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Risk Factors and Diabetes Related Complications Frequency in the Population of the Northeastern Morocco

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Abstract

Objectives: Diabetes is one of the most challenging health problems in the 21st century that brings a considerable economic burden on worldwide healthcare resources. Indeed, people with diabetes have a higher lifetime healthcare expenditure due to the long-term complications, which include micro and macrovascular complications. This study sought to estimate the frequency of diabetes complications, and to investigate the associated risk factors. **Methodology**: Data were obtained from the medical records of 2401 diabetic patients followed at the Reference Center of Diabetes and Chronic Diseases (RCD) in Oujda (Morocco) during the period 2006-2011. **Results**: Our sample of 2401 diabetic patients include 64.7% women. 32% of patients have one or more complications; retinopathy is the most frequent complication (16.8%), followed by nephropathy (12.4%), cardiovascular diseases (5.4%), neuropathy (3.6%) and diabetes foot (2%). Logistic regression in univariate followed by multivariate analysis has showed that age, duration of diabetes and high albuminuria are the major risk factors for the development of diabetic complications in both type 1 and type 2 diabetes. **Conclusions**: Nearly one third of diabetic patients were affected by at least one diabetic complication; retinopathy is the most common complication in these patients. Strengthening programs to improve diabetes management and to reduce the risk of these complications should be a high priority in order to control the cost of treatment.

Keywords

Diabetic Complications, Retinopathy, Nephropathy, North-Eastern Morocco, Risk Factors

1. Introduction

Diabetes is a global threat to human and economic development [1] [2] and one of the most frequent chronic metabolic disorders that continues to present a large worldwide health issue in all countries. It is a disease related to a malfunctioning biological mechanism of blood glucose regulation. When we eat, the blood sugar level increases, the carbohydrates are then converted to glucose. The pancreas detects the increase in blood sugar and the beta cells secrete insulin that allows glucose to enter the cells of the body: in the muscles, in the adipose tissue and in the liver where it will be able to be transformed and stored. The glucose then decreases in the blood. In case of diabetes, this regulation system does not work; the pancreas do not produce enough insulin or cannot use insulin properly, or both. In diabetes, glucose in the blood cannot move efficiently enter into cells, so blood glucose levels remain high [3]. There are four categories of diabetes: type 1 diabetes (occurs when the beta cells of the pancreas are unable to produce insulin); type 2 diabetes (accounts for ~90% of cases of diabetes: occurs when the beta cells do not produce enough insulin or when the body is resistant to insulin actions); gestational diabetes (diabetes occurring during pregnancy) and finally the group of other types of rare specific cases of diabetes (specific genetically defined forms of diabetes or diabetes associated with other diseases or drug use) [4]. The Diabetes type 1 (DT1) formerly called insulin-dependent diabetes (IDD) or juvenile-onset diabetes, appears during childhood or adolescence (most < 25 years and before the age of 6 months) [4] [5] while, the diabetes type 2 (TD2) previously referred to as non-insulin-dependent diabetes (NIDD), or adult-onset diabetes, usually occurs in people over > 25 years, and its incidence increasing with the increasing rate of obesity in children and adolescents [4] [5]. The diabetes symptoms are the same regardless of its type (frequent urination, extreme thirst, excessive hunger, tiredness, and weight loss).

Urbanization, increased consumption of saturated fats and sugar, and a more sedentary lifestyle are increasing the prevalence of diabetes in many countries around the world [6]. According to the IDF Diabetes Atlas, in 2017, there were 451 million (8.4%) (age 18 - 99 years) people with diabetes worldwide [7]. The global prevalence of this silent killer is estimated to increase to 693 million (9.9%) by 2045 [7].

Several differences were found in diabetes prevalence by age group, gender, World Bank income group and geographical region. In high-income countries, diabetes prevalence reached (22%) in the 75 - 79 age group and in middle-income countries among the 60 - 74 age groups (19%). In low-income countries, the prevalence of diabetes was (8%) among the 55 - 64 age group. The prevalence of diabetes among 65 - 69 year olds was 3 times higher in high-income countries compared to low income countries [7]. In 2017, the prevalence of diabetes among women (8.4%) (18 - 99 years) was lower than in men (8.9%) [7]. The highest diabetes prevalence in the world was found in the North American and Caribbean Region (10.8%) followed by the Midlle East and North

Africa (10.5%), the South-East Asia (9.6%), the Western Pacific (8.5%), and the South and Central America (7.5%) while, the lowest was in the Africa Region (4.2%) [8]. The increasing prevalence of diabetes has a great impact in terms of economic burden worldwide. The Current estimates of global healthcare expenditures due to diabetes for people aged 20 - 79 years are 727 billion and are expected to increase to USD 850 billion when expanding the age group to 18 - 99 years [7].

