Biomedical & Pharmacology Journal, June 2023. Vol. **16**(2), p. 989-996

Role of Lifestyle and Stress on Diabetes Mellitus: A Case-Control Study

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https://dx.doi.org/10.13005/bpj/2680

(Received: 16 February 2023; accepted: 27 April 2023)

Type 2-diabetes mellitus (T2DM) is a chronic metabolic disease in which insulin resistance and reduced insulin with increased hepatic glucose production lead to hyperglycemia. The condition cannot be cured; however, the incidence can be delayed and the progression can be halted. This study researches the association of 2 modifiable risk factors- lifestyle and stress with Diabetes Mellitus. The study aimed to assess the role of stress and other lifestyle factors on the occurrence of diabetes mellitus. Studies on diabetes mellitus and its factors have not been done much in United Arab Emirates (UAE) so this research is aimed to determine the association between diabetes mellitus and, stress and lifestyle among residents of UAE. This case-control study was conducted in Ajman, United Arab Emirates. The participants were in the age group of 35 to 70 years. The duration of this study was six months. Patients with type-2 diabetes mellitus and without diabetes mellitus were chosen randomly, and data were collected using a questionnaire. After obtaining the questionnaire with the desired sample size, data analysis was carried out using SPSS-26. The Chi-square test was used to find an association between the categorical variables and a two-sided P-value < 0.05 was taken as significant. The sample size was calculated by taking the level of significance as 5% and the power of the study as 80%. As per the previous study, the stress in the general population reported was 30% and the crude OR for DM those who are stressed as 2.4. This basic information is used to calculate the minimum required sample size for this study. The case-control ratio is taken as 1:2. The total participants for this study was 195 (65 cases and 130 controls). The inclusion criteria were both male and female patients of all nationalities and the exclusion criteria were patients with other disease conditions such as CVD, cancer and pregnant women. A total of 205 participants were included in the study (71 cases; 134 controls). The study results showed that the prevalence of diabetes mellitus was not associated with marital status, type of job, total income, exercise, BMI (Body mass index), and the nature of work seen in Table 1 and Table 2. The age of the participants and the prevalence of diabetes mellitus showed a significance of P<0.001. The psychologic stress also showed a significant association (P<0.05). This study also showed a significant association between the educational qualification of the participant and Diabetes mellitus. This study showed an association between age and diabetes, as well as stress and diabetes. This study shows age and stress are significantly associated with diabetes. Age is a non-modifiable risk factor, while stress is a modifiable risk factor, so reducing stress levels can help reduce the risk and progression of diabetes mellitus.

Keywords: Age; Diabetes Mellitus; Education; Lifestyle; Stress.

Type-2 diabetes mellitus is a chronic, heterogeneous metabolic disease in which insulin resistance and reduced insulin paired with increased hepatic glucose production lead to hyperglycemia. 90-95% of adult cases are caused by type-2 diabetes mellitus. A pathophysiological viewpoint reveals that the three main abnormalities that a patient with type-2 diabetes mellitus demonstrates are:

resistance to the action of insulin in peripheral tissues, particularly muscle, fat, and liver, defects in insulin secretion, particularly in response to a glucose stimulus and an increased glucose production by the liver. Many factors lead to the development of type-2 diabetes mellitus, such as an increase in calorie intake, an increase in fat mass and a sedentary lifestyle, the inability of beta cells in pancreatic cells to adapt to less insulin sensitivity or an increase in insulin resistance. The genetic predisposition to T2DM determines how frequently and which beta failure happens, but no single genetic alteration has been identified that causes beta cell failure. Other factors increase the burden on beta cells, like overeating, leading to weight gain, puberty, pregnancy and a sedentary lifestyle[1].

Some modifiable risk factors include BMI, physical inactivity, diet, and non-modifiable variables such as genetic factors and age[2]. Obesity has been associated with Type-2 Diabetes Mellitus for decades. Visceral/intra-abdominal fat is known to cause insulin resistance alongside several other metabolic variables, such as elevated total plasma cholesterol, insulin, and glucose concentrations. It has also been linked to high triglyceride and decreased plasma high-density lipoprotein cholesterol concentration. However, some studies have suggested that subcutaneous fat helps against insulin resistance. On these grounds, the association between insulin resistance and abdominal fat is independent of total adiposity. The correlation between an abnormal metabolism and intra- abdominal fat has not yet been clearly defined, but several hypotheses have been proposed to explore this association[2].

