Microvascular Complications and Associated Risk Factors in Patients with Type 2 Diabetes Mellitus in Al-Madinah Al-Munawara, Saudi Arabia

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https://dx.doi.org/10.13005/bpj/2779

(Received: 10 August 2023; accepted: 21 November 2023)

Chronic hyperglycemia is a hallmark of the metabolic disorder diabetes mellitus, which also causes microvascular problems that cause morbidity, recurrent hospital stays, and death. Our study's objective is to determine the relationships between microvascular issues and risk factors in people with type 2 diabetes in Al-Madinah Al-Munawara. In Al-Madinah Al-Munawara, 275 patients with type 2 diabetes participated in this descriptive cross-sectional study; 86 of them had microvascular complications. An online questionnaire was used to collect the data. The study covered all participants aged 20 to 65 years old. Incomplete data, patients suffering from COVID-19, chest infections, cancer, and pregnant women were excluded. Microvascular complications affect 37.3% of the elderly (41–65 years old) and 63% of the young (20–40 years old). There is a significant association (p <0.05) between the age of the patients and various types of microvascular complications. Retinopathy and peripheral neuropathy were more common in males than females. There was a positive correlation between HbA1c levels and other variables such as serum cholesterol, hemoglobin, high blood pressure, and the number of hospitalizations. Age, gender, hypertension, and type of treatment have a significant positive effect on the appearance of microvascular complications (p <0.05). In our study, the age, gender, and type of treatment of participants were independent predictors of microvascular complications among type 2 diabetic patients. The risk of complications from DM in this country will be decreased by health education and raising awareness.

Keywords: Microvascular complications, Type 2 diabetes mellitus, , risk factors, Al-Madinah Al-Munawara.

Type 2 diabetes is linked to potentially fatal microvascular and macrovascular complications as well as debilitating symptoms[1-2]. Its prevalence is increasing at an alarming rate worldwide. According to recent studies, there are 422 million diabetics worldwide, and diabetes is directly responsible for 1,600,000 annual fatalities. Type 2 diabetes (T2D) is the most common form of diabetes, affecting 90–95% of all individuals [3-5].

Microvascular complications are a major outcome in patients with T2DM. Their impact on the patient's quality of life is significant. They are a major contributor to morbidity and mortality as well[6-8]. They also place a heavy financial strain on the patient and the healthcare system. Diabetic retinopathy, neuropathy, and nephropathy are examples of microvascular complications[9].

In diabetic nephropathy, deterioration of kidney function is associated with albuminuria or decreased glomerular filtration rate and is the main cause of end-stage renal failure, which necessitates dialysis. In Saudi Arabia, adults with T2DM are believed to have a prevalence of diabetic nephropathy of about 11% , based on data from the Saudi National Diabetes Registry[10].

Diabetic neuropathy can cause nerve damage due to elevated blood glucose levels. The most prevalent type of diabetic neuropathy is peripheral neuropathy which is distal and symmetric. The feet and legs are the first to be affected, followed by the hands and arms. Autonomic neuropathy impacts the intestines, bladder, heart, sexual organs, stomach, and eyes. Focal neuropathies are damage to a single nerve that can affect the hand, head, torso, or leg. Carpal tunnel syndrome is a common occurrence. Proximal neuropathy affects the hip, buttock, or thigh and is a rare and disabling condition. The damage affects one side of body, and symptoms gradually elevate over time[11].

Diabetic retinopathy produces varying degrees of vision deterioration and is a leading cause of blindness worldwide. Given the expanding prevalence of T2DM in Saudi Arabia, it's critical to understand the link between the duration of T2DM and the increased risk of microvascular complications, as well as the effect of controlling blood glucose on lowering the incidence[12]. Therefore, our study's objective is to ascertain the association between microvascular problems and related risk variables in Al-Madinah Al-Munawara patients with type 2 diabetes mellitus.

