

Original Article

Association between perceived stress and executive functions among Egyptian elderly

Nesma Mousa Mohamed¹, Mohamed Shawky Khater¹, Hasnaa abd El-aal Abo Seif², Reem Mohamed Sabry¹, Radwa Magdy Abd El-kader¹.

¹ Department of Geriatrics Medicine and Gerontology, Faculty of Medicine, Ain Shams University.

² Community Medicine Department, Faculty of Medicine, Ain Shams University.

ABSTRACT

Background: Perceived stress is considered as a significant indicator of mental and physical health and there is a strong relationship between psychological stress and cognitive impairment at the level of all cognitive domains up to progression to dementia.

Objective: To assess the relationship between perceived stress and executive functions in a sample of Egyptian older adults.

Methods: A cross sectional study involving 110 elderly attending outpatient clinics, inpatient ward at Ain Shams university hospitals and community dwellers. Demographic data of the participants were collected. Screening for general cognition was done first using Addenbrooke's cognitive Examination III (ACE III) with exclusion of dementia patients scoring 83 or less, exclusion of depressed participants scoring 3 or more in PHQ-2 that was followed by assessment of stress via perceived stress scale-10 (PSS-10) and assessment of executive functions by using trail making test (TMT).

Results: Screening of general cognitive functions was done firstly by using (ACE III), further assessment of executive functions by TMT and perceived stress by PSS-10 revealed that most of the studied sample (52.7%) have moderate level of perceived stress and (38.2%) of them have mild perceived stress. There was a statistically significant difference between perceived stress level and executive function affection with (P value 0.01).

Conclusion: Perceived stress is significantly associated with executive dysfunction. A relationship is present between Perceived stress and executive functions impairment.

Key words: Perceived stress, executive function, cognitive impairment, older adults, education.

INTRODUCTION

Aging is a universal phenomenon that accompanied by gradual reduction in both physical and mental functional capacity of the elderly. Mostly, it is associated by increased risk of morbidity and disability that in turn affects individual, family and community ⁽¹⁾.

Moreover, cognitive impairment is characterized by reduction in intellectual functions sufficient to interfere with the activities of daily living. Generally, cognitive impairment could be divided into three main subtypes, subjective cognitive impairment, mild cognitive impairment (MCI) and dementia. Worldwide, cognitive

impairment has affected about 50 million people, and it is expected that this number to reach a peak of 75 million by 2030. It is expected that the number of people living with dementia will almost double every 20 years to 42.3 million in 2020 and 81.1 million in 2040. The growth rate will be the maximum (around 33.6%) in India, South Asia, and western Pacific regions ⁽²⁾.

Being an irreversible degenerative disorder, cognitive decline possesses a threat to the elderly people affecting their daily activities and progressing to cognitive levels decline as age advances, which reflects normal aging process. There are different factors accelerate the rate of cognitive decline with aging as genetic susceptibility, cardiovascular factors, unhealthy lifestyle behavior, metabolic factors and other comorbidities that promote the progression from the normal age-related decline in cognitive function to cognitive impairment, and further, to dementia ⁽³⁾.

Ideally, there are multiple cognitive screening tests among elderly that can be used for formal diagnosis of any of cognitive impairment, importantly, the Addenbrooke's Cognitive Examination III (ACE-III) is one of the tools that has used worldwide for cognitive evaluation, it is a brief cognitive battery that takes about 15–20 min to complete and assesses multiple aspects of cognition and has been validated in diagnosing dementia ⁽⁴⁾.

On the other side, stress is a major burden to elderly individuals and it has been known as a consequence of environmental events or stressors that exceed an individual's perceived capacity to cope and can affect the person's physical and psychological health ⁽⁵⁾.

Furthermore, there is a strong relationship between psychological stress and cognitive impairment making the timing of stress experience an important determinant of its

effect on dementia development in old age ^{(6), (7)}.

Additionally, research has discussed the detrimental effects of chronic stress on psychological well-being and cognitive functioning, with an emphasis on the relationship between stress and memory ⁽⁸⁾.

