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Prevalence and Risk Factors for Diabetic Peripheral Neuropathy and Diabetic foot ulcer in Primary Care, North Al Batinah Oman

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ABSTRACT

Aim and Background

Diabetic Foot Disease (DFD), which includes peripheral neuropathy and diabetic foot ulcers (DFUs), continues to be a significant cause of morbidity among diabetic patients. Although sex differences in diabetes complications are increasingly recognized, there is limited research in primary care settings, especially in Oman. Identifying the extent of this problem and its risk factors will enable health providers to set up better prevention programs. Foot complications are a serious consequence of diabetes mellitus, posing a major medical and economical threat. Identifying the extent of this problem and its risk factors will enable health providers to set up better prevention programs. Sex-related differences in clinical characteristics, complications, and self-care behaviors among diabetic patients with peripheral neuropathy and DFUs are big challenges in primary care center.

Objective of this study is to assess the Prevalence and Risk Factors for Diabetic Peripheral Neuropathy and Diabetic foot ulcer in Primary Care

Methods

A cross-sectional study was conducted among 218 diabetic patients at the Suhar Extended Health Center (SEHC). Data was collected through face-to-face interviews, clinical examinations, and electronic medical records. The variables included demographic data, diabetes history, comorbidities, clinical complications, and self-care practices. Statistical analyses were performed using SPSS version 22. Chi-square tests and Wilcoxon rank-sum tests assessed sex-based differences, with significance set at $p < 0.05$.

Results

Most participants were aged 41 to 60 years, with no significant differences in age distribution between sexes. Males had higher rates of smoking ($p = 0.003$), kidney disease ($p = 0.042$), and retinopathy ($p = 0.0024$). Females had significantly higher BMI ($p = 0.0001$) and estimated glomerular filtration rate (eGFR) ($p = 0.0148$). No significant differences between sexes were found in neuropathy symptoms or DFU severity (Wagner classification, $p = 0.9064$). Males demonstrated better adherence to physical activity ($p = 0.0076$), while females exhibited a non-significant trend toward more frequent foot checks. Most metabolic and clinical risk factors, including HbA1c, hypertension, and ischemic heart disease, were similar between sexes.

Conclusion

While the prevalence of DFU and neuropathy symptoms did not significantly differ by sex, notable differences in comorbidities, BMI, kidney function, and self-care behaviors underscore the need for sex-specific strategies in the primary care management of diabetic patients at risk for DFD. Differences in systemic risk profiles, the comparable prevalence of DFU and neuropathy across sexes suggests that primary care screening protocols can remain uniform for prevention.

Keywords: Diabetic Foot Disease, Diabetic Foot Ulcers, Peripheral Neuropathy, Gender Differences, Primary Care, Oman

I. BACKGROUND

In 2011, the global estimate of the prevalence of diabetes indicated that there were 366 million people with diabetes, and this number is expected to rise to 552 million by 2030. Most people with diabetes live in low- and middle-income countries, and these countries will also see the greatest increase over the next 19 years [1]. In 2019, an estimated total of 409 000 (95% uncertainty interval 373 000-443 000) adults aged 20 years or older in the Americas died from diabetes, which represented 5·9% of all deaths[2].

The prevalence of foot ulcers in Jordan was reported at 5.3%, while the prevalence of feet at risk was observed in 17.2% of patients. Patients with loss of protective sensation, loss of vibratory sensation, and vascular insufficiency of the lower limbs were found to be at a higher risk for the development of foot ulceration [3]. The prevalence of DPN in the Saudi population reported at 19.9%. Several correlations for DPN, in addition to glycemic control and diabetes duration, were identified, including abdominal obesity, creatinine, and white blood cell count [4].

Diabetic foot ulcer (DFU) is a debilitating and severe manifestation of uncontrolled and prolonged diabetes that presents as an ulceration, usually located at the plantar aspect of the foot. Elevated blood glucose levels over time can damage the nerves in the foot, diminishing a person's ability to feel pain and pressure. Without these sensations, it's easy to develop callused pressure spots and accidentally injure the skin, soft tissue, bones, and joints. During a foot exam for diabetic peripheral neuropathy (DPN), a healthcare provider checks for poor circulation, nerve damage, skin changes, and deformities. Patients should report any issues or symptoms they have noticed in their feet. Examination may reveal diminished or absent reflexes, or a reduced ability to sense pressure, vibration, pinpricks, and changes in temperature. Special devices, including monofilament or a tuning fork, can help assess the extent of nerve damage.

