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Factors affecting type 2 diabetes and their impact on the inflammation of the disease.

Abstract

Psychological stress is one of the aggravating factors of type 2 diabetes, which is divided into different aspects. In this article, the effects of various factors on the level of stress and the stage of type 2 diabetes have been investigated. Study was conducted on 320 people with type 2 diabetes who were randomly selected. All analyses were performed using the SPSS software. Data were expressed as mean, median (interquartile range), or number (percent), as appropriate. Receiver Operator Characteristic (ROC) analysis was used for test-retest reliability measurement to determine the diagnostic. Spearman's test was used to determine the correlations. Data were analyzed using the chi-square test and continuous data using an independent-samples T-test. A p-value less than 0.05 (2-tailed) was considered significant. The correlation between the factors that are directly related to the stage of diabetes is as follows:

- Regularly visiting a doctor" and "Years of being diabetic" (p=0.035, r=-0.119)
- "Regularly measuring blood sugar" and "Regularly visiting a doctor" (p=0.000, r=0.485)
- "Type of cure" and "Years of being diabetic" (p=0.000, r=0.366)
- "Type of cure" and "Regularly visiting a doctor" (p=0.000, r=-0.209)
- "Type of cure" and "Regularly measuring blood sugar" (p=0.016, r=-0.134)
- "Age" and "having an underlying disease" (p=0.000, r=-0.287)
- Type of cure" and "Average of weekly workout per day" (p=0.001, r=-0.193)

By modifying and changing environmental factors such as economic factors, family relationships, etc., the level of stress can be significantly reduced. Among the investigated factors, daily exercise plays a significant role in controlling the severity of the disease.

Keywords: *Psychological Stress; Type 2 Diabetes; Complication*

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1. Introduction

Diabetes mellitus, a chronic metabolic disease, is characterized by impairment or deficiency of insulin production in the pancreas [1]. There are two main types of diabetes: type 1 (T1DM), which is insulin-dependent, and the non-insulin-dependent type, type2 (T2DM) [2]. Type 2 is far more common (approximately 90% of all cases) than type 1 diabetes mellitus [3].

Worldwide, T2DM is uprising to an epidemic level– more than 422 million diabetic people, with the majority living in low and middle-income countries (13.5%), compared to those in high-income countries (10.4%) [4]. It is also expected to be more prevalent and will rise to 629 million in 2045 [5].
A total of 1.6 million deaths worldwide are caused by diabetes, while other harmful health outcomes of T2DM include heart disease, stroke, hearing loss, hypertension, blindness, nerve damage, and kidney disease [6,7].

One of the common mental disorders that are epidemic among adults is stress. Stress is described as a process in which environmental needs exceed the adaptive capacity of an organism, causing biological and psychological changes that may lead people to the risk of disease [8,9]. The physiological stress cycle starts when a rapid activation of the sympathetic nervous system (SNS) is followed by a slower and later response of the hypothalamic-pituitary-adrenal (HPA) axis and causes a biphasic plasma hormonal response in (nor)adrenaline and glucocorticoids (GCs) [10,11].

Recent research has increasingly identified chronic (psychological) stress as a risk factor for T2DM because of its significant effect on all these biological systems [12]. Chronic stresses are regarded as exposure to stress that continues for weeks to years, e.g., during unemployment or poor socioeconomic circumstances [13]. Stress management can modify long-term glycemic control [14,15]. Diabetes can affect both psychological status (e.g., stress and depression) and social relationships, and physical function (e.g., limitations and physical suffering, decreased energy) [16,17].

Therefore this study aimed to recognize the connection between type 2 diabetes and physiological stress in Tehran society.

2. Method

In the recent decade, the increase in the prevalence of diabetes and pre-diabetes in Iranian society is remarkably higher than the global average; From 2014 to 2022, the growth rate of the disease outbreak was 15% and 25.4%, respectively [18]. Among the age groups of Iranian society, the population of older adults over 60 years old has grown the most, so in 2011, 2.8%, and in 2020, more than 20% of the population was made up of people over 60 years old. The rate is still rising [19]. According to the research conducted on the population of Iran, type 2 diabetes is more common in the elderly. In 2017, about 14.4% of the elderly in Tehran were suffering from type 2 diabetes, and this percentage is increasing alarmingly [20]. Accordingly, we decided to research a factor that is less known to cause or progression of the disease, the stress factor, which is nowadays very important, hence Iran's economic and social status.