Socio-economic status, demographic factors and ethnicity are important determinants of diabetes. In fact, higher diabetes proportions were seen in the people who have highest income quintile, in those educated up to advanced levels, and in the urban sectors [9]. Moreover, the risk of developing diabetes increases with family history, age, obesity, hypertension and lack of physical activity [10] [11] [12].

Vascular impairment during diabetes affects the entire vascular network of the body, whatever the size of vessels and tissues which they irrigate. We classically distinguish microangiopathic (kidney, eye, nerve) and macroangiopathic complications, which consist of cardiovascular, cerebrovascular and peripheral vascular diseases. The excess of glucose available (due to diabetes) enters abundantly into the cells of the vascular wall especially endothelial, smooth muscle cells, pericytes and related cells, whose glucose uptake, dependent on the GLUT1 transporter, is not regulated by the insulin. The flow in the pathway of glycolysis is very increased [13] [14] [15]: usually minor pathways (sorbitol pathway, hexosamine pathway, activation of PKC [protein kinase C], synthesis of advanced glycation products [AGE], irreversibly modifying molecules and proteins by glucose) are overwhelmed and their products damage the cell's balance. Moreover, this flow in the pathway of glycolysis leads to mitochondria, whose protection systems in the electron transfer (antioxidant mechanisms) are flooded and insufficient. Reactive oxygen species (ROS) are generated and will randomly react with this or that molecule, modifying it permanently: it is the oxidative stress related to hyperglycemia. The cell will be modified, and does not properly perform its function (endothelial dysfunction, for example). The subsequent consequences depend on the vessel and the tissue involved. The early pathological events are very similar within small and large vessels, suggesting that changes within the microcirculation can lead to the development and progression of large vessel disease [16]. It is well known that vascular complications in a given tissue are often accompanied by signs of pathology in other vascular territories [17]. The strong association between diabetic nephropathy (DN) and diabetic retinopathy (DR) is perhaps the example that is best known to clinicians [16]; The association of DR and DN with cardiovascular disease is another evidence of the intersection of microvascular and macrovascular complications associated with diabetes [16] [17].

In North Africa, the prevalence of chronic diabetes complications ranges from 8.1% to 41.5% for retinopathy, 21% - 22% for high albuminuria, 6.7% to 46.3%

for nephropathy and 21.9% to 60% for neuropathy [18]. Many complications of diabetes can be prevented or delayed by preventive measures and management programs of this disease, especially by identification of risk factors, early diagnosing of diabetes, and educating patients and health professionals.

In Morocco, a North African country which has been undergoing a demographic, nutritional and epidemiological transition during the last two decades [19] [20], the prevalence of diabetes is increasing rapidly. According to the national investigation conducted in 2000 on a Moroccan representative sample aged 20 and over showed that the prevalence of diabetes was 6.6% and type 2 diabetes (T2D) was found to constitute 90% of all cases of diabetes [21]. Furthermore, the number of adults with diabetes in Morocco is predicted to rise from 1.5 million in 2010 to 2.5 million by 2030 [22]. In Eastern Morocco, diabetes and its complications are major public health problems. The study of our research team revealed a prevalence of 10.2% for diabetes in this region for adults aged 40 and older [23]. To the best of our knowledge, there are no studies that have focused on diabetes complications and its risk factors in Eastern Morocco.

2. Objectives

This study aims to estimate the frequency of diabetic complications, and to investigate the association between sociodemographic and clinical risk factors and the occurrence of the diabetes-related complications.

3. Methods

3.1. Study Population

This is an epidemiological study that was conducted at the Reference Center for Diabetology and Chronic Diseases "RCD".

The "RCD" was established in the prefecture of Oujda-Angad (Eastern Morocco, North Africa) on July 31st, 2005 [24].

Its main aim is the management of diabetes complications and the reduction of its mortality among diabetic patients.

This study focuses on a sample of 2401 diabetic patients who visited the "RCD" during the period of 2006-2011. Inclusion criteria were: having type 1 (T1D) and type 2 diabetes (T2D), and having regular medical monitoring (patients who have a follow-up of 2 years and who have received at least one consultation per year). Exclusion criteria included gestational diabetes and irregular medical monitoring (patients who are enrolled in the center but who rarely come for consultations).

