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GLYCEMIC CONTROL AND OVERWEIGHT OBESITY AMONG TYPE 2 DIABETES PATIENTS FOLLOWED AT THE SECONDARY CARE REFERRAL CENTER IN OUJDA-MOROCCO

Naima Abda[1], Mohammed Amine Bouazzaoui[1], Hasna Dahmani[2], Yassamine Bentata[2]

1 Laboratory of Epidemiology, Clinical Research and Public Health, University Mohammed Premier, Oujda, Morocco.
2 Hassan II Reference Center for Diabetes and Chronic Diseases, Oujda, Morocco

Corresponding address: Naima ABDA, *Laboratory of Epidemiology, Clinical Research and Public Health, University Mohammed Premier, Oujda, Morocco.* **E-mail**: n.abda@ump.ac.ma

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Abstract

Background: Maintaining optimal glycemic control is a primary goal in the management of type 2 diabetes, especially among overweight and obese patients. The objective of the study was to explore the relationship between overweight/obesity and glycemic control (HbA1c) among patients diagnosed with diabetes mellitus and admitted to the reference center for chronic diseases in Oujda. **Methods:** This is a retrospective cohort study including all type 2 diabetic patients who had at least 2 consultations between 2005 and December 2020. **Results:** 5123 patients were included in the study, 71.6% were women with an average age of 56.6 ± 11.8 years and 54.8% had diabetes for more than 2.5 years. Arterial hypertension was present in 38.3% at admission, 43.2% were overweight and 30.1% were obese. Almost 16.3% of patients had at least one complication on admission, 3.5% had heart disease, 5% had nephropathy, 3.9% retinopathy, 1.3% neuropathy and 0.6 % had a diabetic foot. During the second visit, almost a quarter (23.7%) of overweight/obese patients had good glycemic control versus 20.5% in patients with an underweight or normal weight (p=0.035) with a more marked decrease of HbA1C between the first and the second visit in overweight/obese patients (8.9±0.1% versus 8.8± 0.1%, p=0.054) compared to underweight or normal weight patients (9.4± 0.1% versus 9.3± 0.1%, p=0.318). The overweight/obese patients were significantly younger than the others (55.4±11.3 years versus 56.7 ±9.4 years, p=0.002), with more comorbidities, more history of hypertension (39.7% versus 28%, p<0.001) and of cardiac complications (3.9% versus 2%, p=0.003). **Conclusion:** The young age and the frequency of comorbidities in our population of overweight/obese patients could explain better glycemic control in this population due to good compliance

Key words: diabetes- glycemic control- overweight-obesity - Morocco.

Introduction

Diabetes is a major public health problem due to its detrimental impact on health and well-being and the costs associated with its complications. According the World Health Organization (WHO), a total of 1.5 million deaths were directly related to diabetes in 2019, and 48% of these deaths occurred in those under the age of 70. Diabetes contributed to an additional 460 000 renal disease fatalities, and high blood sugar was responsible for almost 20% of cardiovascular mortality [1]. Obesity is currently a global epidemic. It concerns 400 million people worldwide, or 7% of the world's population according to the WHO. There is a very close relationship between weight and type 2 diabetes (T2D). Indeed, many previous published data have reported that most of patients with T2D are overweight or obese and that obese people present the highest risk of developing T2D, as excess weight and adipose tissue contribute to insulin resistance and impaired glycemic control [2,3]. Hence, the American Diabetes Association (ADA) recommends weight loss for all overweight or obese individuals who have or are at risk for diabetes [4]. Maintaining optimal glycemic control is a primary goal in the management of type 2 diabetes, and is crucial for reducing the risk

of complications and improving overall health outcomes for individuals with T2D. Understanding the intricate relationship between obesity and glycemic control is essential for developing effective strategies to manage and treat type 2 diabetes in affected individuals. The present study explored the relationship between overweight/obesity and glycemic control (HbA1c) among patients diagnosed with diabetes mellitus and admitted to the reference center for chronic diseases in Oujda.

Methods

Study design and population

This retrospective cohort study was carried out at the Reference Center for Chronic Diseases in Oujda, eastern Morocco. The study included all adult patients with type 2 diabetes, aged 18 or older, who had at least two medical visits between 2005 (the center's opening date) and December 2020 with a minimum of three months between the two visits.