Subjects and methods

Ethical Considerations

The College of Applied Medical Sciences at Taibah University's ethical committee granted approval for this study with the approval number 2021/107/203 CLN. Participants were notified at the start of the questionnaire that participation is fully voluntary and that they can withdraw at any time by not completing and submitting the questionnaire. Because no names or addresses are required, their privacy will be preserved.

Research Design

To better understand the association between vascular outcome and related risk factors in people with T2 DM aged 20 to 65, an observational, descriptive, cross-sectional study was developed. The data was collected using an online questionnaire.

Sample Size Calculation

The targeted sample size was 60 male participants and 60 female participants, as estimated according to Epi Info (Epi Info, v. 7.2.4.0, CDC, Atlanta) with alpha 0.05, beta 0.10, and a 45% expected difference between males and females, determined by a two-sided test. The targeted individuals reside in Al-Madinah Al-Munawara. Type 2 DM patients aged 20 to 65 made up the study population.

Study Setting and Population

Between October 2021 and January 2022, 275 people with T2 DM aged 20 to 65 years old were recruited through an online survey that was circulated on social media platforms such as WhatsApp and Twitter in Al-Madinah Al-Munawara, Saudi Arabia. Then cases are interviewed in diabetes clinic at king Fahd hospital. Type 2 diabetes clients visiting the Hospitals at a regular base (every 3 months) as outpatient and available during the period of data collection were participants and eligible for this study. Those individuals living with diabetes who were critically ill were excluded. Also, incomplete data, patients suffering from COVID-19, chest infections, cancer, and pregnant women were excluded.

According to our study, 86 patients had micro-vascular complications. The variables under study were gender, age, income, duration of illness, family history of diabetes, physical exercise regimen, body mass index, type of treatment, presence of other comorbidities, blood pressure, hemoglobin level, glycosylated hemoglobin (HbA1C) level, and serum lipid profile (e.g., LDL, HDL, cholesterol, and triglycerides). We assumed that the triglyceride level was high at 150 mg/dl and the total blood cholesterol level was high at 200 mg/dl. At 40 mg/dl in men and 50 mg/dl in women, HDL cholesterol was deemed low. At 100 mg/dl, LDL levels were deemed to be high

[13]. Inclusion criteria include T2 DM patients living in Al-Madinah Al-Munawara aged 20–65 years old. Incomplete data, patients suffering from the coronavirus disease of 2019 (COVID-19), chest infections, cancer, or pregnant women were excluded.

The Questionnaire

The tool used for data collection was a questionnaire. No name or address was required; only a phone number was necessary for follow-up questions. The questionnaire consisted of 37 questions. The questionnaire was used to gather data on gender, age, disease duration, family history of diabetes, hospitalization, hospital admission for diabetic ketoacidosis (DKA) with coma, presence of micro-vascular complications, physical activity and patterns of exercise, body mass index (BMI), presence of other comorbidities, frequency of urination, blood pressure, glycosylated hemoglobin (HbA1C) level, fasting blood glucose, and serum calcium level, lipid profile as low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, and cholesterol level. Two bilingual experts translated all the questions from English into Arabic and then the other way around, from Arabic into English.

Operational definitions

Microvascular complications: Diabetic patients who have one or more of the following complications as diabetic nephropathy, diabetic retinopathy, or peripheral neuropathy[14].

Physical activity: Patients with diabetes are categorized as having either good physical activity or poor physical activity depending on whether they exercise for at least 150 minutes three days a week at a moderate level[15].

Obesity: Body mass index (BMI) is divided into three categories: category 1 (BMI: 30–34.9 kg/m2), category 2 (BMI: 35–39.9 kg/m2), and category 3 (BMI: 40 kg/m2)[16].