A recent study on lifestyle's effect on patients with diabetes mellitus found that people who consumed alcohol had the highest HbA1c levels. In the case of patients who practiced smoking, they had a higher risk of diabetes mellitus. However, light to moderate consumption of alcohol showed decreased risk in the case of cardiovascular diseases[3]. In the case of diet, low salt consumption was found effective in T2DM patients and also in managing the risk of cardiovascular diseases. Exercises play a very important role in the management of diabetes mellitus[3]. Sleep disturbances can also affect insulin action, alter leptin secretion and ghrelin, stimulate appetite, increase inflammatory cytokine production, and alter other risk factors. It was found that the alterations in the normal feeding pattern attuned to the circadian metabolism can change the relationship between the nutrient-metabolizing and nutrient-appearance enzymes. The alterations in fatty acid appearance concerning the lipoprotein lipase activity can lead to altered partitioning of lipids concerning vulnerable tissues, further leading to lipotoxicity and decreased leptin secretion, thereby increasing appetite. Another risk factor for insulin resistance and diabetes is Obstructive sleep apnea. Obstructive sleep apnea combines sleep fragmentation and hypoxemia. There is growing evidence of glucose control in patients with T2DM, which can be improved by treating sleep apnea, though poor compliance to therapy is a major barrier to success[4].

Higher stress levels are attributable to diabetes displayed in both cross-sectional and longitudinal relationships with HbA1c. Stress is a potential contributor to chronic hyperglycemia in diabetes. Stress has long been shown to have major effects on metabolic activity. Stress stimulates the release of various hormones, resulting in elevated blood glucose levels. Although this is of adaptive importance in a healthy organism, in diabetes, stress-induced glucose increases cannot be metabolized properly due to the relative or absolute lack of insulin.

Furthermore, regulation of these stress hormones may be abnormal in diabetes[5]. Although human studies on the role of stress in the onset and course of type II diabetes are few[6]. IL-6 is a protein the body produces to stimulate immune response and healing. It is a biomarker of acute and chronic stress that also has been associated with a greater likelihood of diabetes and high blood glucose[7]. Literature showed individuals with low inhibition were more likely to have diabetes than those with high inhibition due to the pathway from high anxiety[5]. This research is aimed to determine the association between diabetes mellitus and, stress and lifestyle among residents of UAE.

MATERIALS AND METHODS

This case-control study was conducted among the residents of Ajman, UAE, within the age group of 35-70 years. The study setting

was Thumbay University Hospital, Ajman. Both male and female patients of all nationalities were included; pregnant women and patients with other disease conditions, such as cardiovascular diseases and cancer, were excluded. The minimum required sample obtained was 195 (65 cases and 130 controls), but collected data from 71 cases and 134 controls. This research was approved by the Institution Review Board of Gulf Medical University. Written consent was taken from the participants. Participants were provided with a brief description of the purpose of this research. Anonymity, privacy and confidentiality were maintained.

A draft questionnaire was developed and sent to the experts for content validation. The suggestions of the experts were included in the questionnaire before finalizing. The 'Perceived stress scale', a global self-assessment tool, analyzed the patient's stress. The smoking and alcohol levels were also inquired in the questionnaire; the ex-user is defined as anyone who previously abstained from drinking alcohol and smoking for more than six months. The final questionnaire was distributed to the selected participants and asked to complete the information. Data were then entered into the Excel sheet, after which the analysis was done. This was recorded in the Excel sheet and then coded into SPSS version 27 for analysis. The descriptive statistics such as frequency, percentage, mean and SD was calculated. To assess the association, the Chi-Square test was used, t-test was also used to test the mean of the continuous variables. Simple and multiple logistic regression analyses were used to get the factors.

