Risk factors for diabetic foot ulceration among patients attending primary health care services

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Abstract:

Diabetes mellitus is a global health problem with rising prevalence worldwide. Diabetes mellitus is a multi-system disease affecting many systems and tissues. Foot problems, including foot ulcerations, are common with diabetes. Foot ulceration risk factors are based on many factors and may differ from community to community. The objective of the study was to determine diabetic foot ulceration risk factors among Saudi patients with Type 2 diabetes in primary care centers. We designed a cross-sectional study and randomly selected 400 patients. Of the 400, 350 participated and completed a standard assessment form. Of the 350 subjects who participated, 57% were male and 43% were female. The prevalence of peripheral vascular disease was 15%, hallux valgus was 22.5%, inappropriate foot wear was 41%, and peripheral neuropathy was 47.5%. Peripheral neuropathy and inappropriate foot wear were the most common risk factors for foot ulceration.

Key words: Diabetes, Diabetic Foot, Diabetic Ulceration

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INTRODUCTION

Diabetes mellitus (DM) is a global health problem. During recent years DM prevalence has increased consistently. Diabetes mellitus has become among the biggest health problem in many countries, especially the low- and middle-income countries. Such growth has a major impact on the quality of life for hundreds of millions of people and their families, overwhelms the capacity of many national healthcare systems, and adversely impacts the economy of countries that are in most need of development.1

The prevalence of diabetes varies among countries; many factors contribute to this. The number of people worldwide with diabetes who are between 20–79 years old was 6.4%, affecting 285 million adults in 2010, and will increase to 7.7% and 439 million adults by 2030. Between 2010 and 2030 there will be a 69% increase in the number of adults with diabetes complications followed. Many changes in the Saudi community led to the change in the number of people with diabetes.2

In 2010, four out of the top five countries with diabetes were from the Arab world: United Arab Emirates (18.7%), Saudi Arabia (16.8%), Bahrain (15.4%) and Kuwait (14.6%).3

A steady increase in diabetes prevalence has been noted in Saudi Arabia.4 (Figure 1). Consequently, an increase in the prevalence of diabetes complications followed. Many changes in the Saudi community led to the change in the number of people with diabetes.

Figure 1. Prevalence of diabetes in Saudi Arabia
Foot problems are common and disabling complications with diabetes, frequently leading to amputation. In a community survey done in the UK, the prevalence of diabetic foot ulcers was 5.3% in patients with Type 2 diabetes. This survey also concluded that 7.4% of patients with Type 1 and 2 diabetes had a history of active or previous foot ulcers. In a US hospital-based survey, researchers found the prevalence of diabetic foot ulceration was 5.8%. In another survey done in The Netherlands, a mean incidence of new ulceration among patients with Type 2 DM alone was found to be 2.1% annually.

In Arab countries no sufficient data exists to help recognize the magnitude of the problem. From the few studies published about diabetic foot problems in the Arab world, great variation was noticed in the prevalence of this problem. The variation was due to different factors. An Iranian study examined the characteristics of patients with diabetic foot ulcers attending an outpatient diabetic clinic in the Kerman province of Southeastern Iran. The investigator examined 247 diabetic patients, with a mean age of 52 years, and found the prevalence of diabetic foot lesions to be 4%, callus 12%, and heel fissures 50%.

Another study found the prevalence of the diabetic foot ulcer was 4.7% among a sample of 375 Saudi patients with Type 2 diabetes. The author compared that group of patients with a corresponding Swedish group (age 46-69 years) and found a prevalence of foot ulcers of 2.3% in the Saudi group. This was significantly lower than in the Swedish patients. This finding may be explained by different styles of footwear.

An interesting study done in Saudi Arabia reported that 59% of the patients had foot ulcers, and 65% of these patients with ulcers needed debridement. In another retrospective study researchers stated that the prevalence of diabetic foot lesions in their Saudi population was found to be 10.4%.

A study done in King Khalid University Hospital, Riyadh from January 2003 to June 2006 included 184 diabetic nephropathy patients who were referred to a nephrology clinic. The prevalence of diabetic foot ulcer in the clinic was 13.5%. The researchers also concluded that baseline creatinine clearance and proteinuria, high systolic blood pressure, advanced age, and longer duration of diabetes were the most significant risk factors for developing complications.

Finally, another study determined the characteristics and risk factors of 13 diabetic patients undergoing chronic hemodialysis at King Abdul-Aziz University Hospital in Jeddah. The author found that 7.7% of the participants had a gangrenous foot, explaining the findings on poor glycemic control, inadequate treatment of hypertension, a high smoking rate, and inadequate screening for microalbuminuria.

