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Prevalence and Risk Factors of Diabetes Mellitus in Younger and Older Patients at a Tertiary Healthcare Facility in Mardan, Pakistan

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Abstract: Diabetes mellitus (DM) is a major non-communicable metabolic disorder characterized by persistent hyperglycemia arising from impaired insulin secretion, insulin resistance, or a combination of both. As the global burden of DM continues to rise, understanding its prevalence and associated risk factors in specific populations is critical for the development of effective prevention and management strategies. A cross-sectional study was conducted among 150 residents (75 males and 75 females) attending a tertiary healthcare facility in Mardan, Pakistan. Sociodemographic characteristics, family history, body mass index (BMI), lifestyle behaviors, dietary patterns, psychological stress, and other potential risk factors were assessed using a structured questionnaire, while venous blood samples were collected to confirm the diagnosis of DM. Overall, the prevalence of DM was found to be 34.67% (n=52), with 29.33% (n=44) previously diagnosed and 5.33% (n=8) newly identified during the investigation. A significant sex-related disparity was observed, with prevalence rates of 26.67% (n=20) in males and 42.67% (n=32) in females. Rural residents exhibited a higher prevalence (42.86%, n=33) compared to urban residents (26.03%, n=19). Several risk factors demonstrated a notable association with DM, including advanced age (>60 years: 8.67%, n=13), obesity (12.67%, n=19), low physical activity (26.67%, n=40), smoking (11.33%, n=17), unhealthy dietary patterns (27.33%, n=41), high psychological stress (17.33%, n=26), hypertension (14%, n=21), and a positive family history (27.33%, n=41). The findings indicate an upward trend in the prevalence of DM in the Mardan region. Immediate implementation of targeted interventions, including public health education, lifestyle modification, dietary counseling, and risk factor management, is essential to mitigate the increasing burden of DM in this population.

Keywords: Diabetes mellitus; Prevalence; Risk factors; Glucose; Young and older adults; Mardan

1. Introduction

DM is the most prevalent non-transmittable metabolic disorder, which was initially identified by the Egyptians. It is characterized by hyperglycemia, weight loss, and frequent urination (Bereda, 2021; Suryasa et al., 2021). DM occurs when the body's hormonal system, which controls blood sugar level, does not function properly, leading to hyperglycemia (Richardson & Park, 2020). Insulin, which is an anabolic hormone produced by beta cells in the pancreas, involves glucose utilization and regulation in the body (Bereda, 2021; Chen et al., 2019). DM is mainly caused by impaired insulin secretion, insulin resistance, or a combination of both (Ohiagu et al., 2021). Globally, the incidence of DM is rising throughout all age groups and genders, with developed and developing countries placing a significant strain on public health services. Almost every ten seconds, one person dies from DM, which is a major cause of multiple chronic disorders and premature death, killing more people than Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS). DM ranks among the top ten disorders responsible for global morbidity and mortality (American Diabetes Association, 2022). The International Diabetes Federation (IDF) estimates that approximately 537 million adults aged 20–79 years were affected by diabetes in 2021 (Khan et al., 2023).

Pakistan, the fifth most populated country in South Asia, is struggling with this issue with limited healthcare

resources and economic difficulties. Pakistan has seen a dramatic rise in adult diabetes cases, jumping from 5.2 million in 2000 to 33 million in 2021 (Hasan & Siddiqui, 2024a). In 2016, the World Health Organization (WHO) estimated that the Non-Communicable Diseases (NCDs) accounted for 58% of all deaths in Pakistan, with diabetes accounting for about 3% (Hasan & Siddiqui, 2024b). In Khyber Pakhtunkhwa (KPK), the total number of diabetic patients also increases very quickly in both male and female genders (Khan et al., 2022). Risk factors such as obesity, physical inactivity, improper diet, high stress, and smoking contribute to the rising incidence of DM in young and older populations (Alam et al., 2021; Wong & Sattar, 2023). Mardan, a major city in KPK, is not an exception to this trend. In Mardan, the prevalence of diabetes has increased rapidly across all age groups, genders, and social classes (Ali et al., 2023), although limited data are available on its prevalence and risk factors, particularly among individuals aged ≥20 years.

