# Factors Associated With Glycaemic Control Among Diabetic Subjects in Essaouira Province, Morocco: A Cross-Sectional Study


## Abstract

**Aims:** The objectives of this study are to determine the frequency of poor glycaemic control, defined by a glycated hemoglobin (HbA1c) rate ≥ 7% in diabetic subjects in the province of Essaouira (Morocco), and to identify the associations between poor glycaemic control and socio-demographic, psychosocial, and pathology-related factors in the diabetic subject.

**Study Design:** This is a a quantitative analytical cross-sectional study.

**Methodology** : A face-to-face interview was conducted with 522 diabetic subjects followed at 12 health centers ,4 urban and 8 rural, in the province of Essaouira, between January and December 2020

**Results:** The mean age of the subjects was 57 years,78% female and 22% male. HbA1c was≥7% in 60% of cases. Rural residence (OR=2.75, 95% CI: 1.86-4.05), poor observance of medication (OR=5.57, 95% CI: 3.07-10.11), poor observance of hygiene and dietary rules (OR=4.1, 95% CI: 2.76-6.11), duration of diabetes more than 8,4 years (OR=1.96, 95% CI: 1.35-2.85), low monthly income (OR=1.96, 95% CI: 1.35-2.85) , were statistically associated with poor glycaemic control. On the other hand, being a member of a diabetes association (OR=2, 95% CI: 1.31-3.06) and having good support from family and friends (OR=1.96, 95% CI: 1.35-2.85) have positively influence glycaemic control.**Conclusion:** More than half of the diabetic subjects had a poor glycaemic control, the diabetic subjects living in rural areas, having a poor observance of medication, having a poor observance of hygiene and dietary rules and having a duration of evolution of the disease more than 8,4 years are more susceptible to have glycaemic imbalance.



**Keywords:** Diabetes, glycaemic control, Essaouira, Morocco.


## 1. Introduction

The global prevalence of diabetes in adults has been increasing over recent decades at an alarming pace [1]. In 2017, 451 million adults (ages 18–99 years) lived with diabetes in worldwide. This number was predicted to rise to 693 million by 2045 [2]. There is no country in the world that does not bear some burden from diabetes [1]. According to the International Diabetes Federation (IFD), in 2013, the most populous countries recorded the largest number

of deaths: 1271,000 in China, 1065,000 deaths in India, 386,400 in Indonesia, 197,300 in the Russian Federation and 192,700 in the United States of America[3]. Increases in type 2 diabetes incidence generally correlate in general with the globalisation, nutrition transition, increasingly sedentary lifestyles, the type of urban growth, etc. [4,5,6]. Obesity, age, family history, environmental and psychosocial factors, are some risk factors [7,8,9]. It is the leading cause end-stage kidney disease, blindness and lower limb amputation, and the sixth leading cause of death [10].

The situation in Morocco is as alarming as at the global level. Some national surveys showed the prevalence of type 2 diabetes in Moroccan adults aged 20 years and older varied from 6.6% in 2000 to 12.4% in 2016[11]. According to the STEPWISE survey - Ministry of Health 2017-2018- Diabetes is the first cause of blindness, the first cause of end-stage renal disease, the first cause of lower limb amputations [10]. Half of all Moroccan diabetics are disregard of their disease and the severity of the complications it causes [10]. However, effective management will decrease the incidence of these complications [12]. Indeed, Diabetes is a metabolic and nutritional pathology, it occurs as a result of a defect in insulin secretion, insulin action or both [13]. Insulin is what lowers blood glucose levels during the course of the metabolic processes following digestion. In recent years, several studies have examined the impact of glycaemic control on the occurrence of complications. The reduction in the risk of developing nephropathy, retinopathy and neuropathy as well as their slowing down was confirmed in the DCCT study [14,15], while the UKPDS study showed a 37% reduction in the risk of microvascular complications, 14% reduction in myocardial infarction and 21% reduction in diabetes-related deaths for each 1% reduction in glycated haemoglobin [16]. Several studies have also evaluated the factors that can influence the glycaemic control, these factors can be related to the socio-demographic or psychosocial profile of the diabetic subject or to the characteristics related to the pathology [17,18,19,20,21]. To our knowledge no study has identified the factors associated with poor glycaemic control in Essaouira province. The objective of our study is to determine the frequency of poor glycaemic control, defined by a glycated haemoglobin level (HbA1c) ≥ 7.0% in diabetic subjects in the province of Essaouira and to determine the associations between poor glycaemic control and sociodemographic, psychosocial and pathology-related factors. Identifying these factors can help healthcare professionals guide diabetic subjects to achieve desired glycaemic control and thereby reduce disease-related complications and promote health.