In particular, both perceived and physiological stress have been found to impair executive functioning ⁽⁹⁾. Yet, the association between stress and executive functioning is not always undesirable, since it was also reported to depend on the type and duration of stressors exposure and the investigated correlates of stress ⁽¹⁰⁾.

Assuming a more global conceptual viewpoint employing models of vulnerability ⁽¹¹⁾ and cognitive reserve ⁽¹²⁾, it is assumed that persons who accumulated less cognitive reserve are more prone to stress-related impairment in executive functioning ^{(13), (14)}.

Therefore, it is predicted that cognitive reserve can modify the cross-sectional relationship between perceived stress and executive functions at a certain point in time and maybe, also, the longitudinal relationship between perceived stress and the rate of the following decline in executive functioning. In line with this theoretical view, recent empirical cross-sectional evidence assumes that in individuals with higher cognitive reserve (in terms of, for example, higher cognitive demand of jobs, higher education and greater involving in leisure activities), the negative cross-sectional relationship between greater perceived stress and poorer executive functioning in elderly was obviously decreased ⁽¹⁵⁾.

Fortunately, it was found that higher values in several markers of cognitive reserve (in terms of, cognitive demand of jobs, education and leisure activities) were associated with better performance in executive functioning (i.e., shown by shorter

TMT completion time). This finding settles the conceptual view that cognitive stimulation could be linked with better cognitive reserve, thereby being associated with better executive functioning among elderly (16).

Lastly, in addition to the detrimental effect of stress on cognition as a whole and particularly on executive functions, unmanaged stress can result in a series of undesirable changes on physiological process and behavioral patterns, including depression, physical inactivity, sleep disorders, obesity, cardiovascular disease, immune dysfunction, and mortality (17), (18), (19).

The aim of the current study is to assess the relation between perceived stress and executive functions in a sample of Egyptian elderly.

METHODS

- **Type of study:** A cross sectional study has been conducted in a convenience sample of Egyptian older adults aging 60 years and above.
- **Study setting:** The sample was recruited from community dwellings, the outpatient clinics and inpatient department at geriatrics hospital – ain shams university during years 2022 and 2023.
- **Inclusion Criteria:**
All educated (at least 12 years of education) elderly patients 60 years old and above accepting to participate in the study from community dwellings, outpatient clinic and inpatient department in ain shams university hospital.
- **Exclusion Criteria:**
 - All individuals who refused to participate in the study.
 - Patients known with dementia, with 83 and below in ACE-III, delirium, hypothyroidism, individuals recently diagnosed with major depression and

individuals with scoring 3 and above in PHQ-2

- Patients receiving antipsychotics.
- Patients with sensory impairment were also excluded from the study.

- **Study sample size:** Using Epi Info 7 program for sample size calculation, setting confidence level at 95% and margin of error at 15%, it is estimated that sample size of 110 persons needed to detect an expected rate of high perceived stress of 20%.

- **Study tools and procedures:**

All participants were interviewed after giving informed consent. Comprehensive geriatric assessment including demographic characteristics, past medical history and drug history was done. Regarding demographic criteria, age (in years), education (completed years), income, social status, current living arrangement and area of living were recorded.

- 1- **Categorizing comorbidities of the participants** by using Charlson comorbidity index (CCI) which predicts the ten-year mortality for a patient who may have a range of comorbid conditions. The severity of comorbidity was categorized into three grades:
 - Mild, with CCI scores of 1–2.
 - Moderate, with CCI scores of 3–4.
 - Severe, with CCI scores ≥ 5 (20).

- 2- **Global cognition assessment** was done using the Egyptian Arabic Addenbrooke's cognitive Examination III (21) for the all participants, the interpretation of its score is as following:

- Persons with score 83 and below were with dementia and were excluded.
- Persons with score 84-88 were considered to be with MCI.
- Persons with score above 88 were with normal cognition. Participants with mild cognitive impairment and normal

cognition were included in the study sample

3- Assessment of depression by using PHQ-2, all participants scoring 3 or more were excluded ⁽²²⁾.