The study aims to assess the prevalence of DM and explore associated risk factors among young and older individuals in a tertiary healthcare facility in Mardan, Pakistan. Understanding these differences will help tailor targeted interventions for prevention and management, ultimately reducing the diabetes burden in this high-risk population.

2.Methodology

This cross-sectional study was conducted at a tertiary healthcare facility in Mardan, KPK, Pakistan, from February to May 2025. A total of 150 participants were investigated and interviewed through questionnaires and their blood was taken for DM diagnosis. Patients were diagnosed in terms of fasting blood sugar (FBS) (≥126 mg/dL), random blood sugar (RBS) (≥200 mg/dL), or HbA1c (glycated hemoglobin) on the basis of the American Diabetes Association (ADA) (American Diabetes Association Professional Practice Committee, 2024). The samples were collected at the Mardan Medical Complex (MMC) pathology lab and other local private hospitals in Mardan District. A special questionnaire was designed for data collection, including age, gender, educational level, family history, BMI, relation to smoking, stress level, lifestyle and behavioral factors.

FBS was measured after an overnight fast of at least eight hours, whereas RBS was measured at any time, regardless of the interval since the last meal. Blood glucose was measured using standard enzymatic techniques, with diagnostic criteria for DM defined as FBS ≥126 mg/dL or RBS ≥200 mg/dL, according to ADA guidelines. All the samples were processed in MMC pathology department or the associated private hospitals for uniformity and accuracy of the findings.

The procedure adopted in the analysis of HbA1c included the venous blood sample collection procedure used for the participants through standardized phlebotomy methods. Samples were analyzed using high-performance liquid chromatography (HPLC) or an equivalent standard method at the MMC pathology lab or another affiliated hospital privately. DM was identified as per the ADA criteria, and an HbA1c level of greater than or equal to 6.5% (48 mmol/mol) was considered to have diabetes. It is a good indicator of average blood glucose levels over the past two to three months with no regard to the recent food intake. All the data from blood samples and questionnaires were collected and analyzed using SPSS version 22 and Microsoft Excel to obtain descriptive statistics, including frequency and percentage.

2.1 Ethical Considerations

Approval was obtained from the Department Ethical Review Board (DERB). Written informed consent was taken from all participants.

3. Results

A total of 150 participants were included in this cross-sectional study conducted at a tertiary healthcare facility in Mardan, Pakistan. Out of 150 samples, 52 tested positive and 98 tested negative for diabetes (RBS and HbA1c). Figure 1 shows the overall prevalence of diabetes in Mardan.

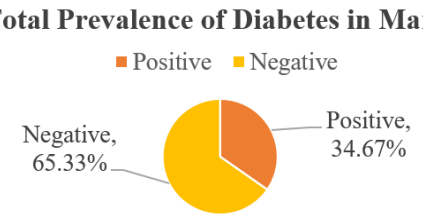

Figure 1. Overall prevalence of diabetes in Mardan

The prevalence of diabetes was significantly different between males and females. Among males, 26.67% (n=20) of the 75 tested samples were positive for diabetes, whereas among females, 42.66% (n=32) of the 75 samples were positive, as shown in Figure 2.

