Do early life conditions explain the gender gaps in late-life cognition among older adults? Evidence from India

Abstract

Societies with a long history of gender-based discrimination, early life conditions may explain the later-life cognition. This study examines the association between early-life circumstances and to what extent it explains the gender difference in cognitive health among older adults in India. We used nationally representative Longitudinal Aging Study in India (LASI) survey, conducted in 2017-18. The analytical sample size for this study was 40,476 individuals who were aged 50 or older at the time of the survey and did not have oblivious cognitive limitations. A composite cognitive score (CCS) was calculated by combining *z*-score of individual cognitive tests of verbal fluency and verbal recall, as well as forward and backward digit test. Early childhood conditions included height, parental education and residence. Result shows that cognitive function was worse among women than men. Education, followed by height substantially reduces the gender gap in cognitive function among older adults. Parental education significantly associated with cognitive function, but it did not reduce the gender gap. Interaction effect results showed better cognitive function among those older adults whose father and mother had completed secondary and higher level of education. Those older adults, whose childhood and current residence was urban, found to be improved cognitive function.

Key words: Cognitive health, gender, education, height, parental education, India

Background

The male-female difference in cognitive health has been widely studied in developed countries as compared to low-and-middle income countries. The most common observation that can be drawn from the developed countries was: cognitive health among older women is as good or even better than the male counterparts (De Frias et al., 2006; Langa et al., 2009; Lewin et al., 2001; Weber et al., 2014). However, few nationally representative studies conducted in developing countries including Asia (Oksuzyan et al., 2017), Africa (Onadja et al., 2013) and Latin America (Nguyen et al., 2008) found women perform significantly worse than men in many cognitive tests. Studies argue that poor cognitive health resulted into several age-related morbidities and mental illness among older adults (Cole and Dendukuri, 2003; Kalaria et al., 2008; Mather and Carstensen, 2005; Munshi et al., 2006). Considering the growing older population in low-and-middle income countries like, India examining the gender gap in cognitive health and its associated factors among older adults is one of the top policy priorities.

Studies that examined the gender difference in cognitive health among older adults while considering life-course perspective are very limited, particularly in Indian setting. For instance, we found one study that included parental level factors mainly father's and mother's education (Lee and Smith, 2014). Study found that father's and mother's literacy positively influences daughter's (currently older women) and son's (currently older men) cognition, respectively. However, study did not show effect of parental education on gender gap in cognitive function (Lee and Smith, 2014). Finding from other countries such as China have suggested early-life

nutritional deprivation contribute significantly to the cognitive impairment among older adults in general and women in particular (Zhang et al., 2010). Another study analyzed that about 83% gender gap in Egypt was accounted by mean difference in childhood, adulthood and current attributes such as parental education, health status during childhood and adulthood, sibling composition etc. (Yount, 2008).

This study differs in many aspects from the existing studied conducted in India and perhaps from Southeast Asia. For instance, it has utilized much larger nationally representative sample of older adults aged 50 and above. Study explicitly employs a life-course perspective approach while considering height, parental education and childhood residence along with other confounding variables and how these contribute to gender differences in late-life cognition among older adults. Moreover, India resembles one of the most diverse countries in terms of geography, culture and socioeconomic development. Thus, the study used multilevel modeling to estimate the community level unobserved variations in cognitive functioning among older adults.

Design & methods

Study Population

This study analysed the data from the Longitudinal Aging Study in India (LASI), a national representative survey exhibiting the information on health, economic and social well-being of the elderly population of India aged 45 and older. The first wave of LASI conducted in the year 2017-18 provided information about 72,250 individuals (aged 45 years or above), including from 35 states and union territories ("LASI Main Survey | Longitudinal Aging Study in India (LASI)," n.d.). The main goal of the LASI is to collect longitudinal data on the burden of disease, functional health, healthcare, and the social and economic wellbeing of older adults based on internationally comparable research design and tools such as Health and Retirement Study (HRS) in the United States, Survey of Health, Ageing and Retirement in Europe (SHARE) the Japanese Study of Aging and Retirement (JSTAR), and the China Health and Retirement Longitudinal Study (CHARLS).

Outcome variable

The survey included tests of verbal fluency and verbal recall, as well as forward and backward digit test to measure the cognitive performance among older adults. These tests assessed the older adults immediate verbal recall, based on number of words immediately recalled from the list of 12 nouns and immediate verbal recall assessed as number of words recalled from the same 12-item list after a delay of around 10 minutes. Forward and backward digit span was examined based on number of correct responses out of a possible 14 on the digits forward task and backward task, respectively. Verbal fluency of survey participants was examined based on number of animals named in one minute. At first, *z*-score were generated to standardized the values for each variable separately. An overall composite cognitive score (CCS), was calculated by combining *z*-score of five individual cognitive tests (Christensen et al., 2013). **Figure 1** shows the distribution of scores for composite cognition for the entire sample

size of older adults included in this study. It is clearly evident from the graph that the distribution is normal and do not indicate the presence of any celling effects (Franco-Marina et al., 2010).