This study was conducted from July to September 2022 in Tehran, Iran. We designed a set of questions inspired by some standard questionnaires such as PHQ-9, DASS21, DSSQ-Family, and DMSES-UK. Then we categorized it into four sections. The first section is about demographic details; In this section, we asked a few questions to collect personal information about the patients and their diabetes status. In the second one, we asked about their financial and economic position because it was guessed to be the most important factor affecting the patient's stress level and also affecting other factors as well (e.g., the financial and economic position can directly affect the relation between family members). The third section analyzes family support and conflicts, and in the fourth part, we quantify the individual stress state. (Table1)

After completing our questionnaires, we distributed them among 320 patients diagnosed with T2DM in hospitals, healthcare centers, and specialized diabetes clinics. After collecting the data, we started to analyze it.

All analyses were performed using the Statistical Package for Social Science (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.). Data were expressed as mean, median (interquartile range), or number (percentages), as appropriate. For test-retest reliability measurement, Spearman's Test was used to determine the correlations. Data were analyzed using the chi-square test and continuous data using an independent-samples T-test. A p-value less than 0.05 (2-tailed) was considered significant.

3. Result

4.1. Baseline of Characteristics

According to the eligible findings of the research, 48.1% of the participants were male, and 51.9% were female. 80.0% were married. The mean age was 56.91 (S. D= 13.637) years, and the mean disease duration of T2D was 9.0 (S. D=8.736) years.
Among all the verified participants (0.3% missed), 65.0% were only taking edible medications, and 12.2% were only using injectable medications, 17.8 % were taking both, and 4.7% were using none.

4.2. Spearman's corrélations

In the research, we studied correlations of the factors provided in the following table (Table 1). With regard to analysis, there is a significant correlation between the following:

Table1

Characteristics of type 2 diabetic patients with and without stress based on questionnaires.

	Mean	Std.Dev	Value1	Value2	Value3	Value4	Value5	Value6	Value7
Demographic details									
Gender (1=male,2=female)	1.52	0.501	0.207	0.002	0.002	0.373	0.081	0.884	0.090
Age	56.98	13.584	0.000	0.165	0.726	0.456	0.000	0.642	0.227
Marital status (1=single,2married,3=divorced,4=widowed)	2.17	0.689	0.004	0.266	0.623	0.740	0.213	0.515	0.314
Average weekly workout per day (at least 30 minutes a day)	3.23	2.725	0.989	0.322	0.054	0.001	0.369	0.766	.
Average of daily sleep(hours)	8.16	0.820	0.001	0.568	0.975	0.811	0.615	.	0.766
Regularly measuring blood sugar(1=yes,2=no)	1.23	0.419	0.447	0.000	.	0.016	0.099	0.975	0.054
Regularly visiting a doctor(1=yes,2=no)	1.24	0.425	0.035	.	0.000	0.000	0.451	0.568	0.322
Type of cure currently being used(1=none,2=oral,3=insulin, 4=both)	2.42	0.835	0.000	0.000	0.016	.	0.933	0.811	0.001
Job and financial factors*									
Job security	3.12	1.098	0.735	0.310	0.425	0.500	0.699	0.520	0.425
Monthly income (million Iranian rials)	61.5M	1.225	0.327	0.152	0.861	0.284	0.283	0.223	0.048
How much do you feel satisfied with your economic status?	2.54	0.958	0.430	0.059	0.588	0.743	0.811	0.272	0.016
Family support and conflicts*									
How much do you face arguments in the family?	2.51	1.255	0.342	0.959	0.895	0.423	0.895	0.173	0.077
Differences between family members in which lead to tension in the family	2.44	1.283	0.724	0.555	0.739	0.828	0.693	0.103	0.190
How much do family members care about each other?	3.69	1.191	0.345	0.052	0.032	0.560	0.294	0.991	0.334
How much do you Benefit from Family support in crisis?	3.83	1.074	0.073	0.289	0.408	0.878	0.185	0.325	0.934
Stress factors *									
Ability to face new situations	3.03	1.127	0.757	0.048	0.030	0.893	0.640	0.158	0.082
How often do you feel you are in control?	3.15	0.979	0.775	0.358	0.567	0.381	0.513	0.159	0.002
How often do you feel pressured?	3.52	1.040	0.241	0.088	0.060	0.525	0.817	0.002	0.034
How much do you feel nervous if things don't go as planned?	3.59	1.065	0.215	0.801	0.785	0.015	0.638	0.020	0.068
How much do you find yourself nervous?	3.13	1.170	0.511	0.835	0.716	0.294	0.884	0.162	0.005

*Questions associated with the **Job and financial factors**, **Family supports and conflicts,** and **Stress factors** were answered on a 1 to 5 scale (1=very rarely true, 2=rarely true, 3=neutral, 4=often true, 5=very often true).Value1=years of being diabetic, Value2=Regularly visiting a doctor, Value3=Regularly measuring blood sugar, Value4=Type of cure currently being used (1=none,2=oral,3=insulin, 4=both), Value5=having an underlying disease, Value6= Average of daily sleep(hours), Value7= Average of weekly workout per day (at least 30 minutes a day).