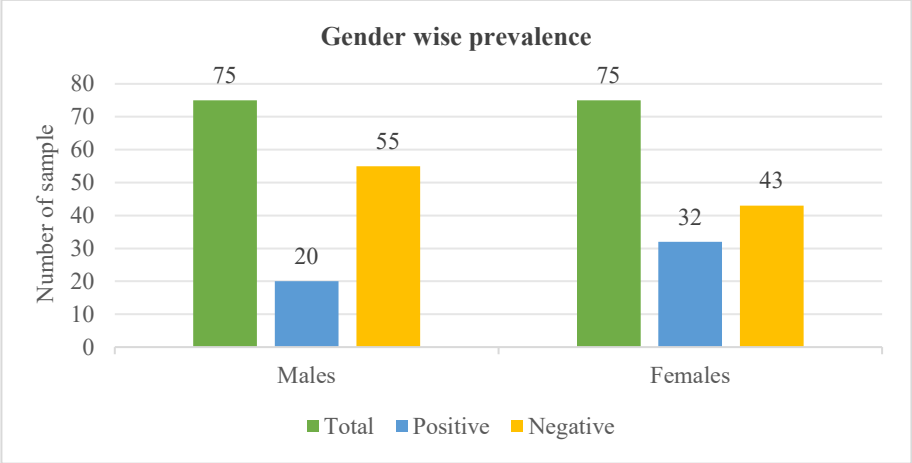

Figure 2. Gender-wise prevalence

With increasing age, the prevalence of diabetes also increased. Among the 150 participants, 32% (n=48) were in the 20–40 years age group, of whom 25% (n=12) were positive for diabetes. The 41–60 years age group accounted for 52.67% (n=79), with 34.18% (n=27) positive. Participants aged >60 years represented 15.33% (n=23), of whom 56.52% (n=13) were positive for diabetes (Table 1).

Table 1. Demographic characteristics of diabetic and non-diabetic patients

Characteristics	Diabetes	Non-diabetes	p-value
Age Group			
20–40	12 (8%)	36 (24%)	
41–60	27 (18%)	52 (34.67%)	0.027
>60	13 (8.67%)	10 (6.67%)	
Marital Status			
Married	41 (8%)	71 (47.33%)	
Unmarried	4 (2.67%)	20 (13.33%)	<0.05
Divorced	-(-)	-(-)	
Widows	7 (4.67%)	-(-)	
Educational Levels			
No formal education	15 (10%)	13 (8.67%)	
Primary (up to Grade 5)	29 (19.33%)	34 (22.67%)	
Middle (Grades 6–8)	3 (2%)	11 (7.33%)	0.002
Secondary/matriculation (Grades 9–10)	1 (0.67%)	19 (12.67%)	
Higher secondary/intermediate (Grades 11–12)	2 (1.33%)	9 (6%)	
Bachelor's or higher	2 (1.33%)	12 (8%)	
Residence			
Urban	19 (12.67%)	54 (36%)	0.009
Rural	33 (22%)	44 (29.33%)	
Income Level			
<20000 Rs	19 (12.67%)	24 (16%)	
20000-50000 Rs	24 (16%)	22 (14.67%)	<0.05
50000-100000 Rs	6 (4%)	36 (24%)	
>100000 Rs	3 (2%)	16 (10.67%)	
Total Family Members			
1–4	7 (4.67%)	19 (12.67%)	
5–6	11 (7.33%)	38 (25.33%)	<0.05
>6	34 (22.67%)	41 (27.33%)	

Among the participants, individuals with a family history of diabetes showed a significant prevalence of 27.33% (n=41) out of 150, while non-diabetic and uncertain cases accounted for 6.67% (n=10) and 0.67% (n=1), respectively. A high prevalence of diabetes was observed among hypertensive patients, at 14% (n=21). Newly diagnosed diabetes accounted for 5.33% (n=8), whereas previously known cases constituted 29.33% (n=44). Use

of diabetic medication was reported in 28% (n=42) of participants, while 26.67% were non-diabetic, as shown in Table 2.