3.2. Ethical Approval

This research was approved by the Moroccan Minister of Health (we obtained authorization to conduct this study from the Regional Director of Public Health in Oujda, representing the Minister of Health in the Eastern Region of Morocco)

and in accordance with the principles embodied in the Declaration of Helsinki. All data were collected from patient records. No individual information including names or initials was published.

3.3. Sample Size

The number of patients who participated in the study was 2401. This number was calculated using the following formula: $\mathbf{n = z^2 \times p\ (1 - p)/m^2}$

n = sample size;

z = confidence level according to the standard normal distribution (for a 95% confidence level, z = 1.96);

p = estimated proportion of the population with complications (50%);

m = tolerated margin of error (2%).

$\mathbf{n = (1.96)^2 \times (0.5)(1 - 0.5)/(0.02)^2 = 2401}$

Our sample of 2401 diabetic patients was selected (by random sampling) from a total population of 11,757 diabetic patients followed at the "RCD" during the period 2006-2011 using inclusion and exclusion criteria.

3.4. Data Collection

The following variables were collected from the medical records of patients: age, gender, educational level, occupation, socio-economic status, medical insurance, type of diabetes, diabetes duration, diabetes treatment, alcohol consumption, smoking status, glycated hemoglobin (HbA1c), hypertension, body weight, height, total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), albuminuria, complications including cardiovascular diseases, diabetic foot complications, nephropathy, neuropathy, retinopathy, and data related to family history of diabetes.

3.5. Diagnostic Criteria of the Variables Studied

- Body mass index (BMI) was calculated as weight (kg) divided by height (m) squared (kg/m^2) and categorized according to World Health Organization BMI criteria as under-weight (<18.5 kg/m^2), normal-weight (18.5 - 24.9 kg/m^2), overweight (25 - 29.9 kg/m^2) and obesity (≥30 kg/m^2) [25].
- In the present analysis, diabetics were considered to have hypertension if they had systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg according to the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure guidelines [26], and/or taking anti-hypertensive medications.
- Glycated hemoglobin (HbA1c) was defined as good glycemic control if HbA1c < 7% and poor glycemic control if HbA1c > 7% [27].
- The available measurement of albuminuria was divided into three groups as described by the 2002 Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines [28]: normo-albuminuria (<30 mg/24h), micro-albuminuria (30 - 299 mg/24h) or macroalbuminuria (≥300 mg/24h).

- Based on the recommendations of the National Cholesterol Education Program Adult Treatment [29], the following were considered as acceptable target values: total cholesterol (TC ≤ 200 mg/dl), low density lipoprotein cholesterol (LDL-C ≤ 130 mg/dl), triglycerides (TG ≤ 150 mg/dl), and high density lipoprotein cholesterol (HDL-C ≥ 40 mg/dl).

3.6. Statistical Analysis

In this study, quantitative variables were expressed as mean ± standard deviation and qualitative variables were expressed as frequency or percentage. The chi-square test is used for comparison of qualitative variables.

Logistic regression in univariate followed by multivariate analysis was investigated with occurrence of complications as dependent variable, and age, educational level, diabetes duration, hypertension, high albuminuria, and other risk factors as independent variables. A P value < 0.05 was considered statistically significant. All the statistical analysis was carried out using Epi Info (version 3.5.4; July 30, 2012).

4. Results

The socio-demographic and bio-clinical data of 2401 diabetic patients are shown in (Table 1). 64.7% of the total sample were women. The sex ratio (men/women) was 0.54. The most diabetic patients (81.1%) are aged > 50 years. A majority of the subjects were illiterate (71.3%), unemployed (80.6%), had a low socioeconomic status (77.1%) and didn't have medical insurance (73.6%) (Table 1).

Among the 2401 diabetics studied, 2101 (87.5%) had type 2 diabetes while 300 (12.5%) had type 1 diabetes (DT1). In addition, 1222 cases (50.9%) had a diabetes duration less than 10 years. For diabetes treatment, 70.3% were taking oral antidiabetic agents (OAD), 25.3% insulin alone and 1.4% a combination of insulin and OAD. Most of diabetics did not smoke (86%) and did not consume alcohol (97%). The frequency of patients with a known family history of diabetes was 69.5%. Hypertension, overweight and obesity are present in 42.3%, 43.4% and 28.5% respectively. In the overall sample, 80.6% had a high HbA1c, 41.7% had a microalbuminuria and 11.7% had a high level of creatinine. Proportions of cholesterol and triglycerides were: 47.4% with high total choletserol, 29.7% with high LDL-C, 31.3% with low HDL and 37% with high triglycerides.

In the present study, we found the overall frequency of diabetes complications to be 32%. The most common complication was retinopathy (16.8%), followed by nephropathy (12.8%), cardiovascular diseases (5.4%), neuropathy (3.6%) and diabetic foot complications (2%) (Figure 1).