4.2.1. Factors associated with diabetes

- "Regularly visiting a doctor" and "Years of being diabetic" (p=0.035, r=-0.119)
- "Regularly measuring blood sugar" and "Regularly visiting a doctor" (p=0.000, r=0.485)
- "Type of cure" and "Years of being diabetic" (p=0.000, r=0.366)
- "Type of cure" and "Regularly visiting a doctor" (p=0.000, r=-0.209)
- "Type of cure" and "Regularly measuring blood sugar" (p=0.016, r=-0.134)
- "Age" and "having an underlying disease" (p=0.000, r=-0.287)
- "Type of cure" and "Average of weekly workout per day" (p=0.001, r=-0.193)

4.2.2. Job and financial factors

- "Monthly income" and "Average of weekly workout per day" (p=0.048, r=0.113)
- "Feeling satisfied with economic status" and "Average of weekly workout per day" (p=0.016, r=0.136)

4.2.3. Family support and conflicts

- "Family members caring" and "Regularly measuring blood sugar" (p=0.032, r=-0.120)

4.2.4. Stress factors

- "Ability to face new situations" and "Regularly visiting a doctor" (p=0.048, r=-0.111)
- "Ability to face new situations" and "Regularly measuring blood sugar" (p=0.030, r=-0.121)
- "Being in control" and "Average of weekly workout per day" (p=0.002, r=0.174)
- "Feeling pressured" and "Average of daily sleep" (p=0.002, r=-0.170)
- "Feeling pressured" and "Average of weekly workout per day" (p=0.034, r=-0.119)
- "Feeling nervous if things don't go as planned" and "Type of cure" (p=0.015, r=0.136)
- "Feeling nervous if things don't go as planned" and "Average of daily sleep" (p=0.020, r=-0.131)
- "Being nervous" and "Average of weekly workout per day" (p=0.005, r=-0.159)

4. Discussion

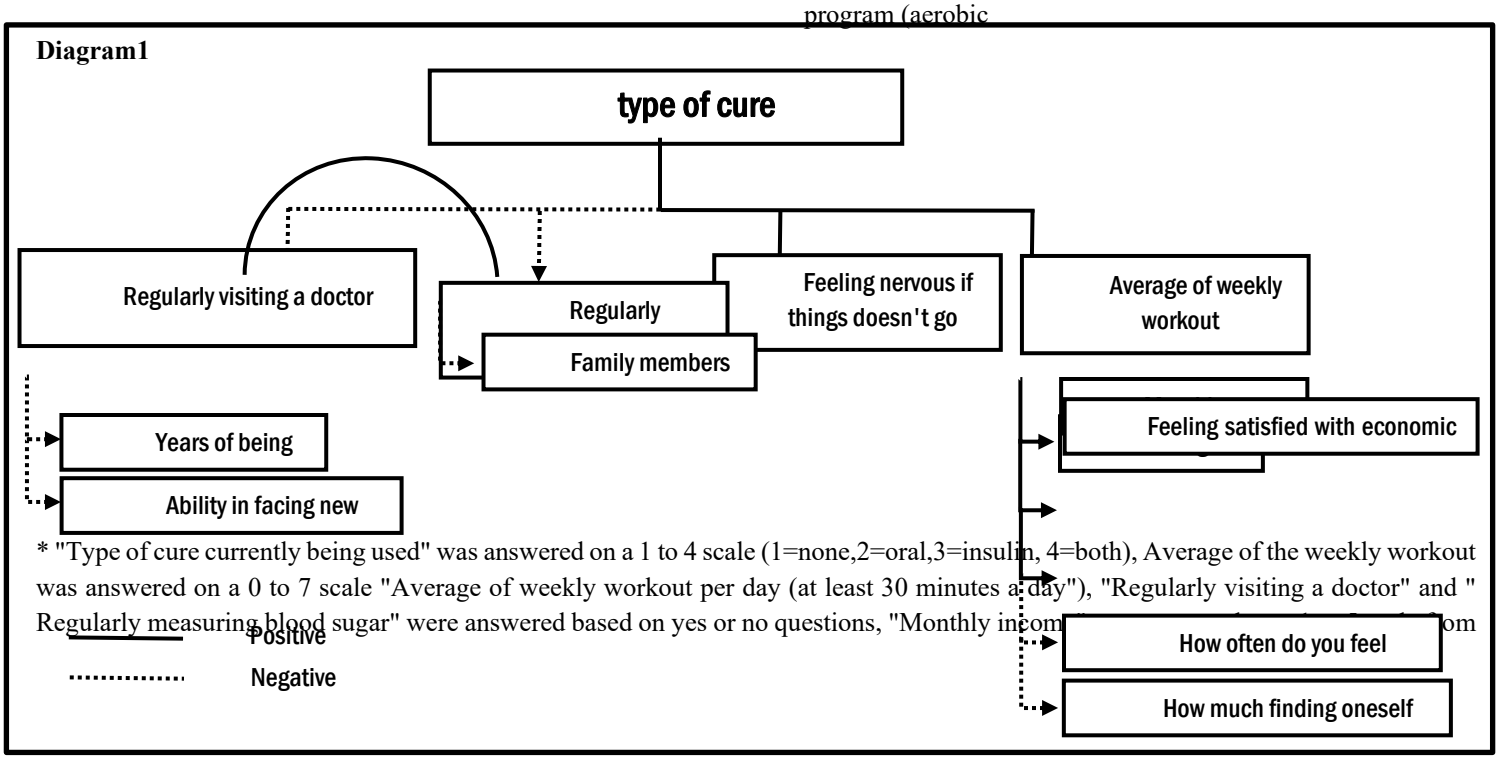
According to Table 1 and Table 2, the correlations between the main effective factors on diabetes level are shown in (**Diagram1**).