Table 2. Medical history of diabetic and non-diabetic patients

Medical History	Diabetes	Non-diabetes	p-value
Family History of Diabetes			
Diabetic	41 (27.33%)	36 (24%)	
Non-diabetic	10 (6.67%)	51 (34%)	<0.05
Not sure	1 (0.67%)	11 (7.33%)	
Status of Diabetes with Positive Results			
New cases		8 (5.33%)	
Known cases		44 (29.33%)	
History of Hypertension			
Normotensive	13 (8.67%)	49 (32.67%)	
Prehypertensive	18 (12%)	27 (18%)	0.019
Hypertensive	21 (14%)	22 (14.67%)	
Medication use (for blood pressure, cholesterol, and related conditions)	42 (28%)	40 (26.67%)	<0.05

The prevalence of diabetes increased with reduced physical activity. The highest prevalence was observed among participants with no physical activity (26.67%, n=40) compared with those who engaged in physical activity (4.67%, n=7). The prevalence of diabetes among smokers was 11.33% (n=17), while among participants with improper diets it was 27.33% (n=41) (Table 3). A total of 23 participants had a high BMI, of whom 12.67% (n=19) were diabetic and 2.67% (n=4) were non-diabetic, as shown in Table 4.

Table 3. Lifestyle and behavioral factors among diabetic and non-diabetic patients

Lifestyle and Behavioral Factors	Diabetes	Non-diabetes	p-value
Physical Activity			
Never	40 (26.67%)	7 (4.67%)	
1–2 times per week	9 (6%)	41 (27.33%)	<0.05
3–4 times per week	3 (2%)	24 (16%)	
≥5 times per week	-(-)	26 (17.33%)	
Smoking Status			
Smoker	17 (11.33%)	8 (5.33%)	0.028
Non-smoker	35 (23.33%)	87 (58%)	
Former smoker	-(-)	3 (2%)	
Improper Diet			
Daily	41 (27.33%)	38 (25.33%)	
3–4 times per week	9 (6%)	41 (27.33%)	0.0005
Rarely	2 (1.33%)	19 (12.67%)	

Table 4. Anthropometric measurements among diabetic and non-diabetic patients

Anthropometric Measurement	Diabetes	Non-diabetes	p-value
BMI (Kg/m^2)			
<18.5	5 (3.33%)	0 (0%)	
18.5–22.9	9 (6%)	21 (14%)	
23–24.9	13 (8.67%)	34 (22.67%)	0.0005
25–29.9	29 (19.33%)	16 (10.67%)	
≥30	19 (12.67%)	4 (2.67%)	

There is a considerable lack of knowledge and awareness about diabetes in the population of Mardan. The prevalence of lack of knowledge and awareness was higher in females (16%, n=24) compared to males (8.67%, n=11), as shown in Figure 3.

Psychological factors such as stress, depression, and anxiety are considered important risk factors for DM. This study aimed to identify the main reasons why individuals lack access to healthcare. As shown in Table 5, the majority of the participants faced high levels of stress and anxiety. Out of 150 participants, individuals with high stress levels accounted for 17.33% of diabetics and 32.67% of non-diabetics. Barriers to healthcare, including cost, distance, lack of awareness, cultural factors, and other social issues, were found to be significant among study participants.

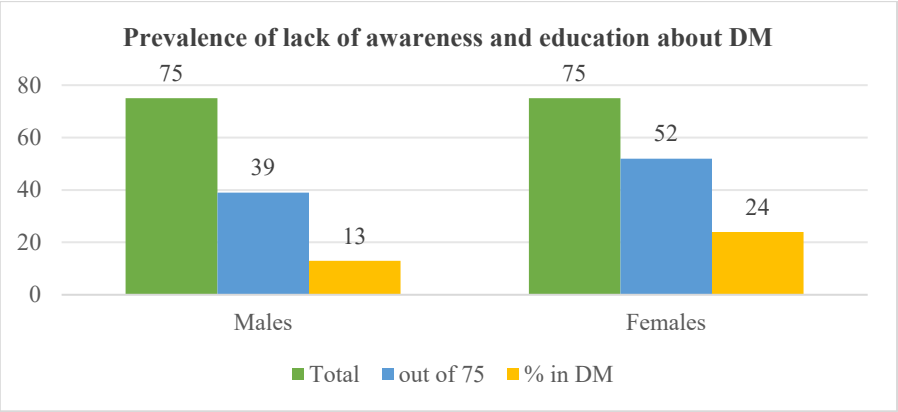

Figure 3. Lack of awareness and education about diabetes in the population of Mardan

