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Association Between Cognitive Function and Metabolic Syndrome Using Montreal Cognitive Assessment Test

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ABSTRACT

Background and Purpose: The increased risk for cognitive defects in individuals affected by metabolic syndrome especially in those patients with cardiovascular disorders is now claimed. We aimed to assess the relationship between cognitive performance and the various components of metabolic syndrome.

Methods: One hundred and eighteen consecutive individuals aged 30 to 86 years were included into this cross-sectional survey. The metabolic syndrome and its definitive components were defined according to the definition described in the Framingham Heart Study by NCEP ATP III criteria. The Montreal Cognitive Assessment (MOCA) questionnaire was employed to cognitive screening.

Results: Those patients with metabolic syndrome had significantly lower mean MOCA score compare to the group without metabolic syndrome (19.11 ± 5.49 versus 21.28 ± 4.56, p = 0.021). Among all cognition sub domains, the mean attention score was significantly lower in the group with metabolic syndrome than in another group. In a multivariate linear regression model adjusting sex and age variables showed that the presence of metabolic syndrome could effectively predict cognitive impairment (beta = -2.202, SE = -0.214, p = 0.013).

Conclusion: The presence of metabolic syndrome can be mainly related to damaging cognition especially impairing the power of attention.

Keywords: Cognitive function; Metabolic syndrome; MoCA.

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INTRODUCTION

Cognitive impairment is a major crisis whole of the world leading mood instability, social dysfunction, and impaired quality of live [1,2]. This issue becomes more important by confirmation of growing population of older people [3]. The cognitive dysfunction frequently refers to different aspects of cognition including attention, perception, executive function, and memory power [4]. In fact, each of these definitive components may be defected resulting in varying degrees of dementia [5,6]. Along with some genetic variants as the potential risk profile for occurring cognitive dysfunction [7-9], some metabolic and neuroendocrine dysfunctions have been identified to be associated with increased risk for cognitive impairment. In this regard, increased risk for cognitive defects has been indicated in patients who suffer thyroid dysfunction, and Cushing syndrome [10-12]. Also, close relationship between impairment of metabolic components and vascular risk factors such as diabetes, hyperlipidemia, and malignant hypertension has been recently shown [13-15]. In fact, it has been recently raised the hypothesis on the possible relationship between different components of metabolic

syndrome and cognitive disorders. Definitely, metabolic syndrome is a cluster of metabolic and cardiovascular risk factors with a high increasing prevalence among both developing and developed populations because of unhealthy dietary habits, improper sedentary lifestyles, and even some genetic predisposing states [16-18]. In this regard, the overall prevalence of metabolic syndrome among our adolescent population has been reported in a wide range of 10.1% to 31.0% emphasizing probable increased risk for cognitive defects in individuals affected by metabolic syndrome among our population [19,20]. The first precondition to prove this claims demonstrating association of cognitive impairment with metabolic syndrome and its components. Hence, we aimed to assess the relationship between cognitive performance and the various components of metabolic syndrome in Iranian sample.

MATERIALS AND METHODS

Subjects

After explaining the purpose and content of the study, 118 consecutive individuals aged 30 to 86 years without any history of cerebrovascular accidents, or head trauma were included into this cross-sectional survey. An inquiry and history taking were conducted including baseline characteristics, history of cardiovascular risk factors, anthropometric parameters, and any medication. Subjects with any neuropsychiatric disorders were excluded from this study.

Metabolic Syndrome Criteria

The metabolic syndrome and its definitive components were defined according to the definition described in the Framingham Heart Study by NCEP ATP III criteria [21]. In this classification, the individual had metabolic syndrome if the presence of at least three of five components of 1) abdominal obesity as body mass index (BMI) more than or equal to 30 kg/m^2, 2) hypertriglyceridaemia (triglycerides ≥1.7 mmol/L) and/ or use of cholesterol-lowering medications, 3) random blood glucose level was ≥ 11.1 mmol/l or using insulin or oral hypoglycemic agents, 4) low HDL cholesterol (HDL cholesterol ≤1.03 mmol/L for men and ≤1.29 mmol/L for women); and 5) elevated blood pressure (systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥85 mmHg or current use of antihypertensive drugs).

Cognitive Assessment

In this study, the *Montreal Cognitive Assessment* (MOCA) questionnaire was employed to cognitive screening to finally eliminating the cognitive deficiencies. This questionnaire can assess more cognitive and is composed of more complex skills and is thus more sensitive than the MMSE tool to diagnose mild cognitive impairments. The MOCA assesses some cognitive domains including attention, concentration, executive functions (following the numbers, letters, words and abstract), short memory (delayed recalling), language (naming and sentence repetition), visuoconstructional skills (drawing cubic or watch), conceptual thinking, calculations, and orientation. The total possible score is 30 points.

