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The effect of perceived stress on glycated hemoglobin value (HbA1c) on Diabetes type 2 patients - An observational study from Lahore, Pakistan

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ABSTRACT

Introduction: Diabetes mellitus (type 2) is a common endocrine disease characterized by elevated blood glucose levels. Various sociodemographic, environmental factors and clinical predictors positively influence blood glucose levels in diabetics. The study investigates the link between stress levels as determined by the Perceived Stress Scale (PSS-10) and HbA1c levels which is used as an indicator of long-term blood glucose control. The aim of this study is to evaluate the correlation between perceived stress and glycemic regulation in individuals diagnosed with Type 2 diabetes-mellitus. *Methodology:* A cross-sectional observational study was conducted to evaluate the association between perceived stress and glycemic control in Type 2 diabetes mellitus patients. A total of 151 patients from Lahore, Punjab were selected for this study. Glycated hemoglobin level (HbA1c) of the patients were recorded on a data collection form along with demographic information. While, the tool used to access stress levels in patients was: Perceives stress scale (PSS-10). Patients visiting endocrinology clinics were recruited in the study upon providing informed consent. *Results:* Majority of the patients were female (53.6%) belonging to the age group 41-50 years of age (35.8%). The average HbA1c value observed was 8.70 ±1.99 (M±SD). The study of the population showed that (57.6%) of participants experienced high stress levels while (39.1%) showed moderate stress and (3.3%) reported low stress. The respondents experiencing high stress were more susceptible to having poor HbA1c levels, indicating a significant correlation between stress and hyperglycemia (p-value<0.001). The recently diagnosed patients with the history of diabetes from past 1-2 years presented maximum stress levels (53.8%). *Conclusion:* The study demonstrates that the stress levels affect glycemic control

in T2DM patients as the results showed a significant correlation between perceived stress levels and HbA1c, but the association of sociodemographic variables with perceived stress was not observed to be significant. The results recommends that stress management (stress management techniques or relaxation techniques) should be considered along with medical intervention for diabetic patients to achieve the desired outcome of the patients.

Keywords: Type 2 diabetes-mellitus, Perceived stress, Glycated hemoglobin, HbA1c, Endocrinology, Sociodemographic variables.

1. INTRODUCTION

Type-2 Diabetes Mellitus (T2DM), the most prevailing endocrine disorder, impacting over 100 million people globally, which accounts for 6% of the population (Iqbal et al., 2019). In the recent few decades, diabetes mellitus has become the most prevalent public health concern. By 2005, it was estimated that over 20 million people in the United States would suffer from diabetes (Iqbal et al., 2014). The increased risk of diabetes mellitus is mainly linked with the factors such as age, ethnicity, family history, smoking, obesity and physical inactivity (Poojar et al., 2017). Diabetes-related complications such as cardiovascular diseases, kidney diseases, neuropathy, blindness, and lower-extremity amputation contribute significantly to raised morbidity among diabetic patients (Bajwa et al., 2024).

The escalating prevalence of diabetes has evolved into a global health crisis, with the number of diagnosed cases continuing to surge at an alarming rate (Khan et al., 2021). The estimated prevalence of diabetes globally is 2.8 (Iqbal et al., 2024). Asian countries account for over 60% of the global diabetic population, driven by rising diabetes prevalence in the region (Khan et al., 2021). As Type 2 diabetes predominantly affects adults, its prevalence rises with shifts from rural to urban living (Kakar et al., 2013). In India, Type 2 diabetes prevalence is 12.1% in urban areas as compared to rural areas which is 2.9% (Ramachandran et al., 2012). In the Asian Indian population, diabetes prevalence peaks between ages 60 and 69, while in the Chinese population, it peaks between ages 79 and 89 (Nanditha et al., 2016).

In China, the prevalence of diabetes in the 35-44 age group increased by 88% over a span of 6 years and in southern India, the prevalence of diabetes cases among individuals under 44 years rose from 25% of the total prevalence in 2000 to 36% in 2006. Similarly, in Pakistan, the urban prevalence is 10.8%, while the rural prevalence stands at 6.5% (Akhtar et al., 2016). Type 2 diabetes can occur at any age but most commonly it occurs at the age of 40 and above (Algren et al., 2018). With increasing age, body functions start getting effected by it, in case of diabetes with advanced age pancreas produces less insulin which leads to elevated blood glucose levels for longer period of time which leads to diabetic condition (Dwivedi and Pandey, 2020). The co-occurrence of diabetes along with obesity is a major epidemic worldwide.