4.1. Complications in Type 1 Diabetes

Among 300 diabetics type 1 (Table 2), 108 (36%) had complications (Table 2). Of them, 58 (32.8%) were females and 50 (40.7%) were males with no significant difference between them (NS) (Table 2). Moreover, the analysis of the data

proved that the risk of developing complications increased with advancement in age (Table 2).

A majority of the subjects with complications were illiterate (42.1%) and had a diabetes duration > 20 years (60.7%) (Table 2). Thus, the results showed a highly significant difference ($P < 0.001$) between patients with complications and those without for several parameters: hypertension, overweight and obesity, creatinine and albuminuria but no significant difference was found between them about other parameters: cholesterol and triglycerides (Table 2).

Using simple logistic regression analysis, age, educational level, diabetes duration, overweight and obesity, hypertension and a high level of albuminuria were significantly associated with the occurence of diabetes complications (Table 3).

However, on multivariate regression analysis, only age (OR = 1.02; 95% CI: 1.008 - 1.04, $P < 0.01$), diabetes duration (OR = 1.05; 95% CI: 1.01 - 1.08, $P < 0.01$), and a high level of albuminuria (OR = 2.81; 95% CI: 1.60 - 4.95, $P < 0.01$) were independent risk factors for diabetes complications (Table 4).

4.2. Complications in Type 2 Diabetes

Table 5 shows the distribution of diabetes complications by socio-demographic and bio-clinical settings among type 2 diabetics. In the whole population 419 (30.5%) of women had complications versus 241 (33.2%) of men; there was no gender difference in diabetes complications frequency (NS). However, older people (≥65 years) showed a higher frequency (42.1%) of diabetes complications.

Besides, diabetics who had hypertension, poor glycemic control and a high albuminuria had a higher frequency of complications (40%, 33.1% and 38.8% respectively).

As illustrated in Table 3, age, diabetes duration, hypertension, poor glycemic control (HbA1c > 7%) and a high level of albuminuria were all significantly related to the development of complications and the maximum risk was with hypertension (OR = 2.05; CI: 1.70 - 2.47, $P < 0.001$) in univariate logistic regression analysis. A multivariate logistic regression analysis was then realized to identify which of the latter were related to diabetes complications. The results listed in Table 4 show that age of the patient, diabetes duration, hypertension and a high albuminuria level were the risk factors of diabetes complications in T2D in this study.

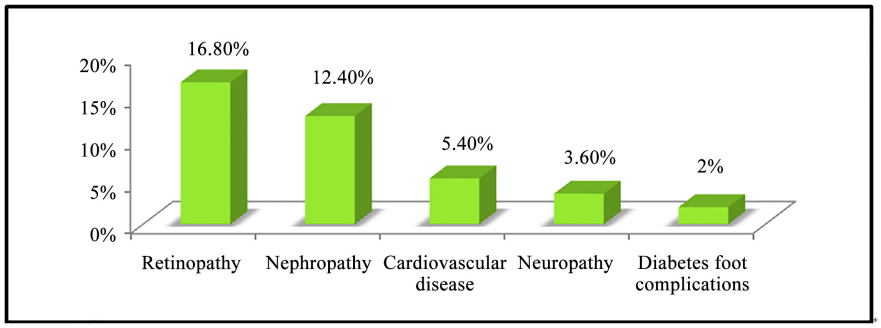

Figure 1. Types of diabetes complications and their frequencies.

Table 1. Descriptive analysis of the total sample according to socio-demographic and bio-clinical settings.

