.[43] Furthermore, in multiple cohort studies, cognitively impaired older adults with depressive symptoms were associated with more rapid cognitive decline than those without depression.[44 45]

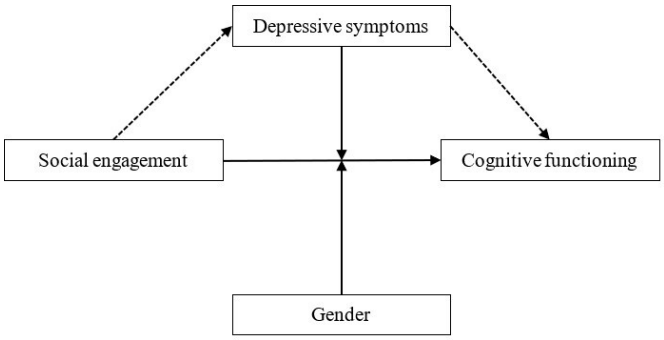

Figure 1 Conceptual framework of the study.

However, it is not clear to what extent social engagement may improve cognitive functioning by minimising depressive symptoms. There is a dearth of studies in LMICs on the association of social engagements and cognitive functioning and the role of depressive symptoms in such association. Filling this gap, the present study, using national-level data of older adults in India, aimed to examine the role of the depressive symptoms in the association between social engagement and cognitive functioning (figure 1). Previous research showed a greater female disadvantage and theorised gender as the crucial factor to be considered in understanding the differences in cognitive functioning in Indian context.[46–48] Also, studies have shown the significant gender differences in the association between social engagement and cognitive functioning.[49 50] Thus, the study also explored the moderation effects of gender in the relationship between social engagement and cognitive functioning. The present study hypothesised that the association between social engagement and cognitive functioning is significantly confounded by depressive symptoms (figure 1).

METHODS

Data

The present study used the individual-level data from the first wave of the Longitudinal Aging Study in India (LASI) conducted during 2017–2019. LASI is a nationally representative longitudinal survey of more than 72 000 adults aged 45 years and over and their spouses regardless of age across all states and union territories of India that provides vital information on the social, physical, psychological and cognitive health of the Indian ageing population. The LASI survey was conducted through a partnership with the International Institute for Population Sciences, Harvard T H Chan School of Public Health and the University of Southern California. In LASI wave 1, the sample selection is based on a multistage stratified cluster sample design, including a three-stage sampling design in rural areas and a four-stage

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sampling design in urban areas. LASI survey provided internationally harmonised data that were comparable with the US Health and Retirement Study (HRS) and other HRS-type surveys in other countries, including England (English Longitudinal Study of Ageing) and China (China Health and Retirement Longitudinal Survey). Further, the details of sampling design, survey instruments and data collection procedures are provided elsewhere.[51]

In the sampled households, the individual survey schedule includes the biomedical examination administered to each consenting respondent aged 45 years and above and their spouses (irrespective of age). The survey agencies authorised to conduct the survey have collected prior consent from all the respondents. Consent forms include the information brochure explaining the purpose of the survey, ways of protecting their privacy and the safety of the health assessments as part of the ethics protocol. The Indian Council of Medical Research extended the necessary guidelines and ethics approval for undertaking the survey.

The sample in the main LASI survey data included 31 464 individuals aged 60 years and above. For the present analysis, we have excluded those cases with missing data for any variable of interest (n=7880). Therefore, the sample for the present study included 23 584 individuals aged 60 years and above from the LASI survey, and among them 11 403 were men and 12 181 were women.

Measures

Cognitive function

By adopting the HRS cognition module, the LASI collected information on measured cognition in various domains—including memory, orientation, executive functioning, arithmetic and object naming (table 1). Previously, various studies have established high validity and reliability of these cognitive domains for measuring cognitive impairment among older adults in community settings in the USA,[52] China[53] and India.[54] The cognitive functioning in the present study is based on different cognitive measures, including immediate (0–10 points) and delayed word recall (0–10 points); orientation

