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Role of the Nutritional Profile Study in the Hygienic-Dietary Management of People with Diabetes Kenitra City (Morocco): A Cross-Sectional Study.

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KEYWORDS

Type 2 diabetes, dietary management, nutritional profile, eating habits, nutritional therapeutic education-Morocco

ABSTRACT:

Introduction: Type 2 diabetes is one of the most dangerous endocrine diseases. Once diabetes has been diagnosed, the patient must follow rigorous hygienic and dietary management to limit the extent of the disease and minimize the risk of developing complications, when managing diabetes, it is essential first and foremost to engage in regular physical activity and, at the same time, to follow a suitable diet recommended by the attending physician, diabetologist or dietician.

Objectives: The aim of our study is to assess the nutritional profile and dietary habits of people with diabetes

Methods: The method uses a questionnaire designed for diabetes people to assess their nutritional profile and eating habits. The study not only assesses daily dietary habits, but also the information and dietary culture pursued by diabetic patients, and their awareness of the importance of diet in the management of the disease

Results: Our present study, carried out on a cohort of 300 patients in a public hospital in Kenitra (Morocco), specifically targets the nutritional profile to highlight the dietary habits of diabetic people The biological and clinical parameters are evaluated to better study the nutritional profile of the population, notably age (56.51±13.11 years), body mass index (26.44±3.4 kg/m²), hypertension (45.7%), blood glucose (1.85±0.64 g/l) .There was mainly a statistical difference between lipid balance and age (p=0.006), between type of snack foods and gender (p=0.05), between weekly food frequency of vegetables and fruit and gender (p=0.05). 31% of the patients believe that diet can be an important factor in diabetes control, and only 19% are sufficiently informed about the nutritional habits of diabetics. Conclusion: Therapeutic nutritional education remains essential for diabetes people to prevent serious consequences and avoid chronic pathologies likely to lead to fatal co-morbidities.

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1. Introduction

According to the World Health Organization (WHO), an estimated 126562 deaths from diabetes (T2DM) and its complications will occur in Morocco in 2019. This figure is rising all the time, underscoring the need for more medical research. Type 2 diabetes is associated, in around 80% of cases, with excess weight, or even obesity (body mass index (BMI) ≥ 30 kg/m²). Obesity is a factor in resistance to insulin action, aggravating the insulin resistance that characterizes diabetic subjects. The prevalence T2DM is constantly rising, in line with the considerable increase in overweight and obesity in our populations **[1].** The prevalence of T2DM in obese adults is higher than in normal-weight subjects. If the BMI ≥ 35 kg/m², the subjects are more likely to develop diabetes **[2].** In addition, obesity is an independent risk factor for dyslipidemia, hypertension and cardiovascular disease, adding to patients' risk of morbidity and mortality **[3].** T2DM is no longer synonymous with a specific diet. Instead, its management relies on a balanced diet, as well as physical activity and medication. It's important to understand what the recommended dietary measures consist of in order to prepare meals adapted to the pathology and thus prevent possible complications, especially cardiovascular disease. A large majority (80%) of diabetic patients do not follow medical recommendations concerning dietary and nutritional principles **[4].** Diet plays an essential role in balancing diabetes, along with medication and physical activity. People with diabetes need to eat a varied and balanced diet, as recommended for the general population. Carbohydrate consumption, whatever it may be, must be carefully monitored and adapted to each individual patient **[5].** Diabetes should be controlled as soon as it is diagnosed, initially by means of dietary hygiene measures (physical activity, balanced diet, weight loss in the event of excess or maintenance of a stable weight), followed by medication (oral antiT2D M or insulin, depending on the severity of the disease or associated complications). This management must be readapted and maintained throughout the patient's life. The aim is to prevent the micro and macro-vascular complications of the disease, while ensuring a good quality of life **[6].** Malnutrition is a pathological state resulting from the relative or absolute deficiency or excess of one or more essential nutrients, whether manifested clinically or detectable only by biochemical, anthropometric or physiological analyses **[7].** Indeed, the direct relationship between BMI and insulin resistance has generally been established. Waist circumference, which reflects visceral obesity, is also a predictive factor for the risk of developing diabetes **[8].** The WHO acknowledges that a BMI exceeding 25 kg/m2 exposes the individual sooner or later to T2DM. Vulnerable patients are also at increased risk of developing coronary heart disease, hypertension and hypercholesterolemia, which would increase their mortality rates. This limit has been reduced to 23 kg/m² in high-risk diabetic populations such as Asian Americans **[9].** Hygienic-dietary measures remain one of the fundamental bases of the management of patients with diabetes, whether type 1 or type 2 **[10,11].**

