Original Article

Association of perceived stress with working memory, visuospatial and global cognitive function in elderly Egyptians.

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ABSTRACT

Background: Although stress has been associated with poor cognitive function, few studies have examined the correlation between perceived stress and cognitive decline in older adults.

Objective: To assess the association of perceived stress with global cognitive function, visuospatial and working memory at Ain Shams University hospitals.

Methods: A cross sectional study involving 104 elderly attending outpatient clinics and the in-patient department at Ain Shams university hospitals. Demographic data of the participants were collected. Perceived stress scale, MOCA-Basic test, digit backward test and stick design test were taken. Excluded were patients with dementia, depression, organic brain lesion and those using psychiatry drugs.

Results: Global cognitive function was assessed by MOCA-B with mean score 21.4 ± 1.99. Most of the participants had moderate level of stress 54.8% and 41.3% have high levels of stress. There was a statistically significant negative effect of stress on cognitive functions of participants (P value <0.001).

Conclusion: High stress levels are significantly associated with decline in cognitive function.

Key words: cognitive impairment, elderly, stress.

INTRODUCTION

Cognitive decline is rapidly rising at the present time and has notable influence on families and health care systems in aging societies. Dementia is defined as cognitive decline that interferes with daily living tasks. Globally, 46.8 million human beings had dementia in 2015, and that number is anticipated to rise to 74.7 million by 2030 due to an increase of 7.7 million new cases per year (1). The cost of treating Alzheimer's disease is calculated to be $305 billion in 2020, and as the population ages, that amount is predicted to rise to more than $1 trillion (2).

Hence, it is important to know the risk factors affecting decrease of cognitive functions for detection and early intervention, and also to postpone dementia complications. These risk factors include age, having positive family history of dementia, stress and depression (3).

Stress might be an important risk factor for developing cognitive impairment, when difficulties / stressors exceed the adaptive capacity of an individual the risk of comorbidities and diseases is enhanced (4) Also, stress affects mood and emotions, behavior cognition and health (5).

According to many studies, stress is particularly common in older adults due to a variety of factors, including retirement, chronic illness, the death of a partner, financial difficulties, and social problems. (6). Therefore, stress has a huge role in the development of psychological and physical health issues such as depression (7), sleep disorders (8) anxiety (9) and cognitive decline (10).

According to the severity, type and time of the stimulus, stress can trigger pathophysiological mechanisms such as psychiatric disturbances, metabolic dysregulation, neurologic disorders, cardiovascular diseases and it might end by death (11). Therefore, measuring perceived

stress in elderly can provide valuable data about the association between stress and age-related pathology (12). So, currently there is rising attention toward the association between stress and global cognitive function and the domains of cognitive function, including the language, learning, memory, visuospatial memory performance and frontal-executive domains (13).

OBJECTIVE

To assess the association of perceived stress with global cognitive function, visuospatial and working memory at Ain Shams University hospitals.

METHODS

One hundred and four elderlies were included. Sample size was calculated using PASS11 program, assuming that 50% of elderly have subjective memory loss, a sample size of at least one hundred and four participants produces two-sided 95% confidence interval with a width equal to 0.199 when the sample proportion is 50%. Participants were collected from inpatient and outpatient clinics at Ain Shams university hospitals.

After receiving informed consent, every participant was questioned. Demographic data,Past history, medication list history and family history were taken.

Inclusion criteria included elderly aged sixty years old and above, consenting to participate in the current study. While exclusion criteria included those who were known to be demented, delirious or depressed , ,in acute medical illness, with antipsychotic drug history , or refusing to participate in this study.

Past medical history was assessed using Charlson Comorbidities Index as a validated measure of burden of disease (14).

Stress assessment by Arabic version of perceived stress scale, which is a valid tool to measure psychological stress and has adequate psychometric features (15). It is a 10 items questionnaire, with each item scored from 0 to 4. Total scores range from 0 to 40. Scoring is as follows:

Scores from 0 to 13 considered to be low level of stress.

Scores from 14 to 26 considered to be moderate level of stress.

Scores from 27to 40 considered to be high level of stress.

Global cognitive function assessment by Montreal Cognitive Assessment-Basic (MOCA-Basic) test . It is a cognitive screening tool translated and validated by Arabic version used in illiterate or lower educational levels (17). The MoCA-B is a thirty point test that evaluates six cognitive domains: executive function (word similarity; problem solving, simplified trail making), language (fruit fluency and animal naming), orientation (to time and place), attention (modified digit Stroop), visual perception (laid over objects in one picture), and memory (five-word delayed recall),The MoCA-B is freely available and it is approximately done in 15 min (18).