Statistical Analysis

Statistical Package for the Social Sciences, version 28, was used to statistically analyze the data that had been collected. The variables were categorized according to independent variables, including socio-demographic characteristics such as age, gender, BMI, disease duration, and the HbA1c level, and dependent variables, such as microvascular complications of T 2 DM. The association between disease characteristics as age, gender, disease duration, glycemic control, BMI, and hypertension) and participants' socio-demographic characteristics was examined using the Fisher test. Analysis using Spearman's correlation was done between the HbA1c level and continuous variables in the study. The correlation's strength is described as follows: 0.0-0.19 "very weak", 0.20-0.39 "weak", 0.40-0.59 "moderate", 0.60-0.79 strong," and 0.80-1.0 "very strong"[17]. To evaluate the relationship between the independent and dependent variables, a multiple logistic regression test was utilized. A p-value of 0.05 was used to determine the significance of associations.

RESULTS

Table (1) shows the socio-demographic, clinical and laboratory characteristics of participants with type 2 diabetes mellitus and those with micro-vascular complications. A total of 275 patients with type 2 diabetes mellitus took part in our study. More than half of the patients (71.3%) were aged between 41 and 65 years old. Males represented 32.7% of the study sample, while 67.3% were females. Most individuals (75.3%) had a positive family history of diabetes; 11.6% didn't read or write; less than a quarter (18.5%) had low income; and more than three-fourths (81.4%) had moderate to high income. Most participants were obese; 117 (42.5%) had a BMI greater than 30 kg/m2, 84 (30.5%) were overweight, and only 74 (26.9%) had a normal BMI of less than 25 kg/m2. Half of the participants (49.1%) were physically inactive, and10.9% were smokers. Hypertension was the most frequently reported co-morbidity, with 32% of the participants having the disease. It was followed by dyslipidemia, anemia, and serum hypocalcemia with 16%, 14.2%, and 12%, respectively, and the HbA1c level was high in all the participants.

A statistically significant association exists between the age of the patients and different types of vascular complications (p =0.002). Micro-vascular complications affect 37.3% of the elderly (41–65 years old), while they affect 63% of the younger (20–40-year-olds). The relationship between gender and micro-vascular problems is statistically significant (p =0.035). Microvascular complications affect 38.3% of female patients compared to 53% of male patients. There is a statistically significant association

Table 1. Socio-demographic, clinical and laboratory characteristics of participants with type 2 diabetes mellitus and those with micro-vascular complications

Variables		All patients (275)	Microvascular complications (86)	P-value
	N (%)	N (%)		
Age	20-40	79 (28.7)	29 (63.0)	<0.001**
	41-65	196 (71.3)	57 (37.3)	
Gender	Male	90 (32.7)	35 (53.0)	0.537
	Female	185 (67.3)	51 (38.3)	
Education	No read or write	32 (11.6)	7 (25.9)	0.212
	Primary, Secondary	46 (16.7)	15 (41.7)	
	High school	45 (16.4)	12 (38.7)	
	Certificate and above	152 (55.3)	52 (49.5)	
Income	Low <3000	51 (18.5)	15 (39.5)	0.991
	Moderate 3000- 10000	134 (48.7)	42 (43.8)	
	High >10000	90 (32.7)	29 (44.6)	
Family history of diabetes	Yes	207 (75.3)	61 (39.6)	0.141
	No	68 (24.7)	25 (55.6)	
Smoking history	Yes	30 (10.9)	7 (33.3)	0.473
	No	245 (89.1)	79 (44.4)	
Physical activity	Yes	140 (50.9)	50 (50.5)	0.268
	No	135 (49.1)	36 (36.0)	
BMI	Normal	74 (26.9)	26 (56.5)	0.049*
	Overweight	84 (30.5)	27 (43.5)	
	Obese	117 (42.5)	33 (36.3)	
Type of treatment	Oral hypoglycemic medications	131 (47.6)	45 (43.7)	0.043*
	Oral +- insulin	99 (36)	34 (50.0)	
Duration of type 2 DM	<5 Years	130 (47.3)	37 (41.6)	0.216
	>5 years	145 (52.7)	49 (44.5)	
Hypertension	Yes	88 (32)	19 (21.6)	<0.001**
	No	187 (68)	67 (60.4)	
Serum cholesterol	< 200 mg/dL	62 (22.5)	16 (34.0)	0.247
	>= 200 mg/dL	44 (16)	16 (44.4)	
HbA1c	7-10 Border line	130 (47.3)	41 (42.3)	0.266
	> 10 Uncontrolled	32 (11.6)	15 (57.7)	
Serum Triglyceride	Less than 150 mg/dl	58 (21.1)	18 (43.9)	0.176
	More than 150 mg/dl	31 (11.3)	10 (40.0)	
Serum HDL	Less than 40 mg/dl	57 (20.7)	15 (37.5)	0.260
	More than 40 mg/dl	25 (9.1)	9 (45.0)	
Serum LDL	Less than 100 mg/dl	48 (17.5)	16 (45.7)	0.476
	More than 100 mg/dl	31 (11.3)	7 (30.4)	
Hemoglobin	Less than 12 g/dl	39 (14.2)	6 (20.7)	0.486
	12-15 g/dl	56 (20.4)	21 (47.7)	
Calcium	Less than 9 mg/dl	33 (12)	8 (30.8)	0.583
	More than 9 mg/dl	26 (9.5)	10 (50.0)	
Hospital visits in the past year	I haven't seen a doctor in the last year	61 22.2)	16 (40.4)	0.018*
	From 1-2	87 (31.6)	28 50.9)	
	From 2-5	71 (25.8)	19 (32.2)	
	More than 5 times	56 (20.4)	23 (51.1)	
Hospital admission in the past 5 years	Yes	67 (24.4)	24 (40.7)	0.002**
	No	208 (75.6)	62 (44.3)	
Number of hospitals admission	No	213 (77.5)	64 (44.4)	0.011*
	One	53 (19.3)	18 (39.1)	
	2 times and above	9 (3.3)	4 (44.4)	
Hospitalized due to diabetic coma	Yes	20 (7.3)	8 (61.5)	0.312
	No	255 (92.7)	78 (41.9)	

