Prevalence and Predictors of Cognitive Impairment among Aged Males and Females: A Population Based Cross-sectional Study

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ABSTRACT: The present cross-sectional study is an attempt to determine the prevalence and predictors of cognitive impairment among 98 males and 100 females of Chandigarh, India. All the participants were between 50 to 70 years of age. A 30- point questionnaire i.e Hindi version of MMSE scale was employed to assess the global cognition. Males with higher cognitive scores were significantly lighter, had less developed circumferential measurements and higher waist/hip ratio than males having lower cognitive scores, whereas an opposite trend was witnessed among females. Multivariate regression analysis predicted that illiteracy and > 3 children among females and vegetarian diet among males were associated with impaired cognitive performance. The identification of such potential risk factors may lead to early diagnosis of individuals vulnerable to severe cognitive deficits in later life.

INTRODUCTION

Aging is an inevitable and irreversible process involving a series of psychological, social and biological changes within an individual (Ruvalcaba, 2018). The impressive increment in life expectancy due to the advent of medical facilities has elevated the incidences of various age associated diseases like cardiovascular diseases, hypertension, diabetes and cognitive impairment. Normal cognitive functioning involves proper performance of various activities of human brain like memory, visuo-spatial skills, language, learning and ability of decision making as well as judgment (Sharma *et al.*, 2013). Whereas cognitive impairment is a psychological condition when an individual has trouble in memorizing names or any recently learnt information, face difficulty in learning, concentration and in decision making, and such changes adversely interfere with the routine activities of life. These age-related cognitive alterations exhibit variability in different cognitive domains as well as in individuals (Glisky, 2007) with the intensity of cognitive decline ranging from mild to severe cases. Review of previous literature (Werner and Korczyn, 2008; Bennett and Thomas, 2014; Pan *et al.,* 2015) have also delineated that cognitive impairment is accompanied by adverse psychiatric conditions like depression, anxiety and sleeplessness, resulting in poor mental as well as physical health, therefore affecting the quality of life of aged people.

The literature has documented many factors such as socio-economic factors (Wu *et al*., 2016), health conditions (Pektzer and Mafuya, 2012), level of education (Maharani and Tampubolon, 2016), rural or urban setting (Miu *et al.*, 2016), quality of life (Konagaya *et al.*, 2009), low level of depression (Hirsch *et al.*, 2011), high blood pressure (Gao *et al.*, 2009), physical activity (Vance *et al.*, 2005) and healthy diet (Ferdous *et al*., 2010) that may contribute to the subsequent development of cognitive impairment. Findings of Cronk *et al.* (2010) noticed an inverse association between BMI and cognitive performance. Whereas contrasting view was depicted by Kim *et al.* (2016) and Smith *et al*. (2014) stating a protective

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nature of obesity towards cognitive performance. Studies conducted by Xu *et al.*, (2011) and Whitmer *et al*. (2005) ascertained a positive association between midlife obesity and cognitive decline in later stage of life. Therefore, no uniform conclusion exists regarding the association of increased adiposity and cognitive performance among researchers globally, hence further investigations are required to explore this association.

The reason of association between obesity and cognitive performance is very complex. Various earlier studies on brain imaging have provided the evidence that obese individuals exhibit some morphological changes in their brain such as lower brain volume (Ward *et al*., 2005) and decreased level of grey matter (Shefer *et al.*, 2013) and white matter (Verstynen *et al*., 2012), which are responsible for accelerated aging of the brain. The obese individuals exhibit a diminished secretion of adiponectin by adipose tissues (Arnoldussen *et al.*, 2014) thereby reducing the neural protection and energy metabolism (Kaser *et al*., 2007). These functional and morphological alterations in brain due to adiposity are considered to be the important factor for alterations in cognitive functioning of an individual.

