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Effect of Obesity on Cognitive Functions in Elderly People

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Original Research / Orijinal Araştırma

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ABSTRACT

Aim: We aimed to evaluate effect of obesity on cognitive functions in 65 years and older patients.

Methods: This study was conducted in the Recep Tayyip Erdogan University Family Medicine outpatient clinic between November 2018 and January 2019. 65 years and older 83 voluntary patients were included in our study. All participants evaluated by a survey for their socio-demographic characteristics, Standardized Mini Mental Examination Test and Rey Auditory and Verbal Learning Test. Statistical comparison was made between patients' body mass indexes and their test scores.

Results: Mini Mental Test total score was statistically higher in men. Besides that, working patients had higher Mini Mental Test total score compared to retired patients and housewives. As participants' waist circumference and body mass index increase, their Mini Mental Test language scores were decreasing.

Conclusions: We found that as body mass index increases, Mini Mental Test language scores were significantly decreasing. In literature there are studies that suggesting obesity is related to decline in cognitive functions, but there are also studies that suggesting obesity has protective effect for cognitive decline. More comprehensive prospective studies are required for clearer results.

Keywords: geriatrics, obesity, cognitive dysfunction

Yaşlılarda Obezitenin Bilişsel Fonksiyonlar Üzerine Etkisi

ÖZ

Amaç: Çalışmamızda 65 yaş üstü hastalarda obezitenin kognitif fonksiyonlara etkisini incelemeyi amaçladık.

Yöntem: Çalışmamız 2018 yılı Kasım ayı ile 2019 yılı Ocak ayı arasında Recep Tayyip Erdoğan Üniversitesi Aile Hekimliği Polikliniği'nde yürütülmüştür. Çalışmaya gönüllülük esasına göre 65 yaş ve üzeri 83 hasta dahil edilmiştir. Tüm katılımcılara araştırmacılar tarafından oluşturulmuş sosyodemografik özelliklere yönelik bir anket ile kognitif fonksiyonları değerlendirmeye yönelik Mini Mental Durum Değerlendirme Testi ve Rey İşitsel Sözel Öğrenme Testi uygulandı. Değerlendirme hastaların hesaplanan vücut kitle indeksleri ile testlerden aldıkları skorlar arasında yapılmıştır.

Bulgular: Erkeklerde Mini Mental Test toplam skoru istatistiksel olarak anlamlı düzeyde daha yüksek tespit edildi. Ayrıca ev hanımları ve emeklilere kıyasla çalışanlarda da Mini Mental Test toplam skor anlamlı olarak yüksek bulundu. Katılımcıların bel çevresi ve vücut kitle indeksleri arttıkça Mini Mental Test lisan skorlarının azaldığı saptanmıştır.

Sonuç: Çalışmamızda vücut kitle indeksi arttıkça Mini Mental Test lisan skorunun anlamlı olarak azaldığı, Mini Mental Test toplam skorunun da azaldığı fakat bu ilişkinin anlamlı olmadığı görülmüştür. Literatürde obezitenin bilişsel fonksiyonlarda düşmeyle ilişkili olduğunu gösteren çalışmalar olduğu gibi, bilişsel fonksiyonlarda bozulmadan koruyucu etkisi olduğunu söyleyen çalışmalar da mevcuttur. Daha net sonuçlara ulaşmak için daha kapsamlı prospektif çalışmaların yapılması gereklidir.

Anahtar kelimeler: geriatri, obezite, bilişsel disfonksiyon

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Introduction

Obesity is defined as abnormal or excessive fat accumulation that presents a risk to health according to World Health Organization (1). Most common method for determining obesity is calculation of body mass index (BMI). People with a BMI equal or greater than 25 considered as overweight and those with a BMI equal or greater than 30 are considered as obese (2). Approximately 35% of adults in the U.S. aged 65 and over between 2007-2010 were obese as defined by body mass index (3). According to Turkey Nutrition and Health Survey 2010 research, obesity prevalence was 30.3% for 19 years and older people (4).

With increasing life expectancy, people at risk for cognitive decline also increased. Peila at al. showed that dementia is related with chronic hyperglycemia, increased insulin level and diabetes mellitus (5). In a study that conducted by Umegaki et al. was found that hyperglycemia is a risk factor for cognitive decline (6). Learning and memory not only affected by changes at the glucose levels, but also affected by insulin. There are studies show that hyperinsulinemia and hyperglycemia play a role for increasing amyloid plaque formation and besides that insulin and glucose play a role for removal of β-amyloids (7).