Multiple epidemiologic research studies proves the simultaneous enhancement of obesity along with diabetes (Sendhilkumar et al., 2017). Both diabetes and obesity are the metabolic disorders that are characterized by the disruption of the function of insulin (Haidara et al., 2006). The pathophysiology associated with diabetes and obesity is mainly characterized by insulin resistance and insulin deficiency. The term stress presents the state of individual under the influence of internal or external stressers or forces, which can modify or alter its homeostasis (Sendhilkumar et al., 2017). The changes that occur in an individual in response to stressors can be both i.e., behavioral and physical.

'Stress' can be defined as any condition that tends to alter or disturb the state of equilibrium or homeostasis between the organism and its environment (Andreou et al., 2011). In daily work life routine, individuals may be encountered with various stressful situations such as work pressure, examination stress, socioeconomic status pressure as well as the physical stress that might be because of trauma or any medical condition (Hara et al., 2014). Stress leads to fear and anxiety and depending on the circumstances, the fear response can lead to either fight or flight. The extent of stress is influenced by the perception of individual to deal with the stressors (Hara et al., 2014). Mainly, interviews and questionnaires are used for the measurement of stress.

For measurements of perceived stress, three common tools can be used including; the stress Appraisal measure-SAM, the "impact of Event Scale-IES", and PSS-perceived stress scale; among which Perceived stress scale is the most commonly and widely used (Andreou et al., 2011). Initially, PSS was designed as a scale that measures or assesses the response or perception of persons by asking them some questions evaluated by the frequency of their thoughts and experiences based upon circumstances and situations that have

occurred over or within one month (Örücü and Demir, 2009). High PSS scores have been related to high biomarkers of stress. PSS questions include both positive and negative aspects.

They are employed to evaluate the existence of stressful situations in individual lives. Based on a 5-point Likert scale, the scores assigned are: 0, 1, 2, 3, and 4. In the present era, the prevalence of type 2 diabetes mellitus is increasing significantly with each passing day. On the other hand, stress and anxiety is increasing day by day in adult population. The present study has been conducted with the aim to evaluate whether any association exist between perceived stress and diabetes. And to observe the effect of enhanced perceived stress on Glycated hemoglobin (HbA1c) of the diabetes type-2 adult patients.

2. METHODOLOGY

Study design, setting & sample size

The present prospective cross-sectional observational study is conducted in Lahore, the capital and largest city of the Pakistani province of Punjab. It is the second largest city in Pakistan, after Karachi, and the 26th largest in the world, with a population of over 13 million. The data was collected from diabetes type-2 adult patients, visiting Endocrinologists across different private and public hospitals. The duration of the present study was of seven months approximately, from February to August of 2024. The sample size of the present study is 151 as recruited through convenient random sampling technique.

Ethical considerations

Ethical approval for this research has been taken from Ethical Review Board of the institution: Lahore University of Biological and Applied Sciences, which includes authorization of all the important sections of study parameters and allotted a protocol approval number:ERB-PHRMD-DPP/3363-A. An informed consent form (ICF) was filled out by the study subjects before enrolling them in the present study. All the respondents were guided about the basic grounds of research, they were assured about the confidentiality of their data and personal information.

Inclusion & Exclusion Criteria

Physician diagnosed adult Diabetes mellitus type-2 patients (age 20 years and above) with the glycated HbA1c level of 6.5% or higher were included in the study. The patients who could communicate in native language (Urdu) or in English language were included to ensure accurate responses from participants. Patients diagnosed with Type 1 Diabetes Mellitus or any other type of diabetes (e.g., gestational diabetes, pre-diabetic) were excluded from the study. Moreover, pediatric patients as well as the patients who failed to present their HbA1c results were excluded from the study. Patients with current or previous history of anxiety and depression were excluded along with patients with co-morbidities or severe health conditions that could interfere with the study or compromise safety, such as cardiovascular events, renal or liver disease, or any mental issues.

Data Collection

Diabetic type-2 patients visiting endocrinologists were approached for recruitment in the present study. Based upon inclusion criteria, a total of 151 study subjects were included in the study. The respondents were guided about the basic protocols of the study and informed consent was attained before enrolling them in the study. The study data were collected using the Cohen Perceived Stress Scale for patients with diabetes to measure their perceived stress and how they cope with stress respectively. The following information was gathered and assessed: Age, gender, place of residence, income, education level, family history, duration of illness, HbA1c level, associated comorbidities, medications, working conditions, and habits related to exercise, alcohol, smoking, leisure, and food.