Data collection

Data was collected from medical records at the Reference Center for Chronic Diseases, including each patient's demographic, clinical, and biological characteristics.

Variables definition

The body mass index (BMI) was calculated according to the WHO definition, then the study population was divided into two groups: underweight and normal weight (BMI ≤ 24.99 kg/m2), overweight and obese (BMI ≥ 25 kg/m2). For glycemic control, we defined glycemic status as good glycemic control if HbA1c <7% and poor glycemic control if HbA1c ≥ 7% according to the American Diabetes Association (ADA) guidelines [5]. The glomerular filtration rate (GFR) was estimated using the MDRD equation (Modification of Diet in Renal Disease) [6,7].

Statistical analysis

Data are described as the mean ± standard deviation (SD) or median and interquartile range (IQR) for continuous variables and proportions for categorical variables. For Univariate analysis, Student t-test was used to compare mean values of the assigned groups, and Chi-square test was performed to evaluate differences in proportions. To compare variables between the first and the second visit, we used the student test (2 tailed) for matched samples for continuous variables and Chi-square tests (McNemar) to examine differences among categorical variables. For all statistical tests, a critical value of $p < 0.05$ indicated statistical significance. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) software version 21.0.

Ethical approval

This study was performed following the Moroccan law and the Helsinki Declaration for the protection of personal data. The study was approved by the biomedical research ethics committee of the Faculty of Medicine at Mohammed First University (05/2017).

Results

Between 2005 and 2020, 19,953 type 2 diabetes patients were identified; however, only, 5123 patients had at least two consecutive visits. The majority were female (71.6%), and the average age was 56.6 ± 11.8 years, ranging from 18 years to 100 years. Diabetes was diagnosed in half of the cases (51.4%) in primary healthcare centers, 36.7% of cases in private practices, and 7.4% in emergency departments. On admission, 54.9% of the patients had had diabetes for more than 2.5 years and 38.3% had high blood pressure. A family history of diabetes was reported in 71.7% of the cases, with nearly half of those (51.3%) having a first-degree relative with diabetes, 37.4% having a second-degree relative with diabetes, and 11.3% having a third-degree relative with diabetes. On admission, 16.3% of patients had at least one diabetes complication, with diabetic nephropathy being the most common (5%), followed by diabetic retinopathy (3.9%). The third most common complication was heart diseases (3.5%) mainly attributable to coronary artery disease (80.5% of cardiac complications), followed by, diabetic neuropathy (1.3%), and diabetic foot disease (0.6%). The mean BMI on admission was 28.0 ± 4.8 kg/m2, and 72.7% were overweight/obese, distributed as follows, 42.1% were overweight ($25 \leq BMI < 30$ kg/m^2), 22.4% had moderate obesity ($30 \leq BMI < 34.9$ kg/m^2), 6.1% had severe obesity ($35 \leq BMI < 39.9$ kg/m^2) and 1.6% had morbid obesity (BMI ≥ 40 kg/m^2). 31.5% were obese (BMI ≥ 30 kg/m^2).

The initial laboratory tests showed that 21.4% of patients had well-controlled diabetes (HbA1C < 7%) and this percentage had increased significantly by the second visit to reach 24.1% (p=0.003). By looking at the difference between, underweight/normal weight and overweight/obese patients, overweight or obese patients were more likely to have an HbA1C<7% than underweight and patients with normal weight even in the first visit (22.5% versus 18.2%, p=0.024) as well as in the second visit (23.7% versus 20.5%, p=0.035). This finding was verified by comparing the HbA1C average at the first and the second visit in the two groups. The decrease of HbA1C was more pronounced in the overweight/obese group (8.9±0.1% versus 8.8± 0.1%, p=0.054) than in the underweight/normal weight group (9.4± 0.1% versus 9.3± 0.1%, p=0.318), but this decrease wasn't significant (**Figure1**).