Table 5. Psychological factors and healthcare access barriers

Psychological Factors and Healthcare Access Barriers	Diabetes	Non-diabetes
Stress Level		
Low	9 (6%)	23 (15.33%)
Moderate	17 (11.33%)	26 (17.33%)
High	26 (17.33%)	49 (32.67%)
Healthcare Access Barriers		
Cost	27 (18%)	32 (21.33%)
Distance	18 (12%)	21 (14%)
Lack of awareness	9 (6%)	7 (4.67%)
Culture or other social issues	21 (14%)	15 (10%)

4. Discussion

The overall prevalence of diabetes in this study was 34.67%, out of which newly diagnosed diabetes and previously known cases constituted 65.33% and 29.33%, respectively (Figure 1). This is different from the result of earlier research, with both cases accounting for 51.7% and 48.3%, respectively (Ali et al., 2023). The differences could be explained by lifestyle changes, age composition, time duration, level of poverty, etc. Figure 2 displays the diabetes prevalence by gender in the Mardan District. 26.67% (n=20) of the 75 males in total were found to be positive, while 73.33% (n=55) were determined to be negative. Similarly, 42.67% (n=32) of the 75 females were found to be positive and 57.33% (n=43) to be negative. The data were similar to the findings of previous research, with prevalence rates of 48% in males and 52% in females (Fatima et al., 2022). Diabetes is more common in women than in men for a variety of complicated reasons, such as obesity, body composition, inactivity, and awareness, as well as cultural, social, and economic variables that might impact the prevalence of diabetes in women.

There is a direct relationship between age and prevalence of diabetes. A total of 48 samples were collected from the age group of 20-40 years, out of which 8% were positive for diabetes and 24% were negative. For the age group of 40-60 years, 79 samples were collected, in which 18% were positive for diabetes and 34.67% were negative. The highest prevalence was recorded in participants more than 60 years old. A total of 23 samples were collected, in which 8.67% were positive for diabetes and 6.67% were negative. The prevalence of diabetes elevated with an increase in age because of diminished body systems activity, physical activity, stress levels, etc. The results are similar to the findings of previous research (Advance Collaborative Group, 2014). In this study, a high prevalence (about 10%) was recorded in low-educated participants because they were not aware of the risk factors for and prevention of diabetes. The majority of people did not receive proper education due to cost, distance, cultural barriers, and other social issues. The finding that educational levels are inversely proportional to the risk of diabetes is consistent with previous studies (Mirzaei et al., 2020; Seiglie et al., 2020).

There were 51.33% (n=77) samples taken from rural areas, of which 42.85% (n=33) were positive for diabetes and 57.14% (n=44) were negative. In addition, 48.61% (n=73) of samples were taken from urban areas, of which 26.02% (n=19) were positive cases and 73.97% (n=54) were negative ones. The causes of high prevalence in rural areas were low education levels, lower income levels, limited access to care, poor dietary habits, a high obesity rate, a lack of awareness, etc., which is similar to the finding in the USA (Dugani et al., 2021; Kobo et al., 2022;

Mercado et al., 2021). The finding of this study shows that family history of diabetes plays a significant role in the development of DM. In this study, a total of 75 (50%) cases were collected, out of which 54.67% (n=41) of cases with a family history of diabetes tested positive for diabetes. Total samples collected from participants with no family history of diabetes accounted for 40% (n=60), in which 16.67% (n=10) tested positive, which aligns with previous research (Zeru et al., 2021). Out of 150 participants, 4.47% (n=7) were diagnosed with new cases of diabetes, and 29.33% (n=44) were previously known cases. The continuous rise in the incidence of DM was caused by many behavioral and lifestyle changes of the population in Mardan.