Table 1 Description of domain-wise cognitive measures in LASI, 2017–2018

Domain	Measure	Measurement	Range
Memory	Immediate word recall	Interviewer read out a list of 10 words and respondents were asked to repeat the words.	0–10
	Delayed word recall	Respondents were asked to recall the same words read out for immediate recall after some time.	0–10
Orientation	Time	Respondents were asked to state today's date, month and year and day of the week. For each question, the score was 0 or 1. Correct responses received 1 point, incorrect responses received 0. The total score for time was 0–4.	0–4
	Place	Orientation towards place was captured based on place of interview, name of the village, street number/colony name/landmark/neighbourhood and name of the district. Each correct response scored 1 point. The total score ranged from 0 to 4.	0–4
Arithmetic function	Backward counting	Respondents were asked to count backward as quickly as possible from the number 20. The respondents were asked to stop after correctly counting backward from 20 to 11 or from 19 to 10. Correct counting received 2 points: counts with a mistake received 1 point. Those who could not count received 0 points.	0–2
	Serial 7	Respondents were asked to subtract 7 from 100 in the first step and asked to continue subtracting 7 from the previous number in each subsequent step for five times. Each correct response received 1 point.	0–5
	Computation	This test involved the mathematical operation of division. Respondents were asked to compute the net sale price of a product after considering a discount sale of half of the original price.	0–2
Executive function: 0–4	Executive (paper folding)	This is a three-stage command task. The respondents were instructed to take a piece of paper from the interviewer, turn it over, fold it in half and give it back to the interviewer. Three points were given if each task was completed successfully.	0–3
	Pentagon drawing	Visuo-construction is the ability to coordinate fine motor skills with visuospatial abilities, usually by reproducing geometric figures. Respondents were asked to copy two overlapping pentagons and scored 1 point for a correct drawing.	0–1
Object naming: 0–2		The interviewer points to a specific object and asks the respondent to name it. Two objects were pointed out and 1 point was given for each correct response.	0–2
Cognition	Composite cognitive index	Combined scores of memory (total word recall), orientation, arithmetic function, executive function and object naming.	0–43

LASI, Longitudinal Aging Study in India.

related to time (0–4 points) and place (0–4 points); executive functioning based on paper folding (0–3) and pentagon drawing (0–1); arithmetic ability based on serial 7s (0–5 points), computation (0–2) and backward counting from 20 (0–2 points); and object naming (0–2).

After adding the scores for each component, the overall score ranged from 0 to 43, and a higher score indicates better cognitive functioning.

Social engagements

Following the previous studies,[55 56] we have derived social engagement based on five indicators: marital status, living arrangement, availability of confidant, and participation in indoor games, and social and cultural functions. Current marital status was set to unmarried (single, widowed, separated or divorced; coded as 0) versus married (married or living with a partner; coded as 1). Regarding current living arrangements, living alone was categorised as 0, and living with extended family is categorised as 1. The availability of a current confidant relationship (spouse, son or daughter, grandchildren, relatives, etc) was coded as no (0) or yes (1). Two more indicators based on participation in social activities, including playing cards or indoor games and attending social and cultural functions, were included (0=several times a month/at least once a month/rarely/once in a year/never/not relevant, 1=daily/several times a week/less than weekly). A composite index of social engagement was constructed by summing the scores for all five indicators, ranging from 0 to 5. Based on the distribution of the overall composite index, individuals were categorised as having low (0–2 social ties; 27.6%), medium (3 ties; 62%) or high (4–5 ties; 10.1%) level of social engagement.

Depressive symptoms

The LASI has used the internationally validated 10-item Center for Epidemiological Studies-Depression (CES-D) scale to capture the presence of depressive symptoms in older Indian adults.[57 58] The 10 items in CES-D consist of seven negative symptoms (feeling depressed, low energy, trouble concentrating, feeling alone, bothered by things, fear of something and everything is an effort) and three positive symptoms (feeling happy, satisfied and hopeful). The possible responses for these items were: rarely or never (<1 day), sometimes (1 or 2 days), often (3 or 4 days), and most or all of the time (5–7 days) in a week prior to the interview. For the negative symptoms, rarely or never (<1 day) and sometimes (1 or 2 days) were scored 0, and often (3 or 4 days) and most or all of the time (5–7 days) categories were scored 1. Scoring was reversed for positive symptoms. The overall depressive symptoms score, calculated by adding the scores from 10 items, ranges from 0 to 10. A score of 4 or higher is considered to represent clinically significant symptoms in the 10-item scale.[59]