2. Objectives

The main aim of our study is to determine the nutritional profile and dietary habits of diabetic patients. We have focused on nutritional habits, because patients are unaware of the seriousness of certain foods that can worsen their condition (lack of knowledge of the glycemic index of foods

3. Methods

Study design and site: The close relationship between diet and T2DM means that we need to know the daily and weekly habits of diabetics. The study concerns patients who already have diabetes and whose glycemia is greater than 1.26 g/l. The study is described as descriptive and cross-sectional. We therefore needed to know the weekly frequency of essential foods. the study, carried out using a questionnaire designed for diabetic people, also covers clinical, anthropometric and biological parameters. The survey was carried out during six months in the midst of the covid-19 virus pandemic crisis at the Moulay Hassan hospital in the city of Kenitra (Morocco). The survey took place at the diabetes association, which helps diabetic patients whose socio-economic situation is relatively weak

Study participants

Diabetic people with a blood glucose level above 1,26 g/l who come to the hospital to have their blood glucose and HbA1c levels checked in the morning on an empty stomach are immediately taken to the interviews and answer the questionnaires, biological parameters are noted immediately, as well as clinical parameters (blood pressure, weight and height). Daily and weekly food

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frequency is seriously taken into account. Type 1 diabetic patients are excluded from the study.

Study size

The size of the sample was limited to 300 T2DM who come to the Moulay Hassan Hospital to have their blood glucose and HbA1c levels checked, and more specifically to the above-mentioned association. Blood glucose and HbA1c measured on site.

Quantitative variables

The means of the variables have been determined and analysed as well as the statistical relationships between the different variables. Nutritional parameters were determined, such as meal skipping, daily water consumption, main meal consumption, snacking, type of snack food and number of meals per day.

Data sources and measurement

The equipment used consists mainly of a blood pressure monitor, a weighing scale, a ruler, blood glucose strips, a haemoglobinometer and a questionnaire designed especially for diabetic people. In addition to the clinical and biological variables (age, gender, glycemia,HbA1c, High blood pressure (HTA) , physical activity level , blood glucose , HbA1c, lipid profile (cholesterol and triglycerides), renal function, duration of diabetes , presence or absence of chronic diseases, and use of oral antidiabetic drugs (OAD) and/or insulin .The questionnaire includes an important section on nutritional habits, which targets the daily and weekly frequency of consumption of essential foods such as carbohydrates (degree of sugar consumption), lipids (degree of consumption of fatty acids and proteins), as well as other variables such as snacking and the type of foods nibbled, as well as meal times and, in particular, knowledge of dietary and nutritional information for diabetic patients.

Statistical methods

Data are entered into SPSS (20) software (nominal, ordinal and metric variables). After coding the data, descriptive analyses (qualitative and quantitative variables) were listed to meet the objectives and study diabetes as a function of the different variables. Bivariate analyses were chosen to study the relationships between the different variables. Chi-square tests were performed for quantitative variables, with a significance level of $p < 0.05$. The essential analysis determined by this study is to compare the various biological parameters of diabetes with the dietary and nutritional parameters of patients and to take into account any statistically positive significance.

Ethical considerations

Our study complies fully with the ethical recommendations for medical research in Morocco. The questionnaire is characterized by absolute anonymity. The research was carried out with the agreement of the Dean of the Kenitra Faculty of Science and the Moulay Hassan Hospital in Kenitra.