A cross-sectional study conducted by Mohan *et al*. (2019) estimated that the occurrence of mild cognitive impairment amongst older adults of Kerala as 26.06%. Similarly, Singh *et al.*, 2010, documented the overall prevalence of cognitive impairment among population of Bikaner as 19.26% and they further highlighted that this prevalence was higher among females. The conversion rate of mild cognitive impairment to severe condition i.e Alzheimer disease was noted to be approximately 13% (Mridula *et al.*, 2008). Findings of Livingston *et al*. (2017) reported that there can be 35% decrement in occurrence of dementia (severe stage of mild cognitive impairment), if its risk factors can be identified and controlled at its initial stage. Therefore, early recognition of the risk factors that enhances the chances of cognitive impairment among older individuals is important. So, the present study provides us an opportunity to understand the prevalence as well as factors associated with cognitive impairment among adult males and females.

RESEARCH METHODOLOGY

The present cross-sectional study was conducted on 198 participants including 100 females and 98 males. The aim and purpose of the study was explained to all the participants and their verbal consent was taken before conducting the study. The study included healthy individuals aged between 50 to 70 years. Whereas participants with the history of any type of chronic disease, prolonged illness, or any physical deformity were excluded from the present study.

An interview-based schedule was used to gather information like age, marital status, occupation, level of education, dietary habit (vegetarian or non-vegetarian diet), milk intake (number of glasses per day), number of children ($\leq$ 3 or more than 3) and physical activity i.e No activity, walking (3-5 days per week) and regular exercise (5-7 days of yoga, exercise or gym per week).

Anthropometric measurements like height (cm), weight (kg), waist-circumference(cm) and hip circumference(cm) of all the participants were taken using the standard techniques of Weiner and Lourie (1969) and were used to assess their body mass index and waist-hip ratio respectively. All the participants were classified into four categories on the basis of their BMI i.e. underweight (BMI <18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), over weight (25-29.9 kg/m^2) and obese (BMI $\geq$ 30 kg/m^2) (WHO, 2008). The presence of central obesity was regarded beyond the cut-off point of waist-hip ratio $\geq$0.90 and $\geq$0.85 for men and women respectively (WHO, 2000).

A 30-point questionnaire i.e. Hindi version of Mini- Mental State Examination scale (Ganguli *et al.*, 1995) was employed to assess the global cognition of all the participants. Individuals scoring below or equal to 23 points were considered as cognitively impaired and the subjects who scored more than 23 points were designated as normal (Tsolaki *et al.*, 2000).

The analysis of collected data was carried out using Statistical Package for the Social Sciences (SPSS) version 16. The quantitative and qualitative data were expressed in mean $\pm$ SD and in percentages (%) or frequencies respectively. Student's t-test was used to compare the mean of continuous variables between individuals of normal cognition and

cognitive impairment groups. Univariate as well as multivariate regression analysis was done to estimate the odds ratio with 95% of confidence Interval (CI) for the various predictors of cognitive impairment in both the sexes. For all the above analysis the level of significance (p value) was considered to be <0.05.

RESULTS

Table 1 presents the general characteristics of 98 males and 100 females of Chandigarh. The mean age of males and females of present study was 59.34±5.94 years and 58.59±5.83years respectively. Out of the total sample 73.5% males were working, whereas 73% females were homemakers. The educational status of the participants included in the study demonstrated that most of the males (43.9%) and females (43%) were graduate or more and studied upto metric respectively. On the basis of their cognitive scores participants were categorised into two groups i.e. 41.4% had normal cognition, whereas 58.6% presented impaired cognition.