According to the results, the "Type of cure" is one of the most important factors in measuring the severity of people's diabetes; It has a direct relation with four other factors. These four items, which are explained below, are:

- "Average of weekly workout" (p=0.001, r=-0.193)
- "Feeling nervous" if things don't go as planned (p=0.015, r=0.136)
- "Regularly visiting a doctor" (p=0.000, r=-0.209)
- "Regularly measuring blood sugar "(p=0.016, r=-0.134)

Exercise plays an effective role in controlling the level of diabetes (**Fig. 1**). Physical activity controls blood glucose levels and prevents the progression of diabetes. Also, weekly exercise can reduce the amount of cholesterol, triglycerides, HDL, and blood pressure in the body by increasing the amount of MET (Metabolic Equivalent). Having a suitable exercise program (aerobic

Diagram1



* "Type of cure currently being used" was answered on a 1 to 4 scale (1=none,2=oral,3=insulin, 4=both), Average of the weekly workout was answered on a 0 to 7 scale "Average of weekly workout per day (at least 30 minutes a day"), "Regularly visiting a doctor" and " Regularly measuring blood sugar" were answered based on yes or no questions, "Monthly income

low incomes to high incomes, other factors were answered on a 1 to 5 scale (1=very rarely true, 2=rarely true, 3=neutral, 4=often true, 5=very often true).