4- Assessment of delirium by using confusion assessment method (CAM test), all individuals with delirium were excluded ⁽²³⁾.

5- Assessment of executive functions by using (TMT) part (B) that requires subjects to connect a series of 25 encircled numbers and letters pseudo-randomly settled on a page in ascending order, alternating between number and letter (e.g., 1-a-2-b), as quickly as possible and performance was assessed by time taken to complete each trial correctly with average score is 75 seconds and deficient score is greater than 273 seconds ⁽²⁴⁾.

6- Assessment of perceived stress by using the Arabic version of (PSS-10) with:

► Scores ranging from 0-13 was considered low stress.

► Scores ranging from 14-26 was considered moderate stress.

► Scores ranging from 27-40 was considered high perceived stress ⁽²⁵⁾.

- **Statistical Analyses**

After collection and revision of questionnaires, data was entered into a personal computer. Analysis of data was done using SPSS program version 20.

Descriptive statistics (means, standard deviations (SD) or frequency distributions) were calculated for quantitative and qualitative data respectively. Qualitative data were expressed as frequencies (n) and percentage (%).

Comparisons of quantitative data (e.g., age) were done using t test, and the chi-squared test and Fisher exact tests for comparing qualitative data (e.g., gender). Pearson correlation coefficient was used to

relate between quantitative variables. P-value ≤ 0.05 was considered significant.

- **Ethical considerations**

The current study was performed in adherence to the principles that reviewed and approved by Ethical Committee of Scientific research and the Research Review Board of the Geriatrics and Gerontology Department, Faculty of Medicine, Ain Shams University with approval number (MS 430/2022). Informed consent was obtained from all the participants, confidentiality and privacy of data were ensured.

RESULTS:

The current study is a cross-sectional study. The study sample finally included 110 elderly Egyptian aged 60 years old and above with the mean age being $(68.7) \pm (6.1)$ years with the majority of them are males (50.9%), married (72.7%), retired (70%), living in Cairo (90%), living with their families (88.2%) and only (11.8%) are living alone. Regarding the level of education, most of the participants are highly educated (64.5%), almost all of them were non-smokers and with no other special habits and most of them were depending on their pension representing (71.8%) and only (13.6%) were depending on family support with the majority were satisfied with their income representing (71.8%) (**Table 1**). There is no statistically significant relation between demographic characteristics and perceived stress (**Table 2**).

By using Charlson comorbidity index most of the studied sample (46.4%) were with mild severity and there is no association between perceived stress among elderly and number of comorbidities (**Table 3**).

As regard ACE III, participants in the study group were divided to two groups, persons with MCI were representing (37.3%) and those with normal cognition were (62.7%) of the studied sample. Regarding TMT score, of the elderly included in the study

presented with average score (69.1%) and only (30.9%) of them presented with deficient score (**Table 4**).
Regarding the relationship between perceived stress and results of ACE III, there is no statistically significant difference between perceived stress, MCI and normal cognition (**Table 5**).

The mean score of total Perceived stress score is $(16) \pm (7.4)$. The majority of the studied sample had moderate stress score (52.7%) and only (9.1%) showed a high perceived stress (**Table 6**).

There is a statistically significant relation between perceived stress and executive function impairment as regard TMT with (P value = 0.01) (**Table 7**).

Table (1): Distribution of socio-demographic characteristics in the studied sample (n=110):

		Mean	Standard deviation (SD)		
Age		68.69	6.13		
		N	%		
Sex	Female	54	49.1%		
	Male	56	50.9%		
Occupation	Retired	77	70.0%		
	Working	13	11.8%		
	Housewife	20	18.2%		
Education	Only 12 years of education	24	21.8%		
	High education (college or high institutes)	71	64.5%		
	Postgraduate	15	13.6%		
Residency	Urban	99	90.0%		
	Rural	11	10.0%		
Marital status	Married	80	72.7%		
	Widow	29	26.4%		
	Divorced	1	0.9%		
	Single	0	0.0%		
Special habits	Smoking	14	12.7%		
	Alcohol use	0	0.0%		
	Drug abuse	0	0.0%		
Number of cigarettes per day		Min.	Max.	Mean	SD
		1.00	40.00	13.79	12.97