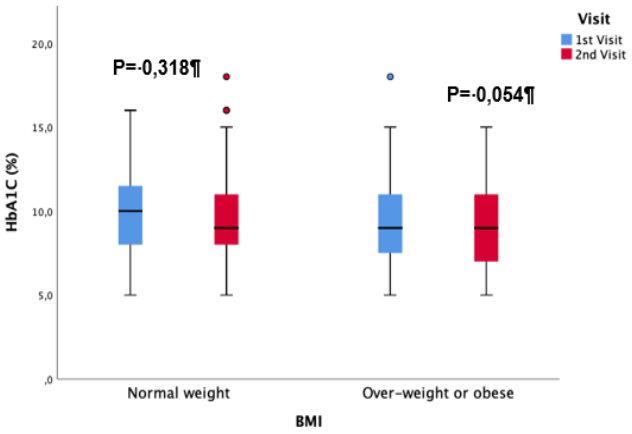

Figure 1- HbA1C changes between the two visits based on BMI classes.

By exploring the other factors associated with overweight and obesity, we found that overweight/obese patients were significantly younger than the others (55.4±11.3 years versus 56.7 ±9.4 years, p=0.002), with more female patients (77.9% versus 55.7%, p<0.001), with more history of high blood pressure (39.7% versus 28%, p<0.001), dyslipidemia (1.2% verus 0.3%, p=0.007), family history of diabetes (72.4% versus 69.1%, p=0.038), and more history of cardiac complications (3.9% versus 2%, p=0.003). In addition, these obese/overweight patients were monitored with more intensive treatments especially by ARA-II inhibitors (7.1% versus 4.5%, p=0.032) and platelet aggregation inhibitors (9.3% versus 5.4%, p<0.001) and were at higher risk of nephrological complications with low GFR (72.9 ± 22.2 ml/min/1.73m^2 versus 75.6 ± 23.2 ml/min/1.73m^2, p=0.011).

Table 1-Demographic, clinical and biological characteristics at admission according to BMI, n=5123.

	BMI < 25 kg/m^2	BMI ≥ 25 kg/m^2	p
Age, years (Mean±SD), n=4020	56.7 ± 12.5	55.5 ± 11.3	0.002
Age ≥ 65 years, N (%), n=4019	284 (26.5)	590 (20.0)	<0.0001
Gender, female N (%), n=4030	599 (55.7)	2300 (77.9)	<0.0001
Duration of diabetes, months (Median (IQR)), n=4024	36 (3-100)	36 (4-92)	0.818
Delay between 1st et 2nd visit, months (Median (IQR)), n=4027	15 (4.2-42.9)	15.5 (4.4-42.9)	0.590
Medical history N (%)			
High blood pressure, n=4030	301 (28.0)	1174 (39.7)	<0.0001
Dyslipidemia, n=3947	3 (0.3)	36 (1.2)	0.007
Menopause, n=1588	237 (73.1)	762 (60.3)	<0.0001
Family history of diabetes, n=4006	740 (69.1)	2126 (72.4)	0.038
History of complications, N (%), n=3407	134 (14.7)	400 (16.0)	0.333
Cardiopathy, n=3955	21 (2.0)	114 (3.9)	0.003
Strokes, n=3943	5 (0.5)	16 (0.6)	0.762
Retinopathy, n=3953	31 (2.9)	119 (4.1)	0.087
Nephropathy, n=4029	44 (4.1)	119 (4.0)	0.933
Neuropathy, n=4030	14 (1.3)	43 (1.5)	0.713
Diabetic feet, n=4030	6 (0.6)	11 (0.4)	0.422
Treatment on admission, N (%)			
Insulin + OHAs, n=3966	86 (8.1)	288 (9.9)	0.089
ARBs, n=2116	24 (4.5)	112 (7.1)	0.032
ACE inhibitors, n=2255	112 (19.6)	395 (23.4)	0.061
Statins, n=2133	29 (5.4)	154 (9.7)	0.002
Antiplatelet drugs, n=2138	23 (4.3)	148 (9.3)	<0.0001
HbA1c ≤ 7%, N (%)			
1st visit, n=2544	116 (18.2)	429 (22.5)	0.024
2nd visit, n=4030	221 (20.5)	700 (23.7)	0.035
Albuminuria on admission, N (%), n=1664	154 (38.1)	546 (43.3)	0.065
GFR (Mean±SD), n=2277	75.6 ± 23.2	72.9 ± 22.2	0.011

OHAs: Oral hypoglycemic agents. ACE: angiotensin-converting enzyme. ARBs: Angiotensin receptor blockers. GFR: Glomerular filtration Rate.