Foot complications are a serious consequence of diabetes mellitus, posing a major medical and economic threat. Identifying the extent of this problem and its risk factors will enable health providers to establish better prevention programs. Diabetic foot is more commonly observed among type 2 patients, although it is also prevalent among type 1 diabetic patients. The overall prevalence of diabetic foot complications in another study is 3.3%, according to the Saudi National Diabetes Registry (SNDR), which includes a cohort of 62,681 patients aged ≥ 25 years from the SNDR database [5].

Another study identified several risk factors that contributed to the development of DPN in Saudis. These factors must be considered in strategies and campaigns aimed at reducing the risk of cardiovascular and chronic diseases and, consequently, the progression of DPN. A total of 2,096 adult diabetic patients were identified during the study period. Of these, 73 patients (3.5%) were confirmed to be suffering from DPN, and 219 were included as controls [6]. The prevalence of diabetes complications and associated conditions among Omani T2D patients was similar to that of other populations. However, the prevalence of retinopathy and neuropathy was lower in one published study, indicating the need for proper assessment and documentation [7]. More than 75% of the disease burden in Oman is attributable to noncommunicable diseases, with cardiovascular disease being the leading cause of death. The distribution of chronic diseases and related risk factors among the general population is similar to that of industrialized nations: 12% of the population has diabetes, 30% is overweight, 20% is obese, 41% has high cholesterol, and 21% has metabolic syndrome [8].

The age-adjusted prevalence of T2DM in Oman varied from 10.4% to 21.1%, while the highest prevalence of impaired fasting glucose was found in males (35.1%). Compared to men, higher incidence rates of T2DM were found in women The results of this study show that by 2050, there will be an estimated 350,000 people with T2DM living in Oman (a 174% increase compared to estimates for 2015) [9]. Men experiencing higher rates of ulceration, amputations, and mortality. Men often have poorer foot self-care, while women may face higher risks due to worse metabolic control and specific foot deformities like calluses. Men generally have a higher prevalence of DFD. Literature also reported that development of diabetic foot were presented differently in women and men.

Longstanding high blood sugar can damage blood vessels, decreasing blood flow to the foot. This poor circulation can weaken the skin, contribute to the formation of ulcers, and impair wound healing. Some bacteria and fungi thrive on high levels of sugar in the bloodstream, and bacterial and fungal infections can break down the skin and complicate ulcers[10].

In Oman, foot care for patients with diabetes is primarily provided in primary and secondary care settings. Among all lower limb amputations performed in public hospitals in Oman between 2002 and 2013, 47.3% were conducted on patients with diabetes. While advances have been made in the delivery of diabetes care, the prevalence of long-term complications of diabetes, including foot ulceration and lower limb amputation, is expected to rise. The ultimate target should be to significantly reduce the rate of diabetes-related lower limb amputations [11]. most of the Arabs' countries particularly those in the GCC region which reported

very high prevalence rates and are expected to hold these rates for the coming decades[12]. In Oman a short primary health-care screening program introduced for diabetic foot disease (DFD) in diabetic patients and to detect the prevalence and predictors of the DFD, to determine their positive risk factors for DFD by identifying patients who have neuropathy or vascular disease, and to examine whether the predictors (neuropathy and vasculopathy) have a significant effect on DFD.

One study reported that over 15% of the sample had a history of foot ulcers, and almost 42% experienced numbness, tingling, and pain in their feet. Positive foot care behaviors correlated with higher income, higher educational attainment, lower body weight, a positive attitude, and greater awareness of diabetes and its management. Targeting individuals with type 2 diabetes who possess low levels of education, low income, and are overweight may help enhance their foot care and reduce foot complications in similar populations. Implications: Those most at risk for foot problems should be targeted for education to increase their awareness of ways to prevent and manage foot issues [13].