*Significant difference at $P < 0.05$, **Highly significant difference at $P \leq 0.01$.

between a family history of diabetes and various types of microvascular complications (p =0.042). Microvascular problems affect 39.6% of people with a history of diabetes.

Microvascular complications affect 36% of patients who do not engage in physical exercise. Physical activity is statistically significantly associated with microvascular complications (p =0.027).

Micro-vascular complications affect 21.6% of hypertension patients. There is a statistically significant association between hypertension and micro-vascular complications (p < 0.001).

There is a statistically significant association between hemoglobin and micro-vascular complications (p = 0.017), as 20.7% of the patients with anemia (hemoglobin less than 12 g/dl) have micro-vascular complications. Otherwise, no statistically significant relationship (p > 0.05) exists between micro-vascular complications and other socio-demographic, clinical and laboratory characteristics of participants, such as education level, income, smoking history, BMI, type of treatment, duration of DM, dyslipidemia, HbA1c, calcium, hospital visits in the last year, hospital admissions in the past 5 years, number of hospital admissions in the last year, and hospitalization due to diabetic coma.

Table (2) shows the results of Spearman's correlation analysis between the HbA1c level and continuous variables in the study. There are statistically significant correlations, according to the results. The HbA1c level and serum cholesterol levels had the strongest association value (r = 0.343, p 0.001), followed by hemoglobin (r = 0.281, p 0.001) and blood pressure (r = 0.156, p = 0.010). Hospitalizations had the least significant connection (r = 0.119, p = 0.049). The findings show that the greater the HbA1c level (> 10), the higher the values of cholesterol, hemoglobin, and blood pressure. Otherwise, the HbA1c level and other factors including age, the length of the DM, and BMI do not have a statistically significant association (p > 0.05).

Table 2. Correlations between continuous variables and HbA1c level of participants.