Statistical Analysis

Table 1. Baseline characteristics in the groups with and without metabolic syndrome

Characteristics	Group with metabolic syndrome (n = 61)	Group without metabolic syndrome (n = 57)	P-value
Male gender	17 (27.9)	24 (42.1)	0.105
Education level			0.025
Illiterate	14 (23.0)	7 (12.3)	
Primary level	40 (65.6)	30 (52.6)	
College degree	7 (11.5)	20 (35.1)	
Age, year	60.39 ± 10.22	61.82 ± 10.67	0.459
BMI, kg/m^2	28.56 ± 4.13	25.37 ± 2.96	<0.001
LDL, mg/dl	114.07 ± 37.62	102.87 ± 35.78	0.100
Triglyceride, mg/dl	168.69 ± 50.88	134.95 ± 44.36	<0.001
Total cholesterol, mg/dl	190.89 ± 40.76	178.00 ± 39.36	0.084
HDL, mg/dl	43.08 ± 10.47	48.14 ± 11.28	0.013
FBS, mg/dl	135.20 ± 50.51	108.33 ± 39.42	0.002
HbA1c, %	6.79 ± 1.19	6.24 ± 1.49	0.065
SBP, mmHg	135.66 ± 19.59	121.47 ± 13.19	<0.001

BMI: Body Mass Index; FBS: Fasting Blood Glucose; HDL: High-Density Lipoprotein cholesterol; LDL: Low-Density Lipoprotein cholesterol; SBP: Systolic Blood Pressure

Results were presented as mean ± standard deviation (SD) for quantitative variables and were summarized by frequency (percentage) for categorical variables. Continuous variables were compared using t test Non-parametric Mann-Whitney test whenever the data did not appear to have normal distribution or when the assumption of equal variances was violated across the study groups. Categorical variables were, on the other hand, compared using chi-square test. The association between different components of metabolic syndrome and subdomains of cognition was assessed using the Pearson's correlation test. The multivariate logistic regression analysis was used to determine the effects of metabolic syndrome on cognitive impairment with the presence of baseline characteristics as the probable confounders. For the statistical analysis, the statistical software SPSS version 21.0 for windows (SPSS Inc., Chicago, IL) was used. P values of 0.05 or less were considered statistically significant.

RESULTS

According to definitive criteria for metabolic syndrome, 61 of 118 patients (51.7%) had metabolic syndrome. Comparing baseline characteristics between the two group with and without metabolic syndrome (Table 1) showed no difference in sex and age distribution, however the former group had higher mean BMI, serum triglyceride, blood sugar, systolic blood pressure as well as lower serum HDL level than in non-metabolic syndrome group. Regarding score of cognition, the mean MOCA score in total population was 20.16 ± 5.16 (ranged 7 to 29) that only 21 patients (17.8%) had normal cognition status. The normal cognition rate was 13.1% in those with metabolic syndrome and 22.8% in those without metabolic syndrome. Assessing relationship between MOCA cognition score and different components of metabolic syndrome (Table 2) showed adverse associations between MOCA score and the components of serum LDL level ($r = -0.263$, $p = 0.004$), blood sugar ($r = -0.196$, $p = 0.034$), systolic blood pressure ($r = -0.378$, $p < 0.001$), and total cholesterol level ($r = -0.235$, $p = 0.010$). Those patients with metabolic syndrome had significantly lower mean MOCA score compare to the group without metabolic syndrome (19.11 ± 5.49 versus 21.28 ± 4.56, $p = 0.021$). Among all cognition sub domains, the mean attention score was significantly lower in the group with metabolic syndrome than in another group (4.21 ± 1.73 versus 4.93 ± 1.27, $p = 0.012$) (Table 3). In a multivariate linear regression model adjusting sex and age variables (Table 4) showed that the presence of metabolic syndrome

Table 2. Correlation between different components of metabolic syndrome and different domains of cognition

		MOCA Score	Visuoconstructional	Naming	Memory	Attention	Language	Abstraction	Orientation
BMI	Pearson Correlation	-.070	-.050	-.039	-.002	-.064	-.166	.003	.010
	p-value	.454	.588	.678	.979	.488	.072	.974	.913
LDL	Pearson Correlation	-.263**	-.120	-.196*	-.073	-.154	-.139	-.347**	-.356**
	p-value	.004	.196	.033	.430	.096	.132	.000	.000
TG	Pearson Correlation	-.128	-.051	-.003	-.005	-.185*	-.077	-.108	-.013
	p-value	.168	.583	.971	.955	.045	.407	.245	.892
HDL	Pearson Correlation	.135	.118	-.071	.256**	.050	.091	.097	.027
	p-value	.144	.204	.445	.005	.588	.327	.297	.769
FBS	Pearson Correlation	-.196*	-.241**	.052	-.128	-.228*	-.150	-.038	-.050
	p-value	.034	.009	.577	.169	.013	.105	.685	.588
SBP	Pearson Correlation	-.378**	-.279**	-.183*	-.160	-.324**	-.373**	-.293**	-.182*
	p-value	.000	.002	.047	.083	.000	.000	.001	.049
Total Cholesterol	Pearson Correlation	-.235*	-.090	-.200*	.002	-.173	-.122	-.318**	-.321**
	p-value	.010	.332	.030	.982	.061	.189	.000	.000
HbA1c	Pearson Correlation	-.155	-.150	-.081	-.085	-.100	-.224*	.057	-.157
	p-value	.153	.169	.461	.434	.361	.038	.601	.150