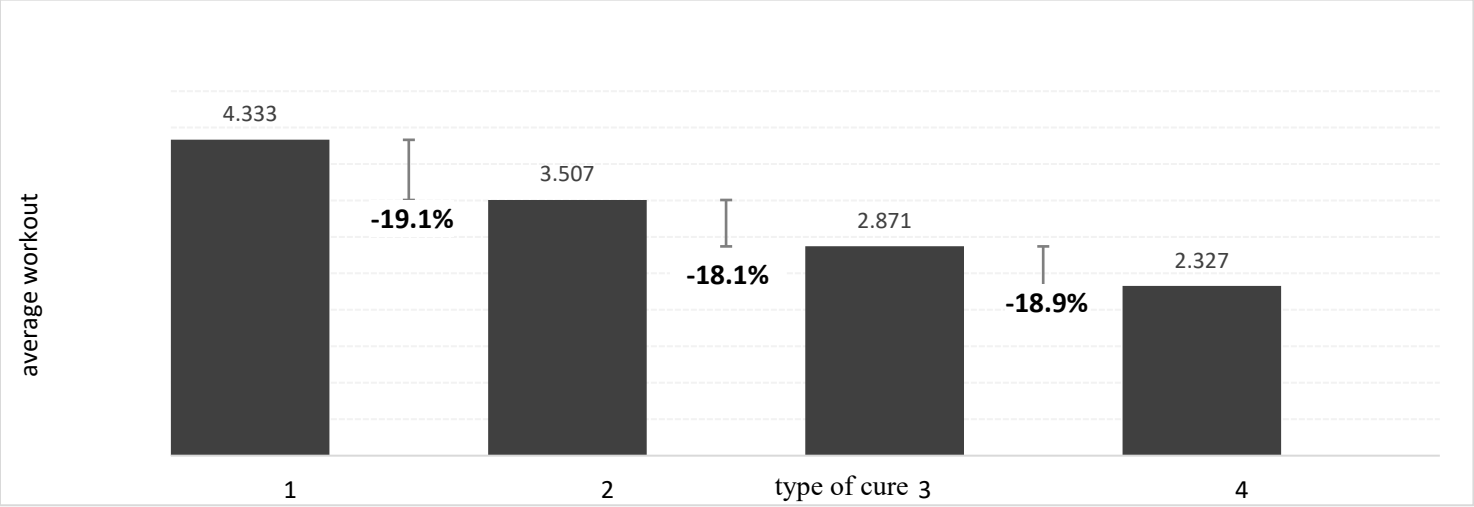


Fig. 1." Type of cure currently being used" was answered on a 1 to 4 scale (1=none,2=oral,3=injectable(insulin), 4=both), Average of the weekly workout was answered on a 0 to 7 scale, "Average of weekly workout per day (at least 30 minutes a day").

endurance) can reduce the risk of cardiovascular diseases by reducing weight and increasing physical fitness, especially in people with type 2 diabetes [21,22]. Based on our findings, exercise itself correlates with five other factors, which are:

- "How much finding oneself nervous?" (p=0.005, r=-0.159)
- "Being in control" (p=0.002, r=0.174)
- "Monthly income" (p=0.048, r=0.113)
- "Feeling satisfied with economic status "(p=0.016, r=0.136)
- "How often do you feel pressured"? (p=0.034, r=-0.119)

According to the findings, it can be concluded that if a person is in a better financial and economic condition, he/she exercises more days due to different reasons; As an example, a person should spend part of his income on sports equipment and services which is less likely for someone with a low income. In addition, people with an unfavorable economic situation may devote more time to earning income and therefore spend less time on sports. Financial literacy and a better economic situation make people think and make decisions more rationally, and for this reason, they pay more attention to their health and become more involved in health and sports issues [23].

The existence of a significant inverse relationship between exercise and stress level indicates that exercise may reduce stress levels. Daily exercise increases resistance to acute stress and may play a protective role against chronic stress-related diseases [24].

Thus, according to the relevance between the amount of exercise and the stress level, exercising causes the stress level to decrease, which in the continuation of this stress reduction, leads to preventing the aggravation of the diabetes condition.

In the following, we discuss the direct relationship between "Feeling nervous if things don't go as planned" and "Type of cure" (r=-0.136, *p=0.015*). The feeling of nervousness if things don't go as planned factor can directly indicate the person's stress status **(Fig. 2)**.

"Regularly visiting a doctor" and "Regularly measuring blood sugar" (r=0.485, p=0.000) have a significant inverse relationship with the type of cure. It is inferred that the less a person visits a doctor and measures hers/his blood sugar, the more the disease progresses. These two factors also have a significant direct relationship with each other, which shows that they occur at the same time.

"Years of being diabetic" has an inverse relation with "Regularly visiting a doctor" (r=-0.111, p=0.048). This inverse relation can be due to the fact that people who have been involved in the disease for extended periods no longer show sensitivity to their disease. Evidence proves that education program is more effective in those who had diagnosed with type 2 diabetes recently than people with at least 3 years of history [25].

Also, the "Ability to face new situations" has an inverse relation with "Regularly visiting a doctor." This factor shows how much self-control a person has and how being in different and new situations leads to individual stress. In people with type 2 diabetes, acute mental stress with a chronic increase in blood glucose level can aggravate the disease [6]. According to studies, reducing a person's stress reduces the severity of the disease. It is possible that self-control and individual crisis management may cause a kind of indifference toward controlling the disease state; for this reason, they visit the doctor less often.