Diabetic peripheral neuropathy (DPN) is one of the most common complications of diabetes and is responsible for morbidity and disability among diabetic patients. This study aims to assess the prevalence of painful DPN and its associated risk factors in patients with diabetes mellitus. One study has shown that type 2 diabetes mellitus affects 74.9% of cases. The prevalence of DPN was 30.1% in type 2 diabetic patients and 25.9% in type 1 diabetic patients, leading to an overall prevalence of 29.1%. DPN was significantly associated with age, duration of diabetes mellitus, uncontrolled A1c levels, and a positive family history of diabetes mellitus. The prevalence of DPN was reported as 25.9% and was linked to age, duration of DM, and uncontrolled Hemoglobin A1C (HbA1c) [14].

Research on diabetic foot disease (DFD) in Oman indicates significant gender differences in prevalence, risk factors, and attitudes toward care, with a higher burden of disease generally falling on men, though with specific risks for women [20]. One systematic review and meta-analysis of observational studies by Chen et al. (2023) found that Diabetic Foot Ulcer (DFU) carries a high mortality rate, with approximately 50% of patients dying within 5 years. Studies in Oman show that DFD is more common in men, with one study reporting 58.0% of DFD cases in males compared to 52.9% in females. Another study indicated that over two-thirds (69.1%) of patients with diabetes-related lower limb amputations in Omani Ministry of Health (MOH) institutions were male [25].

In Oman, a short primary health-care screening program was introduced for diabetic foot disease (DFD) in diabetic patients to detect the prevalence and predictors of DFD, determine positive risk factors by identifying patients with neuropathy or vascular disease, and examine whether these predictors (neuropathy and vasculopathy) have a significant effect on DFD. Out of the total number of patients, 164 (75.9%) cases are diagnosed with DFD. However, the prevalence of foot ulcers, gangrene, and amputations is 4.2%. Among the subjects studied, 65.9% had a poor glycemic profile. Most patients had a history of diabetes lasting more than 5 years [15]. This study investigates the sex differences in diabetic foot ulcers and their associated risk factors among diabetic patients attending primary care.

II. METHODOLOGY

A cross-sectional observational study was conducted. Diabetic patients registered in the catchment area of Suhar Extended Health Center (SEHC) who gave consent were included. Patients who did not give consent and needed hospitalization were excluded. Ethical approval was obtained from the Research and Ethics Committee, College of Medicine and Health Sciences at the National University. Ethical consideration was made by seeking MOH regional ethics committee approval, and permission to access the patient interview and examination and electronic medical records of Sohar Extended Health Center will be taken.

The study included 218 diabetic patients. The minimum sample size was calculated based on a 95% confidence interval, a 5% margin of error, a 15% proportion of foot ulcers,(done after literature search) and 1700 diabetic patients registered in the diabetes register at SEHC by the end of 2022.

The sampling frame is the list of all diabetic clinic appointments requested by Sohar EHC. A simple random sample will be selected from the frame list (replacement of missed appointments considered by adding 10% more to the sample size, to be 194). All selected appointments listed and scheduled to be invited to participate in the study (informed consent will be taken) during their scheduled visits. Those who agreed to participate will be interviewed during their waiting period, and their examination after seeing doctors will be taken from their medical records. The co-investigator will conduct a face-to-face interview with the patient.

Two co- authors of this study was trained by PI for data collection process which was face to face interview. The standardized form was reviewed and validated by experts from the research field (Academics, Researchers, and diabetic-specialized doctors and nurses). Patients during their scheduled appointments was interviewed by co-authors.

Data was collected on age, gender, type and duration of diabetes, treatment modality, smoking status, self-care activities, and other co morbidities. Current symptoms for peripheral neuropathy, BMI, vascular, neurological (detail foot examination), musculoskeletal, dermatological, nail and footwear conditions, and ulcer

risk category will also be assessed. Laboratory parameters extracted from the computerized databases including the most recent HbA1c values. Risk categories defined as: grade 0= No neuropathy present; grade 1= Neuropathy without deformity or history of ulceration; grade 2= Neuropathy with deformity or peripheral vascular disease; and grade 3= History of ulcer or amputation [16]. Wagner ulcer classification system defined as: grade 0= No ulcer, but high-risk feet (bony prominences, callus, claw toes, etc.); grade 1= Superficial full-thickness ulcer; grade 2= Deep ulcer, may involve tendons, no bone involvement; grade 3= Deep ulcer with bone involvement, osteomyelitis; grade 4= Localized gangrene; grade 5= Gangrene of whole foot.[17].

