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Original article

Running title: Cognitive status of diabetic and non-diabetic elderly people

Comparison of Cognitive Status of Diabetic and Non-Diabetic Elderly in the Last Ten Years in Primary Health Care in Iran

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SUMMARY

Introduction. Cognitive disorders and chronic diseases such as diabetes are common problems of aging. The aim of this study was to determine and compare the cognitive status of diabetic and non-diabetic elderly in the past ten years in primary health care in Iran.
Method: This cross-sectional study was performed on people aged 60 years and older in Kerman, Iran in 2020. In total, this study was performed on 200 patients (100 diabetic and 100 non-diabetic) meeting inclusion criteria. The Short Mental Status Questionnaire (MMSE) and The Informant Questionnaire for Cognitive Decline in the Elderly (IQCODE) were used to assess cognitive function. The validity and reliability of the questionnaires were confirmed in this study. Data were analyzed using Chi-square, T-test, and ANOVA analysis in SPSS 21 software.
Results. The results showed that there was a statistically significant difference between diabetic and non-diabetic groups in the current cognitive status and cognitive status in the last ten years. The mean scores of cognitive function from the short mental status questionnaire in the diabetic group were lower than in the non-diabetic group ($p = 0.001$). The mean scores of the cognitive deficit screening questionnaire in diabetic elderly were higher than in non-diabetic elderly ($p < 0.001$).
Conclusion. Based on the results of this study, health care providers and family physicians should focus on controlling diabetes and identifying any cognitive impairment in the early stages of comprehensive care of diabetic patients.

Keywords: **diabetes mellitus, cognitive status, elderly**

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INTRODUCTION

With the implementation of infectious disease control programs and the promotion of education and health, the pattern of social ills has shifted to chronic non-communicable diseases (NCDs), such as diabetes. It is estimated that by 2020, 73% of deaths worldwide will be due to chronic diseases. Epidemiological transmission along with population transfer has increased life expectancy and the proportion of the elderly in many societies, so that one of the most important health challenges in global development in this century is the increase in the elderly population and related diseases (1, 2). Age alone cannot be a determining factor in the definition of old age, and aging depends on temporal, physical and mental changes (3). Mostly, older people have at least one chronic illness that puts them at greater risk for disability and death than others (4). At the same time, diabetes is one of the most common chronic diseases that has become an epidemic, and its prevalence in all societies increases with age, so that the highest prevalence is reported in the oldest age group of any society (5).

On the other hand, the association of cognitive disorders with non-communicable diseases in the elderly is one of the most important health challenges in global development in this century. In addition, another concern related to the increase in the elderly population in the field of health is the increase in the number of people who suffer from cognitive decline related to aging (6). As the elderly population increases, the decline in cognitive function threatens the elderly, posing a challenge to health care systems (7).

Cognitive abilities at an early age in many people, but not all, show at least a small decline, and the most important change in cognitive function in normal aging is a decrease in performance in performing cognitive tasks (8).

The proportion of dementia is increasing in developing countries, but in developed countries the proportion of dementia is decreasing (9). Studies have shown that the prevalence of dementia and cognitive impairment varies in different regions and individuals and its range varies from 9.5 to 32.7% (10 - 13).

In old age, the incidence of diabetes increases, while cognitive function decreases with age. Plastino et al. reported in their study that type 2 diabetes is a risk factor for dementia and Alzheimer's disease (14). In another study, Xu et al. found that diabetes could increase the risk of dementia, which may be associated with diabetes in middle life (15). The study by Baker et al. showed that insulin resistance is associated with decreased cognitive function (16).

Diabetes not only increases the risk of dementia but also doubles its growth. The mechanism of this decline is not fully understood, but it is hypothesized that hyperglycemia, oxidative stress, and insulin resistance may lead to cognitive impairment. The apparent overlap between diabetes and dementia has led to the idea that dementia is both a neurological and an endocrine disorder. In general, it has been proven that there is a relationship between the severity of cognitive problems and age in people with type 2 diabetes in older patients (17).