## 2. Subjects and Methods

### 2.1. Study area

The present study took place in the health centres of the province of Essaouira. Essaouira is a small coastal city located in the southwest of the Marrakech-Safi region. The economic activity of the province is largely directed at tourism and fishing, the main providers of income and employment in urban areas, while in rural areas, it is based primarily on goat

breeding, grain farming and the exploitation of Argan trees [22]. The activity rate in the province is estimated at 45.7%[23]. In terms of education, 48.9% of the population is illiterate[24]. Despite concerted efforts to upgrade it (development of rural tourism [25], Argan cooperatives [26],ect.), Essaouira is among the most vulnerable provinces in the region (a vulnerability rate of 22.2% [27]).

### 2.2. Study design

A cross-sectional survey included 522 diabetic subjects managed at 12 health centres level (4 urban and 8 rural in Essaouira province) between January and December 2020 to identify the factors associated with poor glycaemic control. The health centres provide a basket of health care: monitoring chronic diseases, general medical consultations, nursing services, medication for chronic diseases such as diabetes hypertension.etc [28] .

Based on a review of the literature, the research team developed a detailed structured questionnaire in French. In order to meet the study objectives and to test the hypotheses, cross-cultural adaptation and development of new indicators were necessary. Prior to the validation of the questionnaire, a pre-test was conducted with twenty diabetic participants which resulted in the elimination of questions that seemed redundant or irrelevant. Prior to the validation of the questionnaire, a pre-test was conducted with twenty diabetic participants which resulted in the elimination of questions that seemed redundant or irrelevant. One hundred and five questions were retained instead of the original 124 questions and were organised into six dimensions (20 questions for the Socio-economic characteristics dimension, 21 questions for the diabetes dimension, 27 questions for the nutrition and eating habits, 19 questions for the physical activity and sedentary lifestyle, 14 questions for the well-being dimension and 4 questions for the Anthropometric measurements dimension). The research team chose a single interviewer (a member of the team) who was fluent in French, Arabic and Berber (the respondents' mother tongue) to conduct a face-to-face interview with diabetic subjects who expressed a positive opinion of participating in the study. The interviewer conducts the interview by asking the participants questions, recording the answers and translating the questions into Arabic or Berber if necessary. The interview takes place in a separate room, so that discussion while respecting the privacy of the subject. The designed questionnaire was used as an instrument to collect detailed data on demographic and socio-economic characteristics (place of residence, age, gender, marital status, education level, occupations, monthly income, etc.), pathology-related characteristics (type of treatment, duration of diabetes, glycaemic control, comorbidity, complications, etc.), psychosocial characteristics (To be informed about hygiene and dietary rules, member of diabetes association, family support, etc.), the conditions for observance of medication and for observance of hygiene and dietary rules (diet, lifestyle, physical activity).

By referring to the Moroccan Nutrition Guide [29] and to the thematic guide "therapeutic education of type 2 diabetics" [30], the conditions for observance of medication and for observance of hygiene and dietary rules were considered as follows:

*Observance of medication* : is considered good if the diabetic rigorously follows the drug treatment prescribed without forgetting, changing or stopping it.

*Observance of hygiene and dietary rules:*

-*Diet:* based on the seven classic food groups (beverages, fruits and vegetables, cereals, milk and dairy products, meats, fats, sweet products, medicinal plants have been added because of their undesirable effects), this study has established a list of foods that are not recommended for diabetics and it has noted the corresponding consumption conditions. The interviewee is asked concerning the quantities and frequencies of food consumption in the last four weeks.
-*Lifestyle:* among the advice offered by the guides, this study chose to collect information related to the sleep of the diabetic, the timing of meals and smoking.
-*Physical activity*: the interviewee is asked about the nature and frequency of sports activity.

The specificities and conditions of observance of each hygiene and dietary rule have been summarised in table 1. The diabetic subject is considered "observant" if he respects all the conditions of each rule, otherwise, he is "non-observant".