Table (2): Association between perceived stress, demographic characteristics and Charlson comorbidity index of the studied sample:

		PSS result				t*	p value
		Low stress (N=42)		Moderate/high stress (N=68)			
		Mean	SD	Mean	SD		
Age (years)		69.19	6.67	68.38	5.80	0.67	0.50
		N	%	N	%	X ² **	P value
Sex	Female	22	52.4%	32	47.1%	0.29	0.59
	Male	20	47.6%	36	52.9%		
still working	No	37	88.1%	60	88.2%	0.00 FE	1.00
	Yes	5	11.9%	8	11.8%		
Education	Only 12 years of education	11	26.2%	13	19.1%	0.88	0.64
	High education	25	59.5%	46	67.6%		
	Postgraduate	6	14.3%	9	13.2%		
Residency	Urban	40	95.2%	59	86.8%	2.07 FE	0.20
	Rural	2	4.8%	9	13.2%		
Marital status	Married	33	78.6%	47	69.1%	1.17	0.28
	Widow/ Divorced	9	21.4%	21	30.9%		
special habits (smoking)	Yes	5	11.9%	9	13.2%	0.04	0.84
	No	37	88.1%	59	86.8%		
Satisfactory income	Yes	32	76.2%	47	69.1%	0.64	0.52
	No	10	23.8%	21	30.9%		
living with others	Yes	38	90.5%	59	86.8%	0.34 FE	0.76
	No	4	9.5%	9	13.2%		

*Student t test **Chi square test (FE: Fisher Exact)

Table (3): Charlson comorbidity index and relation with perceived stress:

Charlson comorbidity index		Min.	Max.	Median	IQR		
		0.00	4.00	1.00	0.00-1.00		
		N		%			
Severity of Charlson comorbidity index	Mild	51		46.4%			
	Moderate	50		45.5%			
	Severe	9		8.2%			
		PSS result				Z*	P value
		Low stress		Moderate/high stress			
		Median	IQR	Median	IQR		
Charlson comorbidity index		0.00	0.00-1.00	1.00	0.00-2.00	1.58	0.11
		N	%	N	%	X ^{2**}	P value
Severity	Mild	23	45.1%	28	54.9%	2.38	0.13
	Moderate	17	34.0%	33	66.0%		
	Severe	2	22.2%	7	77.8%		

**Chi square test (FE: Fisher Exact)

Table (4): Description of cognitive functions by ACE III and TMT:

Addenbrooke score	Cut off value	Min.	Max.	Mean	SD
		83	85.00	100.00	90.94
		N		%	
	MCI	41		37.3%	
	Normal cognition	69		72.7%	
		N		%	
Trail making test (TMT) for executive function	Deficient (> 273 seconds)	34		30.9%	
	Average (< 75 seconds)	76		69.1%	

Table (5): Relationship between ACE III score and perceived stress:

		PSS result				X ²	P value
		Low stress		Moderate/high stress			
		N	%	N	%		
Addenbrooke score	MCI	12	29.3%	29	70.7%	2.20	0.14
	Normal cognition	30	43.5%	39	56.5%		

Table (6): Assessment of stress by Arabic version of perceived stress scale (PSS-10):

		Min.	Max.	Mean	SD
Total PSS score		2.00	37.00	16.07	7.38
		N		%	
PSS score	Low stress	42		38.2%	
	Moderate stress	58		52.7%	
	High perceived stress	210		9.1%	

Table (7): Association between perceived stress and executive dysfunction:

		PSS result				X ² *	P value
		Low stress (N=42)		Moderate/high stress (N=68)			
		N	%	N	%		
TMT test for executive function	Deficient	7	16.7%	27	39.7%	6.45	0.01**
	Average	35	83.3%	41	60.3%		

*Chi square test

DISCUSSION

Stress is a major burden to elderly and it is an indicator of mental and physical health. So, the sequelae of both physiological stress and perceived stress on cognitive functions and especially executive functions impairment must be studied.