The required data were collected from the patients' medical records and from the sampled diabetic patients. A standardized form was used to gather data. Clinical characteristics and demographic data were obtained from reviewing medical records (Al Shifa'a system), interviewing, and examining the patients during their scheduled appointments at the diabetic clinic. The standardized form was reviewed and validated by experts from the research field (Academics, Researchers, and diabetic-specialized doctors and nurses). Before starting the data collection, a pilot implementation of the tool was conducted on 5-10 patients during their scheduled appointments to consider the required improvement. No major modification was done after pilot study.

SPSS 22 will be used for data entry, cleaning, editing and analysis. Numerical variables described as means and standard deviations, while categorical variables will be described as frequencies and percentages. The chi-square test assessed the association between sex and independent variables. One-way ANOVA will be used to compare the mean level of HbA1c and other numerical independent variables in the presence of neuropathy and foot ulcer. None of the variables followed a normal distribution, as determined by the Shapiro–Wilk test, and therefore all comparisons employed the Wilcoxon rank-sum test. A value of 5% will be considered for statistical significance for hypothesis testing.

III. RESULT

A total of 218 patients participated in this study,52% female. The distribution of age categories did not significantly differ between males and females ($p = 0.519$). Most participants were between 41 and 60 years old, across both sexes. A statistically significant association was observed in marital status ($p < 0.001$), with a higher proportion of females being widowed (24.8%) compared to males (2.9%). Smoking status also differed significantly by sex ($p = 0.003$); current or ever smoking was more prevalent among males (45.7%) than females (29.6%). The type of diabetes varied significantly between sexes ($p = 0.039$), with Type I DM more common among males (10.5%) than females (2.7%).

No significant association was observed between sex and the duration of diabetes ($p = 0.554$), oral hypoglycemic use ($p = 0.669$), or insulin use ($p = 0.159$). Similarly, hypertension ($p = 0.260$), stroke ($p = 0.432$), ischemic heart disease ($p = 0.538$), depression ($p = 0.713$), and cancer ($p = 1$) showed no statistically significant sex-based differences. However, kidney disease was significantly more prevalent among males (18.1%) than females (8%) ($p = 0.042$). Although not statistically significant, hypothyroidism and liver disease were more common among females, with borderline p-values of 0.118 and 0.108, respectively.

Table 1 Patient's Gender and Comorbidities

	Male	**Female**	**P value**
Age			0.519
age ≤30	4 (3.8%)	3 (2.7%)	
age 31-40	8 (7.6%)	5 (4.4%)	
age 41-50	30 (28.6%)	26 (23%)	
age 51-60	35 (33.3%)	36 (31.9%)	
age 61-70	16 (15.2%)	27 (23.9%)	
age ≥ 70	12 (11.4%)	16 (14.2%)	
Marital Status			<0.001
Divorced	1 (1%)	0 (0%)	
Married	89 (84.8%)	79 (69.9%)	
Separated	3 (2.9%)	2 (1.8%)	
Single	9 (8.6%)	4 (3.5%)	
Widowed	3 (2.9%)	28 (24.8%)	
Smoking			0.003
Current smoker	11 (10.7%)	1 (0.9%)	

Ever smoked	36 (35%)	31 (28.7%)	
Never smoked	56 (54.4%)	76 (70.4%)	
Type of Diabetes			0.039
Type I DM	11 (10.5%)	3 (2.7%)	
Type II DM	94 (89.5%)	109 (97.3%)	
Duration of Diabetes			0.554
<10 years	51 (49%)	61 (54%)	
≥10 years	53 (51%)	52 (46%)	
Oral Hypoglycemic			0.669
No	20 (19%)	18 (15.9%)	
Yes	85 (81%)	95 (84.1%)	
Insulin			0.158
No	74 (70.5%)	90 (79.6%)	
Yes	31 (29.5%)	23 (20.4%)	
Hypertension			0.260
No	45 (42.9%)	39 (34.5%)	
Yes	60 (57.1%)	74 (65.5%)	
Stroke			0.432
No	101 (96.2%)	111 (98.2%)	
Yes	4 (3.8%)	2 (1.8%)	
Ischemic Heart Disease			0.538
No	90 (85.7%)	101 (89.4%)	
Yes	15 (14.3%)	12 (10.6%)	
Hypothyroidism			0.118
No	100 (95.2%)	100 (88.5%)	
Yes	5 (4.8%)	13 (11.5%)	
Liver Disease			0.108
No	101 (97.1%)	113 (100%)	
Yes	3 (2.9%)	0 (0%)	
Kidney Disease			0.042
No	86 (81.9%)	104 (92%)	
Yes	19 (18.1%)	9 (8%)	
Depression			0.713
No	101 (96.2%)	110 (97.3%)	
Yes	4 (3.8%)	3 (2.7%)	
Cancer			1
No	103 (98.1%)	111 (98.2%)	
Yes	2 (1.9%)	2 (1.8%)	

