

ORIGINAL RESEARCH

**RISK FACTORS FOR DIABETIC FOOT IN TETOUAN, MOROCCO
A CASE-CONTROL STUDY**

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ABSTRACT

Introduction Diabetes is a globally major public health problem. Its evolution is insidious and silent before the appearance of serious complications as a consequence in terms of morbidity than of mortality. Complications in the feet are among the most frequent and feared. This study helps identify factors associated with diabetic foot in diabetic patients in the province of Tetouan in public and private sector.

Methods This is a case-control study in which 136 diabetic patients monitored in the public and private sector in the province of Tetouan were chosen. 68 patients had diabetic foot and 68 were diabetic patients without this complication. Data were collected from patients' records and supplemented by interviews. The factors compared between the two groups were socio-demographic, biological and related to diabetes and lifestyle. These risk factors were determined by bivariate and multivariate analyses.

Results Statistically significant associations were found between diabetic foot and several factors including: the irregular monitoring of patients: ORadjusted = 7.7 [1.9-23], the rate of glycosylated hemoglobin: ORadjusted = 1.7 [1.2-2.3], diabetes duration: ORadjusted = 1.2 [1.03-1.26], and physical activity ORadjusted = 1.1 [0.02-0.9]. However, no association was found between diabetic foot and the level of education or occupation.

Conclusion To prevent the development of diabetic foot, more attention should be given to diabetic patients whose diabetes duration is long, patient monitoring should be regular and diabetes control should be optimal. In addition, physical activity is recommended for diabetic patients as part of promoting healthy lifestyles.

KEY WORDS: diabetes, diabetic foot, case-control, OR, Tetouan.

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INTRODUCTION

Diabetes is the first non-communicable disease recognized in 2006 by the United Nations as a more serious threat to global health than infectious epidemics such as tuberculosis, AIDS and malaria (1, 2).

Diabetes is now a globally major public health problem because of its increased prevalence and is a threat to economic health systems mainly due to complications related to this disease (3).

In Morocco, the national survey on cardiovascular disease risk factors conducted in 2000 showed that the prevalence

of diabetes is 6.6% among people aged 20 or over which would be one million diabetic patients (4). The number of diabetic patients registered at basic health care facilities is increasing. Thus, the number of diabetic patients managed at these facilities increased from 207,000 in 2004 to 420,000 in 2010 according to the national diabetes surveillance system, and the number of complicated diabetic cases is estimated at 20,000 or 3% of all diabetic patients (5).

MATERIAL AND METHODS

This is a retrospective case-control study conducted in the province of Tetouan in northern Morocco, from April to June 2012.

The study population consisted of people with diabetes in the province of Tetouan. They were selected from two major sites in the province in the public and private sector: The diabetology unit of the province, and A private practice of general medicine.

Therefore, our population consisted of 2 diabetic groups that may have different characteristics relating to the studied determinants. Selected cases were all registered at these two sites that match the clinical definition of diabetic foot. Controls were monitored diabetic patients in the province of Tetouan who do not have a diabetic foot. For each case, we selected one control. For each patient, a questionnaire of data collection was filled in. The questionnaire included socio-demographic data, lifestyle, data related to diabetes, results of the latest clinical examination, and results of the latest laboratory test. For the cases, these data were collected before the occurrence of diabetic foot; while for the controls, they were the data of the last follow-up visit.

The data entry and analysis were performed using the EPI INFO software, version 3.5.3.

RESULTS

The analysis included 136 diabetic patients, 68 patients had diabetic foot and 68 diabetic patients did not have such complication. 54 patients were monitored in the private

practice where 50% had diabetic foot, and 82 in the public center for diabetes management where 50% had diabetic foot. In the entire study population, the male/female sex ratio was 0.5. The average age was 60 ± 11 years. 88.2% of patients lived in urban areas, 87.5% had no occupation, 60.3% were illiterate and 74.3% practiced physical activity (low, medium or high). 15.4% were former smokers and 3 patients used alcohol. 46.3% of patients had a history of diabetes in the family. The average duration of diabetes was 11 ± 8 years for the entire study population.

84.6% of all people in the study population had type 1 diabetes, 47.8% were regularly monitored at the province of Tetouan and 46.3% were following a low carbohydrate diet adapted to diabetes. In addition to diabetes, 44.9% had high blood pressure and 26.5% had complications other than diabetic foot.