Variables	Correlation coefficient	P value
Age	0.057	0.344
Duration of DM	-0.058	0.337
Body mass index (BMI)	-0.014	0.816
Serum cholesterol	0.343	<0.001**
Hemoglobin	0.281	<0.001**
High blood pressure	0.156	0.010*
Number of hospitalizations	0.119	0.049*

*Significant difference at P < 0.05, **Highly significant difference at P≤0.01

Table 3. Prevalence and association between gender and different types of micro-vascular complications in the studied sample

Variables	All diabetic patients	Micro-vascular complications	Retinopathy	Peripheral Neuropathy
	N (%)	N (%)	N (%)	N (%)
All patients	275 (100)	86 (100)	51 (100)	47 (100)
Male	90 (32.7)	35 (53)	18 (35.3)	15 (32)
Female	185 (67.3)	51 (38.3)	33 (64.7)	32 (68)
P. Value	0.888	0.049*	0.665	0.896

*Significant difference at P < 0.05, **Highly significant difference at P≤0.01.

Table 4. Multiple logistic regression of risk factors associated with the occurrence of micro-vascular complications among patients with type 2 diabetes mellitus

Variables	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
Intercept	-1.988	1.458	1.859	1	.173			
Age	1.086	.402	7.310	1	.007**	2.963	1.348	6.511
Gender	.721	.329	4.800	1	.028*	2.057	1.079	3.923
BMI	.010	.019	.270	1	.603	1.010	.973	1.048
Duration of DM	-.289	.331	.764	1	.382	.749	.391	1.433
Serum HbA1c (past 3 months)	-.286	.238	1.447	1	.229	.751	.472	1.197
Education	-.208	.152	1.892	1	.169	.812	.603	1.093
Type of treatment	-.483	.246	3.858	1	.049*	.617	.381	.999
Physical activity	.499	.314	2.529	1	.112	1.646	.891	3.044

*Significant difference at $P < 0.05$, **Highly significant difference at $P \leq 0.01$.

Table (3) shows the results of Fisher tests for associations between gender and different types of microvascular complications as retinopathy and peripheral neuropathy. There is a statistically significant association between gender and microvascular complications as retinopathy and peripheral neuropathy ($p < 0.05$). In the study, males had a higher prevalence of retinopathy and peripheral neuropathy than females ($p = 0.049$). Otherwise, there is no statistically significant difference ($p > 0.05$) in retinopathy or peripheral neuropathy between the male and female groups.

Table (4) displays the results of multiple logistic regression tests performed to investigate the relationships between factors associated with microvascular complications. The findings revealed that age, gender, and treatment type have a significant positive effect on the appearance of microvascular complications ($p< 0.05$). Gender ($B = 0.721$, $p = 0.028$) indicates that the more males there are, the more complications of microvascular diabetes are likely. Age ($B = 1.086$, $p = 0.007$) indicates that the older one ages, the lower the risk of microvascular complications. The type of treatment ($B = -0.483$, $p = 0.049$) indicates that the more oral hypoglycemic and insulin therapy there is, the more likely complications of microvascular diabetes are. Otherwise, BMI, diabetes duration, HbA1c, education, and physical activity had no effect on the development of microvascular problems ($p > 0.05$).

DISCUSSION

In Saudi Arabia, many adult patients with type 2 DM had micro-vascular complications[9]. Our current study included 275 patients with type 2 DM in Al-Madinah Al-Munawara, 86 of them had Microvascular complications. There is a statistically significant association between the age of the patients and microvascular complications ($p < 0.05$). Microvascular complications affected 63% of the younger age group between 20 and 40 years, which was statistically significantly higher compared to 37.3% of the older age group (41–65 years old) (p 0.05). This is in contrast with a study conducted on patients at Dessie Town hospitals in Ethiopia[18], who reported that micro-vascular problems were higher in older people aged 40–59 years, with 58.2% of patients, compared to 11% of young adult patients aged 20–39 years having micro-vascular problems. Poor health care, poor medication adherence, or an unhealthy lifestyle could all contribute to the difference[18].

In our present study, microvascular problems were more common in males than females, with 53% against 38.3% of patients. This agrees with the study on patients at Dessie town hospitals, Ethiopia, where 54.6% of male patients were affected compared to 45.4% of female patients[18].