Covariates

After an extensive literature review, potentially related covariates were selected which include sociodemographic characteristics, lifestyle factors, health conditions, and cognitive and social activities. Sociodemographic characteristics were: age (in chronological years); gender (men, women); education (no education, primary, secondary, higher); current working status (no, yes); residence (rural, urban); religion (Hindu, Muslim, Christian, others); region (North, Central, East, Northeast, West and South); and monthly per capita consumption expenditure (MPCE) (poorest, poorer, middle, richer and richest). The lifestyle factors were currently smoking (no, yes), currently consuming smokeless tobacco (no, yes), alcohol drinking (never, infrequent non-heavy, frequent non-heavy, heavy episodic drinker) and body mass index (BMI) (underweight (<18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight/obese (>25.0 kg/m^2)). Health conditions include biometric measurement-based hypertension status (normal, prehypertensive, high blood pressure (BP)), and self-reported conditions such as diabetes, cancer, heart disease, and stroke were coded as no and yes. The older adults were categorised as having normal BP (systolic BP (SBP) <120 mm Hg and diastolic BP (DBP) <80 mm Hg), prehypertensive (SBP: 120–139 mm Hg and DBP: 80–89 mm Hg) and high BP (SBP ≥140 mm Hg and DBP ≥90 mm Hg).

The 'caste' of the household is reported by the head of the household, and it is generally grouped into four categories: Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Class (OBC) and other than SC/ST/OBC. SC and ST are considered as among the most deprived and socioeconomically disadvantaged groups in India. The individuals in the general class represent the hierarchically higher social status in India. On the other hand, although OBC is an educationally, economically and socially backward group, but hierarchically, this group is considered as in better social position than SC and ST categories.[60]

According to the procedure suggested by Dong *et al*,[61] we included four social participation activities: (1) eat out of the house, (2) go to the park/beach, visit relatives/friends, (3) go out to a movie, and (4) attend political/community group meetings. Based on the frequency of participation, responses were coded as '1' for daily/several times a week/less than weekly, and '0' for several times a month/at least once a month/rarely/once in a year/never/not relevant for these activities.

Statistical analysis

Descriptive statistics (means and percentages) were used to present the characteristics of the older adults included in the final sample. A two-sample test for difference of mean/proportion was used to assess the gender differences in the reporting of cognition score. Moreover, linear regression models were employed to determine the association of two-way stratification of social engagements and depressive symptoms, and social engagement and

gender, and gender and depressive symptoms with cognitive function. Also, linear regression models were used to assess the association of three-way stratification of social engagement, gender and depressive symptoms with cognitive functioning. We conducted a correlation analysis and a linear regression analysis of depressive symptoms on social engagement. The total effect was divided into direct effects (the association of social engagement with cognitive function controlling for depressive symptoms) and indirect effects (the association of social engagement with cognitive function through depressive symptoms) using linear regression based on Karlson-Holm-Breen (KHB) method[62–64] for the whole sample. The KHB method is a recently developed method for assessing the confounding effects that allow total effects to be divided into direct and indirect effects for both discrete and continuous variables. Contrary to other decomposition methods, the KHB method provides unbiased decomposition results.[65] The confounding percentage (the indirect effect divided by the total effect) is interpreted as the percentage of the association explained by the confounder variable. All statistical models were adjusted for various predictors, including age, gender, education, working status, residence, religion, caste, region, BMI, MPCE, smoking status, consuming smokeless tobacco, alcohol drinking, hypertension, diabetes, cancer, heart disease and stroke. The statistical analysis was performed using Stata V.15.1. We incorporated the complex design of the survey data used in the study. Stata's survey command (*svyset*) was used to incorporate the complex design of LASI, and adjusted for sampling weight, clustering and stratification in the sampling design. The dataset does not contain the information of stratum and so, place of residence (rural/urban) is considered as two different strata. A p value of less than 0.05 was considered statistically significant.

Patient and public involvement

None.

RESULTS

Table 2 presents the descriptive information about cognitive function, sociodemographic factors, lifestyle factors, and chronic conditions of older men and women included in the analysis. The mean cognition score of men was higher than that of women (25.9 vs 21.3). Nearly 85% of older men had at least a medium level of social engagements, while this proportion was 53% for older women. Regarding depressive symptoms score, older women had a slightly higher mean score than older men (3.0 vs 2.8). On average, men were slightly older than women (68.7 vs 68.2 years). A higher proportion of older women were uneducated than older men (68.7% vs 35.1%). Around 44.0% of the older men and 19.3% of women were currently working at the time of the survey. A higher proportion of older women were overweight or obese than men (28.6% vs 20.2%). Around 25% of men and only 4% of women were current tobacco smokers, while 24% of men and 16% of women were consuming smokeless tobacco at the time of the survey. Alcohol consumption is much higher among older men than women (32.4% vs 4.4%). According to measured hypertension status, the prevalence of high BP was slightly higher among older women than men (39.9% vs 37.9%). With regard to religion, around three-fourths of both older male and female participants were Hindus. Most of the participants were rural residents (67.7% men vs 65.8% women). Table 2 also shows the gender comparison across all the selected variables for the sample. The results indicate the significant gender differences in the social engagement, cognitive functioning, depressive symptoms, age, social activities, educational status, work status, residence, BMI, current use of tobacco use, heart disease and stroke.