Covariates

Study included various socioeconomic, demographic and health behavior variables as a potential confounder. The main interest variable of this study is sex of the respondents, categories as male and female. Age was grouped into six categories (50-54, 55-59, 60-64, 65-69, 70-79, 80+) and marital status as: non-married (never married/ divorced/ separated) and currently married. Education of the respondents were coded as – never attended school, primary completed and secondary or higher. Income quintiles were derived from the household ownership of durable goods, dwelling characteristics (type of floors, walls and cooking stove), and access to services such as improved water, sanitation and cooking fuel. The different forms of individual's tobacco use (smoke, sniff, or chew) was categories as never, former, and current user. The current state of morbidity among the survey participants were categorized as having no, one or two or more chronic illness. Indian population composition is significantly influenced by the religious affiliation and social identity (Castes). The study considered three variables to the early-life conditions: height, parental education and childhood place of residence. Survey measured eligible individual's height, whereas information related to parental education and childhood place of residence were obtained from respondent's report. Both father's and mother's education were divided into: never attended, primary completed and secondary and above years of education. Place of childhood residence refers to self-reported urban and rural.

Analytical strategies

At first, we applied *t*-test for independent samples to examine the gender difference in mean CCS by selected background characteristics. The multilevel analysis was used to segregate the individual cognitive health variation in the population between the PSUs and individual levels. The SAGE Wave 1 sampling design allows to apply multilevel modeling as it follows the hierarchical structure of data – individuals nested within PSU (primary sampling unit) and PSUs within urban and rural stratum in each state. We fit multilevel ordinarily least squares linear (OLS) regression models with a random intercept attributable to clustering within PSUs. For example, the multilevel model could be described as:

$$CCS_{ij} = \beta_0 + \beta_1 sex_{ij} \ldots\ldots + u_j + \epsilon_{ij}$$

for $i = 1$ (male) and 2 (female) and j =1,……389 PSUs. The fixed portion of the model, $\beta_0 + \beta_1 weeks_{ij}$, simply states that we want one overall regression line representing the population average. The random effect, u_j, serves to shift this regression line up or down according to each PSUs. Different models have been used including other socioeconomic and health behavior variables along with state specific characteristics.

Model 1: Sex and age.

Model 2: model 1 + education of individuals.

Model 3: model 2 + individuals current marital status, height, tobacco consumption, chronic health condition, caste, religion, household wealth, social cohesion and place of residence.

Model 4: model 3 + presence of chronic illness and tobacco consumption.

Model 5: model 4 + individual height.

Model 6: model 5 + parental (father and mother) education and childhood place of residence.

We have extended the analysis while taking interaction effect between mother and father education and both childhood and current place of residence to examine the effect on gender gap in cognitive function. The variance parameter $\sigma \frac{2}{B}$ quantifies heterogeneity between PSUs, after taking into account covariates in the fixed part. All the analysis was performed using Stata version 12 (StataCorp, 2011).

Results

Descriptive statistics

Table 1 presents the sample distribution of older adults across selected socioeconomic and demographic characteristics. Almost equal number of men and women were included in the survey across major age categories. Women were largely illiterate in the sample as compared to men. For example, every four out of five women did not have any formal level of schooling as against two in every five men. Nearly, 36% of men competed secondary and above schooling, while the corresponding percentage was 10% among women. About 40% women were single (widowed/divorced/separated), compared to 12% among men at the time of survey. Social cohesion was quite low among women as compared to men. Almost equal number of men and women interviewed from both urban and rural areas. Over three out of five men were active consumer of tobacco, whereas the proportion among women was 30%. Not much variations evident between men and women when it comes to their fathers and mother's education level. Similarly, almost equal proportion of men and women spent their early childhood in either urban or rural areas.

The gender difference in mean CCS by background variables is presented in **Table 2**. Overall mean score as significantly lower among women (-0.92) as compared to male counterpart (0.907). Across all age categories, the pattern suggest that mean CCS was considerably lower among women than men, with mean difference of over 1.42. Study did not find difference in mean CCS between men and women with primary and secondary level of education. Similarly, significant gender difference in mean CCS between older men and women was quite evident by marital status, social categories, religion, social cohesion, place of current residence, chronic health status and tobacco consumption. Moreover, mean CCS was significantly lower among women than men across different categories of mother and father education levels and place of childhood residence.