RESULTS

This study included 71 cases and 134 controls, out of which 43 controls and 7 cases were below 40 years of age, 85 controls and 57 cases were between 40-59 years of age and 5 cases and seven controls were over the age of 60. Sixty-six controls and 39 cases were male, while 68 controls and 32 cases were female. Ten controls and five cases were single; 66 cases and 124 controls were married. Fourteen controls and 16 cases had a below-graduate level of education. Twenty-nine cases and 54 controls were graduates, whereas 66 controls and 26 cases were postgraduates. Fifty-six

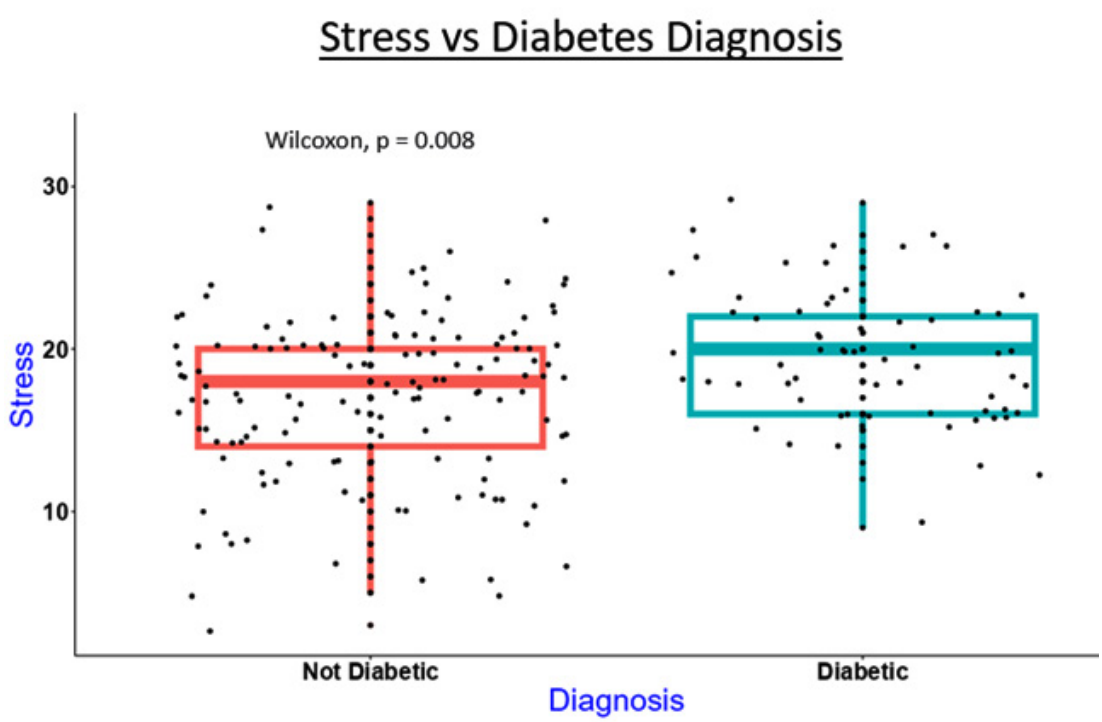

Fig. 1. Association between age and diabetes among cases and control

controls and 31 cases earned less than 4000 USD per month and 23 cases and 54 controls earned more than 4000 USD per month. Thirty-three controls and 12 cases were gold-collar workers, and 37 cases and 61 controls were white-collar workers. Eleven controls and seven cases were blue-collar workers, 27 controls and 15 cases said they were unemployed. The Chi-square test showed that