Assessment of working memory by digit backward test, It is the most common test used to assess working memory capacity (19). The informer told the participant to listen carefully to a series of numbers and ask the participant to say them back

Assessment of visuospatial memory by Stick design test (20): in stick design test, participants arranged wooden match sticks the same as in the standard patterns (a representation of four arranged wooden matches which was printed on a blank page) The designs show a chevron , a square, a triangle with stem, and a rake-like figure .The norms of stick design for elderly with normal cognition was (8 ± 3) (21).

The methodology of the study was reviewed and approved by the Ethical Committee of Scientific Research and the Research Review Board of the Geriatrics and Gerontology Department, Faculty of Medicine, Ain Shams University. The study was carried out in accordance with the principles outlined in the Declaration of Helsinki. All participants provided informed verbal consent because some of the participants were not educated and could not provide signed consent. The ethical committee approved using verbal consent.

Data were organized and statistically analyzed using SPSS, version 20 (SPSS Inc., Chicago, IL). Quantitative data were described as mean and standard deviation

(minimum – maximum)/ median (IQR). ANOVA test was used to compare quantitative variables between groups. Qualitative data were expressed as frequencies (n) and percentage (%). Fisher exact test was used to assess the association between qualitative variables. Pearson correlation coefficient was used to correlate between quantitative variables (A correlation coefficient superior to zero indicates a positive state while a value less than zero signifies a negative state , and A value of zero indicates no relation between the two variables being compared). P-value ≤ 0.05 was considered statistically significant.

RESULTS

The current study is a cross-sectional study. The study sample included one hundred and four elderly aged sixty years old and above with the mean age being 65.1±3.9 years most of them (82.6%) are educated 5-12 years. Males and females were almost equal (51.9%,48% respectively).

The mean score of Charlson comorbidity index of the studied population is 2.7 ±0.6 , and the mean score of Perceived Stress Scale was 24.3 ± 5.6. Most of them had moderate perceived stress (54.8%), followed by high levels of stress 41.3%. The average of MOCA test results in the studied population was 21.4 ± 1.99 .The highest score was in orientation .The average of Stick design test for assessing visuospatial memory of studied population was 6.6 ± 1.5.and the average of digit backwards test for assessing working memory was 0-3.

There was a significant negative association between perceived stress and global cognitive functions assessed by MOCA-B with P value <0.001. Also, there was a highly significant statistical association between perceived stress scale (PSS) and digit backward and between PSS and stick design test with P value 0.001. There was significant negative correlation between years of education and stress. There was significant negative correlation between PSS and years of education. There was marked negative correlation between age and digit back ward test while there was no statistically significant correlation between age and PSS, MOCA-B and stick design test.

Table (1). Distribution of demographic data in this study sample (n=104)

Age	**Range**	60-74	
	Mean ±SD	65.163±3.932	
	Median (IQR)	64(62-69)	
Years of education	**Range**	2-12	
	Mean ±SD	9.915±2.839	
		N	**%**
Education	**Not educated**	10	9.62
	Educated 1-4 Years	8	7.69
	Educated 5-12 Years	86	82.69
Gender	**Female**	50	48.08
	Male	54	51.92

Table (2) Distribution of cognitive function by MOCA-B, working memory by Digit backwards test, visuospatial memory by Stick design test, Perceived stress by PSS and comorbidities by Charlson morbidity index in the studied population

	Range	Mean ± SD	Median	IQR
MOCA-B	18 - 26	21.433 ± 1.994	22	19.5 - 23
Executive	0 - 1	0.663 ± 0.475	1	0 - 1
Fluency	1 - 2	1.308 ± 0.464	1	1 - 2
Orientation	6 - 6	6.000 ± 0.000	-	- - -
Calculation	2 - 3	2.462 ± 0.501	2	2 - 3
Abstraction	1 - 3	2.529 ± 0.521	3	2 - 3
Delay recall	2 - 4	2.942 ± 0.636	3	3 - 3
Visuospatial	1 - 3	1.365 ± 0.504	1	1 - 2
Naming	1 - 4	2.442 ± 0.554	2	2 - 3
Attention	1 - 2	1.471 ± 0.502	1	1 - 2
Stick design test	4 - 9	6.663 ± 1.530	7	6 - 8
Digit backward test	0 - 3	1.096 ± 1.452	0	0 - 3
PSS	12 - 36	24.308 ± 5.591	25	19.5 - 28.5
Charlson morbidity index	2 - 4	2.702 ± 0.605	3	2 - 3

MOCA-B: Montreal cognitive assessment test-Basic. PSS: Perceived stress scale

Table (3) Correlation between age and PSS, MOCA, Stick design digit backward

	Age	
	R	**P-value**
MOCA-B	-0.147	0.138
Stick design test	-0.092	0.351
Digit back ward	-0.200	0.042
PSS	-0.133	0.177