Among diabetic complications, retinopathy showed a statistically significant difference between sexes, with males having a higher prevalence (32.4%) compared to females (14.2%) ($p = 0.0024$). Other complications, including neuropathy, nephropathy, ischemic heart disease, and stroke, did not differ significantly between males and females ($p > 0.1$). No statistically significant sex differences were observed across all risk factors. The proportions of diabetes, hypertension, ischemic heart disease, hypothyroidism, and hyperlipidemia were comparable between males and females (all p-values > 0.1). However, hyperlipidemia was slightly higher in males (2.9%) compared to females ($p = 0.11$).

Finally, the Wagner classification grades for diabetic foot ulcers were similar between the sexes, with most participants in both groups classified as Grade 0. Higher grades (1–5) were rare and did not demonstrate significant variation by sex ($p = 0.9064$).

Table 2 Diabetic complications, risk factors and Wagner classification grades for diabetic foot ulcers

	Male	Female	P value
Retinopathy			0.002
No	71 (67.6%)	97 (85.8%)	
Yes	34 (32.4%)	16 (14.2%)	
Neuropathy			0.166
No	86 (81.9%)	101 (89.4%)	
Yes	19 (18.1%)	12 (10.6%)	
Nephropathy			0.436
No	79 (75.2%)	91 (80.5%)	
Yes	26 (24.8%)	22 (19.5%)	
Ischemic Heart Disease			0.392
No	92 (87.6%)	104 (92%)	
Yes	13 (12.4%)	9 (8%)	
Stroke			0.713
No	101 (96.2%)	110 (97.3%)	
Yes	4 (3.8%)	3 (2.7%)	
Diabetes			0.443
No	12 (11.4%)	18 (15.9%)	
Yes	93 (88.6%)	95 (84.1%)	
Hypertension			0.522
No	41 (39%)	50 (44.2%)	
Yes	64 (61%)	63 (55.8%)	
IHD			0.893
No	80 (76.2%)	88 (77.9%)	
Yes	25 (23.8%)	25 (22.1%)	
Hypothyroidism			0.428
No	80 (78.4%)	92 (83.6%)	
Yes	22 (21.6%)	18 (16.4%)	
Hyperlipidemia			0.110
No	102 (97.1%)	113 (100%)	
Yes	3 (2.9%)	0 (0%)	
Wagner classification			0.906
0	97 (93.3%)	102 (92.7%)	
1	5 (4.8%)	6 (5.5%)	
2	0 (0%)	1 (0.9%)	
3	1 (1%)	0 (0%)	
4	0 (0%)	1 (0.9%)	
5	1 (1%)	0 (0%)	

In general self-care activities, no significant sex differences were observed in fruit and vegetable consumption or high-fat food intake ($p = 1.000$). However, males were significantly more likely to meet recommended physical activity levels (54.3% vs. 35.4%, $p = 0.0076$). Regarding diabetes-specific self-care behaviors, such as blood glucose monitoring, foot checks, and shoe checks over the past three months, no statistically significant sex differences were detected (all p-values > 0.05). However, women tended to perform foot checks more frequently.

For symptoms of peripheral neuropathy, including trauma history, numbness, tingling, and burning sensations, prevalence rates were similar between sexes ($p > 0.2$ for all), indicating no significant gender-related differences in symptom reporting. Foot examination findings were largely similar across sexes. However, callus formation was significantly more common among males (18.1% vs. 6.2%, $p = 0.0124$), while skin changes approached significance (14.3% vs. 6.2%, $p = 0.079$). Other clinical signs, including fungal infection, arterial pulses, vibration sense, and ulcer presence, demonstrated no significant sex-based variation.