TABLE 1

General characteristics of the male and female participants

Category		*Total (N=198)*	*Males (N=98)*	*Females (N=100)*
	Age in years (Mean± SD)	58.96±5.88	59.34±5.94	58.59±5.83
Occupation	Home makers N (%)	77 (38.9%)	4(4.1%)	73 (73%)
	Working N (%)	98 (49.5%)	72(73.5%)	26 (26%)
	Retired N (%)	23 (11.6%)	22(22.4%)	1 (1%)
Education	Illiterate N (%)	39 (19.7%)	16 (16.3%)	23(23%)
	Upto matric N (%)	82 (41.4%)	39 (39.8%)	43 (43%)
	Graduation and more	77 (38.9%)	43 (43.9%)	34 (34%)
Marital Status	Married N (%)	192 (97%)	98 (100%)	94 (94%)
	Widow/widower N (%)	6 (3.0%)	0 (0%)	6 (6%)
No. of children	≤3	153 (77.3%)	73(74.5%)	80(80%)
	>3	45 (22.7%)	25(25.5%)	20(20%)
Diet	Vegetarian N (%)	111 (56.1%)	50 (51%)	61 (61%)
	Non-vegetarian N (%)	87 (43.9%)	48 (49%)	39 (39%)
Milk Intake	No	23 (11.6%)	15 (15.3%)	8 (8%)
	1 glass/ day	109 (55.1%)	49 (50%)	60 (60%)
	2 glasses/ day	58 (29.3%)	32 (32.7%)	26 (26%)
	More than 2 glasses/ day	8 (4.0%)	2 (2.0%)	6 (6%)
Physical activity	No activity N (%)	14 (7.1%)	5(5.1%)	9 (9%)
	Walking N (%)	136 (68.7%)	63 (64.3%)	73 (73%)
	Regular exercise N (%)	48 (24.2%)	30 (30.6%)	18 (18%)
Body mass index (BMI)	Under weight (≤18.5 kg/m^2)	04 (2.0%)	2 (2%)	2 (2%)
	Normal (18.5–24.9 kg/m^2)	39 (19.7%)	20 (20.4%)	19 (19%)
	Overweight (≥25.0 kg/m^2)	89 (44.9%)	48 (49%)	41 (41%)
	Obese (≥ 30.0 kg/m^2)	66 (33.3%)	28 (28.6%)	38 (38%)
Cognitive functioning	Normal Cognition N (%)	82 (41.4%)	34 (34.7%)	48 (48%)
	Cognitive impairment N (%)	116 (58.6%)	64 (65.3%)	52 (52%)

The descriptive statistics of various anthropometric variables of males and females with respect to their normal as well as impaired cognitive scores is depicted in Table 2. In the present study cognitive impairment was identified at the prevalence of 65.3% in males and 52% in females. Both the males as well as females with greater cognitive score (MMSE ≥ 24) were taller than their counterparts with lower cognitive scores (MMSE≤23), although differences were statistically significant only in males. Males with higher cognitive scores were significantly lighter, had less developed circumferential measurements and higher waist/hip ratio than the participants with lower cognitive scores, interestingly an inverse trend was recorded among females for these measurements. The statistically significant differences were observed for waist circumference in both the sexes and for BMI in females only.

TABLE 2

Descriptive statistics of anthropometric variables of males and females with respect to their cognitive scores

Anthropometric and lifestyle Characteristics	*Males (N=98)*			*Females (N=100)*		
	Normal cognitive scores MMSE ≥ 24 (n=34)	*Cognitive impairment* MMSE≤23 (n=64)	*t-test*	*Normal cognitive scores* MMSE ≥ 24 (n=48)	*Cognitive impairment* MMSE≤23 (n=52)	*t-test*
Height (cm)	164.74±4.97	163.82+52.31	0.000***	159.03+5.25	158.32+6.73	1.995
Weight (kg)	72.88±10.10	73.13+10.00	0.006*	70.38+12.42	69.56+11.17	0.973
BMI	28.02±3.99	28.05+4.56	0.762	28.74+5.37	28.35+5.97	0.035*
Waist circumference	93.76±15.04	96.02+12.45	0.000***	93.53+13.08	90.38+15.71	0.009*
Hip circumference	94.01±12.77	98.15+12.66	0.396	102.09+14.44	99.06+12.54	0.693
Waist/hip ratio	0.99±0.07	0.97+0.05	0.931	0.91+0.05	0.92+0.04	1.387

Level of significance = p≤0.05*, p≤ 0.01**, p≤0.001***

Figure 1 outlines the mean MMSE scores with respect to different categories of body mass index in both males and females of the present study. It is inferred from the figure that obese males (MMSE scores= 22.39) had highest mean global MMSE score followed by overweight (MMSE scores= 22.08) and normal weight (MMSE scores= 21.85) individuals and lowest scores were observed among underweight males (MMSE scores = 19.00). Whereas among females the mean cognitive score was highest (MMSE scores= 22.17) among overweight females, followed by obese (MMSE scores= 22), underweight (MMSE scores = 21) and normal weight (MMSE scores= 20.84) subjects.