On the other hand, the elderly population has increased significantly and a significant part of the population resides in developing countries. Cognitive disorders and chronic diseases such as diabetes are also common problems of aging. Therefore, timely screening of these disorders may be useful for early diagnosis and treatment. Therefore, this study was conducted to determine and compare the cognitive status of diabetic and non-diabetic elderly in the past ten years in primary health care in Iran.

METHOD

The present study was a cross-sectional study that was conducted from December 2019 to February 2020 in Kerman, Iran. Kerman is the capital of Kerman province, which is located in the southeast of Iran. The city is divided into four sub-cities and has a health center. Two hundred elderly people aged 60 years and older who were referred to health centers in Kerman for initial medical evaluation were randomly selected and entered the study if they met the inclusion criteria.

Inclusion criteria were: elderly people 60 years and older, speaking the Persian language, and having at least a fourth grade education. Exclusion criteria were: having diseases leading to severe cognitive or functional impairment such as stroke in the prior 12 months or end-stage cancer, Parkinson's disease, impaired vision or hearing. The data collection tool in this study was a questionnaire. The questionnaires were: Short Mental Status Questionnaire or MMS, The Informant Questionnaire for Cognitive

Decline in the Elderly (IQCODE), Elderly Depression Questionnaire.

Short Mental Status Questionnaire or MMS is a test used to assess the quality of consciousness by diagnosing and screening for dementia. Its maximum score is 30. This test consists of 3 items of 5 points (each item has 5 questions of 1 point), 3 items of 3 points, one item of 2 points and four items of 1 point. The MMSE test includes simple questions and problems in a number of areas: the time and place of the test, repeating lists of words, arithmetic such as the serial sevens, language use and comprehension, and basic motor skills. For example, one question, derived from the older Bender-Gestalt Test, asks to copy a drawing of two pentagons (shown on the right or above). The minimum score for people with higher education is 29. The minimum score for people with secondary education is 27. The minimum score for people with primary education is 25. The minimum score for illiterate people is 19. The interpretation of scores is as follows: 25 or more = normal cognition, 20 to 25 = mild cognitive impairment, 10 to 20 = moderate cognitive impairment and 0 to 10 = severe cognitive impairment. Because the score obtained is related to the level of basic education, patients with low level of education may be mistakenly classified as dementia (18). The psychometric properties of MMSE have been confirmed in the elderly population of Iran and its reliability has been confirmed with an alpha of 0.87 (19). In the present study, a retest test was used to confirm the reliability. The reliability of this questionnaire was confirmed with an alpha of 0.85.

The Informant Questionnaire for Cognitive Decline in the Elderly (IQCODE) collects information on changes in the cognitive functions of the elderly over the past 10 years. The questionnaire has 16 items. Scoring is in the form of 5-point Likert and the range of scores is 16 - 80. This questionnaire has 6 subscales of episodic memory, executive functions, daily instrumental activities, long memory, temporal orientation and ability to concentrate (20). This questionnaire is valid and reliable (21). In this study, in order to confirm the reliability, the retest test method was used, which was confirmed with an alpha of 0.87.

The Elderly Depression Inventory has 15 questions. The questions are graded yes (score 1) and no (score 2). The range of scores is between 0 - 15.

This study was conducted after finding the code of ethics from the Vice Chancellor for Research of Kerman University of Medical Sciences (ethics code: IR.KMU.REC.1399.095) and obtaining the necessary licenses. In order to perform sampling, a trained researcher specializing in this field was used. The contact numbers of people with primary health care records were collected. After contacting the relevant people and ensuring that they have inclusion criteria and no exclusion criteria, an appointment was made. At first, the objectives of the research and the method of work were explained to the participants and written consent was obtained to participate in the study. The inclusion and exclusion criteria of the study were checked again. Then the research tool was completed in a participatory way, through interview. Finally, the collected information was coded and entered into SPSS software version 21. Descriptive and analytical statistical tests were used to analyze the data. The normality of the distribution was tested using the Kolmogorov-Smirnov test. Chi-square test was used to show the relationship between the two variables. T-test and ANOVA analysis were used to evaluate the comparison of the mean scores of the groups with different demographic characteristics.