3. Results

Socio-demographic analysis

The study population comprised 162 women (54%) and 138 men (46%), with a sex ratio of 0.85. The mean age of diabetic people was (58.51 ± 13.11) years. The work situation of diabetic patients is generally characterized by an unstable state, especially among women (23.66%) (occasional work). There is also a predominance of private (28%) versus public (14%) employment. The educational level of diabetic patients is unstable. In fact, 17% have a primary school education. The same percentage is observed among illiterate diabetics. Women account for a large percentage of illiterate diabetic people (14.66%), 16% have secondary education, 27% have high school education and 13% have university education.

Descriptive analysis

According to the results obtained, 27.9% of patients had a normal BMI. The average BMI is 26.44 kg/m². Only 1% were underweight, while 61% were overweight and 10% obese. Women are significantly overweight (38%). Severe obesity was observed in 10.6%, with a predominance of 8% in women (highly significant statistical difference, p=0.000).38% of women had the highest BMI values [25-30], compared with 16.3% of men. There was a highly significant statistical difference in BMI according to gender (p=0.000), whereas this difference was not significant for BMI according to age (p>0.05). As for the distribution of patients according to BMI.Our study shows that 52% of patients have a BMI of 26.44 kg/m², while 10,6% have a BMI greater than 30 kg/m². Given that all surveyed diabetic patients are on treatment, we note that for blood glucose, the [1.26 - 2] class is the most representative with 53.6%, followed by

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the [2- 3] class with 25.3%, Meanwhile, 14.2% exhibit blood glucose levels below 1.26 g/l, and 6.6% have blood glucose levels exceeding 3 g/l. The mean glycated hemoglobin is 8.09%, with a standard deviation of 1.725%. HbA1c is represented by a modal class [8-10] of 30.6%, followed by [7-8] with 26.6%, [6-7] with 25% and HbA1c < 6% with 14%. 54.3% have normal hypertension and 45.7% have abnormal hypertension. (Table 1). Diabetic women in this population are more hypertensive than men (27.3% vs. 18.3%). Lipid levels were abnormal in 24.7% (cardiovascular disease), with women accounting for 15.33% and men 9.3%. With regard to renal function tests, 10.7% had kidney complications (4.3% in men and 6.3% in women). The BMI of diabetic patients is distributed according to blood glucose (Glycemia), HbA1c and other bioclinical parameters such as arterial hypertension, lipid profile and renal profile. Our study shows that the average HbA1c is 8.09% with a standard deviation of 1.72%.

The study of HbA1c is also indicative of good diabetes follow-up. During our study, which focuses on the nutritional profile of people with diabetes, it is essential to study the distribution of BMI of people with diabetes according to biological parameters. Our study shows that there is no statistically significant difference between the biological parameters of blood glucose, HbA1c, hypertension, lipid profile and renal function. On the other hand, blood glucose levels between 1.26 and 2 g/l are significant in T2DM with a BMI between 25 and 30 kg/m². T2DM with a BMI [25-30] kg/m² also have a high lipid and renal profile, at 16,6% and 6% respectively. There was no particular statistical difference between glycemia, hypertension, HbA1c, lipid profile, renal profile and BMI. The dietary habits of the T2DM (300 patients) are also an integral part of the hygienic-dietary rules. Our study shows that there is a statistically significant difference between fruit and vegetable consumption and gender (p=0.05), as well as between the type of food eaten by T2DM and gender (p=0.03). It should be noted that 54.9% of T2DM don´t skip meals, compared with 45, 1% who do it. 34% of our population tend to skip dinner, and 18% in the age group [51-70] skip this meal. 60% of patients eat breakfast with a moderate sugar content, versus 39.3% without sugar moderation. The results collected show that 60% of patients eat breakfast with sugar moderation, compared with 39.3% without moderation, and that 45% tend to skip meals, compared with 54% who do not. For water, 24.6% drink more than 1.5 l/d, versus 28% who drink 1 l/d (Table 2). As for cereals, 68.2%, 35.2% and 4.6% consume them once a week, 2 times a week and 3 times a week respectively. Fruit and vegetable consumption is significantly lower than normal. In fact, only 1.6% of the population eat more than 5 portions of fruit and 1 portion of vegetables a day. The snacking factor promotes insulin secretion and disrupts blood sugar levels, especially when it comes to sweet foods. 19% snack frequently, 65.2% snack occasionally and 14.9% never snack. 16.6% snack on sweets, 44.6% on fruit and 23.6% prefer to snack on sweetened drinks. There is also an apparent lack of fruit and vegetable consumption. As for meats, 1% of women eat none at all, while 38,6% eat them twice a week. Fish consumption appears to be normal among T2DM (1 time /week: 32,6%, 2 times /week: 54,3% and 3 times/week: 12.9%). It should also be noted that 0.9% of women do not consume eggs, 1 time / week: 13,9%, 2 times / week: 54.6% and 3 times / week :25.3% and More: 5.9%. As for fat consumption, 4,9% of patients consume it 1 time / week, 38.2% (2 times / week), 47.9% (3 times / week) and 8.9% (more than 3 times / week). While the frequency of consumption of sweet products: 1time /day: 3.6%, 2 times /day: 43.2%, 1 time / 2 days: 42% and, more: 0.9%.