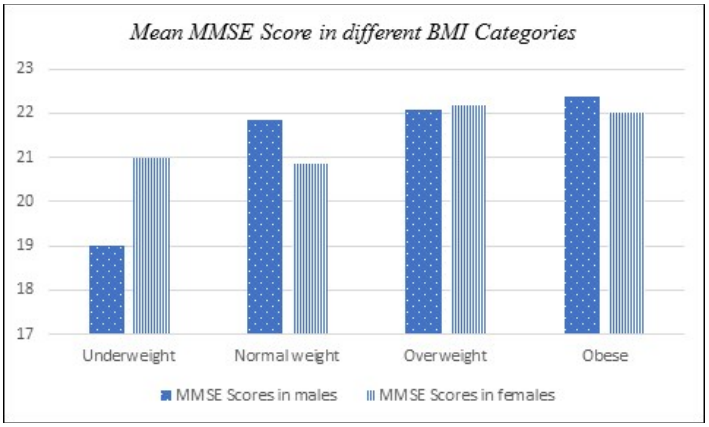

Figure 1 Mean MMSE scores with respect to different categories of body mass index in both males and females

Univariate regression analysis was conducted to estimate the possible predictors of cognitive impairment among males and females. The results of the univariate regression analysis (Table 3) depicted that out of the various factors only level of education and number of children were the significant predictors of cognitive impairment among females. Women having >3 children exhibited higher chances of cognitive decline with odds ratio 27.06 (95% CI 3.45 – 212.22, p≤ 0.05). Similarly, illiteracy was also significantly associated with greater chances of cognitive impairment with odds ratio of 34.46 (95% CI 4.41-269.26, p≤ 0.01). Whereas among males vegetarian diet exhibited 0.34 folds (95% CI 0.14-0.83, p≤ 0.05) higher chances of cognitive impairment. The variables exhibiting statistically significant associations in the univariate model were further subjected to multivariate regression model.

According to multivariate regression model (Table 4), illiterate women were found to have a 27.5 folds (95% CI 3.38-223.44, p<0.001) higher probability of the cognitive impairment. Women having >3 children were 20.64 times (2.48-171.66, p<0.001) more likely to be associated with impaired cognitive

performance**.** Vegetarian males were found to present 0.34 folds (95% CI 0.14-0.83, p<0.01) higher chances of the cognitive impairment.

TABLE 3

Univariate analysis of factors associated with cognitive impairment among males and females

Variables		Males (N=98)		Females (N=100)	
		Odds ratio (95% CI)	p value	Odds ratio (95% CI)	p value
Age (In years) [a]	≤ 55	1		1	
	56-64	0.609(0.230-1.609)	0.3170.602	1.235 (0.507-3.010)	0.6420.083
	≥65	0.727(0.219-2.411)		2.647 (0.880-7.966)	
Level of Education	Illiterate	4.48(0.95-21.03)	0.057	34.46(4.41-269.26)	0.001**
	Literate	1		1	
No. of Children	≤3	1		1	
	>3	1.50(0.55-4.07)	0.417	27.06(3.45-212.22)	0.002*
Diet	Vegetarian	0.34 (0.14-0.83)	0.018*	0.78(0.34-1.76)	0.556
	Non-vegetarian	1		1	
Physical Activity	No activity	0.43(0.04-4.36)	0.477	4.37(0.70-27.16)	0.113
	Waking	0.92(0.37-2.29)	0.869	1.28(0.45-3.62)	0.636
	Regular exercise/ yoga	1		1	
Hypertension	Yes	0.66 (0.21-2.10)	0.490	1.57(0.55-4.45)	0.395
	No	1		1	
Body Mass Index	Underweight	0.42(0.02-8.04)	0.571	0.72(0.03-13.45)	0.831
	Normal weight	1		1	
	Overweight	0.65(0.21-2.00)	0.457	0.69(0.23-2.07)	0.512
	Obese	1.07(0.30-3.77)	0.915	0.80(0.26-2.45)	0.707
Waist-Hip ratio	Normal	1	0.412	1	0.110
Abdominal obesity (WHR ≥0.90 for men and WHR >0.85 for women)		0.69(0.29-1.64)		5.93(0.66-52.72)	