The diabetic subject is considered as "observant" of all hygiene and dietary rules if he respects at least two of the three rules (diet, lifestyle and physical activity).



| Hygiene and dietary rules | Specificity | | Conditions for respecting the hygiene and dietary rules | |
|---|---|---|---|---|
| **Diet** | ***Beverages*** | Tea and coffee | If they are consumed without sugar | The **"diet"** rule is considered to be observed if all |
| | | Lemonades and alcoholic beverages | If they are not consumed | |

**Table 1: Conditions for respecting the hygiene and dietary rules**

| | | | |
|---|---|---|---|
| | ***Fruits and vegetables*** | Fruits and vegetables with a high glycaemic index | they are not consumed<br>In case of good glycaemic control (HbA1c<7%): if consumed on an occasional basis |
| | ***Meats*** | Red Meats | If their consumption does not exceed two times a week. |
| | ***Fats*** | Animal fats | If they are not consumed |
| | | Frying | If they are not consumed |
| | ***Sweet products*** | Products with a high glycaemic index | In case of poor glycaemic control (HbA1c>7%): if they are not consumed<br>In case of good glycaemic control (HbA1c<7%): if consumed on an occasional basis |
| | ***Medicinal plants*** | | If they are not consumed |
| **Lifestyle** | ***Sleep*** | | If the diabetic reports no sleep disturbances. |
| | ***Timing of meals*** | | If the diabetic reports having meals at set times. |
| | ***Smoking*** | | If the diabetic declares that he does not smoke. |
| **Physical activity** | | | The Rule **"physical activity"** is considered to be observed if the diabetic practices a sports activity at least 3 times a week for 30 minutes each time. |

onditions are completed

The Rule **"healthy lifestyle"** is considered to be observed if the three conditions are completed

### *Inclusion criteria*

Only diabetic subjects who had measured glycated haemoglobin (HbA1c ) in the last three months were included in the study.

### *Exclusion criteria*

Diabetic subjects under 18 years of age and pregnant women with diabetes have been excluded from the study.

### 2.3. Statistical analysis

Data acquisition , calculation of percentages, univariate, bivariate analyses, Khi2 tests were realised by the Statistical package for the Social Science (SPSS) version 20. All statistical tests were performed at the 5% significance level. Observations containing at least one missing data item have been removed. Using the analyses conducted by this software, the factors associated with glycaemic control were identified . On the basis of the observed results, the variables that retained in the logistic regression model have been chosen, in order to determine the weight of the factors associated with the glycaemic control. An adjustment of the variables was necessary for the logistic regression model. This survey considered for the age "less than or equal to 60 years old" against "over 60 years old", for the monthly family income " <2000MAD "against" greater than or equal to 2000MAD ".

## 3. Results

### 3.1. Demographic, socio-economic and cultural characteristics of respondents

Five hundred and twenty-two diabetic subjects participated in the survey. They were overwhelmingly female (77.8%), with a sex ratio of 0.28. The age of the surveyed ranged

from 20 to 94 years, with an average of 56.6 years (SD = 11.4 years). The age-class distribution showed that the age group between 40 and 60 were the most dominant (56.9%). More than half of those surveyed lived in the urban areas (61.7%). Most subjects had never attended school (82.2% of women and 17.8% of men) [p<0.001], among the literate subjects, only 8% reached secondary education. Moreover, 25.3% of the interviewees were performing a professional activity (41.7% of women and 58.3% of men) [p<0.001]. Eighty-nine percent had a monthly income of less than 2 000 MAD per family (**Table 2**).

### 3.2. Characteristics of diabetes

Of the total of 522 respondents, 67% had non-insulin-dependent diabetes and more than half were on oral anti-diabetic drugs (59.8%). The mean duration of diabetes was 8.4 years (SD = 6.9 years). Hypertension and dyslipidaemia were the most common diabetes comorbidities associated (25.1% and 9.6% respectively). Almost 60% of the interviewed had a family history of diabetes. As regards the complications, 10.3% had retinopathy, 3.3% had neuropathy and 1.9% had nephropathy (**Table 2**).

### 3.3. The rate of glycated haemoglobin

In the present study, Only diabetic subjects who had measured glycated haemoglobin (HbA1c ) in the last three months were selected. Evaluating glycaemic control noted that 61% of the total study population did not achieve the ADA-recommended goal is HbA1c <7%.