The average cognitive score increased with an increase in the level of social engagement, and it was higher among the non-depressed older adults (24.0 vs 22.1) (online supplemental table 1). Moreover, the prevalence of depressive symptoms decreased with an increase in the level of social engagement.

Table 3 presents the gender differences in the mean cognition score according to selected covariates. Results suggest a significant gender difference in the cognitive performance (difference=4.7; p<0.001). Men had a significantly greater mean cognition score than women irrespective of age, working status, number of social activities, residence, obesity status, MPCE quintiles, tobacco and alcohol use, and morbidity status. With regard to education, women with higher education had a significantly greater mean cognitive score than men.

Table 4 shows the linear regression results for the two-way stratification of social engagement and depressive symptoms, and social engagement and gender, and gender and depressive symptoms, and three-way stratification of the social engagement, gender, and depressive symptoms on the cognitive functioning after adjusting the selected explanatory variables including sociodemographic, lifestyle and chronic conditions. Two-way stratification of social engagements and depressive symptoms depicts the estimated effects of the depressive symptoms on cognitive functioning for all levels of social engagement. The negative relationship between depressive symptoms and cognitive score significantly reduces with a higher level of social engagement. Furthermore, the two-way stratification of social engagement and gender suggests that men with a low level of social engagements had significantly poor cognitive functioning (β=−1.12; 95% CI: −1.53 to −0.72) compared with men with a high level of social engagements. On the other hand, women with a higher level of social engagement performed poorly on cognitive tests (β=−1.54; 95% CI: −2.11 to −0.98) than men with higher social engagements. The two-way stratification of the gender and depressive symptoms suggests that the magnitude of negative relationship between depressive symptoms and cognitive functioning is higher in women than in men. The results corresponding to three-way

Table 2 Descriptive statistics for sample characteristics of older adults included in the analysis, by gender, India (N=23 584)

	Men		Women			
	n	%	n	%	Difference (%)	P value for difference
Social engagement						
Low	1681	14.7	5720	47.0	−32.3	<0.001
Medium	8347	73.2	5705	46.8	26.4	<0.001
High	1375	12.1	756	6.2	5.9	<0.001
Cognition*	25.9	6.7	21.3	7.0	4.6	<0.001‡
Depressive symptoms score*	2.8	1.6	3.0	1.7	−0.2	<0.001‡
Age (years)*	68.7	7.1	68.2	7.2	0.5	<0.001‡
Social activities (0–5)*	0.3	0.6	0.2	0.5	0.1	<0.001‡
Education level						
No education	4005	35.1	8364	68.7	−33.6	<0.001
Primary	3505	30.7	2404	19.7	11.0	<0.001
Secondary	2537	22.2	1006	8.3	13.9	<0.001
Higher	1356	11.9	407	3.3	8.6	<0.001
Currently working						
No	6383	56.0	9830	80.7	−24.7	<0.001
Yes	5020	44.0	2351	19.3	24.7	<0.001
Place of residence						
Rural	7719	67.7	8018	65.8	1.9	0.002
Urban	3684	32.3	4163	34.2	−1.9	0.002
Religion						
Hindu	8405	73.7	9009	74.0	−0.3	0.662
Muslim	1265	11.1	1311	10.8	0.3	0.416
Christian	1154	10.1	1256	10.3	−0.2	0.628
Others†	579	5.1	605	5.0	0.1	0.697
Caste						
Scheduled Caste	1921	16.8	2032	16.7	0.1	0.735
Scheduled Tribe	1975	17.3	2159	17.7	−0.4	0.414
OBC	4428	38.8	4681	38.4	0.4	0.525
Others	3079	27.0	3309	27.2	−0.2	0.778
Regions						
North	2104	18.5	2291	18.8	−0.3	0.482
Central	1588	13.9	1531	12.6	1.3	0.002
East	2276	20.0	2246	18.4	1.6	0.003
Northeast	1399	12.3	1466	12.0	0.3	0.583
West	1409	12.4	1666	13.7	−1.3	0.003
South	2627	23.0	2981	24.5	−1.5	0.010
BMI categories						
Normal	6406	56.2	5961	48.9	7.3	<0.001
Underweight	2698	23.7	2738	22.5	1.2	0.031
Overweight/obese	2299	20.2	3482	28.6	−8.4	<0.001
MPCE quintile						
Poorest	2283	20.0	2544	20.9	−0.9	0.100
Poorer	2318	20.3	2543	20.9	−0.6	0.297
Middle	2334	20.5	2528	20.8	−0.3	0.588