Level of significance = p≤0.05*, p≤ 0.01**, p≤0.001***

TABLE 4

Multivariate analysis of factors associated with cognitive impairment among males and females

Variables	Odds Ratio (95% CI)	p-value
Females: Model 1		
Level of education		
illiterate	27.5(3.38-223.44)	0.00**
Literate	1	
Number of Children		
>3	20.64(2.48-171.66)	0.00**
≤3	1	
Males: Model 1		
Diet		
Vegetarian	0.34 (0.14-0.83)	0.01*
Non-vegetarian	1	

Level of significance = p≤0.05*, p≤ 0.01**, p≤0.001***

DISCUSSION

In the present sample overall prevalence of cognitive impairment was estimated as high as 58.6%, with higher prevalence among males (65.3%) as compared to their female (52%) counterparts. Similarly, Ramchandran *et al*. (2018) also conducted a cross-sectional study to analyse the cognitive functioning using MMSE Scale on 100 elderly subjects of Kerala and observed the prevalence of cognitive impairment to be 55%. Previous cross-sectional studies recorded 42.9% cognitive impairment in Varanasi (Gambhir *et al.*, 2014), 38% in Hyderabad (Rao *et al.*, 2014) and 42.7% in Chennai (Samuel et al., 2016). Recently, Vidyanti *et al*. (2020) documented the higher prevalence of cognitive impairment (75.5%) among people of Indonesia as assessed by Indonesian version of Montreal Cognitive Assessment Scale. Similar results were documented by Arjuna *et al*. (2017)

who indicated its prevalence to be about 59% and 80% among urban and rural population of Indonesia respectively. Earlier authors (Wlkie and Eisdorfer, 1971) considered that cognitive impairment is not a product of normal aging process, but it should be viewed as secondary to some pathologic conditions.

In the present study prevalence of cognitive impairment was higher among males than females. Recently Abi-Ghanem *et al*. (2020) explained the effects of androgens on cerebrovascular function and noticed higher risk of stroke and dementia (VCID) among males as compared to females throughout the lifespan. While conflicting findings were seen in the study of Liu *et al.* (2019) where females exhibited signiûcantly higher prevalence of cognitive impairment than males (males 41.5% vs females 58.5%, $\chi^2 = 9.49^{**}$). In the present study most of the males (73.5%) were working, while substantial percentage of women were involved in household chores only. Therefore, males were having more stressful circumstances than their female counterparts. This could be one of the reasons for higher prevalence of cognitive impairment among males.

The results of the present study depicted that the males with normal cognition were significantly taller, lighter but lower BMI and circumferential measurements than cognitively impaired males. West *et al*. (2015) also observed that men with short stature were associated with poor cognitive functioning especially in the domains of global cognition ($p = 0.016$), executive functioning ($p = 0.001$) and attention ($p = 0.007$). Similar observations were noticed by Quan *et al*. (2013) among Korean population that men with short height exhibited higher chances of cognitive impairment. A report of Perneczky (2010) explained that individuals with short height have smaller head circumference, resulting in lower brain reserve, which in turn is associated with decline in cognitive functioning. Divergent results were observed by Noh *et al*. (2017) among Korean population, where males with cognitive impairment presented higher values of height, BMI and waist-hip ratio as compared to their cognitively normal counterparts.