**Table 2 : Description of the study population (n=522)**

| | | | Effective | % |
|---|---|---|---|---|
| **Socio-demographic characteristics** | **Age groups (years)** | <40 | 40 | 7.7 |
| | | [40-60] | 297 | 56.9 |
| | | >60 | 185 | 35.4 |

| | | | | |
|---|---|---|---|---|
| | **Instruction level** | Illiterate | 432 | 82.8 |
| | | Primary school | 48 | 9.2 |
| | | High school and university | 42 | 8.0 |
| | **professional activity** | SPC1 | 390 | 74.7 |
| | | SPC2 | 118 | 22.6 |
| | | SPC3 | 12 | 2.3 |
| | | SPC4 | 2 | 0.4 |
| | **monthly family income** | <2 000 MAD | 454 | 87.0 |
| | | [2 000-4 000 MAD] | 47 | 9.0 |
| | | >4 000 MAD | 20 | 3.8 |
| | **Marital Status** | Married | 376 | 72.0 |
| | | Divorced | 28 | 5.4 |
| | | Widowed | 100 | 19.2 |
| | | Single | 18 | 3.4 |
| | **place of residence** | Urban | 322 | 61.7 |
| | | Rural | 200 | 38.3 |
| **characteristics of diabetes** | **Type of diabetes** | NIDD | 349 | 66.9 |
| | | IDD | 173 | 33.1 |
| | **Treatment** | OAD | 320 | 59.8 |
| | | Insulin | 178 | 34.1 |
| | | without treatment | 24 | 6.1 |
| | **Duration of diabetes (years)** | <8.4 | 313 | 60.0 |
| | | ≥8.4 | 209 | 40.0 |
| | **Glycaemic control** | HbAc1<7% | 202 | 38.7 |
| | | HbAc1≥7% | 320 | 61.3 |
| | **Co-morbidities** | No comorbidities | 266 | 51.0 |
| | | HBP | 131 | 25.1 |
| | | Dyslipidemia | 56 | 10.7 |
| | | Others/several | 69 | 13.2 |
| | **Complications** | No complications | 302 | 57.9 |
| | | Retinopathy | 54 | 10.3 |
| | | Nephropathy | 10 | 1.9 |
| | | Neuropathy | 17 | 3.3 |
| | | Others/several | 139 | 26.6 |
| **Psychosocial characteristics** | **To be informed about HDR** | Yes | 68 | 13 |
| | | No | 454 | 87 |
| | **Family support** | Yes | 405 | 77,6 |
| | | No | 117 | 22,4 |
| | **Member of a diabetes association** | Yes | 384 | 73,6 |
| | | No | 138 | 26,4 |

Note: ***SPC:*** *socio-professional categories:* ***SPC1****: no occupation;* ***SPC2:*** *: artisans, employees, workers, shop assistants, farmers, employed workers, labourers, drivers... ;* ***SPC3*** *: officials, middle-level professionals...;* ***SPC 4*** *: liberal professions, higher management, major merchants…*
***NIDD:*** *non-insulin-dependent diabetes;* ***IDD****: insulin-dependent diabetes;* ***OAD****: oral antidiabetic drugs;* ***HBP****: high blood pressure,* ***HDR****: hygiene and dietary rules.*

### 3.4. Factors associated with glycaemic control:

The glycaemic control was compared according to the socio-demographic, the psychosocial and pathology-related factors. The variables that were retained were: gender, age, monthly family income, place of residence, duration of diabetes, observance of hygiene and dietary rules (RHD), observance of medication, membership in a diabetes association and Family support (**Table 3**). Indeed, urban residents were almost 3 times more likely to have good glycaemic control (OR=2.75, 95% CI: 1.86-4.05). Diabetes association members are twice as likely to be balanced (OR=2, 95% CI: 1.31-3.06). In contrast, diabetic subjects with poor therapeutic observance were five times more susceptible to have glycaemic imbalance (OR=5.57, 95% CI: 3.07-10.11), and diabetic subjects with poor observance of hygiene and dietary rules were four times more susceptible to have glycaemic imbalance (OR=4.1, 95% CI: 2.76-6.11). In addition, diabetic subjects with a duration of diabetes of more than 8.4 years

were twice as susceptible to have glycaemic imbalance (OR=1.96, 95% CI: 1.35-2.85). Low monthly income (OR=1.96, 95% CI: 1.35-2.85) and lack of family support (OR=1.96, 95% CI: 1.35-2.85) also showed a significant [p<0.01] association with poor glucose control. Binary logistic regression model results reveal that, in order of importance, glycaemic control is highly associated with therapeutic observance, observance of hygiene and dietary rules, duration of diabetes and the place of residence (**Table 4**).