	Total		Women		Men	
	N	%	N	%	N	%
Gender	2401	100	1553	64.7	848	35.3
Age (years)						
<30	77	3.2	47	3	30	3.5
30 - 40	116	4.8	77	5	39	4.6
40 - 50	261	10.9	189	12.2	72	8.5
50 - 60	682	28.4	452	29.1	230	27.1
60 - 70	672	28	427	27.5	245	28.9
>70	593	24.7	361	23.2	232	27.4
Educational level						
Illiterate	1711	71.3	1322	85.1	389	45.9
Coranic studies	220	9.2	87	5.6	133	15.7
Primary school	209	8.7	86	5.5	123	14.5
Middle school-High school	214	8.9	43	2.8	171	20.2
University	47	2	15	1	32	3.8
Employment						
Yes	466	19.4	68	4.4	398	46.9
No	1935	80.6	1485	95.6	450	53.1
Socio-economic status						
Low	1851	77.1	1285	82.7	566	66.7
Medium/High	550	22.9	268	17.3	282	33.3
Medical insurance						
Without	1768	73.6	1181	76	587	69.2
Ramed	330	13.7	224	14.4	106	12.5
Insured	303	12.6	148	9.5	155	18.3
Type of diabetes						
Type 1	300	12.5	177	11.4	123	14.5
Type 2	2101	87.5	1376	88.6	725	85.5
Diabetes duration (years)						
<10	1222	50.9	802	51.6	420	49.5
10 - 20	904	37.7	583	37.5	321	37.9
>20	275	11.5	168	10.8	107	12.6
Diabetes treatment						
Diet alone	74	3.1	54	3.5	20	2.4
OAD	1687	70.3	1111	71.5	576	67.9
Insulin alone	607	25.3	362	23.3	245	28.9
OAD + Insulin	33	1.4	26	1.7	7	0.8
Smoking status						
Smoker	247	10.3	0	0	247	29.1
Ex-smoker	89	3.7	0	0	89	10.5
Non smoker	2065	86	1553	100	512	60.4
Alcohol consumption						
Yes	16	0.7	0	0	16	1.9
Former	56	2.3	0	0	56	6.6
No	2329	97	1553	100	776	91.5

Continued

Family history of diabetes						
Yes	1668	69.5	1103	71	565	66.6
No	733	30.5	450	29	283	33.4
Hypertension						
Yes	1015	42.3	666	42.9	349	41.2
No	1386	57.7	887	57.1	499	58.8
Body weight						
Under-weight	26	1.1	8	0.5	18	2.1
Normal weight	650	27.1	295	19	355	41.9
Overweight	1041	43.4	689	44.4	352	41.5
Obesity	684	28.5	561	36.1	123	14.5
HbA1c (%)						
Good glycemic control < 7	465	19.4	300	19.3	165	19.5
Poor glycemic control >7	1936	80.6	1253	80.7	683	80.5
Creatinine (mg/l)						
Normal	2092	88.3	1358	88.2	734	88.4
High	278	11.7	182	11.8	96	11.6
Albuminuria (mg/24)						
Normal	1267	56.8	851	58.3	416	54
Microalbuminuria	930	41.7	592	40.5	338	43.9
Macroalbuminuria	33	1.5	17	1.2	16	2.1
Total cholesterol (g/l)						
Normal	568	52.6	325	46.5	243	63.9
High	511	47.4	374	53.5	137	36.1
LDL-C (g/l)						
Normal	408	70.3	265	68.8	143	73.3
High	172	29.7	120	31.2	52	26.7
HDL-C (g/l)						
Normal	40	68.7	278	73.4	115	59.6
Low	179	31.3	101	26.6	78	40.4
Triglycerides (g/l)						
Normal	578	63	334	56.9	244	73.9
High	339	37	253	43.1	86	26.1

N, effective; RAMED, medical insurance plan; OAD, oral antidiabetic agents; HbA1c, glycated hemoglobin; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol.

Table 2. (a) Distribution of diabetes complications among diabetics type 1 by socio-demographic and bio-clinical settings (n = 300 type 1 diabetic patients); (b) Distribution of diabetes complications among diabetics type 1 by socio-demographic and bio-clinical settings (continued).

(a)

	Complications			
	Yes		**No**	
	N	**%**	**N**	**%**
Total	108	36	192	64

Continued

Gender				
Women	58	32.8	119	67.2
Men	50	40.7	73	59.3
P			NS	
Age (years)				
<30	8	11.9	59	88.1
30 - 40	13	22.4	45	77.6
40 - 50	16	33.3	32	66.7
50 - 60	23	56.1	18	43.9
60 - 70	18	54.5	15	45.5
>70	30	56.6	23	43.4
P			<0.001	
Educational level				
Illiterate	75	42.1	103	57.9
Coranic studies-Primary school	25	30.9	56	69.1
Middle-high school-University	8	19.5	33	80.5
P			<0.01	
Employment				
Yes	16	26.2	45	73.8
No	92	38.5	147	61.5
P			NS	
Socio-economic status				
Low	93	37.2	157	62.8
Medium/high	15	30	35	70
P			NS	
Diabetes duration (years)				
<10	25	19.5	103	80.5
10 - 20	46	41.4	65	58.6
>20	37	60.7	24	39.3
P			<0.001	
Hypertension				
Yes	46	57.5	34	42.5
No	62	28.2	158	71.8
P			<0.001	
Overweight and Obesity				
Yes	67	44.7	83	55.3
No	41	27.3	109	72.7
P			<0.001	
HbA1c (%)				
Good glycemic control (<7)	11	28.2	28	71.8
Poor glycemic control (>7)	97	37.2	164	62.8
P			NS	
Creatinine (mg/l)				
Normal	59	23.1	188	76.1
High	45	100	0	0
P			<0.001	