The average weight was 73.6 ± 13.4 kg for the entire study population: 70.4 ± 10.7 kg for women and 78.7 ± 15.6 kg for men. The average size was 1.64 ± 0.83 m and the average BMI was 27.4 ± 4.5 kg/m². Analysis of the results of laboratory tests showed an average HbA1c rate of $9.4 \pm 2.2\%$, total cholesterol of 1.8 ± 0.6 g/l, HDL cholesterol of 0.5 ± 0.1 g/l and triglycerides of 1.6 ± 0.7 g/l.

The bivariate analysis between diabetic foot and socio-demographic factors showed that there was a statistically significant association between the presence of diabetic foot and age: p-value = 0.001, sex: OR = 0.5 [0.2- 0.9] and place of residence: OR = 5.1 [1.3-18.9]. However, there was no association between diabetic foot and occupation or level of education (see Table I).

Socio-demographic factors	Diabetic foot	No diabetic foot	OR	IC95%	p-value
Sex n(%)			0.5	[0.2-0.9]	0.04
Female	39 (57.4)	50 (56.2)			
Male	29 (42.6)	18 (73.5)			
Residence n(%)			5.1	[1.3-18.9]	0.007
Rural	13 (19.1)	3 (4.4)			
Urban	55 (80.9)	65 (95.6)			
Occupation n(%)			0.4	[0.1-1.1]	0.07
without	63 (92.6)	56 (82.4)			
with	5 (7.4)	12 (17.6)			
Level of education n(%)			1.6	[0.8-331]	0.2
Illiterate	45 (66.2)	37 (54.4)			
Literate	23 (33.8)	31 (45.6)			
Age (Average \pm ET)	63 \pm 13	57 \pm 8			0.001

Table I: Socio-demographic risk factors for diabetic foot: Bivariate analysis.

There was a statistically significant association between the occurrence of diabetic foot and factors related to

lifestyle such as physical activity and smoking, whereas there was no association with alcohol (see Table II).

Factors related to lifestyle	Diabetic foot	No diabetic foot	OR	IC95%	p-value
Physical activity n(%)			0.03	[0.007-0.14]	<0.0001
Yes	35 (51.5)	66 (97.1)			
No (Low)	33 (48.5)	2 (2.9)			
Smoking n(%)			2.9	[0.8-5.4]	0.03
Yes	15 (22.1)	6 (8.8)			
No	53 (77.9)	62 (81.2)			
Alcohol			2.03	[0.2-22.9]	0.5
Yes	2 (2.9)	1 (1.5)			
No	66 (97.1)	67 (98.5)			

Table II: Diabetic foot risk Factors related to lifestyle: Bivariate analysis.

For factors related to diabetes, the analysis showed a statistically significant association of diabetic foot with the majority of these factors, namely the duration and

monitoring of diabetes; the presence of high blood pressure and a complication of diabetes and following adapted diet for diabetic patients (see Table III).

Factors related to diabetes	Diabetic foot	No diabetic foot	OR	IC95%	p-value
Diabetes type n(%)			0.4	[0.1-1.1]	0.07
Type 1	63 (92.6)	56 (82.4)			
Type 2	5 (7.4)	12 (17.6)			
Diabetes in the family history n(%)			0.5	[0.3-1.1]	0.06
Yes	26 (38.2)	37 (54.4)			
No	42 (61.8)	31 (45.6)			
Associated high blood pressure n(%)			3.2	[1.6-6.5]	0.008
Yes	40 (58.8)	21 (30.9)			
No	28 (41.2)	47 (69.1)			
Associated complications n(%)			8.1	[3.1-21.4]	<0.0001
Yes	30 (44.1)	6 (8.8)			
No	38 (55.9)	62 (91.2)			
Diet followed n(%)			0.08	[0.04-0.2]	<0.0001
Yes	13 (19.1)	50 (73.5)			
No	55 (80.9)	18 (26.5)			
Irregular monitoring n(%)			37.5	[15.2-92.5]	<0.0001
Yes	60 (88.2)	11 (16.2)			
No	8 (11.8)	57 (83.8)			
Duration of diabetes (Average ±ET)	15 ±8	7 ±6			<0.0001
BMI* (kg/m2)	27.8 ±4.7	27.9 ±4.2			0.3

Table III: Diabetic foot risk factors related to diabetes: Bivariate analysis.

After classifying diabetes into 2 categories: <15 years and ≥ or = 15 years, the bivariate analysis between this new variable and diabetic foot showed that diabetic patients whose diabetes duration was ≥ 15 years would 15 times more likely to develop diabetic foot than diabetic patients whose diabetes duration was <15 years.

Bivariate analysis of laboratory test data with the occurrence of diabetic foot showed a significant association between the occurrence of this complication and increased HbA1c, total cholesterol and triglycerides (see Table IV).