Continued

Table 2 Continued

	Men		Women			
	n	%	n	%	Difference (%)	P value for difference
Richer	2283	20.0	2364	19.4	0.6	0.236
Richest	2185	19.2	2202	18.1	1.1	0.033
Currently smoking tobacco						
No	8570	75.2	11 640	95.6	−20.4	<0.001
Yes	2833	24.8	541	4.4	20.4	<0.001
Currently consuming smokeless tobacco						
No	8638	75.8	10 233	84.0	−8.2	<0.001
Yes	2765	24.2	1948	16.0	8.2	<0.001
Drinking status						
Never	7718	67.7	11 650	95.6	−27.9	<0.001
Infrequent non-heavy	2269	19.9	299	2.5	17.4	<0.001
Frequent non-heavy	748	6.6	122	1.0	5.6	<0.001
Heavy episodic drinker	668	5.9	110	0.9	5.0	0.193
Hypertension status						
Normal	2612	22.9	2774	22.8	0.1	0.808
Prehypertensive	4465	39.2	4550	37.4	1.8	0.004
High BP	4326	37.9	4857	39.9	−2.0	0.002
Diabetes						
No	9599	84.2	10 388	85.3	−1.1	0.019
Yes	1804	15.8	1793	14.7	1.1	0.019
Cancer						
No	11 332	99.4	12 088	99.2	0.2	0.193
Yes	71	0.6	93	0.8	−0.2	0.193
Heart disease						
No	10 721	94.0	11 678	95.9	−1.9	<0.001
Yes	682	6.0	503	4.1	1.9	<0.001
Stroke						
No	11 091	97.3	11 978	98.3	−1.0	<0.001
Yes	312	2.7	203	1.7	1.0	<0.001
Total	11 403	100	12 181	100		

*Mean and SD.
†Includes Sikh, Buddhist/neo-Buddhist, Jain, Parsi/Zoroastrian and others.
‡p-value for the t-test
BMI, body mass index; BP, blood pressure; MPCE, monthly per capita consumption expenditure; OBC, Other Backward Class.

stratification between social engagement, gender and depressive symptoms show that social engagement's buffering effects are lower in women than men. The complete table with all the covariates is provided in the online supplemental table 2.

Table 5 presents the regression results for two-way stratification of gender and educational status on the cognitive functioning after controlling for selected covariates. The results indicate that men with higher education had significantly better cognition than men with no education (β=7.24; 95% CI: 6.90 to 7.57). Women with no education had poorer cognitive performance than men with no education (β=−2.60; 95% CI: −2.82 to −2.39). The complete table including all the covariates adjusted in the analysis is provided in the online supplemental table 3. The correlation between social engagement and depressive symptoms was −0.12 (p<0.001) (online supplemental table 4).

The linear regression model demonstrated that higher levels of social engagement were significantly negatively associated with depressive symptoms (β=−0.18, p<0.001)

Table 3 Gender comparison of the mean cognition score (0–43) according to background characteristics in older adults, India (N=23 584)