**METHODOLOGY**

A cross sectional study was conducted from January to the end of December 2012 at a primary health care center. Four hundred patients were randomly selected; 350 people with Type 2 DM then consented to participate in the study. Participants' medical records were reviewed and patients were assessed using a standard assessment form.

The following was the enrollment inclusion criteria.

- Saudi nationality
- Medical record availability
- Type 2 diabetes
- No current ulceration
- No recent surgical foot intervention
- No recent foot trauma

SPSS software was used to analyze the data.

**RESULTS**

The study included 350 participants, 57% of whom were male.

Table 1 shows the demographic and clinical characteristics of the participants. As shown in Table 2, 56% of the patients had hypertension,
72% had dislipidaemia, 69% checked glucose regularly, 34% had glycemic control of HbA1c <7.5%, 78% had families with diabetes, 37% of patients were practicing sport, 18% were smokers, 6% had heart complications, 22% had diabetic retinopathy, 48% had diabetic neuropathy, and 24% of the patients had diseases other than diabetes, including dyspepsia, thyroid gland diseases, and osteoarthritis (Figure 2).

During peripheral vascular assessment, peripheral pulsation was not felt in 15% of patients (32 male and 20 female). Among foot deformities, hallux valgus was the most common (22.5%) deformity, and it was more prevalent in the female group (30%) than in male group (17%). Interestingly, inappropriate foot wear was the
second most common risk factor. Forty one percent (41%) of patients (143 patients; 87 male and 56 female) had inappropriate foot wear. Inappropriate traditional foot wear was the most common foot wear problem as shown in Table 3.

Among male participants, except for foot deformity (i.e., hallux valgus), risk factors were higher. Table 3 and Figure 3 show the differences between risk factors among male and female participants. Diabetic neuropathy was the most common risk factor among both groups (50% in male and 45% in female) followed by inappropriate foot wear (44.5% in male and 36% in female).

Table 3. Differences in risk factors for diabetic foot ulceration between male and female

<table>
<thead>
<tr>
<th>p-value</th>
<th>Female 43% (N: 150)</th>
<th>Male 57% (N: 200)</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8415</td>
<td>55.3% (n=83)</td>
<td>56.5% (n=113)</td>
<td>Hypertension</td>
</tr>
<tr>
<td>0.0719</td>
<td>67.3% (n=101)</td>
<td>75.5% (n=151)</td>
<td>Dyslipidaemia</td>
</tr>
<tr>
<td>0.024</td>
<td>13.3% (n=20)</td>
<td>21.5% (n=43)</td>
<td>Smoking</td>
</tr>
<tr>
<td>0.2301</td>
<td>4% (n=6)</td>
<td>7.5% (n=15)</td>
<td>Heart diseases</td>
</tr>
<tr>
<td>0.3173</td>
<td>45.3% (n=68)</td>
<td>50% (n=100)</td>
<td>Diabetic neuropathy</td>
</tr>
<tr>
<td>0.999</td>
<td>85% (n=128)</td>
<td>85% (n=169)</td>
<td>Peripheral pulsation, present</td>
</tr>
<tr>
<td>0.999</td>
<td>15% (n=22)</td>
<td>15% (n=31)</td>
<td>absent</td>
</tr>
<tr>
<td>0.6171</td>
<td>20.7% (n=31)</td>
<td>23% (n=46)</td>
<td>Diabetic retinopathy</td>
</tr>
<tr>
<td>0.0001</td>
<td>43.3% (n=65)</td>
<td>22% (n=44)</td>
<td>Irregular glucose checking</td>
</tr>
<tr>
<td>0.711</td>
<td>62% (n=98)</td>
<td>64% (n=128)</td>
<td>Irregular exercise</td>
</tr>
<tr>
<td>0.0001</td>
<td>64% (n=96)</td>
<td>88.5% (n=177)</td>
<td>Family history of diabetes</td>
</tr>
<tr>
<td>0.1936</td>
<td>4.7% (n=7)</td>
<td>8.5% (n=17)</td>
<td>Previous history of ulceration</td>
</tr>
<tr>
<td>0.0010</td>
<td>28.7% (n=43)</td>
<td>18% (n=36)</td>
<td>Hallux valgus</td>
</tr>
<tr>
<td>0.0010</td>
<td>36% (n=54)</td>
<td>44.5% (n=89)</td>
<td>Inappropriate foot wear</td>
</tr>
</tbody>
</table>

Figure 3: Prevalence of risk factors in males and females samples (%)

Diabetic neuropathy and inappropriate foot wear were found in 37% of all participants, being more common in men (85 participants) than in women (45 participants). In patients with non-palpable pulses, 95% had hypertension and dyslipidaemia or they had treatment for hypertension and dyslipidaemia (50 participants; 32 males vs. 18 female). Among those with a non-palpable pulse, the dorsalis pedis was the most common impalpable vessel (95%), while posterior tibialis was the second impalpable vessel (90%). Five percent of those with non-palpable pulses had neither pulse. All feet with non-palpable pedal pulses were referred to our vascular clinic.