For the distribution of T2DM according to their information on nutrition, only 30% (12% men and 18.6% women) are absolutely certain that diet is a primary factor in the control of T2DM, while 49.6% % (24% men and 25.6% women) admit quite the opposite. Also, 18.9% claim to have sufficient information on nutrition and its impact on diabetes. General knowledge of food and nutrition remains clearly inadequate among the majority of T2DM. According to our survey, the majority of patients have unhealthy eating habits. In fact, 45.2% skip meals. 34.6% of T2DM prefer to skip dinner, this percentage mainly concerns the elderly, whereas 54.6% do not skip meals (25.3% of men and 29.3% of women). 67.3% of T2DM prefer chicken with meals, while red meat consumption is 23.3%. Water consumption remains inadequate, with 39.6% of T2D not exceeding one liter per day. According to our results, 30% of T2DM confirm that diet can be an important factor in diabetes control. In addition, 45.2% tend to snack, 66.7% visit restaurants at least once a month, and there is a low level of diabetes disease management among T2DM. Indeed, the

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identification of unbalanced dietary practices suggests that T2DM have not yet assimilated the importance of nutritional self-management of diabetes. Our results also show that 46% of diabetic people are physically active, compared with 54% who are physically inactive. However, only 8.7% do so more than 3 times a week. Women were more likely to engage in walking (19.3%) than men (14.3%), and the [51-60] age group was most likely to engage in walking (9.3%), followed by the [41-50] age group (8%). Daily dietary intake of essential foods is taken into consideration, and meticulously mapped against BMI and blood glucose levels to detect any significant relationships.

Bivariate analysis

The distribution of biological parameters in diabetic patients according to age showed no statistically significant difference (p > 0.005), while there was a highly significant difference between HTA and age (p=0.001) (Table 1). There was a significant difference between the type of meal missed and BMI (p=0.02) (Table 3). There was also a significant difference between daily meal frequency and BMI (p=0.012). There was a very high statistical difference between physical activity and patient age (p=0.04), while there was no statistical difference between physical activity and patient gender. For the influence of other dietary variables, there was no significant difference on BMI (p >0.05). There was a highly significant statistical difference between fruit consumption and patient gender (p=0.005) and between fish consumption and age (p= 0.005), while there was no significant difference between the other dietary variables according to gender and age. Our study shows that there was a significant difference between cereal consumption and blood glucose levels (p=0,042), while there was no significant relationship between the other food variables and blood glucose levels and gender (p>0.05). Nevertheless, there was a slight influence of fat consumption on BMI (p=0.074). The same was true of daily vegetable consumption and blood glucose levels. The identification of unbalanced dietary practices suggests that T2DM have not yet assimilated the importance of nutritional self-management of diabetes (Figure 1). the consumption of essential foodstuffs on a daily and weekly basis is very unhealthy.