	Men	Women	Difference	P value for difference*
Social engagement				
Low	23.7	19.7	4.0	<0.001
Medium	26.0	22.3	3.7	<0.001
High	27.6	24.2	3.4	<0.001
Age groups				
60–69	26.6	22.2	4.4	<0.001
70–79	24.9	19.9	5.0	<0.001
80+	23.3	18.2	5.1	<0.001
Social activities				
0	23.1	18.7	4.4	<0.001
1	25.3	21.3	4.0	<0.001
2	28.8	25.1	3.7	<0.001
3+	30	28.2	1.8	<0.001
Education level				
No education	21.5	19.0	2.5	<0.001
Primary	26.1	24.5	1.6	<0.001
Secondary	29.7	29.6	0.1	0.203
Higher	31.0	31.9	–0.9	<0.001
Currently working				
No	25.7	21.2	4.5	<0.001
Yes	26.0	20.8	5.2	<0.001
Place of residence				
Rural	24.7	19.8	4.9	<0.001
Urban	28.7	24.4	4.3	<0.001
Religion				
Hindu	25.9	21.2	4.7	<0.001
Muslim	25.9	20.5	5.4	<0.001
Christian	24.6	21.8	2.8	<0.001
Others†	24.3	21.2	3.1	<0.001
Caste				
Scheduled Caste	24.1	19.4	4.7	<0.001
Scheduled Tribe	22.2	17.8	4.4	<0.001
OBC	26.2	21.7	4.5	<0.001
Others	27.4	22.4	5.0	<0.001
Regions				
North	25.4	20.0	5.4	<0.001
Central	25.9	20.8	5.1	<0.001
East	25.4	20.2	5.2	<0.001
Northeast	26.5	21.3	5.2	<0.001
West	25.7	21.0	4.7	<0.001
South	26.3	23.2	3.1	<0.001
BMI categories				
Normal	26.0	20.8	5.2	<0.001
Underweight	23.3	18.2	5.1	<0.001
Overweight/obese	28.7	24.5	4.2	<0.001
MPCE quintile				

Continued

Table 3 Continued

	Men	Women	Difference	P value for difference*
Poorest	24.2	19.6	4.6	<0.001
Poorer	24.9	20.3	4.6	<0.001
Middle	26.4	21.7	4.7	<0.001
Richer	26.3	21.9	4.4	<0.001
Richest	27.4	22.7	4.7	<0.001
Currently smoking tobacco				
No	26.1	21.2	4.9	<0.001
Yes	24.7	18.1	6.6	<0.001
Currently consuming smokeless tobacco				
No	26.1	21.4	4.7	<0.001
Yes	25.0	19.5	5.5	<0.001
Drinking status				
Never	26.2	21.2	5.0	<0.001
Infrequent non-heavy	25.4	18.9	6.5	<0.001
Frequent non-heavy	23.5	16.7	6.8	<0.001
Heavy episodic drinker	22.9	15.7	7.2	<0.001
Hypertension status				
Normal	24.7	20.6	4.1	<0.001
Prehypertensive	26.1	21.6	4.5	<0.001
High BP	26.2	20.9	5.3	<0.001
Diabetes				
No	25.5	20.8	4.7	<0.001
Yes	27.7	23.3	4.4	<0.001
Cancer				
No	25.8	21.1	4.7	<0.001
Yes	27.8	22.4	5.4	<0.001
Heart disease				
No	25.7	21.1	4.6	<0.001
Yes	27.7	22.5	5.2	<0.001
Stroke				
No	25.8	21.1	4.7	<0.001
Yes	24.3	19.4	4.9	<0.001
Total	25.8	21.1	4.7	<0.001

*Based on two-sample t-test.
†Includes Sikh, Buddhist/neo-Buddhist, Jain, Parsi/Zoroastrian and others.
BMI, body mass index; BP, blood pressure; MPCE, monthly per capita consumption expenditure; OBC, Other Backward Class.

(online supplemental table 4). Table 6 shows the results obtained from the KHB analysis for the sample under study. After controlling the selected covariates, results indicate that depressive symptoms significantly confounded 14.4% of the association between social engagement and cognitive function.

DISCUSSION

The COVID-19 pandemic has called for international attention on the importance of social relationships/social engagement/social inclusion in terms of supporting the physical, emotional and cognitive health of older adults.[66 67] Evidence suggests significant correlations exist between engaging in social activities and enhanced cognitive outcomes.[10 50] However, depression and other mental illnesses that may lead to reduced social networks and activities resulting in cognitive decline among older adults are little explored, especially in LMICs. The present study examined the direct, indirect and total effects of social engagement on cognitive functioning confounded by depressive symptoms among older adults in India. We found that a higher level of social engagement was associated with greater cognitive functioning, whereas

Table 4 Linear regression results of stratification of social engagement, gender and depressive symptoms on cognitive functioning (N=23 584)