The Chi-Squared test was used to detect any statistical difference between the prevalence of risk factors between males and females. There was no statistically significant differences in the prevalence of hypertension, dyslipidaemia, heart disease, diabetic neuropathy, diabetic retinopathy, and history of previous ulceration and palpable and impalpable vessels between males and females. However, there were statistically significant differences in the following risk factors: smoking, irregular glucose checking, irregular exercise, family history of diabetes, hallux valgus, and inappropriate foot wear (p-value <0.005).
Sixty-six percent (66%) of participants had four or more risk factors, 15% had three risk factors, 13% had two risk factors, and 6% had one risk factor. Some participants had more than one risk factor clustered together (Figure 4).

**DISCUSSION**

Diabetic foot problems are common throughout the world.

The literature identifies a wide range of prevalence rates for diabetic foot pathologies. However, it is difficult to compare this variation in pathologies since reports are from different regions, countries, and ethnic populations; are from different health care delivery systems; and include methodological differences. Furthermore, studies use different techniques and definitions to identify foot pathologies, as well as the population at risk.

An interesting paper from Malta looked at the prevalence of risk factors for diabetic foot complications and found that the prevalence of hallux valgus was 49.1%, while it was only 22% in our study. This could be explained by the small size of the Malta study (234 participants) compared to 350 participants in our study, as well as the race variation between the two study populations. The prevalence of hypertension and dyslipidaemia were high in both studies. In the Malta study, they were 71.2% and 65.8% respectively. They were 56% and 72% respectively in our study. These findings could be explained by the low prevalence of controlled diabetic subjects. In the Malta study, 54% reported a mean HbA1c of 7.2%, while only 34% in our study recalled a mean HbA1c of 7.5% or below. In our study the prevalence of diabetic neuropathy was 48%, while it was only 12.96% in the Malta study. This difference may be due to the differences in definition of diabetic neuropathy and method of diagnosis. In both studies the prevalence of inappropriate footwear was high, 56% in the Malta study and 41% in ours. Traditional open footwear and environmental factors in Saudi Arabia and other Arab countries, such as dry weather and some religious beliefs, also add to this high prevalence.

In population-based studies, the prevalence of diabetic neuropathy varies widely, according to the study populations, definitions, and methods used. A community-based study done in the UK recruited 34,198 participants with Type 2 diabetes (47.1% female). The study identified additional risk factors than were noted in our study. In addition to the peripheral diabetic neuropathy and peripheral arterial disease, it found that foot mycoses and open wounds of the foot were both risk factors for foot ulceration. It found a lower prevalence of diabetic peripheral neuropathy than our prevalence (6% vs. 48%). The UK study shared approximately the same results as a German study where the prevalence of peripheral diabetic neuropathy was 9.7%. Other population-based studies found higher prevalences than the UK and German studies.

In our study, the prevalence of peripheral arterial disease (PAD) was 15%. An interesting paper from the UK determined the prevalence of PAD in patients with Type 2 diabetes in the UK to be 11% (95% CI: 9.1–13.7). Sixteen percent of the diabetic population in a primary care setting in Malaysia was diagnosed with PAD. The prevalence of PAD in the Australian diabetic population was found to be 13.9% among patients with known diabetes and 6.9% in those newly diagnosed.

The authors of a Seattle diabetic foot study had a different point of view. This prospective
study looked at the effect of autonomic neuropathy on ulcer development. The Seattle study involved 749 subjects, most of the whom were elderly (mean age 63.2 years) and the majority were males (98%). The Seattle study concluded that there was a reduction of foot sensitivity due to peripheral sensory neuropathy detected by insensitivity to 5.07 monofilament, past history of amputation or foot ulcer, insulin use, Charcot deformity, 15 mmHg higher dorsal foot transcutaneous pO2, 20 kg higher body weight, 0.3 higher ankle – arm index, poor vision, and 13mm Hg orthostatic blood pressure fall are independently related to foot ulcer. This study did not look for inappropriate foot wear as a risk factor.