RESULTS

The mean age of participants in the diabetic elderly group was 66.07 years (5.80 years) and in the non-diabetic elderly group was 65.02 years (6.02 years). In this regard, there was no statistically significant difference between the two groups ($p = 0.444$).

The results showed that most of the participants in both groups were married. In both groups, the majority of participants were women. In both groups, most participants had primary education and most were unemployed. The two groups were homogeneous in terms of demographic variables (Table 1).

The cognitive status based on MMSE scores in diabetic individuals was as follows: 49% of subjects had normal cognitive status (MMSE scores 25%), 29% of people had mild cognitive impairment (MMSE scores 20 - 25), 17% of people had moderate cognitive impairment (MMSE score 10 - 20), 5% of people had severe cognitive impairment (MMSE scores 10%). In non-diabetics, 72% had normal cognition, 19% had mild cognitive impairment, 8% had moderate cognitive impairment, and 1% had severe cognitive impairment ($p < 0.001$). The relationship between cognitive status and diabetes status is presented in Table 2. The mean scores of mental status in

Table 1. *Comparison of demographic characteristics and depression scores of the elderly in the two groups*

Variables		Diabetes (n = 100)	Non diabetes (n = 100)	*P*-Value
Marital status	Single	30	22	0.3
	Married	70	78	
Gender	Male	49	48	0.06
	Female	51	52	
Education	Primary	38	40	0.12
	Under Diploma	32	31	
	Diploma	30	29	
Job	Unemployed	82	85	0.09
	Employed	18	15	
GDS*	Negative	54	72	0.1
	Positive	36	28	

*Geriatric Depression Scale

Table 2. *Investigating the relationship between cognitive status and diabetes status*

Variables		Mean	SD	Score	*P*-Value
MMSE	With diabetes	25.45	3.23	^{t}5.132	0.002
	Without diabetes	26.01	3.57		
IQCODE	With diabetes	61.92	7.9	^{t} -3.445	< 0.001
	Without diabetes	56.34	6.01		

Mini Mental State Examination (MMSE)
Footnote: SD: Standard deviation

diabetic groups were lower than in non-diabetic groups (p = 0.002). The mean scores of cognitive impairment in diabetic elderly were higher than in non-diabetic elderly (p < 0.001).

Comparison of cognitive status scores of diabetic elderly in terms of demographic variables and depression scores is presented in Table 3. The findings show that the mean score of cognitive status (MMSE and IQCODE) was significant in terms of gender, marital status, education, occupation and depression (GDS score). In the non-diabetic group, there was a significant relationship between cognitive status and level of education and depression (Table 4).

Table 3. *Comparison of mean cognitive status score (MMSE and IQCODE) and demographic variables in the elderly with diabetes*

Variables		MMSE	IQCODE
Gender	Male	26.11 (3.12)	55.26 (5.62)
	Female	25.23 (2.31)	60.12 (6.11)
Score (P-Value)	T-Test	t4.238 (0.002)	t3.709 (0.01)
Marital status	Single	25.12 (3.09)	59.11 (6.32)
	Married	25.87 (2.77)	56.33 (6.57)
Score (P-Value)	T-Test	t -3.121 (0.016)	t4.276 (0.03)
Education	Primary	24.24 (3.65)	58.12 (6.44)
	Under Diploma	24.24 (3.23)	52.25 (6.01)
	Diploma and above	27.34 (2.66)	48.24 (5.5)
Score (P-Value)	ANOVA	F-9.245 (< 0.001)	F7.11 (< 0.001)
Job	Unemployed	25.39 (3.56)	60.12 (7.09)
	Employed	26.89 (2.44)	51.23 (6.45)
Score (P-Value)	T-Test	t-5.245 (0.02)	t6.11 (0.012)
Complications	Yes	25.13 (3.24)	59.34 (8.11)
	No	26.09 (3.44)	51.22 (4.11)
Score (P-Value)	T-Test	t -1.34 (0.9)	t0.789 (0.2)
GDS	Positive	24.12 (3.12)	60.23 (6.13)
	Negative	26.34 (2.88)	50.46 (6.55)
Score (P-Value)	T-Test	t -7.34 (0.04)	t5.67 (0.001)