The current study showed that the characteristics of the sampled elderly aged ≥60 years revealing the mean age to be 68.7±6.1 years with the majority living in Cairo, married and living with their families. The majority of them were non-smokers. Regarding the level of education, most of them were highly educated representing 64.5%.

As regard age this study is in line with another previous study that revealed that levels of perceived stress were not related to age after controlling for health-related factors using the same stress measurement in a sample of community dwellers aged (54–91)

and controlled for a number of potential confounders including health status ⁽²⁶⁾.

With respect to gender, the current study did not show a statistically significant difference between perceived stress and gender, but many studies on gender variances among older adults propose that women live more than men and this advantage was mostly explained by differential vulnerability to social, genetic, and biological risk factors but that their extra years of life are spent in states of functional dependence, so, perceiving higher levels of stress ⁽²⁷⁾.

Furthermore, the results of the current study revealed that there is no significant association between perceived stress and level of education, that is due to all participants received relative high level of education, in contrast, some studies predicted that better-educated individuals are more likely to live alone and therefore

less likely to obtain help from family member to deal with stressful conditions in their lives and so, perceiving higher levels of stress ⁽²⁸⁾. But on the other side, several research suggested better-educated elderly have lower levels of stress as they have advanced coping strategies of perceived stress ⁽²⁹⁾.

Regarding financial support, most of elderly in this study were community dwellers, of high socio-economic status, supported by their own pension and (71.8%) are satisfied by their income making it difficult to clarify the relation between perceived stress and economic status of the studied sample which require a greater sample size in future studies, on the other hand, Yeung and colleague reported in a previous study that higher income elderly perceived lower levels of stress as better financial support is considered one of the important coping mechanisms⁽³⁰⁾.

Moreover, by using Carlson comorbidity index, the current study revealed that there is no association between it and perceived stress level and that may come with the inclusion of some factors in the scale that excluded in this study as dementia which, certainly, is a major triggering factor of perceived stress ⁽³¹⁾. Also, some factors are not included in the scale but are very common in the studied group as hypertension which was in (44.5%) of the participants. Also, this is line with another prospective study on psychological distress that did not necessarily address multimorbidity ⁽³²⁾.

By using PSS, moderate level of stress was the most common in the studied sample representing (52.7%) with mean total score (16 ± 7.4). Many studies have reported that severe and persistent stress may induce poor health, and generally adversely influence quality of life ⁽³³⁾. So, these findings indicate a need for a new health policy, and call for the design and application of evidence-based interventions that target the highest-risk groups as educational and counselling

programs as well as mental healthcare in hospitals and clinics, community-based clinics should be established to provide high-risk groups with necessary psychological counselling and Support groups to learn stress-management skills. Up to now, comparing stress levels across studies was hindered by the lack of consistent measurements ⁽³⁴⁾.

In this study, it is reported that perceived stress is not associated with decline in global cognition assessed by (ACEIII) and that is due to exclusion of persons known with dementia scoring 83 and below in (ACEIII). That may be with agreement with another study that did not observe an association between perceived stress and global cognitive function measured with the MMSE ⁽³⁵⁾. Also, there is no statistically significant difference between persons with MCI included in the study and stress perceiving, also, another study In the Chicago Health and Aging Project (CHAP) that reported cognitive decline was associated with levels of perceived stress though MCI was not reported ⁽³⁶⁾.

In the current study, the cross-sectional association between perceived stress and following deterioration in executive functions was reported through performance variations in the TMT and the results revealed that higher perceived stress levels are related to executive functions impairment.

This is constant with a previous study that revealed both perceived and physiological stress have been considered to hinder executive functions ⁽⁹⁾. Also, the association between stress and executive functioning depends on the type and duration of stressor exposure ⁽¹⁰⁾.

The current study has some limitations being in single center with relatively small sample size.