Even if clinical trials strongly suggests that obesity causes cognitive impairment and brain atrophy, it is difficult to determine if this changes occur due to obesity itself or obesity related situations like metabolic syndrome, diabetes mellitus and vascular disease (8). There are also studies that show positive relationship between obesity and cognitive functions (9). We aimed to evaluate the effect of obesity on cognitive functions by using Standardized Mini Mental Examination Test (MMT) and Rey Auditory and Verbal Learning Test in geriatric patients who applied to Recep Tayyip Erdogan University Family Medicine outpatient clinic.

Methods

This study was conducted in the Recep Tayyip Erdogan University Family Medicine Outpatient Clinic. Survey forms prepared by researchers according to the purpose of the study are applied using face to face interviewing. We prepared six questions for evaluation of socio-demographic features of the participants (age of participant, gender, chronic disease history, smoking history, job and education level). By adding Mini Mental Examination Test (MMT) and Rey Auditory and Verbal Learning Test forms to these questions, our survey form was created. Waist circumference, hip circumference, height, weight, arterial blood pressure measurements and serum insulin levels were done during the interview. BMI values calculated as person's weight in kilograms divided by the square of height in meters. The data were collected after taking patients' informed consents. We intended to collect data about participants' cognitive test scores and their features that might be related to cognitive functions. This study was conducted between November 2018 and January 2019.

All geriatric patients who applied to our outpatient clinic between November 2018 and January 2019 included to our study. We didn't select any certain population. Patients who have dementia or Alzheimer disease, using antidepressant drugs, incapable of communication at the level that can't answer our questions, taking medication for cancer in last three years excluded from the study. 92 patients who applied to our outpatient clinic during data collection included to study. 9 patients excluded from the study according to exclusion criteria (5 patients had Alzheimer disease, 4 patients was incapable of communication at the level that can't answer our questions). 65 years and older, 83 voluntary patients were included to our study. There were no drop-outs.

All participants evaluated by a survey for their socio-demographic characteristics, Standardized Mini Mental Examination Test (MMT) and Rey Auditory and Verbal Learning Test for evaluation of their cognitive functions. Rey Auditory and Verbal Learning Test gives information about immediate memory, attention, perception, retention of information, recall and recognition. Mini Mental Examination Test gives information about memory, working memory and learning fields.

Most common test for evaluation of dementia is Mini-Mental Test (MMT) which first published in

1975 by M. F. Folstein et al. (10). MMT includes eleven questions and scored out of 30. Total score of MMT between 18-23 evaluated as mild cognitive impairment, total score of 17 or less evaluated as severe cognitive impairment. Turkish version of the MMT has high discriminant validity and interrater reliability in the diagnosis of mild dementia. The cut off score 23/24 was found to have the highest sensitivity (0.91), specificity (0.95), positive and negative predictive values (0.90 and 0.95) and kappa score (0.86). Interrater reliability analysis showed high correlation (r:0.99) and kappa value (0.92) (11).

Rey Auditory and Verbal Learning Test (RAVLT) gives information about immediate memory, attention, perception, retention of information, recall and recognition. This test was translated into Turkish by Oktem and its reliability and validity were tested. Verbal information, immediate and delayed memory functions are evaluated in this test. RAVLT consists of presenting a list of 15 words across five consecutive trials. The list is read aloud to the participant, and then the participant is immediately asked to recall as many as words as he/she remembers. This procedure is repeated for 5 consecutive trials. After that, a new mixing list of 15 new words is read one time to the participant, who then is immediately asked to recall the words. After 30-minutes from this test, the participant is again asked to recall the words from the first list (delayed recall). Different summary scores are derived from raw RAVLT scores. Number of words responded at first read accepted as "short-term memory score", the maximum number of words he/she remembers from 15 words after repeating accepted as "maximum learning score" and number of words responded correctly after 30 minutes accepted as long-term memory score (12).

Statistical comparison was made between patients' body mass indexes (BMI) and their test scores. Statistical analyses were performed using the SPSS 22.0 for Windows. Data expressed as mean (±standard deviation) values. We used Fisher's exact test and the x^2-test to compare categorical variables. We used Mann–Whitney U test and independent t-test to compare quantitative variables. Pearson method used for correlation analysis. P values <0.05 were considered as statistically significant.

The ethics committee approval for this study was taken from the Ethics Committee of Recep Tayyip Erdogan University Faculty of Medicine with the protocol number 2019/27.