BMI: Body Mass Index; FBS: Fasting Blood Glucose; HDL: High-Density Lipoprotein cholesterol; LDL: Low-Density Lipoprotein cholesterol; SBP: Systolic Blood Pressure

Table 3. Mean scores for cognition domains in groups with and without metabolic syndrome.

Characteristics	Group with METs (n = 61)	Group without METs (n = 57)	P-value
MOCA Score	19.11 ± 5.49	21.28 ± 4.56	0.021
Visuoconstructional	2.31 ± 1.52	2.81 ± 1.66	0.093
Naming	2.43 ± 0.67	2.58 ± 0.50	0.165
Memory	1.66 ± 1.34	2.02 ± 1.37	0.150
Attention	4.21 ± 1.73	4.93 ± 1.27	0.012
Language	1.34 ± 1.08	1.72 ± 1.06	0.060
Abstraction	0.84 ± 0.80	0.96 ± 0.78	0.377
Orientation	5.43 ± 1.07	5.51 ± 0.76	0.632

Table 4. Association of MOCA score and metabolic syndrome adjusted for sex and age.

Item	Unstandardized Coefficients		Standardized Coefficients	t	P-value
	B	Std. Error	Beta		
(Constant)	36.301	3.533		10.274	0<.0001
metabolic syndrome	-2.202	.875	-.214	-2.516	0.013
Sex	-1.742	.962	-.162	-1.810	0.073
age	-.198	.044	-.401	-4.535	0.000

could effectively predict cognitive impairment (beta = -2.202, SE = -0.214, p = 0.013).

DISCUSSION

In parallel with previous studies on association between metabolic syndrome and its main components and cognitive dysfunction, we attempted to assess this relationship in a sample of our patients' population. In this context, our study could show a direct association between metabolic syndrome and cognitive impairment, even after adjusted for gender and age. In fact, we could show that the presence of metabolic syndrome can be mainly related to damaging the power of attention as one of the main domains of cognition. Also, we indicated that among different components of metabolic syndrome, high serum LDL level, uncontrolled blood sugar, crisis of systolic blood pressure and hypercholesterolemia adversely could affect cognition status. Reviewing the literature obtain similar findings. In a study by Yaffe et al on older women [22], the overall prevalence of cognitive problem in those with and without metabolic syndrome was 7.2% and 4.1%, respectively with a significant difference between them. According to their result, increased risk for cognitive disorder was directly associated with the number of the components of metabolic syndrome. In Chang et al study [23] on Taiwanese older adults, by adjusting sex, age, education level, marital status and even apolipoprotein genotype, metabolic syndrome remained a major predictor for cognitive impairment. Some studies emphasized mild level of cognitive impairment in those with metabolic syndrome. In a study by Bachyns'ka et al [24], the presence of metabolic syndrome could negatively affect cognitive functions especially its sub domains of reproduction of information, attention, and orientation in time. This association was revealed in all age subgroups. In a systematic review by Collins et al [25], the presence of metabolic syndrome was associated with executive cognitive dysfunction and memory deficits for both men and women who younger than 75 years, but contradictory results were achieved for the people older than 75 years. In another study by Parnowski et al [26], dementia was significantly correlated with metabolic syndrome and its components of low HDL cholesterol, and hyperglycemia. Oh et al [27] also indicated a close association between metabolic syndrome and cognitive function in patients with Alzheimer.

Different recommends have been presented to explain association between metabolic syndrome and cognitive impairment. In this regard, some evidences have emphasized a combination of neuroanatomical and neuroendocrine changes resulting cognitive deficit [28,29]. It has been also suggested a close association between metabolic syndrome and white matter alterations, and altered brain metabolism. In some studies based on imaging techniques, in those with metabolic syndrome, volume losses in the hippocampus and frontal lobes have been clearly discovered leading cognitive problems in affected ones. In fact, in metabolic syndrome, both brain structure and brain lipid metabolism may be affected leading cognitive impairment [30].

CONCLUSION

According to our finding, the domain of attention was mostly affected by metabolic syndrome and thus the areas of brain controlling the ability of attention may be more impaired by this syndrome. This claim should be more assessed in further molecular and experimental studies.

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