CONCLUSION

This study shows a statistically significant impact of perceived stress and executive function impairment among well educated, non demented Egyptian older adults which highlights the importance of interventions to decrease the perceived stress levels among these older adults. In addition, early identification of the first manifestations of perceived stress can enable early diagnosis and suitable interventions. This can also help in decreasing the social and economic burden of executive functions impairment and possible progression to dementia.

RECOMMENDATIONS

- 1- It is recommended to hold more studies in that topic for more clarification of the association between perceived stress and all types of cognitive decline and all domains that could be affected by it.
- 2- Further studies to complete that work in multicenter manner and for larger sample of older adults as these results could not be generalized to all Egyptian elderly.

REFERENCES

- 1- **Karmakar N, Datta A, Nag K, Tripura K. (2018):** Quality of life among geriatric population: A cross-sectional study in a rural area of Sepahijala District, Tripura. *Indian J Public Health.* Apr 1;62(2):95.
- 2- **Qiu C, Johansson G, Zhu F, Kivipelto M, et al. (2019):** Prevention of cognitive decline in old age—varying effects of interventions in different populations. *Ann Transl Med.* [cited 2020 Jun 4];7(Suppl 3).
- 3- **Espinosa PH, Espinosa PS, Donadi EA, et al. (2020):** Cognitive Decline in Adults Aged 65 and Older in Cumbayá, Quito, Ecuador: Prevalence and Risk Factors. *Cureus.*10(9).
- 4- **Hsieh S, Schubert S, Hoon C, et al., (2013):** Validation of the Addenbrooke's Cognitive Examination III in frontotemporal dementia and Alzheimer's disease. *Dement Geriatr Cogn Disord.* 36(3-4): 242–50
- 5- **Lazarus, R. S. (2006):** *Stress and emotion: A new synthesis.* Springer publishing company.
- 6- **Gaffey AE, Bergeman CS, Clark LA, et al. (2016):** Aging and the HPA axis: Stress and resilience in older adults. *Neuroscience & Biobehavioral Reviews,* 68, 928–945
- 7- **Novais A, Monteiro S, Roque S, et al. (2017):** How age, sex and genotype shape the stress response. *Neurobiology and Stress,* 6, 44–56.
- 8- **Wolf, OT (2009):** Stress and memory in humans: twelve years of progress? *Brain Research,* 2009; 1293, 142-154.