Multilevel results

Table 3 presents the results of regression analysis showing gender difference in cognitive functioning. *Model 1* shows that women performed considerably poor than men in mean CCS score (β = - 1.838, 95%CI: -1.986, -1.690). Introducing education in the *Model 2* substantially reduces the gender gap in cognitive function (β = - 0.988, 95%CI: -1.135, -0.842). In *model 3,* we controlled for marital status, social group, religion, social cohesion and place of residence, the gender gap in CCS was further declined as compared with previous model (β = - 0.810, 95%CI: -0.971, -0.650). But the gender difference in CCS was increased in *model 4* (β = - 0.875, 95%CI: -1.049, -0.702)*,* when we additionally adjusted for chronic health and tobacco consumption. In the *model 5,* the male-female difference in CCS was greatly reduced after adjusting height in the analysis (β = - 0.488, 95%CI: -0.697, -0.279), along with all covariates included in *model 4.* Additional adjustment to parental level education (both mother and father) and childhood place of residence were increased the gender gap in CCS in *model 6* (β = - 0.567, 95%CI: -0.775, -0.358)*,* as compared with previous *model 5* (β = - 0.488, 95%CI: -0.697, -0.279)*.*

We have performed additional interaction effect analysis between father and mother education and current and early childhood residence on gender difference in CCS among older adults, after adjusting for other covariates (**Table 4**)**.** Finding suggests gender gap in CCS remains to be significant and no change was evident once compared from the *model 6* of table 3. However, the result does depict better CCS among those older adults whose mother and father had secondary and above level of schooling than to those whose both parents were illiterate (β = 1.708, 95%CI: 1.133, 2.284). Similarly, as compared with older adults whose current and childhood place of residence was urban, the risk of mean CCS was significantly lower among those who were currently living in rural areas and spent their childhood as well (β = - 0.637, 95%CI: -0.903, -0.372).

Discussion & conclusion

Finding of this study confirms that older women in India perform substantially poor on cognitive tests as compared to men. This result is consistent with studies conducted in other developing countries. Furthermore, the effect of education and height in reducing the gender gap in cognitive functioning was noticeable. Both parent's higher educational status significantly improves the mean CCS, but not contributed in reducing the gender gap. Study did not find any effect of childhood place of residence on later life cognitive function. Other factors such as marital status, social group, religion, household wealth, social cohesion, health status and place of residence significantly associated with mean CCS among older population in India.

Results of this study make significant contribution to the limited understanding of health and wellbeing in later-life in India and other developing countries. Study adds to the evidence about childhood conditions while examining the gender gap in cognitive function among older adults, especially the role of education, height and parental education. There is need to look beyond the role of ongoing policy initiatives and intervention that addresses gender gap in resource distribution including education, nutrition, healthcare provision, economic opportunity merely from the current perspective. Rather it must be seen and designed considering life-cycle approach which eventually will have a huge implication for whole society many decades later in

terms of reducing the burden of cognitive impairment of older adults, particularly among women. Further research is desirable to unearth the rooted gender difference in cognitive function after considering other childhood and adulthood variables in future.

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Figure 1. Density of composite cognitive scores, LASI, India