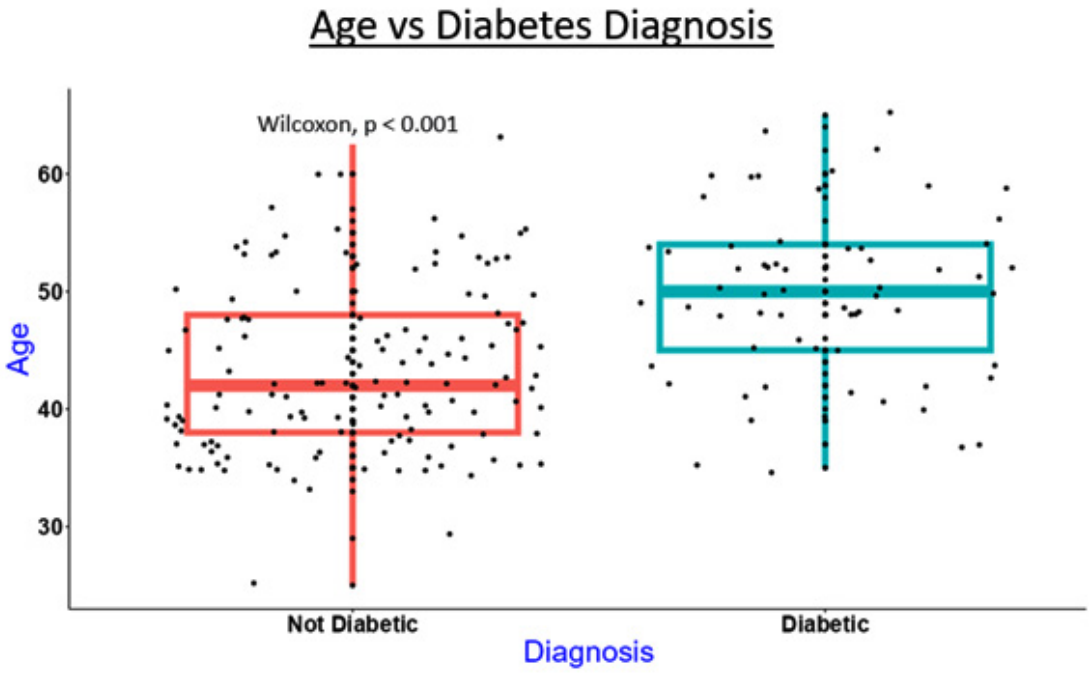

Fig. 2. Association between stress and diabetes among cases and control

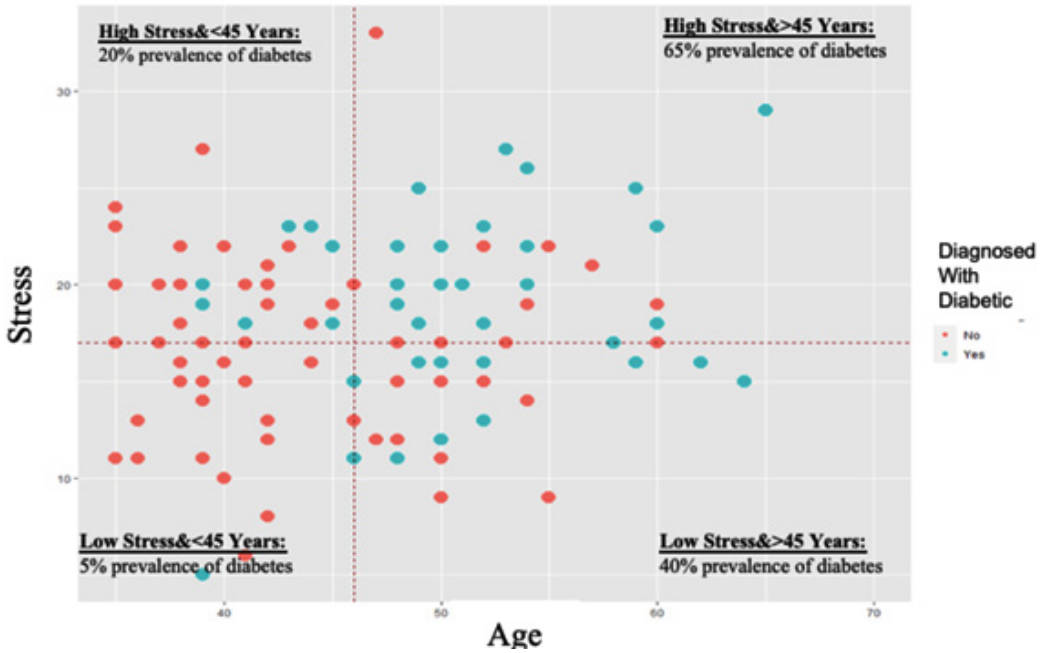

Fig. 3. Prevalence of diabetes by categorizing in terms of stress and age among cases and control

the participant's age and the presence of diabetes mellitus were associated (P <0.001). A statistically significant association was observed with education (P<0.05); cases were more in the higher education group compared to the control group. There was no statistically significant association between gender, marital status, income, occupation, and diabetes mellitus (table 1).