**Table 3: Factors associated with glycaemic control (n=522)**

| variables | | Glycaemic level | | Test $\chi^2$ |
|---|---|---|---|---|
| | | Good (HbAc1<7%) n(%) | Poor (HbAc1≥7%) n(%) | |
| | | **204(39,1)** | **318(60,9)** | |
| **Gender** | Female | 161(39,7) | 245(60,3) | $0,2^{NS}$ |
| | Male | 43(37,1) | 73(62,9) | |
| **Age groups (years)** | <40 | 10(25) | 30(75) | $3,6^{NS}$ |
| | [40-60] | 120(40,4) | 177(59,6) | |
| | >60 | 74(40) | 111(60) | |
| **Monthly family income** | <2000Dh | 173(37,4) | 290(62,6) | $11,4^{**}$ |
| | [2000-4000Dh] | 19(43,2) | 25(56,8) | |
| | >4000Dh | 12(80) | 3(20) | |
| **Place of residence** | urbain | 154(47,8) | 168(52,2) | $27^{***}$ |
| | rural | 50(25) | 150(75) | |
| **Duration of diabetes** | <8,4ans | 142(45,4) | 171(54,6) | $12,9^{***}$ |
| | ≥8,4ans | 62(29,7) | 147(70,3) | |
| **Therapeutic observance** | Good | 174(44,8) | 214(55,2) | $37,6^{***}$ |
| | Poor | 14(12,7) | 96(87,3) | |
| **Observance of hygiene and dietary rules** | Good | 159(52) | 147(48) | $51,5^{***}$ |
| | Poor | 45(20,8) | 171(79,2) | |
| **Membership in a diabetes association** | Yes | 166(43,2) | 218(56,8) | $10,5^{***}$ |
| | No | 38(27,5) | 100(72,5) | |
| **Family support** | Good | 171(42,2) | 234(57,8) | $7,4^{**}$ |
| | Poor | 33(28,2) | 84(71,8) | |

***p<0,05 ; ** p<0,01; *** p<0,001 ; NS: non significatif***

**Table 4: Binary logistic regression model variables and factors associated with glycaemic control**

| | A | E.S. | Wald | ddl | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| **Place of residence (urbain vs rural)** | 1,200 | 0,359 | 11,176 | 1 | 0,001 | 3,318 |
| **Therapeutic observance (good vs poor)** | 1,747 | 0,326 | 28,624 | 1 | 0,000 | 5,736 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Observance of hygiene and dietary rules(good vs poor)** | -1,426 | 0,230 | 38,319 | 1 | 0,000 | 0,240 |
| **Duration of diabetes(<8,4ans vs ≥8,4ans)** | 0,719 | 0,220 | 10,695 | 1 | 0,001 | 2,052 |
| **Membership in a diabetes association(yes vs no)** | 0,050 | 0,390 | 0,016 | 1 | 0,898 | 1,051 |
| **Monthly family income(<2000MAD vs ≥2000MAD)** | -0,373 | 0,344 | 1,173 | 1 | 0,279 | 0,689 |
| **Family support (good vs poor)** | 0,401 | 0,272 | 2,177 | 1 | 0,140 | 1,493 |
| **Constante** | -3,403 | 1,048 | 10,539 | 1 | 0,001 | 0,033 |

***A** : coefficient de régression, **ES** : erreur standard, **wald**: statistique de odds ratio, rapport de côte, **ddl** : degré de liberté, **p** : probabilité, **Exp(B):** odds ratio estimé*