Table 3 Self-care Behaviors, Neuropathy Symptoms, and Foot Examination Findings

	Male	Female	P value
5 servings of fruits/vegetable			**1**
No	25 (23.8%)	27 (23.9%)	
Yes	80 (76.2%)	86 (76.1%)	
High fat food >6 times/wk			1
No	95 (90.5%)	102 (90.3%)	
Yes	10 (9.5%)	11 (9.7%)	
Physical activity 150 min/wk			0.008
No	48 (45.7%)	73 (64.6%)	
Yes	57 (54.3%)	40 (35.4%)	
Blood sugar			0.538
<3 times	66 (62.9%)	69 (61.1%)	
3–7 times	25 (23.8%)	33 (29.2%)	
>7 times	14 (13.3%)	11 (9.7%)	
Feet checked			0.092
<3 times	55 (52.4%)	52 (46%)	
3–7 times	27 (25.7%)	44 (38.9%)	
>7 times	23 (21.9%)	17 (15%)	
Shoes checked			0.682
<3 times	56 (53.3%)	61 (54%)	
3–7 times	25 (23.8%)	31 (27.4%)	
>7 times	24 (22.9%)	21 (18.6%)	
History of trauma			0.223
No	95 (90.5%)	108 (95.6%)	
Yes	10 (9.5%)	5 (4.4%)	
Numbness			0.996
No	91 (86.7%)	99 (87.6%)	
Yes	14 (13.3%)	14 (12.4%)	
Tingling			0.203
No	90 (85.7%)	104 (92%)	
Yes	15 (14.3%)	9 (8%)	
Burning sensation			0.419
No	88 (83.8%)	100 (88.5%)	
Yes	17 (16.2%)	13 (11.5%)	
Skin changes			0.079
No	90 (85.7%)	106 (93.8%)	
Yes	15 (14.3%)	7 (6.2%)	
Callus			0.012
No	86 (81.9%)	106 (93.8%)	
Yes	19 (18.1%)	7 (6.2%)	
Dry cracked skin			0.109
No	77 (73.3%)	94 (83.2%)	
Yes	28 (26.7%)	19 (16.8%)	
Foot deformity			1

No	97 (92.4%)	104 (92%)	
Yes	8 (7.6%)	9 (8%)	
Fungal infection			0.568
No	86 (81.9%)	88 (77.9%)	
Yes	19 (18.1%)	25 (22.1%)	
Dorsalis pedis artery			0.336
No	3 (2.9%)	7 (6.2%)	
Yes	102 (97.1%)	106 (93.8%)	
Posterior tibial artery			0.684
No	2 (1.9%)	4 (3.5%)	
Yes	103 (98.1%)	109 (96.5%)	
Vibration sense			0.859
No	11 (10.5%)	10 (8.8%)	
Yes	94 (89.5%)	103 (91.2%)	
Fine touch			1
No	7 (6.7%)	7 (6.2%)	
Yes	98 (93.3%)	106 (93.8%)	
Microfilament sensation			0.754
No	8 (7.6%)	11 (9.7%)	
Yes	97 (92.4%)	102 (90.3%)	
Proprioception			0.749
No	4 (3.8%)	6 (5.3%)	
Yes	101 (96.2%)	107 (94.7%)	
Ankle jerk			1
No	5 (4.8%)	6 (5.3%)	
Yes	100 (95.2%)	107 (94.7%)	
Foot ulcer			0.527
No	99 (94.3%)	109 (96.5%)	
Yes	6 (5.7%)	4 (3.5%)	

The comparison of clinical parameters between male and female patients revealed significant differences in several variables. Body Mass Index (BMI) was significantly higher among females (32.02 ± 6.33) compared to males (28.99 ± 6.03), with a Wilcoxon p-value of 0.0001. Although fasting blood sugar (FBS) and random blood sugar (RBS) levels were slightly lower among females, only the RBS difference reached statistical significance ($p = 0.0405$), albeit with a small effect size ($d = –0.09$). HbA1c levels did not differ significantly between genders ($p = 0.077$). However, the estimated glomerular filtration rate (eGFR) was notably higher in females (83.95 ± 13.65) than in males (79.88 ± 18.08), with a p-value of 0.0148 and a small effect size ($d = 0.26$).