Footnote: Mean(SD): Standard deviation

Table 4. *Description of group difference between MMSE and IQCODE mean score and socio-demographic measures in non-diabetic subjects*

Variables		MMSE	IQCODE
Gender	Male	27.01 (2.23)	57.13 (6.77)
	Female	27.45 (4.09)	58.24 (6.29)
Score (P-Value)	T-Test	t -0.238 (0.09)	t -1.42 (0.2)
Marital status	Single	26.32 (2.78)	56.32 (5.80)
	Married	26.96 (3.27)	56.45 (6.45)
Score (P-Value)	T-Test	t0.987 (0.07)	t -1.68 (0.21)
Education	Primary	26.01 (4.4)	59.32 (5.67)
	Under Diploma	26.89 (3.6)	56.25 (6.56)
	Diploma and above	28.02 (3.1)	47.36 (6.29)
Score (P-Value)	ANOVA	F9.305 (0.01)	F12.26 (0.03)
Job	Unemployed	26.13 (4.7)	56.11 (5.86)
	Employed	26.79 (4.01)	55.45 (6.09)
Score (P-Value)	T-Test	t0.904 (0.35)	t -1.254 (0.9)
GDS	Positive	25.37 (4.76)	57.25 (5.48)
	Negative	27.09 (3.5)	49.77 (5.92)
Score (P-Value)	T-Test	t4.27 (0.02)	t -6.378 (< 0.001)

Footnote: Mean(SD): Standard deviation

DISCUSSION

The results of this study showed that type 2 diabetes is one of the risk factors for poor cognitive function. In this regard, the results of the study by Van den Berg et al. showed that patients with type 2 diabetes have a moderate decrease in information processing, attention and executive functions compared to the control group (22). A meta-analysis and systematic study with more than 100 million participants showed that the relative risk of dementia in diabetic patients compared with non-diabetic patients is 1.73 (1.65-1.82) (23). In a study by Haroon et al., it was found that diabetic patients have lower cognitive function than non-diabetic patients (24). Also, the study of Li et al. showed that people with type 2 diabetes had lower performance in verbal memory than healthy people (25). Teixeira et al. reported that even a cognitive assessment is important in assessing the impact of diabetes on the mental health of this population, which may be very important for many similar low- and middle-income countries (26). Many studies have confirmed the effect of diabetes on cognitive function. There are certain patterns that affect dysfunction in aging and diabetes. Brain volume loss has been reported in the elderly with diabetes, particularly in the hippocampus, thalamus, and cerebellum. In people with diabetes, resting brain activity decreases in all areas of the brain (27 - 28). It now seems that cognitive impairment is not one of the main complications of diabetes, but in order to provide better care, cognitive screening or cognitive evaluation of these patients is an important mechanism for the optimal management of type 2 diabetes in Iran.

The results of the present study also showed that the prevalence of cognitive impairment in diabetic women is higher than in men, which is consistent with some similar studies. Some studies have shown that there is a significant difference between the two sexes in cognitive impairment, so that cognitive impairment is greater in women than in men (13, 29 - 31). However, Hatami et al.'s study did not report a significant difference in the prevalence of cognitive impairment between men and women (30).

The results of the present study also showed that low level of education is associated with a higher risk of dementia, which is consistent with other studies (31 - 35). A systematic review reported that 61% of studies have shown that low education is a justifiable risk for dementia (36). Highly educated and employed people use their brain capacity effectively and efficiently. More challenging activities with more brain involvement (such as education and employment in a social setting) play an active role in improving memory and cognitive reserves and are excellent ways to reduce dementia in older diabetics. The results of this study showed that the symptoms of cognitive disorders were higher in single people. This finding indicates the possible role of normal and married life in reducing the incidence of cognitive disorders in old age. This finding is consistent with the results of the study of Wu et al. (37). Lower involvement of married people with cognitive disorders may be due to their mental state and better life.