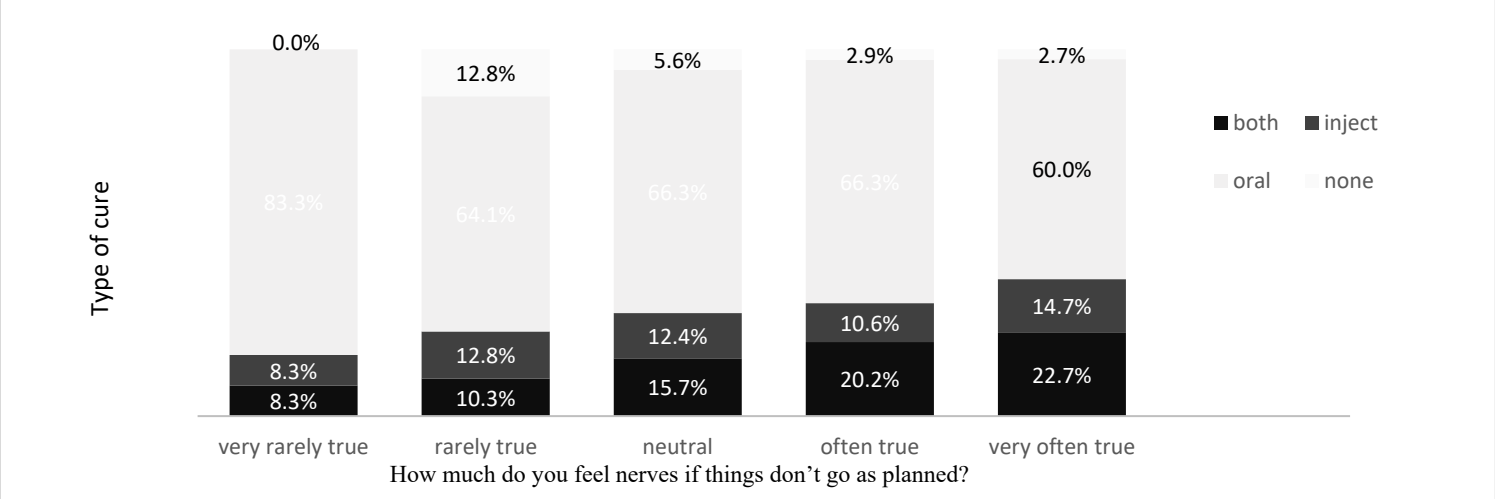


Fig. 2. Chart with percentages changes to indicate the change of cure in each group.

The last relation that is discussed is the significant inverse relation between "Regularly measuring blood sugar" and "Family members' caring." This relation states that if a person is paid attention to in the family and can share his/her emotions with them, it will cause the person to measure his/her blood sugar less. Family and friends show the most social support to diabetic people [27]. According to some studies, in diabetic patients, social support increases the level of self-care and decreases the level of HbA1 C [8]; But in our study, this relation is reversed. One of the factors that significantly affect "Family members' caring" is "Job security" **(Fig. 3)**.

The relation between these factors is direct so that the more "Job security" is, the more care and attention is given to the family. "Job security" itself has a significant direct relation with the two following factors: "Being satisfied with economic status" and "Monthly income." According to **(Table 2)**, we can see that these 3 economic factors are cyclically related. At the head of this cycle, as mentioned above, job security is connected to "Being satisfied with economic status," so a new possibility can be proposed. So, in general, in our study, there is a direct relation between "Family members' caring" and economic factors. Hence there is a possibility that the difference between the results of the research reviewed above and our results is due to the unfavorable economic situation.

One of the factors that are most studied is gender. Based on our research, "Regularly visiting a doctor" and "Measuring blood sugar" is related to gender. **(Table 1)** According to our findings, women show more sensitivity to self-caring and visit a doctor more often. Also, based on the graph **(fig. 4)**, women who regularly visit a doctor rate themselves as significantly more anxious. The reason for this may go back to the fact that more anxious people are more likely to seek self-management, and as we found, women show more importance to self-caring.