Table 1. Association of diabetes mellitus and sociodemographic variables

Variable	Group	Control		Cases		Total	P
		No.	%	No.	%		
Age	<40	43	32.1	7	9.8	50	<0.001
	40 -59	86	64.2	57	80.3	143	
	>=60	5	3.7	7	9.5	12	
Gender	Male	66	49.3	39	54.9	105	NS
	Female	68	50.7	32	45.1	100	
Marital Status	Single	10	92.5	5	7	15	NS
	Married	124	7.5	66	93	190	
Education	Below Graduate	14	10.4	16	22.5	30	<0.05
	Graduate	54	40.3	29	40.8	83	
	Postgraduate	66	49.3	26	36.6	92	
Income	No income	24	17.9	17	43.7	41	NS
	<15000	56	41.8	31	32.4	87	
	> 15000	54	40.3	23	32.4	77	
Occupation	Gold Collar	33	25.0	12	16.9	45	NS
	White Collar	61	46.2	37	52.1	98	
	Blue-collar	11	8.3	7	9.9	18	
	Unemployed	27	20.5	15	21.1	42	

The chi-square test was used to assess the association.

Table 2. Association of diabetes mellitus and other variables

Variable	Group	Control		Cases		Total	P
		No.	%	No.	%		
FH of diabetes	No	35	26.1	15	21.1	50	NS
	Yes	99	73.9	56	78.9	155	
Exercise	No	44	32.8	25	35.2	69	NS
	Yes	90	67.2	46	64.8	136	
BMI	Normal Weight	32	23.9	22	31.0	54	NS
	Overweight	65	48.5	30	42.3	95	
	Obese	37	27.6	19	26.8	56	
Smoking habit	Current User	12	9	10	14.1	22	NS
	Ex-User	8	6	7	9.9	15	
	Never User	114	85.1	54	76.1	168	
Alcohol use	Current User	29	21.6	11	15.5	40	NS
	Ex-User	13	9.7	5	7	18	
	Never User	92	68.7	55	77.5	147	
Consumption of fast food	Never	18	13.4	23	32.4	41	<0.001
	Once a week	99	73.9	34	47.9	133	
	> Once a week	17	12.7	14	19.7	31	
Stress	Low Stress	36	26.9	8	11.3	44	<0.05
	High Stress	98	73.1	63	88.7	161	

The chi-square test was used to assess the association.

Table 3. Crude and adjusted Odds Ratio

Variable	Group	Crude		Adjusted	
		OR	CI	OR	CI
Age	<40	1	—	1	—
	40-59	4.1	1.7-9.7	4.2	1.8-10.1
	>=60	8.6	2.1-34.9	9.7	2.3-40.6
Stress	Low stress	1	—	1	—
	High stress	2.8	1.3-6.6	3.1	1.3-7.3

Simple and multiple logistic regression was used

This study showed the likelihood of diabetes increases as age increases. Figure 1 shows the association between age and diabetes. The yellow colour represents those with diabetes and the blue represents those without diabetes. A significant association was found between age and diabetic status (P<0.001). An increase in age showed an increase in the prevalence of diabetics by several folds. The adjusted OR observed was 4.2 and 9.7, respectively.

In Figure 2, the yellow colour represents those with diabetes and the blue represents those without diabetes. As seen, there is a significant association between stress and diabetes (P<0.05), i.e., an increase in stress levels and an increase in the prevalence of diabetes was observed. Stress significantly increases glucose concentrations in patients with Type-2 diabetes.

Figure 3 shows the combined impact of stress and age on diabetes. This graph is split into four quadrants based on the median age and median stress. The four quadrants are those with High stress with older age, high stress with younger age, low stress with old age and low stress with older age. The highest prevalence of diabetes is seen in those with high stress and old age, while the lowest prevalence is seen in the quadrant with low stress and younger age. This shows that age and stress increase the prevalence of diabetes independently, but those of older age with increased stress levels increase the prevalence of diabetes by further folds.

The study investigated the association between various lifestyle factors and diabetes. This study observed an association between fast-food consumption and diabetes mellitus (P<0.01). Among the cases, about 20% used to take fast food more than once a week, whereas, in the control group, it was only 13%. Among the participants without diabetes, 26.9% had low stress and 73.1% had high stress, whereas, among the participants with diabetes, 11.3% had low stress and 88.7% had high stress. The results showed no association between smoking habits, alcohol consumption, type of diet, consumption of foods with high sugar content, carbonated drinks, and coffee/tea consumption with the status of the disease. However, there was an inverse association between fast food consumption and disease status (P<0.001). The consumption of white rice was not associated with the status of the disease.