(b)

	Complications			
	Yes		No	
	N	%	N	%
Albuminuria (mg/24h)				
Normal	32	23.9	102	76.1
High	70	50.4	69	49.6
P	<0.001			
Total cholesterol (g/l)				
Normal	16	33.3	32	66.7
High	14	45.2	17	54.8
P	NS			
LDL-C (g/l)				
Normal	17	42.5	23	57.5
High	1	50.0	1	50.5
P	NS			
HDL-C (g/l)				
Normal	12	41.4	17	58.6
Low	5	41.7	7	58.3
P	NS			
Triglycerides (g/l)				
Normal	16	34.8	30	65.2
High	8	74.1	9	52.9
P	NS			

N, effective; HbA1c, glycated hemoglobin; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; NS, not significant; *P*, *P*-value (comparison the presence of complications with other variables).

Table 3. Association of diabetes complications in type 1 and type 2 diabetes with risk factors in logistic regression in univariate analysis.

Dependent variable	Diabetes complications (T1D)		Diabetes complications (T2D)	
Independent variables	Odds ratio brut [95% CI]	*P*	Odds ratio brut [95% CI]	*P*
Age	1.04 [1.02 - 1.05]	<0.001	1.04 [1.03 - 1.05]	<0.001
Educational level	0.50 [0.30 - 0.83]	<0.01	-	-
Diabetes duration	1.08 [1.05 - 1.11]	<0.001	1.08 [1.06 - 1.09]	<0.001
Overweight and obesity	2.14 [1.32 - 3.47]	<0.001	-	-
Hypertension	3.44 [2.02 - 5.86]	<0.001	2.05 [1.70 - 2.47]	<0.001
HbA1c (%)	-	-	1.49 [1.17 - 1.90]	<0.001
Albuminuria (mg/24h)	3.23 [1.92 - 5.42]	<0.001	1.82 [1.50 - 2.20]	<0.001

CI, confidence interval; HbA1c, glycated hemoglobin.

Table 4. Association between diabetic complications in diabetics (T1 and T2) and risk factors with logistic regression in multivariate analysis.

Dependent variable	Diabetes complications (T1D)		Diabetes complications (T2D)	
Independent variables	**Odds ratio adjusted [95% CI]**	***P***	**Odds ratio adjusted [95% CI]**	***P***
Age	1.02 [1.008 - 1.04]	<0.01	1.02 [1.01 - 1.03]	<0.001
Diabetes duration	1.05 [1.01 - 1.08]	<0.01	1.06 [1.04 - 1.08]	<0.001
Hypertension	-	-	1.56 [1.26 - 1.92]	<0.001
Albuminuria (mg/24h)	2.81 [1.60 - 4.95]	<0.01	1.69 [1.38 - 2.08]	<0.001

CI, confidence interval.

Table 5. (a) Distribution of diabetes complications among type 2 diabetic patients by socio-demographic and bio-clinical settings (n = 2101 type 2 diabetic patients); (b) Distribution of diabetes complications among diabetics type 2 by socio-demographic and bio-clinical settings (continued).

(a)

	Complications			
	Yes		**No**	
	N	**%**	**N**	**%**
Total	660	31.4	1441	68.6
Gender				
Women	419	30.5	957	69.5
Men	241	33.2	484	66.8
P		NS		
Age (years)				
≤45	13	9	132	91
45 - 50	25	18.4	111	81.6
50 - 55	72	26.1	204	73.9
55 - 60	104	28.5	261	71.5
60 - 65	111	28.9	273	71.1
≥65	335	42.1	460	57.9
P		<0.001		
Educational level				
Illiterate	497	32.4	1036	67.6
Coranic studies-Primary school	101	29	247	71
Middle-high school-University	62	28.2	158	71.8
P		NS		
Employment				
Yes	114	28.1	291	71.9
No	546	32.2	1150	67.8
P		NS		
Socio-economic status				
Low	114	32.3	1084	67.7
Medium/high	143	28.6	357	71.4
P		NS		