Table 4 Comparison of Gender difference

Variable	Male	Female	P value
BMI (Kg/m^2)	28.99 ± 6.03	32.02 ± 6.33	<0.001
FBS	14.41 ± 31.06	12.49 ± 28.32	0.757
RBS	30.04 ± 59.97	24.95 ± 59.72	0.041
HbA1c	7.67 ± 1.41	7.48 ± 1.66	0.077
eGFR	79.88 ± 18.08	83.95 ± 13.65	0.015

IV. DISCUSSION

This study aimed to explore gender-based differences in diabetic foot disease (DFD), including peripheral neuropathy and diabetic foot ulcers (DFUs), among patients attending a primary care center in North Al Batinah, Oman. DFUs can have serious consequences, including a high rate of disability, mortality, and recurrence, as well as high treatment costs and prolonged hospitalization.

In this study several notable distinctions emerged in comorbidities, clinical parameters, and self-care behaviors. Most participants were between 41 and 60 years old, across both sexes. A statistically significant association was observed in marital status. Smoking status for current or ever smoking was more prevalent among males than females. The type of diabetes varied significantly between sexes (Table 1).The comparison of clinical parameters between male and female patients revealed significant differences in several variables. Body Mass Index (BMI) was significantly higher among females compared to males . HbA1c levels did not differ significantly between genders. However, the estimated glomerular filtration rate (eGFR) was notably higher in females than in males.

In our study, there is no significant gender differences seen in the result however callus formation is more in male.One recent study has shown that several factors, such as longer duration of diabetes over 10 years, insulin therapy, male sex, older age, smoking, addiction to other drugs, family history of diabetes, higher body mass index, physical inactivity, and diabetes complications such as proliferative and non-proliferative retinopathy and nephropathy, were identified as major risk factors contributing to the development of DFU[18].
In this study,among diabetic complications, retinopathy showed a statistically significant difference, with males having a higher prevalence compared to females . Wagner classification grades for diabetic foot ulcers were similar between the sexes, with most participants in both groups classified as Grade 0. Higher grades (1–5) were rare and did not demonstrate significant variation by sex . For symptoms of peripheral neuropathy, including trauma history, numbness, tingling, and burning sensations, prevalence rates indicating no significant gender-related differences in symptom reporting. Foot examination findings were largely similar across sexes. However, callus formation was significantly more common among males, while skin changes approached significance in females. Other clinical signs, including fungal infection, arterial pulses, vibration sense, and ulcer presence, demonstrated no significant sex-based variation (Table 2). Literature reported that ulcers significantly associated with the risk of developing DF is more common in men especially sensory changes in feet. In women, older age (≥80 years), presence of calluses and claw toes were determinant in the development of diabetic foot, with a chance at least two times higher than those who did not present these factors [19].

This study showed that diabetic foot ulcers are present in 4.6% of patients in our center. Ulceration was associated mainly with the male gender, neuropathy, and increased duration of diabetes the only factors that were associated with a foot ulcer were gender, duration of diabetes, and sensory neuropathy. Males were almost twice more likely to have a foot ulcer compared to women. Prevalence of diabetes-related complications, including diabetic foot disease (DFD), is expected to rise in Oman. The pathologic mechanisms underlying DFU are comprise a triad: Neuropathy, vascular insufficiency, and secondary infection due to trauma of the foot. Standard local and invasive care along with novel approaches like stem cell therapy pave the way to reduce morbidity, decrease amputations, and prevent mortality from DFU. Studies in Oman show that DFD is more common in men, with one study reporting 58.0% of DFD cases in males compared to 52.9% in females. Another study indicated that over two-thirds (69.1%) of patients with diabetes-related lower limb amputations in Omani Ministry of Health (MOH) institutions were male [20]

Literature has shown that the use of insulin increased the risk of developing diabetic foot [19]. The presence of sensory comorbidities and ulcers also increased the risk for men. In our study males were significantly more likely to meet recommended physical activity levels. Regarding diabetes-specific self-care behaviors, such as blood glucose monitoring, foot checks, and shoe checks over the past three months, no statistically significant sex differences were detected (all p-values > 0.05) (Table3). However, women tended to perform foot checks more frequently.

The female participants in our study demonstrated significantly higher body mass index (BMI) and estimated glomerular filtration rate (eGFR), indicating more pronounced obesity but potentially better-preserved renal function. This sex-specific metabolic profile is underreported in the broader diabetic foot ulcer literature, underscoring the relevance of our findings for personalized prevention strategies.