Biological factors	Diabetic foot	No diabetic foot	p-value
HbA1c (%)	10.6 ±2	8.1 ±1.7	<0.0001
Total cholesterol (g/l)	2.1 ±0.3	1.6 ±0.3	<0.0001
HDL cholesterol (g/l)	0.4 ±1.7	0.5 ±0.1	0.06
Triglyceride (g/l)	1.9 ±0.7	1.4 ±0.7	<0.0001

Table IV: Biological risk factors for diabetic foot: Bivariate analysis.

After classifying HbA1c rate into 2: < 6.5% and > 6.5%, the bivariate analysis between this new variable and diabetic foot showed that diabetic patients with HbA1c > 6.5% have 14 times more risk of developing diabetic foot than diabetic patients with HbA1c <6.5%.

According to the bivariate analysis, the variables where the association with diabetic foot was statistically significant were: Socio-demographic factors: age, sex and place of residence; Factors related to lifestyle: physical activity and smoking; Factors related to diabetes: duration and irregular monitoring of diabetes, high blood pressure

and/or associated complications, and following a low carbohydrate diet adapted to diabetes; Factors related to laboratory test: HbA1c, total cholesterol and triglyceride. Finally, multivariate analysis using logistic regression allowed us to identify potential associations between the occurrence of diabetic foot and various risk factors. To do this, the adjusted OR was calculated and only a final logistic regression model was selected and showed that the duration of diabetes, irregular monitoring of diabetic patients, HbA1c and physical activity represent risk factors for the occurrence of diabetic foot (see Table V).

Risk factors	ORadjusted	IC95%	P-value
Diabetes duration	1.2	1.03-1.26	0.01
Irregular monitoring	7.7	1.9-23	0.004
HbA1c	1.7	1.2-2.3	0.006
Physical activity	0.1	0.02-0.9	0.04

Table V: Diabetic foot risk factors: Multivariate analysis using logistic regression (68 cases, 68 controls): Final model.

DISCUSSION

This study included patients monitored in the public and private sector. The public sector is represented by the center of diabetes management which is the center that receives all diabetic patients in the province of Tetouan.

This work allowed us to study the relationship between the occurrence of diabetic foot and socio-demographic factors, factors related to lifestyle and diabetes, clinical factors and finally biological factors in diabetic patients in the province of Tetouan.

Thus, the study showed that the risk of the occurrence of diabetic foot increased significantly with age (p-value = 0.001), which is similar to the literature data (6-9). In fact, a study in the United States showed a significant association between diabetic foot and age (p-value <0.001) (10).

The average age of patients with diabetic foot was 63 ± 13 years in our study. Various authors report average ages ranging from 63-73 years and over (6)[30, 31, 32], whereas some studies especially in Africa (11), found an average age between 50 and 55 years. This may be due to life expectancy that is shorter in Africa (11).

Diabetic males are twice more likely to develop diabetic foot than diabetic females. Several studies confirm this association (6-8), while a study in the Caribbean countries showed that sex is not associated with the occurrence of diabetic foot OR = 0.9 [0.7-1.2] (9).

In this study, a diabetic patient living in rural areas would have five times more risk of developing diabetic foot complications than a diabetic patient living in urban areas. This may be due to poor hygiene of the feet and the difficulty to access health care in rural areas.

The association of diabetic foot with occupation and level of education were not significant, because the majority of patients (cases and controls) of our population had no occupation and were illiterate especially for diabetic patients monitored in the public sector which represents 60% in our sample. According to a study conducted in Morocco on factors influencing the awareness of diabetic foot risks, 40% were illiterate, which partly explains the poor compliance with hygiene and dietary rules (12). The study conducted in the United States showed no association between the level of education and diabetic foot (p-value = 0.1) (10).

Lifestyle significantly influenced the occurrence of diabetic foot in diabetic patients monitored in the province of Tetouan. Physical activity constitutes a protective factor against the occurrence of diabetic foot. Thus, diabetic patients who practice physical activity are 10 times less likely to develop diabetic foot than diabetic patients who perform sedentary or low physical activity by adjusting diabetes duration, HbA1c and irregular monitoring. Other studies did not seek the association between the occurrence of diabetic foot and physical activity.

Smoking seems to be a significant risk factor for diabetic foot in this study. Diabetic smokers have three times more risk of developing diabetic foot complications than diabetic nonsmokers. Several studies found a direct causal association between smoking and foot ulcers or amputations (6). A cross-sectional study of 1,142 type 2 diabetic patients in Jordan showed that smoking was a strong predictor of amputation (13). Concerning alcohol, there was no significant difference between diabetic patients with diabetic foot and those without this complication.