	β	95% CI
Social engagements # depressive symptoms		
Low+depressive symptoms	−0.61***	−0.66 to −0.56
Medium+depressive symptoms	−0.28***	−0.33 to −0.23
High+depressive symptoms	−0.10*	−0.20 to −0.01
Social engagements # gender		
Low+men	−1.12***	−1.53 to −0.72
Low+women	−3.45***	−3.81 to −3.08
Medium+men	−0.35*	−0.68 to −0.01
Medium+women	−2.39***	−2.75 to −2.03
High+men	Ref.	
High+women	−1.54***	−2.11 to −0.98
Gender # depressive symptoms		
Men+depressive symptoms	−0.10***	−0.15 to −0.05
Women+depressive symptoms	−0.66***	−0.70 to −0.61
Social engagements # gender # depressive symptoms		
Low+men+depressive symptoms	−0.24***	−0.31 to −0.16
Low+women+depressive symptoms	−0.75***	−0.80 to −0.70
Medium+men+depressive symptoms	−0.07**	−0.12 to −0.02
Medium+women+depressive symptoms	−0.55***	−0.60 to −0.49
High+men+depressive symptoms	0.07	−0.05 to 0.18
High+women+depressive symptoms	−0.35***	−0.50 to −0.20

Controlled variables were age, gender, education, working status, social activities, place of residence, religion, caste, region, body mass index, MPCE, smoking status, consuming smokeless tobacco, alcohol status, hypertension, diabetes, cancer, heart disease and stroke.
*P<0.05, **p<0.01, ***p<0.001.
MPCE, monthly per capita consumption expenditure; Ref, reference category.

depressive symptoms confounded 14.4% of the observed association. In addition, gender-based moderation effects were also examined, which were found significant with female disadvantages.

Structural aspects of social network might be essential to maintain an optimal level of cognitive functioning.[68] As documented, social networks and activities are related concepts, and individuals who have larger social networks tend to take part in more social activities.[69] Similarly, the satisfaction achieved from the social and support networks was observed to lead to better episodic memory performance, and processing speed and global cognition.[70] The main effect hypothesis in the present study is confirmed by the results showing that social engagements are independently associated with a greater level of cognitive functioning. The finding is consistent with previous studies linking social involvement with enhancing the well-being, boosting the self-esteem and creating a sense of belonging that result in better cognitive functioning.[71–73] A systematic review reported that although the exact nature of the associations is unclear, different aspects of social relationships such as social activity, social networks, social support and composite measures of social relationships are associated with cognitive functioning.[74] Thus, social engagement interventions should be prioritised in public policies to help older adults optimise their cognitive health, regardless of underlying mechanisms.

Although social engagements including the structural support from the spouse and family members are found to enhance cognitive functioning,[75–77] the role of mental illnesses adversely affecting the association is less investigated. A recent study found the mediating role of the hippocampal volume of the brain, which is known to be affected by a variety of psychiatric disorders in the association of emotional support with specific cognitive domains.[78] Consistently, the current results showed that depressive symptom was a significant confounder in the social engagement–cognitive functioning relationship. The finding is also parallel with a recent study conducted in China showing the mediating role of depressive symptoms in the protective effect of frequent exercise on cognitive functioning.[79] Therefore, our results support the previous finding that the protective effect of social relationships is more related to the aspects of quality and functionality of such relationships than the quantity and structural characteristics.[80] Furthermore, the indirect

Table 5 Linear regression results of stratification of gender and education on cognitive functioning in older adults, LASI, 2017–2018 (N=23 584)

	β	95% CI
Gender # education		
Men # no education	Ref.	
Men # primary	3.95***	3.71 to 4.19
Men # secondary	6.73***	6.46 to 7.01
Men # higher	7.24***	6.90 to 7.57
Women # no education	–2.60***	–2.82 to –2.39
Women # primary	1.80***	1.49 to 2.10
Women # secondary	5.86***	5.45 to 6.27
Women # higher	7.67***	7.06 to 8.28

Controlled for age, social engagements, depressive symptoms, working status, social activities, place of residence, religion, caste, region, body mass index, MPCE, smoking status, consuming smokeless tobacco, alcohol status, hypertension, diabetes, cancer, heart disease and stroke.
*P<0.05, **p<0.01, ***p<0.001.
Ref. - Reference category
LASI, Longitudinal Aging Study in India; MPCE, monthly per capita expenditure.

effects of social engagements on cognitive functioning suggest that social resources can be related to better cognitive functioning through minimising mental disorders in older adults, indicating that depressive symptoms may serve as an important intervening target and that reversing such illnesses might be related to greater cognitive functioning. This is similar to an earlier finding that a lack of social engagements may be particularly detrimental to late-life cognitive abilities when it is associated with mental illnesses.[81] Earlier meta-analyses and reviews have investigated loneliness, being one of the depressive symptoms, and social isolation together as part of health promotion interventions and suggested that loneliness is often experienced as part of a lack of social engagement and partly contributes to the factors of cognitive decline.[82 83] This indicates the need for social interventions that promote active participation of older people and help them in maintaining social and structural relationships and coping with age-related stress factors.