Continued

Diabetes duration (years)				
<10	246	22.5	848	77.5
10 - 20	284	35.8	509	64.2
>20	130	60.7	84	39.3
P		<0.001		
Hpertension				
Yes	374	40	561	60
No	286	24.5	880	75.5
P		<0.001		
Overweight and obesity				
Yes	495	31.4	1080	68.6
No	165	31.4	361	68.6
P		NS		
HbA1c (%)				
Good glycemic control (<7)	106	24.9	320	75.1
Poor glycemic control (>7)	554	33.1	1121	66.9
P		<0.001		
Creatinine (mg/l)				
Normal	584	29.1	1423	70.9
High	71	100	0	0
P		<0.001		

(b)

	Complications			
	Yes		**No**	
	N	**%**	**N**	**%**
Albuminuria (mg/24h)				
Normal	293	25.9	840	74.1
High	320	38.8	504	61.2
P		<0.001		
Total cholesterol (g/l)				
Normal	160	30.8	360	69.2
High	139	29	341	71
P		NS		
LDL-C (g/l)				
Normal	151	30.1	350	69.9
High	15	40.5	22	59.5
P		NS		
HDL-C (g/l)				
Normal	115	31.6	249	68.4
Low	51	30.5	116	69.5
P		NS		
Triglycerides (g/l)				
Normal	155	29.1	377	70.9
High	94	29.2	228	70.8
P		NS		

N, effective; HbA1c, glycated hemoglobin; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; NS, not significant; *P*, *P*-value (comparison the presence of complications with other variables).

5. Discussion

This study, the first of its kind in Eastern Morocco, describes the socio-demographic, clinical features and complications of 2401 diabetic patients, and provides important data on the frequency of diabetes complications and the associated risk factors. These data will serve as references for later studies and help to develop effective strategies against the development of diabetes complications, in order to reduce the mortality rate caused by this endocrine disorder and its complications.

Since women have a better attention to their health and are more accustomed to take care of themselves and their family in general, the majority of participants were women (64.7%). Furthermore, numerous studies have revealed that women report higher rates of preventive and therapeutic health care for chronic and acute conditions than men in this region [30] and in other regions of the world [30] [31] [32] [33] [34]. Also, women have got enough time to devote to the follow-up of their diseases due to the fact that the majority of them are unemployed (95.6%). This fact is proved by the shown response to various initiatives and screening campaigns [23].

In this study, we found that 81.1% of diabetics are aged between 50 and 70 years. This can be explained by the fact that 87.5% of diabetics in our sample are type 2, and as is known in the literature, this type of diabetes affects especially adults more than young people [35] [36].

Our results showed that the percentages of illiterate (71.3%) and unemployed (80.6%) people were larger compared to those found (34.4%; 21.5%) in the Eastern region of Morocco in 2014 [37]. This may be due to our sample containing mostly women and elderly.

Moreover, 87.5% of diabetic patients in our sample are type 2, which is similar to other findings in previous studies [21] [38] [39]. This data can be explained in large part by our sample caracteristics (age 61.0 ± 14.1 years and 50.9% of patients have a diabetes duration less than 10 years).

The results of our study, which took place in the Eastern region of Morocco especially at the Reference Center for Diabetology and Chronic Diseases, reported a high frequency of overweight and obesity in our sample: (43.4% and 28.5% respectively). These results are nearly the same to those found by our team in the same region (40.3% and 25.1%) [23]. On the other hand, the proportion of obesity was higher among women (36.1%) compared to men (14.5%). This huge rate of obesity in women is similar to that found in other studies in Morocco [16] [40] [41].

In the present study, the data concerning the frequency of hypertension is presented in (**Table 1**). We found the overall frequency of hypertension to be 42.3%. In a report realized by our team [42] in the East of Morocco, revealed a frequency of hypertension of 31.7% in a population aged 40 years and older, and a high frequency (69.9%) in diabetic subjects of the same population. In the same way other studies published a frequency of hypertension ranged between

49.3% and 70.4% among patients with type 2 diabetes in different Moroccan regions [43] [44] [45]. These alarming rates of hypertension confirm that this disease has become a scourge of health in our study area like all regions of Morocco.

The pathogenesis of diabetes complications is not fully understood, and controversy exists about why they occur in some patients and not in others. This study was undertaken to define more clearly the risk factors influencing susceptibility to such complications in diabetic patients. In this regard, 32% of the 2401 patients studied had one or more complications. This frequency is lower than the rates obtained in previous studies (63.8% in Morocco (Fez) [45], 60% in Algeria [46], 68.7% in Libya [47] and 86% in Oman [48]). This difference in the frequencies of diabetic complications can be largely explained by the methodology of work of each study and the specific characteristics of the population studied.