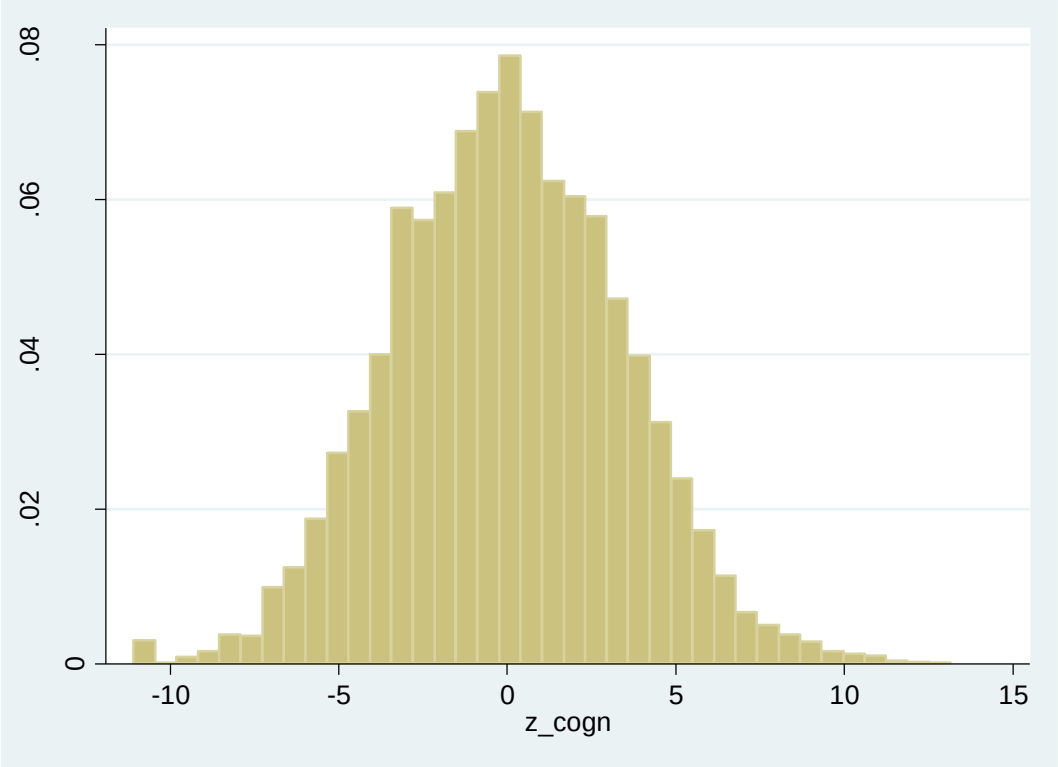

Table 2. Gender difference in mean composite cognitive score (CCS) by background variables, LASI, India

Background variables	Male		Female		Mean difference	P-value of difference (*t*-test)
	Mean	SE	Mean	SE		
Age						
50-54	1.779	0.123	-0.047	0.113	1.827	*p*=0.000
55-59	1.508	0.116	-0.377	0.124	1.886	*p*=0.000
60-64	0.931	0.133	-1.054	0.125	1.985	*p*=0.000
65-69	0.706	0.143	-1.363	0.139	2.068	*p*=0.000
70-74	0.281	0.156	-1.911	0.168	2.192	*p*=0.000
75-79	-0.455	0.225	-1.881	0.286	1.427	*p*=0.000
80+	-1.549	0.251	-3.164	0.244	1.615	*p*=0.000
Education						
Never attended	-0.504	0.076	-1.654	0.057	1.150	*p*=0.000
Primary	0.887	0.120	0.774	0.156	0.112	*p*=0.567
Secondary & above	2.743	0.088	2.958	0.175	-0.215	*p*=0.259
Current marital status						
Non-married	-0.334	0.172	-1.696	0.088	1.362	*p*=0.000
Married	1.083	0.061	-0.411	0.074	1.494	*p*=0.000
Social group (Caste)						
General/OBCs	1.200	0.066	-0.683	0.067	1.883	*p*=0.000
SCs/STs	-0.059	0.116	-1.738	0.108	1.679	*p*=0.000
Religion						
Hindu	0.902	0.063	-0.824	0.063	1.726	*p*=0.000
Others	0.933	0.141	-1.442	0.133	2.375	*p*=0.000
HH wealth						
Quintiles 1	-0.602	0.121	-2.293	0.109	1.692	*p*=0.000
Quintiles 2	0.035	0.115	-1.718	0.116	1.752	*p*=0.000
Quintiles 3	0.845	0.125	-0.948	0.120	1.793	*p*=0.000
Quintiles 4	1.612	0.122	-0.072	0.130	1.684	*p*=0.000
Quintiles 5	2.690	0.126	0.573	0.138	2.117	*p*=0.000
Social cohesion						
Low	-0.682	0.167	-1.533	0.104	0.851	*p*=0.000
Medium	0.378	0.100	-0.880	0.082	1.258	*p*=0.000
High	1.526	0.074	-0.227	0.122	1.753	*p*=0.000
Place of current residence						
Urban	2.044	0.117	0.407	0.117	1.637	*p*=0.000
Rural	0.551	0.065	-1.418	0.063	1.968	*p*=0.000
Chronic health condition						
None	1.108	0.080	-0.968	0.082	2.075	*p*=0.000
1	0.856	0.109	-0.947	0.106	1.803	*p*=0.000
2+	0.506	0.128	-0.774	0.126	1.280	*p*=0.000

Tobacco consumption						
Never used	1.448	0.113	-0.593	0.072	2.041	*p*=0.000
Former user	0.441	0.199	-1.699	0.374	2.140	*p*=0.000
Current user	0.739	0.071	-1.602	0.095	2.341	*p*=0.000
Mother's education						
Never attended	0.317	0.068	-1.603	0.063	1.920	*p*=0.000
Primary	1.731	0.110	-0.042	0.119	1.772	*p*=0.000
Secondary & above	2.995	0.209	1.744	0.194	1.251	*p*=0.000
Father's education						
Never attended	0.686	0.059	-1.239	0.057	1.925	*p*=0.000
Primary	2.694	0.196	1.539	0.216	1.155	*p*=0.000
Secondary & above	3.301	0.579	3.162	0.390	0.139	*p*=0.838
Childhood residence						
Urban	2.016	0.123	0.487	0.126	1.529	*p*=0.000
Rural	0.605	0.065	-1.332	0.063	1.938	*p*=0.000
Overall cognitive score	**0.907**	**0.058**	**-0.920**	**0.058**	**1.827**	***p*=0.000**

Note: All '*n'* uweighted.