The data collection form was filled by the respondents in the presence of investigator. Demographic details include age, gender, socioeconomic status, occupation, history of Diabetes, education, and residence. It also consisted of questions about exercise, use of tobacco, alcohol, and diabetic medication. The lab values of HbA1c of study subjects were included from the patient's medical file. The criteria for scoring the lab values of HbA1c of respondents are as follows: Good controlled: 4%-6%, Normal 7%-8%, Poorly controlled: 9%-14%.

Study tool: Perceived Stress Scale

Perceived Stress Scale (PSS) is a classical assessment instrument comprising of 10 questions. The questions on this scale inquire about respondent feelings and thoughts over the past month. In each question, respondents will need to indicate how frequently they experienced or thought a certain way. While some questions may seem similar, they have distinct differences, so treat each one as an individual question. It's best to respond promptly.

In other words, don't try to tally the exact number of times you felt a certain way. Instead, select the option that seems like the most reasonable estimate. The criteria for scoring the Perceived Stress Scale (PSS) was in accordance to Likert scale, score from all questions were added up to get a total. Individual scores on this scale can range from: 0-40, the higher the scores, the greater the level of perceived stress. While, scores lying in the range from 0-13 are categorized as low stress, 14-26-moderate stress and 27-40 would be considered high perceived stress.

Statistical Analysis

For the statistical analysis, (SPSS) version 21.0 was used for analyzing the collected data. Descriptive and inferential statistics were applied for analyzing the frequencies and association between variables. The p-values of <0.05 were considered statistically significant.

3. RESULTS

A total of 151 study subjects were included in the current study, the demographic variables are mentioned in the (Table 1). Majority of the respondents were female patients belonging to the age group 41-50 years.

Table 1 Demographic characteristics of the study subjects (N=151)

No.	Variables	Categories	N (%)
1	Age	20-30	6 (4.0)
		31-40	14 (9.3)
		41-50	54 (35.8)
		51-60	46 (30.5)
		>60	31 (20.5)
2	Gender	Male	70 (46.4)
		Female	81 (53.6)
3	Socioeconomic Status	High	17 (11.3)
		Middle	125 (82.8)
		Low	9 (6.0)
4	Occupation	House Staying	91 (60.3)
		Job involving physical activity	36 (23.8)
		Job not involving physical activity	24 (15.9)
5	History of Diabetes	1-2 Years	26 (17.2)
		3-4 Years	38 (25.2)
		>4 Years	87 (57.6)
6	Education	Secondary School	73 (48.3)
		Graduation	64 (42.4)
		Post-Graduation	14 (9.3)
7	Residency	Urban	132 (87.4)
		Rural	19 (12.6)

Majority of the patients recruited in the present study, did not smoke, exercise and consume alcohol. 80.1% patients regularly checked their blood glucose levels. Majority of the patients (45%) had hypertension along with type-2 diabetes mellitus. The details are mentioned in (Table 2).

Table 2 Life style variables of study subjects

No.	Variables	Categories	N (%)
1	Exercise	Yes	38 (25.2)
		No	113 (74.8)
2	Tobacco	Yes	14 (9.3)
		No	137 (90.7)
3	Alcohol	Yes	1 (0.7)
		No	150 (99.3)
4	Diabetic Medication	Yes	125 (82.8)
		No	26 (17.2)
5	Regular Blood Sugar check	Yes	121 (80.1)
		No	30 (19.9)
6	Comorbidities	High Blood Pressure	68 (45.0)
		Depression	13 (8.6)
		Kidney Problem	1 (0.7)
		Eye Problem	16 (10.6)
		Other	53 (35.1)

The average HbA1c of the respondents is 8.70 ±1.99, and majority of the patients (41.1%) had HbA1c levels categorized as poorly controlled as mentioned in (Table 3).

Table 3 Blood glucose measurement (HbA1c) of study subjects

No.	Variables	Mean ± SD	Categories	N (%)
1	HbA1c	8.70 ±1.99	Good controlled 4%-6%	33 (21.9)
			Normal controlled 7%-8%	56 (37.1)
			Poorly controlled 9%-14%	62 (41.1)

The perceived stress of the respondents was categorized into three categories based upon the sum of total scores as obtained by the response of patients to each question item. Among total patients 57.6% presented high stress as mentioned in (Table 4).