Discussion

Diabetes with chronically elevated blood sugar levels can lead to various complications, including cardiovascular disease, kidney damage, nerve damage, and vision problems. One of the main objectives in managing type 2 diabetes is maintaining optimal glycemic control, which is essential for lowering the risk of severe complications and enhancing overall health outcomes for people with type 2 diabetes.

Obesity is a major risk factor for the development of type 2 diabetes and managing obesity and improving glycemic control in individuals with type 2 diabetes requires a comprehensive approach. In line of this, the present study assessed the relationship between overweight/obesity and glycemic control among type 2 diabetes patients. The results showed that over two-thirds of the patients (72.7%) were overweight or obese; a frequency that is quite similar to that found in a study carried out in Beni Mellal-Khenifra region in

2017 among diabetic patients (69%) [4], but slightly higher than in the Moroccan general population, where overweight/obesity was found to occur among 53.0% of people [8]. This high frequency is explained by the well-established fact that obesity and overweight are predictive factors of type 2 diabetes [9], supported by the oxidative stress induced by abdominal adiposity and the activation of the renin-angiotensin-aldosterone system (RAAS) as well as insulin resistance [10].

Our study showed an increase in glycemic control between the first and the second medical visits, which is obviously due to the establishment of monitoring and drug treatment. But this optimal glycemic control was more likely found in overweight/obese patients than underweight and patients with normal weight. Such a result was also found in the study carried out in Beni Mellal-Khenifra region [4] and in another study carried out in Hong Kong [11]. On the other hand, other research studies revealed that being overweight or obese was associated with a significantly higher probability of having poorly controlled diabetes. In particular, a large retrospective cohort by Boye et al., which found that obese individuals with T2D were more likely to have their HbA1c at or above the thresholds of 7% or 8% [3]. The same result was found in a cross-sectional study conducted by Lotfi et al., among 2227 diabetic patients in the Kenitra provincial reference center for diabetes in Morocco [12]. Another literature review showed that the proportion of patients failing to achieve glycemic control increased with overweight and obesity [13]. This discordance with our results could be explained by the fact that the overweight/obese patients included in our study had more comorbidities, more cardiac complications, and were at risk of nephropathy complications and perhaps were more adhering to a healthy lifestyle and more observant of diabetes medication therapy. The relationship between obesity and glycemic control in type 2 diabetes is complex and bidirectional. On the one hand, excess body weight and adipose tissue contribute to insulin resistance, making it challenging to achieve and maintain stable blood sugar levels. On the other hand, chronically high blood sugar levels resulting from poor glycemic control can worsen insulin resistance and contribute to weight gain, further exacerbating obesity.

Although our study's large relative sample size provided valuable insights, it has some limitations. First, the retrospective design limits conclusions regarding the causality of the identified associations, and leads to a substantial number of missing data; second, some factors that potentially affect glycemic control such as dietary habits, physical activity, and lifestyle modification were not assessed in this study.

Conclusion

The interaction between obesity and glycemic control in type 2 diabetes underscores the importance of addressing both aspects by implementing lifestyle modifications, incorporating appropriate medication therapy, and closely monitoring blood glucose levels for effective disease management. Understanding and addressing the underlying factors contributing to obesity and impaired glycemic control is crucial for improving the overall health and quality of life of individuals with type 2 diabetes.

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Consent for publication: Not applicable**.**

Availability of data and materials: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. The file is available in SPSS file format and includes all data from 5123 patients. For those who want to request the data from this study, contact the corresponding author of the research grant Naima ABDA, MD (**Email**: n.abda@ump.ac.ma, phone +212666951387).

Competing interests: All the authors declare that they have no conflicts of interest.

Authors' contribution: YB and NA designed the study and analyzed the data. NA wrote the manuscript. MB entered and validated the data. MF and HD edited and reviewed of the manuscript.

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