## 4. Discussion

The present study attempted to identify factors that may influence glycaemic control in diabetic subjects followed up at health centres in the province of Essaouira. Results showed first that 61% of the subjects surveyed had not reached the goal recommended by the ADA (American Diabetes Association), i.e. an HbA1c level < 7%. Many epidemiological studies reveal that the glycaemic control is often poor. In Guinea, the frequency of poor glycaemic control was 84%[31], 68% in Cameroon[31], 71% in Ethiopia[32], 83% in Tunisia[33] and 61% in Jordan[34]. Good glycaemic control can only influence the health of the diabetic by minimizing the risk of developing degenerative complications of diabetes. Several studies have examined the impact of glycaemic control on the occurrence of complications. The reduction in the risk of developing nephropathy, retinopathy and neuropathy as well as their slowing down was confirmed in the DCCT study [14,15], while the UKPDS study showed a 37% reduction in the risk of microvascular complications, 14% reduction in myocardial infarction and 21% reduction in diabetes-related deaths for each 1% reduction in glycated haemoglobin [16]. In the present study, we noted that diabetic subjects with poor therapeutic observance were five times more susceptible to have glycaemic imbalance. This same finding was reported in a study conducted in Ethiopia [32]. In addition, diabetic subjects with poor observance of hygiene and dietary rules were four times more susceptible to have glycaemic imbalance. A study conducted in the north of the country reported a correlation between poor glycaemic control and unsatisfactory dietary habits[35]. Moreover, no-observance of with hygiene and dietary rules can only have serious repercussions on glycaemic imbalance and consequently on the health status of the diabetic in the short and long term[36,37]. In addition, the concordance between a rigorous follow-up therapy and strict hygiene-dietary modifications is advocated to improve glycaemic control and, consequently, minimize complications [38]. This can only be achieved by taking into consideration all the factors influencing observance, namely, the socio-cultural and psychosocial profile of the diabetic subject, the therapeutic conditions and the care provider[37]. However, it is recommended that health professionals simplify and adapt their medical and hygiene-dietary discourse according to the profile of diabetic and that local and regional authorities encourage and finance diabetes associations in view of their role in the development of therapeutic education. In fact, in the present study, diabetic subjects who were members of a diabetes association were twice as likely to be balanced. Reporting that the social services offered by

the association of diabetes are to accompany the members, to organize days of awareness on the disease and the importance of hygiene and dietary advice and the realization of medical analysis (fasting blood sugar and glycated haemoglobin). Thus, in the province studied, only one association offers diabetes services to its members, who are predominantly urban (83%), which could influence glycaemic control in rural areas. Indeed, in the present study, subjects residing in rural areas were three times more susceptible to be unbalanced. As in all developing countries, in Morocco, belonging to a rural area is associated with a precarious and vulnerable life, a low level of education, difficulty in accessing healthcare, and a lack of specialists and equipment at health care facilities [39,40]. Thus, in the health centres visited in the present study, there is even a lack of general practitioners and sometimes shortages of anti-diabetic drugs, which will have a direct impact on therapeutic education, hygiene and dietary education, therapeutic observance and hygiene and dietary observance. This will undoubtedly influence glycaemic control.

It was noted that diabetic subjects with a duration of diabetes greater than 8.4 years are twice as susceptible to have a glycaemic imbalance. Other studies have also noted a positive correlation between glycaemic imbalance and the duration of diabetes [31, 33,31,42,43]. M Verma et al. showed that HbA1c levels increase significantly with the duration of diabetes [44]. Over time, maintaining beneficial lifestyle habits for disease management becomes difficult. In addition, the body becomes more resistant to insulin as diabetes progresses [34]. According to our results, no significant correlation was found between age and glycaemic control. The same finding was demonstrated in the study of M Verma et al.[44]. In contrast, some studies have shown that glycaemic imbalance is associated with young age [31, 34]. E Barankanira et al. reported, however, that glycaemic imbalance is observed in subjects aged 40 and over [19]. Our results did not show any significant difference regarding the gender factor. The same finding was demonstrated in the study conducted by E Barankanira et al. [19] in contrast to other studies that showed that poor glycaemic control is significantly higher in women than in men [32,45,46].

## 5. Conclusion

Monitoring blood glucose fluctuations is a key factor in diabetes management. Identifying factors associated with glycaemic control can help health professionals to guide diabetic subjects to achieve desired glycaemic control and thereby reduce disease-related complications and promote health.

## Ethics approval and consent to participate

The survey was conducted in full respect of local ethical considerations, namely obtaining authorisation [N°8874] from the regional and local services of the Moroccan Ministry of Health. The project was approved by the ethics committee (Moroccan Association for Research and Ethics). After informing the diabetic subjects of the purpose of this research, it has sought their consent and agreement to participate in the study. All participants gave their informed consent and all data were collected anonymously.

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