In this study 47.9% of participants were at risk for DFUs. This risk was higher in patients who were older, male, widowed, working, illiterate, living in rural areas, and patients with diabetes duration >10 years, body mass index >32 kg/m2, uncontrolled blood glucose levels, on an insulin regimen, and smokers[21-22]
Our study stands alone among those reviewed that provides a clear, statistically significant sex-based analysis of both BMI and eGFR. The Silesia Diabetes-Heart Project Study supports the link between higher BMI and complications like DPN and DKD, but does not analyses by sex . On the other hand, other studies either do not report BMI/eGFR, or present group averages without sex disaggregation (Table 3 and 4).

Literature has shown the prevalence of DPN in the study group was 37.5%. The regression model analysis revealed that the presence of DPN was significantly associated with the presence of diabetic kidney disease (DKD) (P = 0.0034;) and patient's age which has significant association with DFD[23-24]

When it comes to the prevalence and severity of DFUs, as measured by the Wagner classification, were comparable between men and women. The majority of participants in both groups were categorized as Grade 0, indicating no active ulceration. Similarly, symptoms of peripheral neuropathy (including numbness, tingling, and burning sensations) did not differ by sex, nor did most physical examination findings such as vibration loss, fungal infections, or deformities. This suggests that while systemic risk profiles differ, the local foot manifestations of DFD are largely similar between sexes in this primary care population.

Our data collection questioners specifically addressed the risk of callus formation. The higher rate of callus formation among males could result from mechanical stress factors including improper footwear and different activity levels and delayed foot care. The observed trend of skin changes in males requires additional research despite its non-significant nature.

These data suggest that engaging patients with DFU in a multidisciplinary care model with frequent follow-up and focused patient education may serve to decrease DFU morbidity. Independent predictors of ulcer recurrence included abnormal proprioception (HR, 1.57 [95% CI 1.02-4.43]) and younger age number is rising with increased longevity and medical complexity of people with diabetes. Morbidity Prevention and early detection of DFU through guideline-directed multidisciplinary care is critical to decrease the morbidity and disparities associated with DFU. This meta-analysis found that the overall mortality of DFU was high, with nearly 50% mortality within 5 years. Cardiovascular disease and infection were the two leading causes of death [25-27]

V. CONCLUSION

Taken together, these findings emphasize the need for sex-specific strategies in the prevention and management of diabetic complications. For example, interventions targeting smoking cessation and retinopathy screening may be particularly beneficial for men, whereas obesity management and reinforcement of physical activity should be emphasized among women. Despite differences in systemic risk profiles, the comparable prevalence of DFU and neuropathy across sexes suggests that primary care screening protocols can remain uniform, with added emphasis on personalized risk mitigation.

Overall, this study reinforces the value of sex-disaggregated analysis in understanding and addressing the complex interplay of biological, behavioral, and social factors in diabetic foot disease. Future research should explore the longitudinal outcomes associated with these sex-based differences and evaluate the impact of targeted interventions in reducing the burden of diabetic foot complications in Oman and similar settings.

Limitations and Future Recommendations:

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design limits the ability to establish causality between sex and diabetic foot-related outcomes. Additionally, the study was conducted at a single primary care center in North Al Batinah, which may limit the generalizability of the results to other regions or healthcare settings in Oman. Self-reported data on behaviors such as physical activity and foot care may also be subject to recall or social desirability bias. Furthermore, some potentially influential factors (such as socioeconomic status, footwear habits, or glycemic variability over time) were not assessed.

Community awareness of DFD and emphasize the importance of optimal diabetes control to prevent complications ,regular foot self-care practices, wear appropriate shoes to prevent foot ulcers and proper health care services.

Future research should consider multicenter, longitudinal designs to better understand temporal relationships and progression of diabetic foot complications. There is also a need for interventional studies that evaluate the effectiveness of sex-specific education and management programs in improving outcomes and reducing complications among diabetic patients in primary care.

Ethical Consideration: Ethical approval taken from ethics committee Ministry of Health Oman
Authors Contribution: All authors contributed formulating hypothesis, research question,
Dr Muna and Dr Salim and Eman has done data collection,
Dr Siddiqui analyzed the data, FJ and all coauthors did the write up reviewed the manuscript
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