From East Africa, an interesting cross sectional study recruited 1,788 subjects and looked at risk factors related to development of foot ulcers in diabetic patients. The researchers found that neuropathy was found in 78% of patients. Ulcers were associated with high HbA1c, systolic hypertension, and dyslipidemia. Ischemia was found in 48.5% of participants. Only 18.3% recalled HbA1c <7% which reflect wide-spread poor glycemic control. Poor diabetic knowledge and inappropriate foot wear were contributing factors to ulcer formation. Surprisingly, this study agreed with us on the importance of the co-factors, such as hypertension and dyslipidemia, in the increasing prevalence of diabetic foot problems. The aforementioned study used clinical assessment for foot risk assessment, and we shared the same approach.

From Cameroon, an interesting cross sectional study recruited 300 diabetic patients. The authors reviewed records, conducted an interview, and performed a meticulous foot examination with assessment of neuropathy (monofilaments and tuning fork) and ischemia (pulses). The authors sought to determine the prevalence and risk factors of the diabetic foot in a clinic population. The prevalence of foot lesions was 13.0% (inpatients 25.6% and outpatients 11.1%). Diabetic neuropathy assessed using monofilaments was found in 81 patients (27.3%). The prevalence of ischemia was 21.3% and deformity was 17.3%, whereas 37 patients (12.3%) had a previous history of foot lesions. Foot examination was done in 14.3% of the patients, and 47% had a risky nail-trimming habit. Twenty-two percent wore ill-fitting shoes. The prevalence of diabetic foot lesions was high, and known risk factors were significantly present, especially poor foot care. Inappropriate foot wear, although less prevalent than in our study, was a problem in this study as well. It could also be explained by the effect of cultural habits.

A researcher from the Middle East found in his study that the following variables were significant risk factors for ulceration: male gender (P=0.009), previous foot ulcer (P=0.003), peripheral vascular disease (P=0.004), peripheral neuropathy (P=0.006), poor glycemic control (P=0.006), anemia (0.003), and lack of frequent foot self-examination.

The current study was important because it opened new windows for research. The development of a foot ulcer has traditionally been considered to result from a combination of peripheral vascular disease, peripheral neuropathy, and infection. However, there has been no convincing evidence that these three factors are the only important factors in developing diabetic foot ulceration. Gender, anemia, and duration of diabetes were among the other factors to be considered.

Patients living in rural areas, and those with poor socioeconomic conditions, were at a higher risk for developing diabetic foot ulcers. This result is consistent with many previous studies. The explanation may be that these patients are less likely to take care of their foot problems. In our study, participants did not reside in rural areas and did not belong to the middle economic class. Their beliefs affect their behavior towards foot care.

An interesting cross-sectional study from Al-Ain district, United Arab Emirates (UAE) recruited 513 subjects; 86% of them were diabetic with Type 2 diabetes with a mean age of 53 +/- 13 years. All subjects completed an interviewer-administered questionnaire and underwent medical assessment, including foot
examination. The researchers found that of the total population, 39% had peripheral neuropathy, 12% had peripheral vascular disease, 36% had hypertension, 76% were obese or overweight, 61% had microalbuminuria, 34% had high total cholesterol, 53% had high LDL, 37.6% had HbA1c <7%, and 62.4% had HbA1c >7%. They concluded that significant risk factors for peripheral neuropathy and peripheral vascular disease were: male gender, poor level of education, UAE nationality, increased duration of diabetes, Type 2 DM, and the presence of hypertension and microalbuminuria. Researchers in this study used clinical examination to judge peripheral vascularity, and this may explain the low prevalence of peripheral vascular disease (12%). Compared with our study, this study did not report any cases of foot deformities or previous ulceration. This may be a systematic sampling bias due to the fact that the majority of the sample populations (82%) were recruited from primary health care centers (PHCCs). It is known, and naturally expected, that diabetic patients with severe complications report and follow-up in hospitals and not in PHCCs. In our study, participants received follow-up care at specialty clinics.

The sample size was one limitation of our study, and we recognized there is a need for large community-based studies looking at other risk factors. Also, recruited patients, through diabetic care services, may add selection bias because most of these patients have risk factors that forced them to select this service. Community-based selection may decrease this bias.

CONCLUSION

Early screening for diabetic foot ulceration risk factors is an important process. Screenings can detect modifiable local risk factors and alert both the patients and health care providers to initiate preventive measures.

Diabetic neuropathy, peripheral vascular disease, and risk factors such as smoking, hypertension, and dyslipidemia, as well as inappropriate foot wear and foot deformity (mainly hallux valgus) were the most common risk factors detected in our study.

Conflict of Interest Statement

I declare that I have no conflict of interest. Also, I had no support from any organization for the submitted work, no financial relationships with any organizations that might have an interest in the submitted work in the previous three years, and no other relationships or activities that could appear to have influenced the submitted work.

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References