In our work, DR is the most frequent complication of diabetes. The prevalence of DR shows wide variations between countries of Northern Africa, ranging from 8.1% to 41.5% [18]. In this database, retinopathy was found in 16.8% of patients, which is consistent with previous studies in Arab countries that reported its ranging from 11% to 19% [49] [50] [51]. However, our results are inconsistent with other studies, which found higher prevalence of retinopathy among diabetic patients that ranged from 34.5% to 48.6% [52]. Besides, DR in the Eastern Mediterranean countries was estimated between 10% - 64% [53]. The divergence in the prevalence of retinopathy may be due to differences in the age structure of different populations and to differences in study methodologies and population samples.

The second common complication of diabetes in our sample was the diabetic nephropathy (12.8%). DN results from the same pathological mechanisms as DR, which makes them appear almost at the same time during the disease; the discovery of one of these complications must necessarily lead to the search for the other.

Studies on this microvascular disease reported various rates of prevalence: 10.8% in Saudi [54], 11.6% in Sudan [55] and 13.1% in Tunisia [56]. In addition, Afifi and colleagues in Egypt [57] performed multiple cross-sectional study between 1996 and 2001 and showed that DN gradually increased from 8.9% in 1996 to 14.5% in 2001, which is similar to our findings. Other data indicated higher rates than ours (25.2% in Libya, 41.7% in Egypt and 25% in Cameroon) [58] [59] [60]. The rate of nephropathy was lower and this could be attributed to the fact that 50.9% of patients had a diabetes duration less than 10 years.

Regarding macrovascular complications in our work, the rate of cardiovascular diseases was 5.4%, similar to that showed in Iran (6.5%) [61]. According to some studies realized in the Middle East and North Africa, the macrovascular complications ranged from 9% to 17% in people with diabetes [62] [63] [64]. In Montana American Indians the rate of cardiovascular complications was very high (27%) [65].

Our findings showed a low frequency of neuropathy and diabetes foot complications which reached 3.6% and 2% respectively. In other populations, the prevalence of neuropathy ranged from 21.9% to 66% [66] [67] [68]. However, a recent study carried out in Iraq [69] reported a prevalence of 2.4% for diabetes foot complications in patients with diabetes which is consistent to our value. The low frequency of neuropathy and diabetes foot complications probably resulted from the good accompaniment and education of the patients by health professionals of (RCD) in the long-term follow-up of their disease.

Our analysis has showed that age, diabetes duration and a high level of albuminuria were the principal risk factors associated with development of diabetes complications in both T1D and T2D. These findings are consistent with other reports [70]-[77] showing that the risk of developing these complications is positively associated with these variables.

This retrospective study confirms previously reported trends in the relationship between hypertension and diabetes complications [72] [75]. We have found that hypertension in patients with type 1 and type 2 diabetes was significantly ($P < 0.001$) associated with development of complications. Furthermore, this association persists after multivariate logistic regression analysis in type 2 diabetes (OR = 1.56; 95% CI: 1.26 - 1.92, $P < 0.001$).

Consistent with foregoing studies [78] [79], we have found that lower levels of education are significantly ($P < 0.01$) associated with an increased rate of complications in T1D patients and a higher levels of education had a protective effect against diabetic complications in these patients. In the same context, researchers evaluating the relationship between socioeconomic status and diabetic complications indicated that the incidences over 1 to 20 years' follow-up of end-stage renal disease and coronary artery disease were two to three times greater for T1D individuals with lower level of education, compared to those with higher one [79].

In this paper, the risk of each micro and macrovascular complications of T2D is statistically associated with high HbA1c ($P < 0.001$). 33.1% of patients with T2D who have complications, have a poor glyceamic control (HbA1c > 7%). This result as others [80] [81] [82] has demonstrated that an improved glyceamic control can reduce the incidence and the risk of micro and macrovascular complications in these people.

There is evidence that overweight and obesity are associated with an increased risk of mortality, cardiovascular diseases, and diabetes [12] [83]. Our study has confirmed this data and found overweight and obesity to be strongly associated ($P < 0.001$) with an increased risk for diabetes complications in patients with T1D.

6. Conclusion

To our knowledge, this is the first study in Eastern Morocco to identify diabetes complications and its risk factors. In this finding, the frequency of diabetes complications is 32%; diabetic retinopathy is the most frequent diabetic complications

(16.8%), and the diabetes foot is the complication that has a lower frequency (2%). Moreover, age, diabetes duration, and high albuminuria are the major risk factors for the occurrence of diabetes complications in both type 1 and type 2 diabetes. Biological studies must be conducted to identify new biomarkers and key mechanisms responsible for these diabetic complications, particularly at the onset of the disease.

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Conflicts of Interest

The authors declare that they have no competing interests regarding the publication of this paper.

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