MOCA-B: Montreal cognitive assessment test-Basic. PSS: Perceived stress scale

Table (4) Correlation between PSS, MOCA, Stick design and digit backward

	Perceived Stress Scale Score	
	R	**P-value**
MOCA-B total score	-0.574	<0.001*
Executive	-0.341	<0.001*
Fluency	-0.306	0.002*
Calculation	-0.346	<0.001*
Abstraction	-0.383	<0.001*
Delay recall	-0.339	<0.001*
Visuospatial	-0.289	0.003*
Naming	-0.332	0.001*
Attention	-0.346	<0.001*
Stick design test	-0.587	<0.001*
Digit back-ward	-0.003	0.001*

MOCA-B: Montreal cognitive assessment test-Basic

Table (5) Correlation between charlson morbidity index and PSS, MOCA-B, digit back ward and stick design test

	Charlson comorbidity index	
	R	**P-value**
PSS	-0.162	0.101
MOCA-B total score	-0.037	0.710
Digit backwards test	0.011	0.913
Stick design test	0.027	0.786

MOCA-B: Montreal cognitive assessment test-Basic. PSS: Perceived stress scale

Table (6) A regression study between Age, PSS, Digit back ward test.

	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	**Std. Error**	**Beta**		
Age	-0.092	0.034	-0.249	-2.724	0.008*
Perceived Stress Scale Score	-0.095	0.024	-0.366	-4.003	<0.001*
Dependent Variable: Digit backwards test					

PSS: Perceived stress scale

DISCUSSION

The study population, 104 elderly sixty years and older, were recruited from Ain Shams University Hospitals outpatient clinics and in patient wards in a cross-sectional study. The current work showed the mean age of the studied participants is 65.1±3.9 years. Males and females were almost equally distributed (51.9 %, 48% respectively).

Regarding the correlation between PSS and age, there was no statistically significant correlation between them. Data regarding this correlation in literature is mixed. The study of ***Munoz et al., 2015*** did not detect any

correlation between age and PSS in their study conducted on One hundred sixteen older adults in New York, in a longitudinal study, with average age at baseline was 80.38 years ± 6.40 (22). Also, ***Aggarwal et al., 2014*** conducted a study on 6207 participants with a mean age 72.9 ±6.23 years and found stress was not related to age (23). While ***Osmanovic et al., 2015*** found increasing levels of perceived stress with increasing age (24). This may be due to the older age group included in their study (mean age of 74.6+7.0) than the current study (mean age 65±3.9). Also, the study by ***Osmanovic*** and colleagues included multi-morbidities, which are known to increase the risk of stress (as depression, malignancy, and disabilities), while these co-morbidities were excluded in this current study.

The current work showed no statistically significant relation between age and global cognitive function. Data in literature regarding age and MOCA is mixed with some studies suggesting negative correlation and others showing no significant correlation. ***Hayek et al., 2020*** study that was conducted on Lebanese population with mean age 70.1 ± 6.9 showed that there was no significant relation between age and global cognitive function (25). This contrasts with ***Turner et al., 2017*** that revealed a significant negative correlation between age and cognitive function (26). A possible explanation is that this study population has narrow age range (60-74 years old) while Turner's study had a wider range (60 to 97 years old).

Regarding the correlation between age and working memory, there was significant negative correlation with P value=0.042. This finding is consistent with most published data as the study of ***Zhang et al., 2017*** that was conducted on 90 Chinese participants with range of age 60 to 80 years old and detected that there is significant negative correlation between age and working memory assessed by digit forward and backward test suggesting that increased age was related to decrease in working memory (27).

As regard the age and visuospatial assessment using stick design test there is no significant correlation between them. This is similar to ***Zarantonelloa et al., 2020*** that was conducted on 134 participants between twenty and eighty years old and used n-back test to assess visuospatial ability (28). This is in contrary to ***Castilla et al., 2022*** a comparable study performed on 50 healthy participants split into two groups: 31 Young Adult and 19 Older Adult. The two age groups were not different in terms of educational level (29). The Walking Corsi test and the online Mental Rotation Test were performed. The difference between ***Castilla*** and colleagues' results and this study's results could be attributed to unequal number of participants between the young and the older participants in Castilla's study sample, as well difference in educational level between both studies. Castilla's study used the online mental rotation test which is not applicable to Egyptian elderly and needs a higher educational and financial status.

In this study there was no significant correlation between PSS and the Charlson comorbid index, this mirrors the findings of ***Huntley et al., 2012*** , who measured multimorbidity by a simple count of chronic diseases, showed that multimorbidity was not related to psychological distress (30). This contrasts with ***Osmanovic et al., 2015*** study that compared Multimorbidity by Cumulative Illness Rating Scale (CIRS) score with a mean of 7.0 ± 3.8 that could be explained by multi-comorbidities in ***Osmanovic*** study such as physical disability, cancer, and depression, which are excluded in this current study (24).