In the present study females with normal cognition were taller, heavier, higher BMI and circumferential measurements than cognitively impaired females. Similar results were observed among three hundred twenty participants of South Korea aged 65 years or older, in which females with normal cognition as assessed by Korean version of Mini Mental state examination exhibited significantly higher body mass index (25.52 ± 3.58) as compared to cognitively impaired females (23.72 ± 3.14) (Noh *et al.* 2017). Konda *et al.* (2018) also conducted a cross-sectional study and reported that both lower weight and waist-hip ratio were significantly associated with higher chances of cognitive impairment among older adults (60 years or older) of Hyderabad, India. Similarly, Skinner *et al*. (2017) evaluated the cognitive performance of three hundred thirty-one individuals (aged 55 years or above), out of which majority (94.6%) of the participants were women and documented the beneficial effect of obesity towards cognitive functioning. Findings of Bagger *et al*. (2004) documented that body fat mass may play a protective role in halting cognitive deterioration and this protection can be attributed to nonprotein-bound estradiol produced by visceral adipocytes.

Health benefits could be accomplished by identifying possible determinants, in the present study univariate regression analysis and further multivariate regression depicted that out of the various factors only illiteracy (OR=27.5, 95% CI 3.38-223.44) and more than three children (OR=20.64, 95% CI 2.48-171.66) were the significant predictors of cognitive impairment among females, whereas vegetarian diet (OR=0.34, 95%CI 0.14-0.83) was significantly associated with lower chances of cognitive impairment among males. In accordance to our findings, Rao *et al.* (2014) also evaluated the cognitive functioning of older adults (aged 60 years or above) of Hyderabad using Mini Mental state Examination scale and observed that covariates such as age, gender (female), lower educational level, marital status (widow/ widower) and nuclear family type were significantly associated with higher chances of cognitive impairment. Similar to these results various other studies (Khairiah *et al*., 2016; Maroof *et al*., 2016 and Konda *et al.*, 2018) also observed a positive association between cognitive impairment and no formal education among different elderly populations of Malaysians, rural areas of Aligarh and Urban area of Hyderabad respectively. In Latin America, the illiteracy rate was noted to be 9.3% and the prevalence of

dementia (severe stage of mild cognitive impairment) in illiterate population was almost double as compared to the literates (Nitrini *et al.*, 2009). In India, Sengupta *et al.* (2014) analysed the correlates of impaired cognition among older adults (60 years or above) of Ludhiana, Punjab using Hindi Mental state examination scale and found that older age, no education, widowed status, unemployment and lower monthly income (< 1000 rupees) were the significant predictors of cognitive impairment. A study performed by Grossi *et al.* (1993) illustrated that the basic learning during the formative years of schooling is responsible for improvement of mental strategies, and are well preserved during the normal aging process. Whereas Bruki, (2010) explained that illiteracy is associated with lower cognitive performance, due to unsuitable adaptation of a neuropsychological test for a particular population and difficulty in cognitive evaluation therefore documenting poor cognitive scores among illiterate population.

The major limitation of the current study is its cross-sectional nature, as it does not examine the longitudinal performance of the participants and the true causal relationship could only be identified through extended follow-up studies among both males and females. The study has only assessed the global cognitive functioning of the participants without specifically focusing on each cognitive domain. More information regarding the dietary patterns of the participants would have presented better results.

Despite of certain limitations there are several strengths of the study. To the best of our knowledge this is the first report assessing the prevalence and factors associated with cognitive impairment among both males and females of Chandigarh, India. The study provides us the epidemiological data for a population for which, as yet, there is no such information.

CONCLUSION

With expanding age people are spending more years of their life in old ages. World health organisation (2019) had documented that approximately 10 million new cases suffer from dementia (severe stage of mild cognitive impairment) every year. In addition to this, mild cognitive impairment also leads to psychological symptoms like depression and insomnia among both patients and caregivers (Na, 2019). In order to flatten this increasing curve, there is an urgent need for the identification of potential risk factors, which can lead to early diagnosis of individuals vulnerable to severe cognitive deficit in later life and is also important for the development of preventive strategies, which can therefore help in halting the progression of cognitive deterioration among elderly population.

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