The duration of the course of diabetes is generally considered a risk factor for the occurrence of diabetic foot (6). Our study confirms, by adjusting the rate of HbA1c, irregular monitoring of diabetes and physical activity, the longer the duration of diabetes increases a year, the greater the risk of developing diabetic foot is multiplied by 1.2. However, this association was not strong which can be explained by the underestimation of this duration, ignorance of the disease and the fact that diabetes can sometimes occur in its subclinical form (12). This association is demonstrated in the majority of studies (6-16).

The existence of high blood pressure and complications, other than diabetic foot, would increase the risk of developing diabetic foot. In fact, a diabetic patient with high blood pressure would have three times more risk of developing diabetic foot than a diabetic with normal blood pressure. Also, a diabetic patient with a complication (other than diabetic foot) would have eight times more risk of developing a diabetic foot than a diabetic patient with no complication. A study in Saudi Arabia showed a significant association of diabetic foot with nephropathy; OR = 2.79 [1.02-7.78] and with coronary artery disease; OR = 4.83 [1.67-14.45] whereas the association with high blood pressure was not significant (13).

Since the implementation of programs for combating, controlling and monitoring diabetes, the risk of complications decreased. Regular long-term monitoring of diabetes plays a role in the prevention of diabetic foot (16). In this study, a poorly monitored diabetic patient would have 37 times more risk of developing diabetic foot than a well-monitored diabetic patient. This monitoring included clinical, biological, therapeutic and educational management (therapeutic education). In multivariate analysis, and after adjustment on diabetes duration, rate of HbA1c and physical activity, a poorly monitored diabetic patient would have an eight times higher risk of developing a diabetic foot than a well-monitored diabetic patient.

The association between diabetic foot and diabetic balance is assessed by measuring the association between the occurrence of diabetic foot and the rate of HbA1c. Thus, diabetic patients with a rate of HbA1c > 6.5% have 14 times more risk of developing diabetic foot than diabetic patients with a rate of HbA1c <6.5%. This association was found in several studies such as the one conducted in the United States where the poor glycemic control (HbA1c > 9%) was significantly associated with diabetic OR = 3.2 foot; p <0.03 (17). In another study, compared to a rate of HbA1c <6.5%, the risk of amputation was doubled to a rate between 6.5 and 9% and tripled to over 9% (6). A study in India also showed this association with a p-value = 0.01 (18). Moreover, diabetic balance, represented mainly by HbA1c, is an obvious factor in the development of complications related to diabetes (16). In the UKPDS trial (United Kingdom Prospective Diabetes Study) in the UK, an average 1% decrease of HbA1c was associated with a 25% reduction in complications, including neuropathy and diabetic foot (19).

This association was also significant in the multivariate analysis. Adjusting the irregular monitoring of diabetes, diabetes duration and physical activity, the risk a diabetic patient has of developing diabetic foot would be multiplied by 1.7 when HbA1c rate is increased by one (1%).

Dyslipidemia contributes to the development of diabetic foot (20). In this study, the association was significant

between the occurrence of diabetic foot and the rate of triglycerides p-value <0.0001 and total cholesterol p-value <0.0001. A study in the United States (10) and a survey by Korea national diabetes program confirm this association (21) as well as a study in China that showed a significant association between increased triglyceride rates and total cholesterol with a p-value <0.001 (22). However, in the Netherlands, this association was not significant with OR (total cholesterol = 1.13), p-value = 0.15, OR (TR) = 1.04, p-value = 0.84 (23). However, in our study and in some cases, this information was collected after the occurrence of diabetic foot; thus, the time sequence was difficult to highlight.

CONCLUSION

The diabetic foot is a common complication and a serious one due to the mortality, morbidity and disability it causes. Its cost is the highest among degenerative complications of diabetes. The fight against this burden is partly based on prevention by educating patients and caregivers and early detection of lesions, and on the other part on a multidisciplinary management.

Based on the results of this study on the risk factors for diabetic foot that seems to be the first conducted in Morocco, it would be advisable to pay more attention to older diabetic patients whose diabetes duration is long, as well as diabetic males and those living in rural areas.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the [Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals](#) of the [International Committee of Medical Journal Editors](#). Indeed, all the authors have actively participated in the redaction, the revision of the manuscript and provided approval for this final revised version.

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PATIENT CONSENT

Written informed consent was obtained from patients for publication of this study.

COMPETING INTERESTS

The authors declare no competing interests.

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