Table 4 Perceived stress of study subjects

No.	Variables	Categories	N (%)
1	Stress	Low Stress	5 (3.3)
		Moderate Stress	59 (39.1)
		High Stress	87 (57.6)

The study tool: PSS-10 contained a total of 10 questions to be answered by the study subjects, and the response was calculated and summarized, based upon which, the three categories were filled. The response of study subjects to each question item is presented in (Table 5). The tool accesses the level of stress as perceived through the response of patient to different situations of life in past few days.

The statistical association of blood glucose levels- Glycated hemoglobin levels (HbA1c) with perceived stress of the included study subjects are presented in (Table 6). A strong statistical association of stress is observed with blood glucose levels ($p<0.001$). Majority of the patients 96.8% were the ones with poor glycemic control and presented high levels of perceived stress. The association of demographic variables of the respondents with perceived stress is presented in (Table 7). Presenting that demographic variables does not have any statistical association with the perceived stress.

Table 5 PSS-10 outcome variables of study subjects

No.	Variable (PSS- 10 Questions)	Categories N (%)				
		Never	Almost Never	Sometimes	Fairly Often	Very Often
1.	In the last month, how often have you been upset because of something that happened unexpectedly?	7 (4.6)	10 (6.6)	36 (23.8)	31 (20.5)	67 (44.4)
2.	In the last, month how often have you felt that you were unable to control the important things in your life?	9 (6)	12 (7.9)	33 (21.9)	47 (31.1)	50 (33.1)
3.	In the last month, how often have you felt nervous and stressed?	5 (3.3)	6 (4)	39 (25.8)	51 (33.8)	50 (33.1)
4.	In the last month, how often have you felt confident about your ability to handle your personal problems?	35 (23.2)	32 (21.2)	33 (21.9)	38 (25.2)	13 (8.6)
5.	In the last month, how often have you felt that things were going your way?	34 (22.5)	27 (17.9)	43 (28.5)	35 (23.2)	12 (7.9)
6.	In the last month, how often have you found that you could not cope with all the things that you had to do?	8 (5.3)	15 (9.9)	33 (21.9)	47 (31.1)	48 (31.8)
7.	In the last month, how often have you been able to control irritations in your life?	35 (23.2)	31 (20.5)	50 (33.1)	26 (17.2)	9 (6)
8.	In the last month, how often have you felt that you were on the top of things?	40 (26.5)	28 (18.5)	35 (23.2)	38 (25.2)	10 (6.6)
9.	In the last month, how often have you been angered because of things that were outside of your control?	6 (4)	7 (4.6)	34 (22.5)	58 (38.4)	46 (30.5)
10.	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	7 (4.6)	15 (9.9)	29 (19.2)	49 (32.5)	51 (33.8)

Table 6 Association of HbA1c with perceived stress of study subjects

No.	Variable	Categories	Perceived Stress (PSS-10) N (%)			*p-value*	Effect size (η2)
			Low	Moderate	High		
1	HbA1c	Excellent	3 (9.1)	28 (84.8)	2 (6.1)	*<0.001*	0.720
		Good	2 (3.6)	29 (51.8)	25 (44.6)		
		Poor	0 (0)	2 (3.2)	60 (96.8)		

Among demographic variables, history of the disease (diabetes) was the only variable that presented statistically significant association with the perceives stress of patients ($p<0.05$).

Table 7 Association of demographic variables with perceived stress of study subjects