The results of the present study also showed that the prevalence of cognitive impairment is higher in depressed patients. In this regard, the results of the study of Aajami et al. showed that in the elderly with depression, the risk of cognitive dysfunction is double (11). A longitudinal study showed that depression was present in 16.9% of the elderly with cognitive impairment (38). Depression and cognitive impairment may show similar symptoms. Thus, people with cognitive impairment may experience depressive symptoms and vice versa (39 - 40).

Population aging and the prevalence of type 2 diabetes are the most important challenges of the Iranian health system (41 - 44). According to the results of the present study, it seems that in the study of cognitive disorders in the elderly, various aspects of people's lives should be examined, including diseases and family and social status. One of the limitations of this study is its cross-sectional nature. Therefore, longitudinal studies are recommended to identify the factors affecting cognitive disorders in the elderly. Also in this study, a questionnaire was used to screen people, and it is recommended that future studies be performed with diagnoses such as tests and clinical approach.

CONCLUSION

The results of this study show that type 2 diabetes is associated with a higher prevalence of cognitive impairment in the elderly. Due to the increasing elderly population and the prevalence of chronic diseases such as diabetes and the prevalence of cognitive disorders, health care providers and family physicians should focus on diabetes control in order to provide more comprehensive care to diabetic patients. Therefore, with these measures, pa-

tients will be identified earlier and early treatment will be performed. Fortunately, in countries like Iran, diabetes control and prevention programs have been running in primary health care for years.

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Conflict of Interest

There is no conflict of interest to be declared.

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Upoređivanje kognitivnog statusa starije populacije sa dijabetesom i bez dijabetesa u poslednjih deset godina u primarnoj zdravstvenoj zaštiti u Iranu

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SAŽETAK

Uvod. Kognitivni poremećaji i hronične bolesti poput dijabetesa melitusa česti su problemi procesa starenja. Cilj ove studije bilo je određivanje i upoređivanje kognitivnog statusa starije populacije sa dijabetesom i bez dijabetesa u poslednjih deset godina u primarnoj zdravstvenoj zaštiti u Iranu.

Metode. Ova studija preseka uključila je populaciju starosti od 60 i više godina, i sprovedena je u Kermanu, u Iranu 2020. godine. U studiji je ukupno učestvovalo 200 bolesnika (100 dijabetičara i 100 bolesnika bez dijabetesa). Za procenu mentalne funkcije korišćeni su sledeći upitnici: Short Mental Status Questionnaire (MMSE) i Informant Questionnaire for Cognitive Decline in the Elderly (IQCODE). Validnost i pouzdanost upitnika potvrđeni su u ovoj studiji. Podaci su analizirani pomoću Chi-square testa, T-testa i ANOVA testa primenon SPSS21 softvera.

Rezultat. Rezultati su pokazali to da između bolesnika sa dijabetesom i bez dijabetesa postoji značajna razlika u trenutnom kognitivnom statusu, kao i kognitivnom statusu u poslednjih deset godina. Srednje vrednosti kognitivne funkcije iz mini skale za procenu mentalnog statusa bile su niže u grupi dijabetičara u poređenju sa populacijom bez dijabetesa ($p = 0,001$). Srednje vrednosti skrininga kognitivnog deficita kod starije populacije sa dijabetesom bile su veće nego kod populacije bez dijabetesa ($p < 0,001$).

Zaključak. Na osnovu rezultata ove studije, zdravstveni radnici, uključujući i porodične lekare, trebalo bi da se fokusiraju na kontrolisanje dijabetesa i identifikovanje pogoršanja kognitivne funkcije u ranim fazama sveobuhvatne nege dijabetičara.

Ključne reči: **dijabetes melitus, kognitivni status, starija populacija**