Table 1: Breakdown of patients' biological parameters by gender and age

Bioclinical parameters		**Gender (%)**		**Age (%)**					**P**
Glycemia (g/l)	< 1.26 g /l	M	W	<40	[41-50]	[51-60]	[61-70]	>70	* < 0.05
		6.6	8	1.3	1.3	4.6	4.3	3	
	[1.26 –2]	25.6	27.6	5.3	12.6	15.3	11.3	8.6	
	[2 – 3]	11.3	14	2.3	4.6	6	6.3	6	P=0.724
	> 3 g /l	2.3	4.3	0.3	0.6	1.6	3	1	P=0.410
HbA1c (%)	< 6	4	0.3	0.3	1.3	2	0	0	
	[6 – 7]	10	13.6	3.6	5.3	7.3	5.3	2.3	
	[7 - 8]	13	14.3	1.3	7	1.3	6	8.6	
	[8 – 10]	15.3	15.3	3.3	4.3	7	10	6	P=0.399
	> 10	3.3	9.6	0.6	1.3	5.3	3	2.6	P=0.531
HTA (mm Hg)	Normale	27.6	26.6	6.6	13.6	15.3	11.6	7	P=0.062
	Anormale	18.3	27.3	2.6	5.6	12.3	13.3	11.6	P=0.001*

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Lipid profile	Normale	36.3	38.6	8.6	16	21	18.6	11	P=0.068
	Anormale	9.3	13.3	0.6	3.3	6.6	6.33	7.6	P=0.006*
Renal assessment	Normale	41.6	47.6	9.3	18.3	24.6	21.3	15.6	P=0.325
	Anormale	4.3	6.3	0	1	3	3.6	3	P=0.086

HTA: High blood pressure- HbA1c: glycated hemoglobin - P=p value in statistical analysis (p< 0.05)-M: man -W: woman.

Table 2. Breakdown of eating habits among type 2 diabetic patients

Food variables	**Gender (%)**		**Age (%)**				**P**
	M	W	< 40	[41-50]	[51-70]	>70	* < 0.05
Skipping meal							
Yes	20.6	24.6	4.3	8.3	23.3	9.3	P=0.896
No	25.3	29.3	5	11	29.3	9.3	P=0.932
Missing meal							
No missed meals	25.6	29.3	5	11	29.3	9.6	
Breakfast	3.6	4.3	1	1.6	3.6	1.6	
Lunch	0.6	1.6	0	0.3	1.6	0.3	P=0.829
Dinner	16	18.6	3.3	6.3	18	7	P=0.924
Main meal							
Chicken	29	38.3	7	12.3	36	12	
Red meat	11.3	12	2	5.3	10.6	5	
Fish	4.6	3	0	1.3	4.6	1.6	P=0.344
Other	1	0.6	0.3	0.3	1	0	P=0.889
Amount of water per day							
500 ml	4.3	6.3	0.3	3.6	4.6	2	
1 liter	12	16	3.3	5.3	14.3	5	
1.5 liters	18	17	3	4.6	19	8.3	
More than 1.5 liters	11	13.6	2	3.3	14.3	3	P=0.720
Less than 500 ml	0.6	1	0.6	0.3	0.3	0.3	P=0.261
Daily meal frequency							
1 meal	1.6	3	0.3	0.6	2.6	1	
2 meals	2	2	0.3	1	2	0.6	