Results

62 of the patients were male (74.7%), and 21 of them were female (25.3%). The mean age for all cases was 69.45±0.25 years (min. 65, max. 82). 58 of the patients (69.8%) had a systematic disease. 20 of them had diabetes mellitus (24.1%), 20 of them had hyperlipidemia (24.1%) and 49 of them (59%) had hypertension diagnosis. Four patients had a history of previous myocardial infarction (MI). Seventeen of the participants (20.4%) were middle school or higher educational level. Sociodemographic features of the geriatric patients who included study is shown at Table 1.

Table 1. Sociodemographic features of the geriatric patients

Participants (n=83)	Number	%
Gender		
Male	62	74.7
Female	21	25.3
Diabetes mellitus diagnosis		
Yes	20	24.1
No	63	75.8
Hypertension diagnosis		
Yes	49	59
No	34	40.9
Hyperlipidemia diagnosis		
Yes	20	24.1
No	63	75.8
MI diagnosis		
Yes	4	4.8
No	79	95.1
SVD history		
Yes	2	2.4
No	81	97.5
Psychiatric disease history		
Yes	5	6
No	78	93.9
Working		
Yes	3	3.6
No	80	96.3
People who lives with		
Alone	5	6
Not alone	78	93.9
Tobacco/alcohol use		
Yes	35	42.1
No	48	57.8
Educational level		
Primary school or lower	66	79.5
Middle school or higher	17	20.4

Mean BMI value of the participants was 29.62±4.86 and mean hemoglobin value was 13.85±1.72 gr/dl. Mean MMT total score of the participants was 21.84±3.89. Measurements of the patients and their cognitive test scores are shown as mean ± standard deviation at Table 2.

MMT total score was significantly higher in males ($p<0.05$). Besides that working patients had higher MMT total scores compared to retired patients and housewives (p=0,001). Comparison between Mini Mental test scores of patients who grouped according to their gender, working situation, tobacco/alcohol use and educational levels are shown in Table 3.

When MMT scores and the factors that can effect cognitive function levels evaluated by correlation analysis, it has been shown that there was negative correlation between patients' age and MMT total and MMT language scores (r=-0,272, p=0,013; r=-0,233, p=0,034). As patients' waist circumference and BMI increase, their MMT language scores were decreasing (r=-0,235, p=0,032; r=-0,219, p=0,046). There was a negative correlation between patients' insulin level and MMT language scores but this relationship was not significant (r=-0,036, p=0,776). There wasn't significant relationship between the factors that can effect cognitive decline and patients' Rey short-term memory, Rey maximum learning score and Rey long-term memory score. Evaluation of participants' MMT scores with correlation analysis is presented in Table 4.

Table 2. Measurements of the patients and their cognitive test scores

	Minimum	Maximum	Mean ± SD
Age	65	82	69.45±0.25
Height (cm)	149	187	167.63±7.82
Weight (kg)	60	130	83.31±14.15
BMI (kg/m^2)	20	41	29.62±4.86
Hemoglobin (gr/dl)	10	17	13.85±1.72
Insulin level (25 mIU/L)	2	86	10.44±12.60
Systolic Blood Pressure (mmHg)	110	170	133.01±11.96
Diastolic Blood Pressure (mmHg)	60	110	78.79±8.88
Waist circumference (cm)	80	138	107.04±12.57
Hip circumference (cm)	92	145	111.11±10.58
MMT Orientation	3	10	8.74±1.26
MMT Registration	2	3	2.9±0.27
MMT Attention	0	5	2.08±1.82
MMT Recall	0	3	1.19±0.94
MMT Language	2	9	6.85±1.62
MMT Total	11	30	21.84±3.89
Rey Short-term Memory	0	6	2.69±1.51
Rey Maximum Learning	2	10	6.33±1.74
Rey Long-term Memory	0	8	3.13±1.64

Table 3. Comparison between Mini Mental test scores of patients who grouped according to their gender, work status, tobacco/alcohol use and educational level