Table 6 Effect of social engagement on cognition confounded by depressive symptoms (Karlson-Holm-Breen method), by gender, LASI, 2017–2019 (N=23 584)

	β	95% CI
Social engagements		
Total effect	0.52***	0.40 to 0.63
Direct effect of social engagement	0.44***	0.33 to 0.55
Indirect effect via depressive symptoms	0.07***	0.06 to 0.09
N	23 584	
Confounding percentage	14.40%	

Controlled variables were age, gender, education, working status, social activities, place of residence, religion, caste, region, body mass index, MPCE, smoking status, consuming smokeless tobacco, alcohol status, hypertension, diabetes, cancer, heart disease and stroke.
*P<0.05, **p<0.01, ***p<0.001.
LASI, Longitudinal Aging Study in India; MPCE, monthly per capita expenditure.

The available evidence suggests that there are gender differences in the relationship between social engagement and cognitive functioning. For instance, in developed countries, numerous studies have found that the cognitive performance of older women is as good as or better than that of men.[84–86] In contrast, studies on cognitive abilities in developing countries find older women often perform worse than older men.[87 88] Moreover, earlier studies in India reported a relatively lower cognitive functioning level among older women than men.[46–48 89] In line with the previous literature, the current findings suggest a significant female disadvantage in cognitive function among older Indian adults and call for special attention with regard to public policy frameworks, clinical practice and future research.

On the other hand, studies suggest that a greater social engagement protects against rapid cognitive decline, particularly among low-educated older women.[90] In addition, social networks were reported as highly influential for women than men in determining better health behaviours related to cognitive maintenance.[87] In contrast to these studies, our findings suggest greater buffering effects of the social engagements on cognitive functioning in men than in women. Nevertheless, it still needs to be further investigated whether gender differences exist in the association of social engagements confounded by depressive symptoms with cognitive functioning using a longitudinal design.

There are several limitations of the present study to be noted. The composite index of social engagement was generated from the questions which were self-reported. The responses may have been exaggerated or under-reported. However, self-reporting is endorsed as an optimal method to measure how the participants subjectively find themselves having social networks and being involved in social activities. On the other hand, exploring the aspect of social engagements that include participating in indoor games, for example, as distinct from domains of cognitive activities is questionable, since it is not feasible to completely differentiate social engagements from cognitive engagements. Also, many activities have a psychiatric element which may have positive impacts on cognitive processes and a complex confounding effect in the associations of the three key variables in our study. Hence, considering the differences in relationships between cognitive domains and the distinct forms of social engagements that also include structural support from marital status and living

arrangements, it is important to define social relationships more clearly in future studies to achieve more reliable findings.

Besides, in a population with a huge proportion of illiterate people, the assessment of cognitive functioning with multiple domains might be subject to measurement error which can create bias in the current findings. Similarly, older women in India who are largely deprived of education and other opportunities including work participation might have resulted in a greater gender gap in cognitive functioning observed in our study. Finally, the present study was cross-sectional, and thus, a causal relationship between the variables cannot be inferred. Further investigation with longitudinal design is needed to explore the neural mechanisms that underlie the effects of social engagements on cognitive decline. Future research might also consider the impact of technology, internet and social media on social relationships, particularly feelings of social support.

CONCLUSION

The positive association of social engagement with cognitive functioning was significantly confounded by depressive symptoms, suggesting the need for maintaining social relations that help improve cognitive functioning among older adults. This needs to be confirmed with future longitudinal and interventional studies. The study also highlights the potential of social engagements independently or with others as an intervention to prevent cognitive impairment among older individuals, especially among women.

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Data availability statement Data are available upon reasonable request. The study uses secondary data which are available in a private database and accessible on reasonable request through https://www.iipsindia.ac.in/content/lasiwave-i. Applications to use the LASI data will be reviewed by the inquiry committee and, once approved, raw data will be provided to the applicant.

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