No.	Variables	Categories	Perceived Stress (PSS-10) N (%)			*p-value*
			Low	Moderate	High	
1	Age	20-30	0	2 (33.3)	4 (66.7)	*0.847*
		31-40	1 (7.1)	6 (42.9)	7 (50)	
		41-50	1 (1.9)	18 (33.3)	35 (64.8)	
		51-60	1 (2.2)	20 (43.5)	25 (54.3)	
		>60	2 (6.5)	13 (41.9)	16 (51.6)	
2	Gender	Male	3 (4.3)	28 (40)	39 (55.7)	*0.785*
		Female	2 (2.5)	31 (38.3)	48 (59.3)	
3	Socioeconomic status	High	0	7 (41.2)	10 (58.8)	*0.676*
		Middle	4 (3.2)	49 (39.2)	72 (57.6)	
		Low	1 (11.1)	3 (33.3)	5 (55.6)	
4	Occupation	House Staying	4 (4.4)	37 (40)	50 (54)	*0.587*
		Job involving physical activity	1 (2.8)	11 (30.6)	24 (66.7)	
		Job not involving physical activity	0	11 (45.8)	13 (54.2)	
5	History of Diabetes	1-2 Years	1 (3.8)	11 (42.3)	14 (53.8)	*0.003*
		3-4 Years	1 (2.6)	13 (34.2)	24 (63.2)	
		>4 Years	3 (3.4)	35 (40.2)	49 (56.3)	
6	Education	Secondary	3 4.1)	27 (37)	43 (58.9)	*0.935*
		Graduation	2 (3.1)	26 (40.6)	36 (56.3)	
		Post-Graduation	0	6 (42.9)	8 (57.1)	
7	Residence	Urban	4 (3)	55 (41.7)	73 (55.3)	*0.220*
		Rural	1 (5.3)	4 (21.1)	14 (73.7)	

4. DISCUSSION

Diabetes mellitus is an endocrine disorder in which pancreatic production of insulin stops or decreases which leads to high levels of blood glucose. Globally, the prevalence of diabetes mellitus has been increased tremendously in recent years. In the present era, anxiety and stress is also increasing in the population with each passing decade. The present study was conducted with the aim to observe the association of stress with Type 2 Diabetes Mellitus (T2DM) in adult diabetics. A sample of 151 diabetes type-2 patients (aged 20 years or above) were enrolled in the study to access the association of stress with T2DM by using the PSS-10 stress scale (Table 5). Out of 151 T2DM patients, 3.3% have low stress, 39.1% have moderate stress and 57.6% have high stress as shown in (Table 4).

The average HbA1c value was 8.70 ±1.99 (Table 3). Out of 151 T2DM patients, 21.9% have good controlled HbA1c value, 37.1% have normally controlled HbA1c value and 41.1% have poorly controlled HbA1c values as presented in (Table 3). According to this study, stress significantly increases the risk of higher blood glucose levels in T2DM patients. The result showed a high statistically significant association between stress and T2DM. The p-value between stress and HbA1c level is less than 0.001 ($p<0.001$) which is highly significant. This study revealed that the prevalence of high stress was higher in T2DM patients with HbA1c greater than 9% (>5) in comparison to those with HbA1c level less than 9% (<9%) as shown in (Table 6).

Similarly, a mixed method study, involving qualitive and quantitative data collection methods was conducted in Tamil Nadu, India showed the significant association between stress and T2DM, presenting that 35% of the type 2 diabetes mellitus patients presented high stress (Sendhilkumar et al., 2017). However, we have not found any article that showed that stress is not associated with T2DM. The reason for the association of stress with T2DM might be the effect of stress on the release of hormones i.e., the stress triggers the release of hormones (Cortisol) which causes liver to release glucose that leads to high glycated hemoglobin (HbA1c).

The study was conducted to evaluate the association between stress and age and results showed no statistically significant association as the p-value was 0.847. However, the findings between stress and age highlighted several findings, as different age groups showed different stress levels older participants showed slightly lower stress levels (54.3%) than the middle-aged participants (64.8%), but stress remained a significant issue across all age groups. Similarly, the study was conducted showing level of perceived stress increases with increasing age among men and women aged 66-97. The present study also showed that the association was independent of gender, and mostly stress-inducing factors were health-related such as incidence of diabetes, especially the duration and history of diabetes (p-value=0.003) (Table 7).

The study showed no statistical significance between stress and age but pointed out a few findings such as: middle aged group respondents presented higher levels of stress as compared to old age participants. The stress in middle age participants might be due to work related pressure, family responsibilities as well as financial concerns. While, in older participants the stress was majorly seen due to physical inabilities and health-related factors. However, the lack of statistical significance between stress and age indicates that stress-reducing interventions should not be age-specific but rather focus on addressing health-related factors that contribute the stress across the lifespan.