		MMT Orientation	**MMT Registration**	**MMT Attention**	**MMT Recall**	**MMT Language**	**MMT Total**
Gender	Male	8,95±1,10	2,93±0,24	2,45±1,80	1,04 ±0,96	7,35±1,08	22,75±3,45
	Female	8,14±1,52	2,85±0,35	1,00±1,41	1,61±0,74	5,38±2,03	19,14±3,94
	p	**P=0,007**	P=0,262	**P=0,000**	**P=0,015**	**P=0,000**	**P=0,000**
Work status	Working	8,66±1,52	3,00±0,00	3,66±2,30	0,66±1,15**	7,66±0,57	23,66±3,21
	Housewifes	8,14±1,52*	2,85±0,35	1,00±1,41*	1,61±0,74**	5,38±2,03*	19,14±3,94*
	Retired	8,96±1,09	2,93±0,25	2,38±1,78	1,06±0,96	7,33±1,10	22,71±3,48
	p	**P=0,025**	P=0,497	**P=0,001**	**P=0,040**	**P=0,000**	**P=0,001**
Tobacco use	Ex-smoker	8,52±1,44	2,90±0,30	1,80±1,71	1,37±0,83	6,27±1,83*	20,97±4,09
	Smoker	8,52±1,17	2,88±0,33	2,00±1,80	1,23±1,03	7,17±1,33	21,82±3,79
	None	9,23±0,86*	2,96±0,19	2,57±1,96	0,88±0,99	7,53±1,06	23,19±3,37
	p	**P=0,045**	P=0,587	P=0,275	P=0,118	**P=0,001**	P=0,142
Educational level	None	8,05±1,56*	2,82±0,39	0,64±0,93*	1,52±0,87	5,41±2,20*	18,58±3,98*
	Primary or lower	8,92±1,15	2,92±0,25	2,28±1,81	1,12±0,99	7,14±1,25	22,44±3,54
	Highschool or higher	8,90±0,99	3,00±0,00	3,40±1,57	1,00±0,66	7,70±0,67	24,00±2,40
	p	**P=0,031**	P=0,237	**P=0,000**	P=0,244	**P=0,001**	**P=0,000**

Table 4. Evaluation of participants' MMT scores with correlation analysis

	MMTO	MMTR	MMTA	MMTR	MMTL	MMT	REY 1	REY 2	REY 3
Age	r=-0,167	r=-0,206	r=-0,080	r=-0,067	**r=-0,272***	**r=-0,233***	**r=-0,233***	r=-0,173	r=-0,171
	p=0,130	p=0,062	p=0,470	p=0,546	**p=0,013**	**p=0,034**	**p=0,009**	p=0,117	p=0,121
Height (cm)	**r=0,250***	r=0,097	r=0,195	r=-0,127	**r=0,331****	**r=0,274***	r=-0,078	r=0,102	r=-0,046
	p=0,023	p=0,384	p=0,078	p=0,252	**p=0,002**	**p=0,012**	p=0,485	p=0,358	p=0,682
Weight (kg)	r=0,049	r=0,013	r=-0,008	r=0,115	r=-0,014	r=0,048	r=-0,164	r=-0,018	r=-0,042
	p=0,663	p=0,910	p=0,946	p=0,301	p=0,902	p=0,663	p=0,138	p=0,872	p=0,706
Hg (gr/dL)	r=0,034	r=-0,088	r=0,116	r=-0,099	**r=0,253***	r=0,144	r=-0,075	r=0,118	r=0,109
	p=0,761	p=0,428	p=0,295	p=0,372	**p=0,021**	p=0,195	p=0,502	p=0,289	p=0,327
SBP (mmHg)	r=0,111	r=-0,014	r=-0,003	r=0,067	r=0,142	r=0,119	r=0,027	r=0,069	r=0,098
	p=0,317	p=0,898	p=0,976	p=0,549	p=0,201	p=0,285	p=0,807	p=0,533	p=0,379
DBP (mmHg)	r=-0,006	r=-0,041	r=0,033	r=-0,088	r=0,022	r=0,005	r=0,000	r=-0,004	r=0,044
	p=0,959	p=0,710	p=0,769	p=0,427	p=0,846	p=0,964	p=0,999	p=0,973	p=0,691
Waist circumference (cm)	r=-0,060	r=-0,023	r=-0,119	**r=0,217***	**r=-0,235***	r=-0,107	r=-0,119	r=-0,083	r=-0,065
	p=0,591	p=0,834	p=0,285	**p=0,048**	**p=0,032**	p=0,334	p=0,283	p=0,457	p=0,558
Hip circumference (cm)	r=-0,172	r=-0,115	r=-0,192	**r=0,244***	**r=0,354****	**r=-0,216***	r=-0,164	r=-0,090	r=-0,071
	p=0,119	p=0,301	p=0,083	**p=0,026**	**p=0,001**	**p=0,050**	p=0,138	p=0,417	p=0,523
BMI (kg/m^2)	r=-0,110	r=-0,054	r=-0,116	r=0,193	**r=-0,219***	r=-0,116	r=-0,127	r=-0,080	r=-0,022
	p=0,320	p=0,630	p=0,298	p=0,081	**p=0,046**	p=0,296	p=0,253	p=0,475	p=0,845