According to the study's findings, medication treatment techniques may be partly responsible for the relatively high prevalence of DM in Mardan. Some medications used for treating hypertension, cholesterol, etc., can cause problems for the management of diabetes (Abinaya et al., 2020). 51.21% (n=42) of the 54.67% (n=82) patients in the current study had diabetes. Lack of physical exercise is the main risk factor, and its prevalence is rapidly growing in the Mardan population. Engaging in physical activity improves the body's mental and physical wellness as well as metabolic function. The findings of this study also align with the results of previous studies, which show that low physical activity raises the incidence of type 2 diabetes (Azeem et al., 2022; Nazeer et al., 2020). In this study, 31.33% (n=47) of samples were taken from persons who were not engaged in any physical activity, 85.11% (n=40) of which tested positive for diabetes. 33.33% (n=50) of participants exercised 1-2 times per week, 18% (n=9) of whom had diabetes, as shown in Table 3.

Those participants whose BMI was 25–29.9 kg/m² accounted for 28.67% (n=43), in which 67.44% (n=43) tested positive for diabetes. The participants whose BMI values were more than 30 accounted for 15.33% (n=23), in which 82.61% (n=19) tested positive for diabetes, as shown in Table 4. Obesity was mostly found in females, the rural population, people with low education levels and aged participants. The result of this study is similar to the findings of previous studies, which show that obesity and DM are interconnected with each other, with a high obesity rate raising the probability of DM (Chandrasekaran & Weiskirchen, 2024; Zhou et al., 2022). Many healthcare barriers can prevent the patient from early diagnosis and treatment of diabetes. The majority of the patients face different problems such as financial, social, and cultural issues, and distance from the healthcare region, as shown in Table 5. The development of DM is significantly influenced by stress. Chronic stress affects blood glucose levels, increases the rate of glycogen breakdown, and promotes insulin resistance, among other effects.

Smoking is very dangerous for our health, and it not only causes lung cancer and cardiovascular diseases but also involves metabolic dysfunction and increases the risk of type 2 DM. Several chemicals in cigarettes, such as nicotine, contribute to insulin resistance (Durlach et al., 2022; Indrahadi et al., 2021). In this research, out of 16.67% (n=25) participants, 68% (n=17) participants were identified as positive for diabetes, which is a high ratio. In the study area, the proportion of female cigarette smokers is negligible, but the number of male smokers is increasing rapidly. This issue could be addressed by controlling the supply of cigarettes, promoting nicotine replacement therapy, and conducting awareness programs on its harmful effects (Durlach et al., 2022). A comprehensive approach that includes prevention, early identification, and care is necessary to control DM in the Mardan population. Seminars on the risk factors of diabetes, like stress, no physical activity, family history, obesity, and excessive sugar consumption, can be organized. The information on free medical camps available in several parts of Mardan can be spread on social media. Various government agencies can be encouraged to create DM management and prevention policies.

5. Conclusion

This study demonstrated that the prevalence of DM was very high in the Mardan population (34.67%) attending a tertiary healthcare center in Pakistan. The prevalence was predominantly higher in women, older age groups (>60 years), rural populations, and persons with lower education levels. The major predisposing remediable risk factors closely linked to diabetes were identified as obesity, a lack of physical exercise, inappropriate nutrition, smoking, and stress related to high levels. A high familial inclination was also ascertained. These facts highlight the necessity of the extensive public health measures that involve the development of awareness campaigns, lifestyle changes, and enhanced access to healthcare services. Interventional approaches that tackle the identified risk factors would need to be prioritized, especially targeting high-risk groups, i.e., women, the elderly, and rural residents, to reduce the increasing burden of diabetes in the Mardan region. Further research is recommended to validate these findings in other populations with similar socio-cultural and economic barriers to diabetes prevention and management.

Data Availability

The datasets used and analyzed during this study are not publicly available due to restrictions from the corresponding author but can be provided upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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