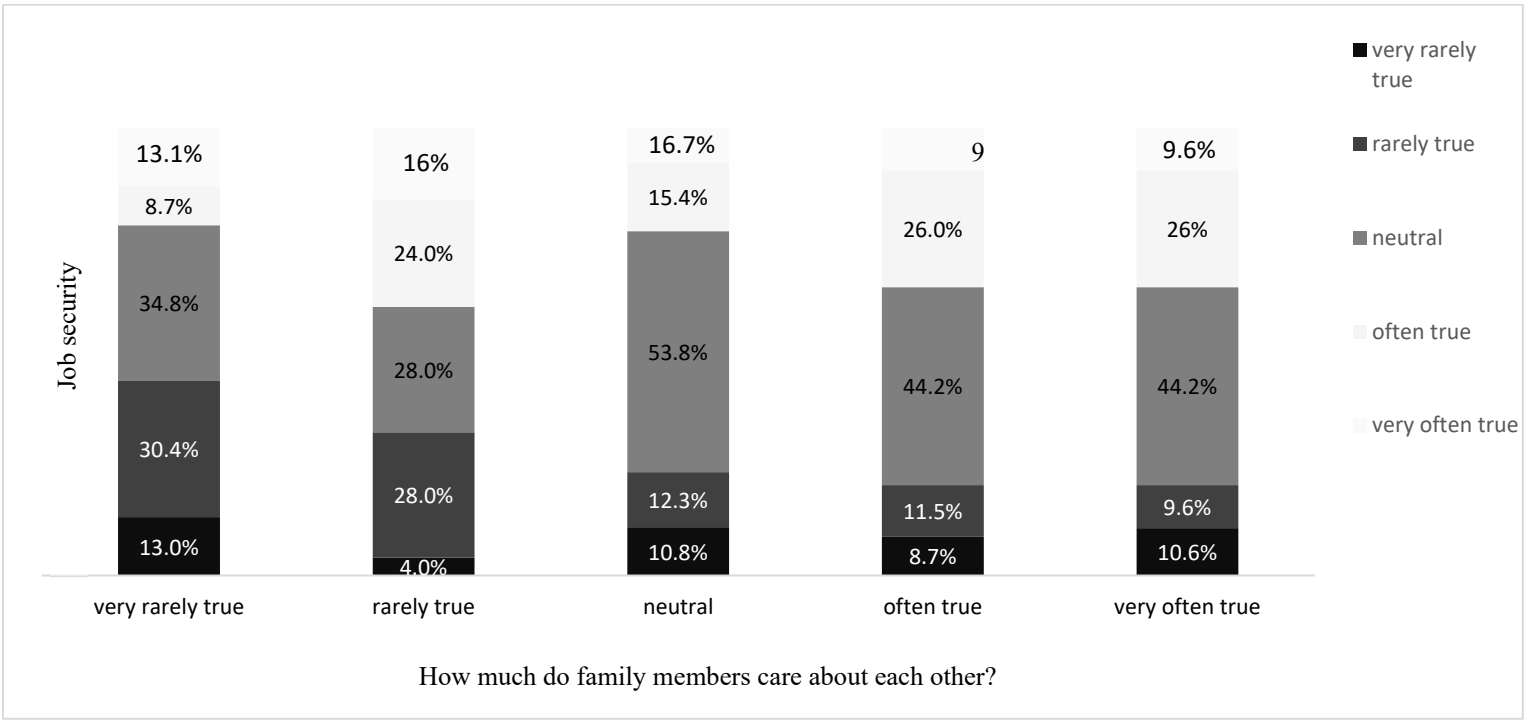


Fig. 3. Chart with percentages changes to indicate the change of job security stage in each group of people with different family support.

Table2

Characteristics of type 2 diabetic patients with and without stress based on questionnaires.

	Value1	Value1	Value3	Value4	Value5	Value6	Value7	Value8	Value9	Value10	Value11	Value12
Job and financial factors*												
Job security	-	-	-	-	-	-	-	-	-	-	-	-
Monthly income (million Iranian Rial)	0.000	-	-	-	-	-	-	-	-	-	-	-
How much do you feel satisfied with your economic status?	0.000	0.000	-	-	-	-	-	-	-	-	-	-
Family support and conflicts*												
How much do you face arguments in the family?	0.411	0.386	0.369	-	-	-	-	-	-	-	-	-
Differences between family members in which lead to tension in the family	0.356	0.567	0.299	0.000	-	-	-	-	-	-	-	-
How much do family members care about each other?	0.026	0.101	0.681	0.308	0.308	-	-	-	-	-	-	-
How much do you Benefit from Family support in crisis?	0.032	0.908	0.286	0.000	0.000	0.000	-	-	-	-	-	-
Stress factors *												
Ability to face new situations	0.597	0.016	0.131	0.263	0.051	0.001	0.012	-	-	-	-	-
How often do you feel you are in control?	0.003	0.000	0.005	0.001	0.001	0.000	0.000	0.000	-	-	-	-
How often do you feel pressured?	0.274	0.073	0.000	0.000	0.008	0.256	0.011	0.170	0.647	-	-	-
How much do you feel nervous if things don't go as planned?	0.180	0.020	0.014	0.000	0.009	0.575	0.754	0.000	0.000	0.000	-	-
How much do you find yourself nervous?	0.026	0.007	0.003	0.000	0.000	0.422	0.990	0.000	0.000	0.000	0.000	-

*Questions associated with the Job and financial factors, Family supports and conflicts, and Stress factors were answered on a 1 to 5 scale (1=very rarely true, 2=rarely true, 3=neutral, 4=often true, 5=very often true).

Value1= Job security / Value2= Monthly income (million Iranian Rial) / Value3= How much do you feel satisfied with your economic status? / Value4= How much do you face arguments in family? / Value5= Differences between family members, which leads to tension in the family / Value6= How much do family members care about each other? / Value7= How much do you Benefit from Family support in crisis? / Value8= Ability to face new situations / Value9= How often do you feel you are in control? / Value10= How often do you feel pressured? / Value11= How much do you feel nervous if things don't go as planned? / Value12= How much do you find yourself nervous?