The study categorized the participants into a control group and a case group. In the control group, 36 participants reported low-stress levels, while 98 reported high-stress levels. In contrast, in the cases group, only 8 participants reported low-stress levels, while 63 reported high-stress levels. The study found a statistically significant association between stress levels and disease status (P<=0.05), suggesting that higher stress levels may be a risk factor for developing diabetes (Table 2).

Crude and adjusted OR of variables associated with Diabetes Mellitus

The study found that age and stress were significant risk factors for developing the disease. The crude OR for the age group between the age of 40 to 59 shows four times increase in the chance of developing diabetes mellitus, while those greater than or equal to 60 show nine times. Concerning stress, the crude OR shows three times increase in the likelihood of diabetes mellitus among those with stress. The adjusted OR for the age group between 40 to 59 also shows a four times higher chance and those above 60 show an almost ten times higher likelihood of developing diabetes mellitus. The study found that people between the ages of 40 and 59 were four times more likely to

develop the disease than younger people. Similarly, people over 60 were nine times more likely to develop the disease than younger people. The study also found that people with high stress were three times more likely to develop the disease than those with low stress. This means that stress was a significant risk factor for developing the disease. (Table 3).

DISCUSSION

Diabetes mellitus and Age

The OR observed for the variable age showed a high likelihood compared to other factors; the onset of diabetes is closely related to the ageing process. In the last few decades, the elderly population has increased worldwide, resulting in a high prevalence of diabetes mellites. Age was the most significant variable in this study. An increase in age showed an increase in the prevalence of diabetics by several folds[6,7]. The adjusted OR observed was 4.2 and 9.7, respectively. A systematic review of the studies from the Arabic countries reported that more than 50% of the studies agree that age is one of the main determinants of Type-2 DM[8]. Older people have more chances to practice a sedentary lifestyle which may also lead to obesity and T2DM[9].

Diabetes mellitus and stress

The present study observed an association between stress and the status of diabetes mellitus. A Swiss study also supports the finding of the current study[10]. A study from the USA also observed the same finding; the study reported that as the levels of depression, distress and anxiety decreased, a downward trend was observed in the levels of HbA1c[11]. These studies were conducted in different populations and reported the same results. Growing evidence suggests that stress is associated with an increased risk of developing diabetes. A study investigated the relationship between stress and diabetes and found that chronic stress may contribute to developing the disease[12]. It is possible to conclude that there is an association between stress and Diabetes Mellitus.

Diabetes mellitus and fast-food consumption

The present study observed an association between fast food consumption and diabetes mellitus; patients who had diabetes consumed less fast food. A study from Cambridge University found that more fast-food outlets increased the odds of diabetes cases; for every additional two outlets per neighborhood can expect one additional diabetes case[11,12].

Another study also reported a strong positive association between weight gain and insulin resistance, suggesting that fast food increases the risk of obesity and type-2 diabetes[13,14]. Most studies show a significant association between fast food and diabetes, while our study shows an inverse association. This could be because of the diet advised by their physician to maintain and improve their blood glucose levels, as the cases included were prevalent. Most studies attempt to establish a relationship between fast food consumption and diabetes, suggesting that fast food contributes to the disease's development. However, my study indicates an inverse relationship between fast food intake and the incidence of diabetes[15,16].

This unexpected finding suggests that the relationship between fast food consumption and diabetes may not be as straightforward as previously assumed and warrants further investigation. A Systematic Review observed that statistically significant association between diabetes mellitus and age. The disease's prevalence was higher among older age groups in urban dominance[17.18]. These studies concur with our study and show a significant association between age and the prevalence of diabetes mellitus.

Diabetes mellitus and, family history and BMI

This study did not observe any statistically significant association with a family history of diabetes mellitus, even though studies have found that family history is an important risk factor for prediabetes, especially for combined impaired glucose tolerance and impaired fasting glucose[9,16]. Although there was no association between BMI and Diabetes in the present study, a study in India found that the likelihood of being diabetic is higher among overweight and obese individuals than among non-overweight individuals[19,20].

CONCLUSION

This study observed a significant association between age and stress to type 2 diabetes mellitus. Based on this study, it can be inferred that age and stress are both factors associated with the development of diabetes.

Specifically, the study suggests that individuals who experience high levels of stress may have an increased risk of developing diabetes and that older individuals may also be at a greater risk for developing the condition. These findings highlight the importance of managing stress and maintaining healthy lifestyle habits as people age, to reduce the risk of developing diabetes.

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