In this study, the relationship between stress and socioeconomic status showed no statistical significance as the p-value was 0.676 showing that socioeconomic factors do not influence perceived stress levels in this sample. High-stress levels were observed in 58.8% of participants who were from the high socioeconomic status group, 57.6% were from the middle while 55.6% were from the low socioeconomic status group. There was no substantial difference in stress based on participant's financial standings. However, a cross-sectional observational study was conducted upon 5113 adults in Denmark which showed that individuals with lower socio-economic status often experience higher levels of stress because of economic instability, poor quality of life and financial dependance.

Similarly, it is observed that stress levels increases in deprived neighborhoods, unemployment ratio, poor living conditions, and insufficient resources are prevalent (Algren et al., 2018). In conclusion, socioeconomic status did not show any significant role in determining the stress levels among the participants, which may be due to the fact that the participants were influenced by other factors like health-related factors or lifestyle variables rather than socioeconomic factors. The p-value for the relation of occupation and stress is 0.587 which is not significant and it means there is no association between type of occupation and stress.

A similar study was conducted in the university of Gothenburg Sweden which showed that there is no association between stress and work weather it’s from home or not ((Håkansson and Ahlborg, 2017)). Similarly, the cross-sectional study conducted in Denmark, presented similar findings that stress is directly linked to socio-economic status of the individuals, while, no direct association is observed between occupation and stress (Algren et al., 2018). The reason behind the result of this research might be that stress is also affected by many other factors in our daily life and it is not significantly affected by the type of occupation. The p-value for the relation of stress and a history of diabetes is 0.003 which shows a strong association between stress and long-term diabetes.

A similar study was conducted at the University of Gothenburg Sweden which indicates a strong association between stress and long-term diabetic patients who had long-term permanent stress were significantly diagnosed with diabetes, the total sample size was 6828.15.5 percent of men were reported with permanent stress and a total 899 men were diagnosed with diabetes (Novak et al., 2013). The possible reason behind the association between stress and long-term diabetes is that patients are at risk of getting some other complications such as hypertension and stress stimulates certain hormones (cortisol and adrenaline) that cause elevated blood glucose levels.

5. CONCLUSION

The prevalence of type-2 diabetes mellitus is increasing with each passing year. In the similar manner, stress is also increasing in the present times. The present study was conducted with the aim, to observe the association between perceived stress and glycated hemoglobin (HbA1c) values. The study findings present the evidence of perceive stress with blood glucose levels, presents that

majority of the diabetic type 2 patients with high perceive stress had poorly controlled blood glucose levels. History of diabetes was the factor that was positively associated with high perceived stress. Whereas, gender, socio-economic status and level of education were the factors that were observed to have no statistical association with perceived stress.

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Author Contributions

Author AM, MQ, RMSA, GM and SS collected data from study subjects and performed initial statistical analysis. Author AA, MA, TY and SS wrote the initial draft of the manuscript. Author MZI and SS performed refined statistical analysis for the final manuscript. All authors contributed in the preparation of the final manuscript.

Ethical approval

The present study has been granted ethical approval by the Institutional Ethical Review Board and the Bio-Ethical Committee (BEC) of Lahore University of Biological & Applied Sciences and allotted a protocol approval number: ERB-PHRMD-DPP/3363-A

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

REFERENCES

1. Akhtar S, Khan Z, Rafiq M, Khan A. Prevalence of type II diabetes in District Dir Lower in Pakistan. Pak J Med Sci 2016; 32(3):622-625. doi: 10.12669/pjms.323.9795
2. Algren MH, Ekholm O, Nielsen L, Ersbøll AK, Bak CK, Andersen PT. Associations between perceived stress, socioeconomic status, and health-risk behaviour in deprived neighbourhoods in Denmark: a cross-sectional study. BMC Public Health 2018; 18(1):250. doi: 10.1186/s12889-018-5170-x
3. Andreou E, Alexopoulos EC, Lionis C, Varvogli L, Gnardellis C, Chrousos GP, Darviri C. Perceived Stress Scale: reliability and validity study in Greece. Int J Environ Res Public Health 2011; 8(8):3287-98. doi: 10.3390/ijerph8083287
4. Bajwa A, Shahid S, Athar M, Sana A, Abid I, Latif SM, Fahad M, Mughal M, Ayesha M, Ahmed F, Iqbal MZ. Diabetic patients' adequacy of knowledge related to insulin injecting techniques and practices. A cross-sectional study from Punjab, Pakistan. Med Sci 2024; 28(151):e129ms3434. doi: 10.54905/dissi.v28i151.e129ms3434
5. Dwivedi M, Pandey AR. Diabetes Mellitus and Its Treatment: An Overview. J Adv Pharmacol 2020; 1(1):48–58.
6. Haidara MA, Yassin HZ, Rateb M, Ammar H, Zorkani MA. Role of oxidative stress in development of cardiovascular complications in diabetes mellitus. Curr Vasc Pharmacol 2006; 4(3):215-27. doi: 10.2174/157016106777698469
7. Håkansson C, Ahlborg G Jr. Occupations, perceived stress, and stress-related disorders among women and men in the public sector in Sweden. Scand J Occup Ther 2017; 24(1):10-17. doi: 10.3109/11038128.2016.1170196
8. Hara Y, Hisatomi M, Ito H, Nakao M, Tsuboi K, Ishihara Y. Effects of gender, age, family support, and treatment on