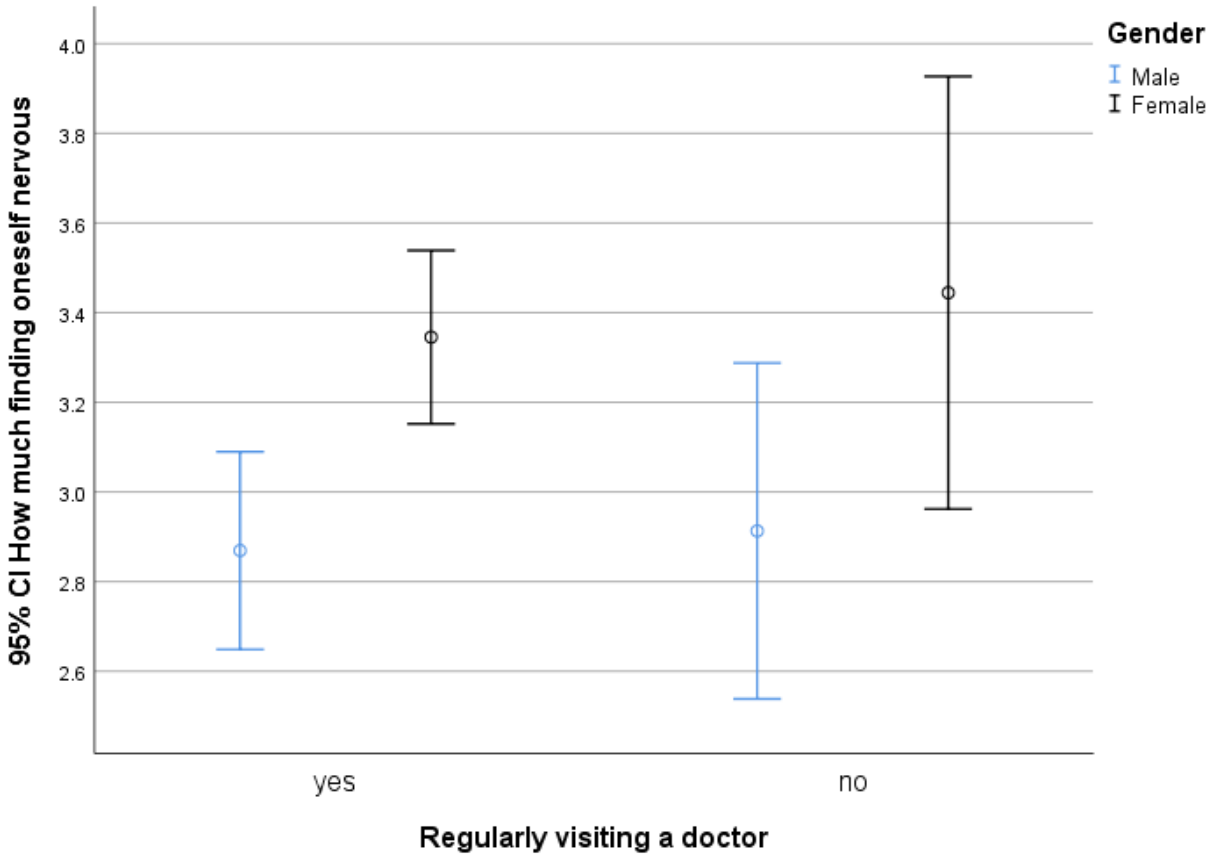


fig. 4. Relation between regularly visiting a doctor and feeling nervous in both genders. (Numbers in the y-axis refer to stress level: The more it is, the stress level is increased) "How much do you find yourself nervous?" was answered on a 1 to 5 scale.

6. Conclusion

In the study conducted, the effect of personal, social, and financial factors on the amount of stress that aggravates diabetes and the level of the disease itself was investigated. According to the results of this research, exercise plays a vital role in controlling diabetes, so the more physical activity he does, the less likely he will need to inject insulin. Therefore, it is suggested that those who are involved in diabetes (even in the early years) take exercise seriously.

Moreover, people with diabetes should change their living conditions in such a way that they do not suffer from stress (economic, personal, or family). If the amount of stress on the person is controlled and reaches its minimum value, the aggravation of the disease condition will prevent.

Furthermore, the two factors of visiting the doctor and blood sugar significantly prevent the exacerbation of diabetes. So it is recommended that people with diabetes do regular checkups. Even healthy people should be checked once in a while so that if they are diagnosed with diabetes, they can prevent the exacerbation of their diabetes by considering the disease and looking for treatment.

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