Regarding the correlation between PSS and global cognitive function, there was a significant negative correlation between them with P value <0.001. Data regarding correlation between PSS and cognitive function in literature is abundant and most data suggest this negative correlation. ***Aggarwal et al., 2014*** conducted an analytical study on 6207 participants over 6.8 years. They used mini mental state examination to assess global cognitive function and demonstrated, that increasing levels of stress were associated with a decrease in cognitive

scores with p value <0.001 and more decline in cognitive function with p value < 0.001 (23) , also ***Koyanagi et al., 2019*** showed similar results (31).

A retrospective cohort study by ***Jaja and Dapper, 2021*** , that was conducted on 115 participants and used the same tools as in current study (MOCA and PSS) showed marked negative association between stress and cognitive impairment (32).

Concerning the relation between PSS and the executive function, there is a negative correlation between them using simple trail making test in MOCA-B with P value <0.001. Most of the published data about the relation between PSS and executive function detected worse executive function with higher stress levels as in current study. The study of ***Cazassa et al., 2020*** showed similar results (33), as well as a study by ***Turner et al., 2017,*** where the mean years of education amongst their participants was 14.99±3.46 years, that assessed executive function by Stroop neuropsychological screening test (26). But this is not in consistent with ***Jiang, 2018*** study. This could be explained by the difference of the assessment tool (Trail making test A and B) which needs higher educational level unlike this study that focused on lower educational levels (34).

As regard the correlation between PSS and language domain, the case control study of ***Roonald et al., 2013*** detected that there was a statistically negative correlation between PSS and fluency item in MOCA-B with P value 0.001. This concurred with this current study (35).

Turner et al., 2017 cohort study that used CERAD test (Consortium to Establish a Registry for Alzheimer's Disease) for fruits, vegetables and animals naming in one minute duration showed similar results with P value = 0.006 (26).

Regarding the correlation between PSS and naming in MOCA-B, there is a significant negative correlation between them with P value =0.001. This is similar to ***Jiang et al., 2017*** study which assessed naming by the Boston Naming Task (BNT) as the participant names pictures of objects (36).

As regard PSS and recall item in MOCA-B test there is significant negative correlation between them, this is similar to ***Jiang et al., 2017*** who assessed recall by Wechsler Memory Scale-Revised (WMS-R). Stories are told to the participant and at the end of each story, the participant is asked to remember it (36).

Regarding the correlation between PSS and attention in MOCA-B there is a statistically significant negative correlation with P value <0.001. This agreed with ***Zhang et al., 2017*** study that assessed attention by useful field of view (UFOV) (27).

Concerning the correlation between PSS and visuospatial function assessed by visuo-perception tool in MOCA-B and by using stick design test, there is a negative association between them with P value <0.001 and this is similar to ***Aggarwal et al., 2014*** that used Symbol Digit Modalities test with P value <0.001(23) and ***Ronnlund et al ., 2013*** cohort study conducted among middle and older age group with mean years of education 13.3 ± 3.4 and used WAIS-R Block Design test to assess visuospatial ability (35).

About the correlation between the PSS and working memory that was assessed by digit backward test, the results showed a statistically significant negative correlation, this is similar to most of literature data suggesting that negative correlation. ***Zuelsdorff et al., 2020*** among 1,241 participants in Wisconsin Registry for Alzheimer's Prevention (WRAP) with mean age 54.8± 6.5 and mean years of education 15.3 2.5 that used Digit Span Forward and Backward (37) also ***Schoofs et al., 2008*** used n– back test revealed that stress resulted in impairment in working memory function (38). This is contrary to ***Lukasik et al., 2019 study*** conducted among American adult participants who were recruited online (39). This difference may be attributed to many factors such as the different age group in Lukasik and colleagues' study as more than half of the participants aged 25 to 44 years and elderly participants were only 10% of their sample. Also most of the participants had Bachelor's degree or even higher, in contrast this study.

Because there is a negative correlation between digit back-wards and age, as well as a negative correlation between digit back-wards and PSS, a regression model was done which showed that PSS still has significant negative association with digit back ward test, even after adjustment for age.

CONCLUSION

Stress is an important risk factor and plays a major role in cognitive decline in elderly, high stress levels are significantly associated with decline in cognitive function. The previous results showed that there was a negative correlation between PSS and global cognitive abilities, visuospatial and working memory . The need for a prospective cohort study is apparent to better assess the causes and confirm these results. In light of the findings of the current study all efforts should be done to enhance cognitive abilities such as cognitive training and decrease the effect of stress by many ways such as Yoga, meditation and psychotherapy.

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