According to a study conducted in Sudan[12], 22.4% of patients had a family history of diabetes and had microvascular problems. In our study, microvascular complications were more likely in 39.6% of individuals with a family history of diabetes, compared to 55.6% of patients without a family history.

In the current study, those who are physically inactive have a lower prevalence of microvascular complications (36% vs. 50.5%) than those who participated in any type of physical activity. According to studies in Ethiopia[18] and in Sudan[12], individuals who were not active had higher rates of microvascular problems (62.2%) and 42.6%, respectively.

In our study, micro-vascular complications affect 21.6% of hypertension patients. There is a statistically significant association between hypertension and micro-vascular complications ($p < 0.001$). The result is supported by studies in Ethiopia[18] and Sudan[12], where the prevalence of micro-vascular complications for those who have hypertension is reported to be higher.

Hemoglobin levels were significantly positively correlated with HbA1c levels ($r = 0.281$, $p < 0.001$) in our study. The result is supported by Sinha et al.[12], in which hemoglobin and HbA1c levels were positively correlated in patients with DM before treatment[19].

In our study, there was a significant positive correlation between HbA1c and serum total cholesterol ($r = 0.343$, $p < 0.001$). Therefore, the association between glycemic control and serum total cholesterol can be explained by the fact that in both men and women with DM, lower glycemic control, higher weight, and more insulin resistance are associated with a larger distribution of atherogenic cholesterol[20]. Also, the increase in blood pressure is significantly correlated with increased HbA1C levels ($r = 0.156$, $p =0.010$) supporting our results. They found that subjects with higher HbA1c were hypertensive, and they also had a higher lipid profile as measured by serum total cholesterol and LDL cholesterol[21]. The coexistence of risk variables, particularly obesity, could be the cause of the positive correlation between hyperglycemia and hypertension. Additionally, inflammatory mechanisms contribute to the development of hypertension and hyperglycemia [22]. In our study, a significantly higher number of hospitalizations were noted in patients with significantly higher HbA1c levels ($r = 0.119$, $p = 0.049$). This result is supported by[23].

In our study, gender and microvascular complications were significantly associated. Males had a considerably higher percentage of microvascular problems (53% vs. 38.3% for females). In the comparison with primary health care research conducted in Sudan, males were more likely than females to have micro-vascular complications, which agrees with our results[12].

Factors linked to the development of microvascular complications were studied using multiple logistic regression analysis. In our study, young age ($B = 1.086$, $P = 0.007$) and male gender ($B = 0.721$, $P = 0.028$) had a significant positive effect on the appearance of microvascular complications. This contradicts a Riyadh study[24], which found that the likelihood of getting microvascular problems increases by 4% for every year of age increase. Each year that a person has diabetes, their chances of developing microvascular complications increase by 5%. Our findings showed that the type of treatment ($B = -0.483$, $P = 0.049$) had a significant positive effect on the appearance of microvascular complications, which agrees with a study done in Ethiopia (18).

Patients aged 20–39 years have a higher prevalence of microvascular disease because of poor health care, poor medication adherence, or an unhealthy lifestyle[18]. Males have a higher prevalence of microvascular disease because of genetic and environmental factors, and males are more likely to have hypertension.

CONCLUSION

In Al-Madinah Al-Munawara, our study is the first of its type to provide insight into the scope of the microvascular complications of DM. The current investigation found that a large number of patients had clinically substantial morbidity at the time of diagnosis and for many years before the diagnosis of diabetes and its sequelae. This study showed that retinopathy was more prevalent than peripheral neuropathy; T2DM patients also need rigorous lipid management because blood cholesterol levels and HbA1c levels had a strong correlation.

The age, gender, and type of treatment of the subjects, according to our findings, were independent predictors of microvascular problems. Males in the study had a higher prevalence of retinopathy and peripheral neuropathy than females.

Recommendation

In our region, there is a need for more awareness and attention to the microvascular problems that might occur in people with type 2 diabetes. Improved public health awareness services and better health education and promotion programs will reduce the risk of complications of DM in the country.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Funding source

Not applicable.

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