perceived stress and coping of patients with type 2 diabetes mellitus. Biopsychosoc Med 2014; 8:16. doi: 10.1186/1751-0759-8-16

9. Iqbal MZ, Alqahtani SS, Mubarak N, Shahid S, Mohammed R, Mustafa A, Khan AH, Iqbal MS. The influence of pharmacist-led collaborative care on clinical outcomes in type 2 diabetes mellitus: a multicenter randomized control trial. Front Public Health 2024; 12:1323102. doi: 10.3389/fpubh.2024.1323102
10. Iqbal MZ, Khan AH, Iqbal MS, Syed-Sulaiman SA. A Review of Pharmacist-led Interventions on Diabetes Outcomes: An Observational Analysis to Explore Diabetes Care Opportunities for Pharmacists. J Pharm Bioallied Sci 2019; 11 (4):299-309. doi: 10.4103/jpbs.JPBS_138_19
11. Iqbal M, Khan A, Sulaiman S, Iqbal M, Hussain Z. Guideline for Adherence and Diabetes Control in Co-Morbid Conditions in a Tertiary Hospital in Malaysia. Trop J Pharm Res 2014; 13 (10):1739-1744. doi: 10.4314/tjpr.v13i10.25
12. Kakar ZA, Siddiqui MA, Amin RA. Prevalence and risk factors of diabetes in adult population of South Asia. Clinical Medicine of Diagnosis 2013; 3:18-28. doi: 10.5923/j.cmd.20130302.02
13. Khan AH, Iqbal MZ, Syed Sulaiman SA, Ibrahim A, Azmi NSBY, Iqbal MS, Albassam AA. Impact of Pharmacist-led Educational Intervention on Predictors of Diabetic Foot at Two Different Hospitals of Malaysia. J Pharm Bioallied Sci 2021; 13(1):108-115. doi: 10.4103/jpbs.JPBS_475_20
14. Nanditha A, Ma RC, Ramachandran A, Snehalatha C, Chan JC, Chia KS, Shaw JE, Zimmet PZ. Diabetes in Asia and the Pacific: Implications for the Global Epidemic. Diabetes Care 2016; 39(3):472-85. doi: 10.2337/dc15-1536
15. Novak M, Björck L, Giang KW, Heden-Ståhl C, Wilhelmsen L, Rosengren A. Perceived stress and incidence of Type 2 diabetes: a 35-year follow-up study of middle-aged Swedish men. Diabet Med 2013; 30(1):e8-16. doi: 10.1111/dme.12037
16. Örücü MÇ, Demir A. Psychometric evaluation of perceived stress scale for Turkish university students. Stress Health 2009; 25(1):103–109.
17. Poojar B, Ommurugan B, Adiga S, Thomas H, Sori RK, Poojar B, Hodlur N, Tilak A, Korde R, Gandigawad P. Methodology Used in the Study. Asian J Pharm Clin Res 2017; 7(10):1–5.
18. Ramachandran A, Snehalatha C, Shetty AS, Nanditha A. Trends in prevalence of diabetes in Asian countries. World J Diabetes 2012; 3(6):110-7. doi: 10.4239/wjd.v3.i6.110
19. Sendhilkumar M, Tripathy JP, Harries AD, Dongre AR, Deepa M, Vidyulatha A, Poongothai S, Venkatesan U, Anjana RM, Mohan V. Factors associated with high stress levels in adults with diabetes mellitus attending a tertiary diabetes care center, Chennai, Tamil Nadu, India. Indian J Endocrinol Metab 2017; 21(1):56-63. doi: 10.4103/2230-8210.196006