- 9- **Korten NC, Comijs HC, Penninx BW, et al. (2017):** Perceived stress and cognitive function in older adults: which aspect of perceived stress is important? *Int J Geriatr Psychiatry*. 2017 Apr; 32(4): 439–45
- 10- **Lupien SJ, McEwen BS, Gunnar MR, et al. (2009):** Effects of stress throughout the lifespan on the brain, behaviour and cognition. *Nat Rev Neurosci*. 2009 Jun; 10(6): 434–45.
- 11- **Spini D, Bernardi L and Oris M. (2017):** Toward a Life Course Framework for Studying Vulnerability. *Res Hum Dev*. 2017; 14(1): 5–25.
- 12- **Stern Y. (2012):** Cognitive reserve in ageing and Alzheimer's disease. *Lancet Neurol*. 2012 Nov; 11(11): 1006–12.
- 13- **Cullati S, Kliegel M and Widmer E. (2018):** Development of reserves over the life course and onset of vulnerability in later life. *Nat Hum Behav*. 2018; 2(8): 551–8.
- 14- **Ihle A, Oris M, Sauter J, et al., (2018):** Cognitive Reserve and Social Capital Accrued in Early and Midlife Moderate the Relation of Psychological Stress to Cognitive Performance in Old Age. *Dement Geriatr Cogn Disord*. 2018; 45(3-4): 190–7.
- 15- **Pertl MM, Hannigan C, Brennan S, et al., (2017):** Cognitive reserve and self-efficacy as moderators of the relationship between stress exposure and executive functioning among spousal dementia caregivers. *Int Psychogeriatr*. 2017 Apr; 29(4): 615–25.
- 16- **Opdebeeck C, Martyr A and Clare L. (2016):** Cognitive reserve and cognitive function in healthy older people: a meta-analysis. *Neuropsychol Dev Cogn B Aging Neuropsychol Cogn*. 2016; 23(1): 40–60.
- 17- **Stults-Kolehmainen MA and Sinha R. (2013):** The effects of stress on physical activity and exercise *Sports Med* 44: 81-121.
- 18- **Marcellini F, Giuli C, Papa R, et al. (2010):** BMI, life-style and psychological conditions in a sample of elderly Italian men and women. *J Nutr Health Aging* 14: 515-522.
- 19- **Henderson KM, Clark CJ, Lewis TT, et al. (2013):** Psychosocial distress and stroke risk in older adults. *Stroke* 44: 367-372.
- 20- **Quan, H., Li, B., Couris, C. M., et al., (2011):** Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *American journal of epidemiology*, 173(6), 676-682.
- 21- **Qassem T, Khater MS, Emara T, et al. (2015):** Normative data for healthy adult performance on the Egyptian-Arabic Addenbrooke's Cognitive Examination III. *Middle East Curr Psychiatry*. 22(1): 27–36
- 22- **AlHadi A N., AlAteeq D A., Al-sharif E, et al: (2017).** An Arabic translation, reliability, and validation of Patient Health Questionnaire in a Saudi sample. *Annals of general psychiatry*.
- 23- **Aljuaid, Maha H., deeb, et al.: (2018).** "Psychometric properties of the Arabic version of the confusion assessment method for the intensive care unit (CAM-ICU)." *BMC psychiatry* 18.1: 1-9.
- 24- **Reitan, R.M., and Wolfson, D. (1995):** Category test and trail making test as measures of frontal lobe functions. *The Clinical Neuropsychologist*, 9(1), 50–56.
- 25- **Almadi, T., Cathers, I., Mansour, et al., (2012):** An Arabic version of the Perceived Stress Scale: Translation and validation study. *International journal of nursing studies*, 49(1), 84-89.
- 26- **Scott SB, Jackson BR and Bergeman C. (2011):** What contributes to perceived stress in later life? A recursive partitioning approaches. *Psychol Aging* 2011; 26: 830–43.
- 27- **Kaneda T, Zimmer Z, Fang X, et al. (2009):** Gender differences in functional health and mortality among the Chinese elderly: testing an exposure versus vulnerability hypothesis. *Res Aging* 31: 361-388.

- 28- **Mui AC. (1998):** Living alone and depression among older Chinese immigrants. *J Gerontol Soc Work* 30: 147-166.
- 29- **Ross CE and Zhang W. (2008):** Education and psychological distress among older Chinese. *J Aging Health* 20: 273-289.
- 30- **Yeung W and Xu Z. (2012):** Economic stress, quality of life, and mortality for the oldest-old in China. 108: 131-152.
- 31- **Nabe-Nielsen, K., Rod, N. H., Hansen, Å. M., et al., (2020):** Perceived stress and dementia: Results from the Copenhagen city heart study. *Aging & Mental Health*, 24(11), 1828-1836.
- 32- **Russ TC, Stamatakis E, Hamer M, et al. (2012):** Association between psychological distress and mortality: individual participant pooled analysis of 10 prospective cohort studies. *BMJ*. 345:4933.
- 33- **Charney DS and Manji HK (2004):** Life stress, genes, and depression: multiple pathways lead to increased risk and new opportunities for intervention.
- 34- **Yang T, Wu D, Zhang W, et al. (2012):** Comparative stress levels among residents in three Chinese provincial capitals, 2001 and 2008.
- 35- **Peters JL, Weiskopf MG, Spiro A III, et al. (2010):** Interaction of stress, lead burden, and age on cognition in older men: the VA Normative Aging Study. *Environ Health Perspect* 118(4): 505– 510.
- 36- **Aggarwal NT, Wilson RS, Beck TL, et al. (2014):** Perceived stress and change in cognitive function among adults 65 years and older. *Psychosom Med* 76(1): 80–8