Discussion

It is thought that obesity is not only related with diabetes mellitus, systemic hypertension, dyslipidemia, stroke, myocardial infarction, coronary heart disease, congestive heart failure like diseases, but also frontal lobe related cognitive decline (13). As participants' BMI increase, their MMT language scores were decreasing significantly and also MMT total score decreasing. In literature there are studies that suggesting obesity is related to decline in cognitive functions, but there are also studies that suggesting obesity has protective effect for cognitive decline (14,15). Cournot at al. (16) showed that a higher BMI was associated with lower cognitive scores after adjustment for educational level, age, diabetes, gender, blood pressure, and other psycho-social covariables. In addition to proinflammatory agents, hormones such as leptin and adiponectin are secreted from adipose tissue in obese patients. Abnormal high levels of adiponectin cause insulin resistance. Insulin-sensitive glucose transporters and insulin receptors in the medial temporal region of the brain play an important role in maintaining normal cognitive function. Because of this, in addition to insulin secretion disorders, also cognitive function disorders can be seen in obese patients (17).

Onat at al. showed that the mean MMT score of the patients who are aged from 65 to 74 were found significantly higher than the mean MMT score of the individuals who are aged from 75 to 88 ($p<0.05$) (18). In our study we also showed that as participants' age increase, their MMT total scores and Rey AVLT scores were decreasing. This result may be caused by structural brain aging that directly affects age-related cognitive functions through neural challenges including elevated amyloid burden, volumetric reductions, changes to the macro- and microstructure of the white matter, cortical thinning and dopamine depletion (19).

In our study it is shown that as hip circumference increase, Mini Mental Test Language (MMTL) and Mini Mental Test Recall (MMTR) scores of the participants were decreasing. Liu et al. (20) showed strong relationship between waist circumference/hip circumference ratio and cognitive decline. Despite waist circumference has better correlation with visceral adipose tissue amount, higher than 1 waist circumference/hip circumference ratio is used as an indicator of abdominal obesity. Increasing of this ratio increases tendency to metabolic complications including formation of diabetes mellitus and atherosclerosis (21). Leptin that produced from adipocytes, atrial natriuretic peptide, hormones like renin angiotensin, sodium retention caused by hyperinsulinemia induced sympatic nerve system stimulation disrupts the body's fluid balance, increases

left ventricular stroke volume and cardiac output (22). According to data from multiple studies, obesity is an independent risk factor for mortality in people with coronary heart disease (CHD). Besides that causing diabetes mellitus and hypertension, effects on lipid levels also increases CHD (22).

In our study, MMT total scores of participants who had high school or higher educational level were significantly higher and this was compatible with literature (23). This result may be caused by more highly educated persons' having higher level of cognitive functioning and taking longer time until formation of neurodegenerative pathology at that people (24). MMT total score was significantly higher in males in our study ($p<0.05$). In a study from our country, Tezel at al. (25) also found that male had significantly higher MMT score.

In our study we showed that nonsmoking patients had higher cognitive functions. Ott et al. also showed that smoking may accelerate cognitive decline in nondemented elderly (26). In a study published by Durazzo et. al (27), it is told that computed tomography (CT) and magnetic resonance (MR)-based neurocognitive and neurobiological findings suggest that chronic smoking may be related with neurocognitive deficiencies. Chronic smoking is related to global brain atrophy and to biochemical and structural abnormalities in anterior frontal regions and subcortical nuclei.

This is a cross-sectional study that aiming to evaluate effect of obesity on cognitive functions in 65 years and older 83 patients. Study performed at patients only who applied to our outpatient clinic and this limited sample size was a limitation. Short study time period and local data were also limitations of our study. On the other hand variety of the tests used in study provided us to evaluate multiple cognitive fields and this was strength of the study.

Conclusion

In our study, as BMI increases, MMTL scores of the participants were decreasing; besides that, as their waist circumference increase, MMTL and MMTR scores were decreasing. Since cognitive impairment is one of the major causes of morbidity and mortality in geriatric patients, further investigation is needed. Prevention of obesity in elderly patients will improve cognitive functions and therefore incidence of one of the major causes of mortality and morbidity in the aging population will be reduced.

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