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3 meals	19.6	20.3	3.6	6	22	8.3	P=0.713
4 meals	22.6	28.6	5	11.6	26	8.6	P=0.750
Fruits and vegetables (F: V)							
<5 portions of F and V.	31.3	44	7.6	15	37.3	15.3	
5 portions of F and V.	14.3	8.6	1.6	4.3	13.6	3.3	P=0.050*
> 5 portions of F and V.	0.3	1.3	0	0	1.6	0	P=0.162
Eating out							
Never	27.6	33.3	1.6	5.3	12.6	3.3	
1 time	11	12	1.3	3.6	4	0.1	
2 times	4.6	5.3	0.1	0.1	2	2	P=0.986
More than 3 times	2.6	3.3	5.3	9.3	34	12.3	P=0.134
Frequently	9	10.6	2	4	10.3	3.3	
Snacking between meals							
Occasionally	29.6	35.6	5.6	12	34.6	13	P=0.914
Never	7.3	7.6	1.6	3.3	7.6	2.3	P=0.495
Type of food snacking							
No snacking	7.66	7.33	2	3.3	7.3	2.3	
Sweets	5.3	11.3	2	3	9.6	2	
Fruit	19.3	25.3	3.6	6.6	23.6	10.6	P=0.030*
Sugary drinks	13.6	10	1.6	6.3	12	3.6	P=0.404

Table 3. Distribution of dietary variables according to BMI and blood glucose levels

Food variables	**BMI (kg/m²) (%)**				**Glycemia (g/l) (%)**				**P**
	< 18.5	[18.5-25]	[25-30]	>30	<1.26	[1.26-2]	[2-3]	>3	* < 0.05
Skipping meal									
Yes	0.3	18.6	21.6	4.6	6.3	23	13.3	2.6	P=0.921
No	0	26.6	22	6	8.3	30.3	12	4	P=0.520
Missing meal									
No missed meals	0	26.6	22.3	6	8.3	30.6	12	4	
Breakfast	0.3	2.3	4.3	0.6	2.6	3.33	1.6	0.3	
Lunch	0	1	0.3	1	0.3	1	0.6	0.3	P=0.020*
Dinner	0.3	15.3	16.6	2.6	3.33	18.3	11	2	P=0.200

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Main meal									
Chicken	0.3	33.3	31	5.3	9.3	34.3	18	5.6	
Red meat	0	10	6.6	3.6	2.6	14.3	19	0.6	
Fish	0	3.6	3	1	2	4	1.3	0.1	P=0.618
Other	0.3	1	0.6	0	0.6	0.6	0.3	0	P=0.363
water per day									
500 ml	0	5	5	0.6	1.6	5.6	3.3	0	
1 liter	0.3	11.3	12.3	4	3.6	14.3	7.3	2.6	
1.5 liters	0	16	15.3	3.6	5.3	20	11	2	
More than 1.5 liters	0	12.6	9.6	2.3	4	12.3	6.6	1.6	P=0.759
Less than 500 ml	0	0.3	1.3	0	0	1	0.3	0.3	P=0.835
Daily meal frequency									
1meal	0	1.6	1.6	1.3	1	2	1.3	0.3	
2 meals	0	1.3	2	0.6	1.3	2	0.3	0.3	
3 meals	0.3	18.6	18.3	2.3	8.6	22.6	9.3	2.6	P=0.012*
4 meals	0	13.3	23.6	6.6	7	26.6	14.3	3.3	P=0.715
Eating out									
Never	0.3	9	12.3	1.3	2.6	14.6	4.3	1.3	
1 time	0	4.6	3.6	1.6	0.6	5.6	3.3	0.3	
2 times	0.3	3	3	0	1	3.6	1	0.3	P=0.456
More than 3 times	0	28.6	24.6	7.3	10.3	29.3	16.6	4.6	P=0.468
Snacking between									
meals									
Frequently	0.3	8.3	9.6	1.3	2.3	13.6	2.6	1	
Occasionally	0	29	28.3	8	9.3	33	18.3	4.6	P=0.877
Never	0	8	5.6	1.3	3	6.6	4.3	1	P=0.154
Type of food snacking									
No snacking	0	8	5.6	1.3	2.6	6.6	4.6	0.1	
Sweets	0	6.3	7.6	2.6	2.3	8.3	3.6	2.3	
Fruit	0.3	18	21.3	5	5.6	25.3	11	2.6	P=0.247
Sugary drinks	0	13	9	1.6	4	13	6	0.6	P=0.480

BMI: Body mass index- P: p value in statistical analysis- *p<0.05

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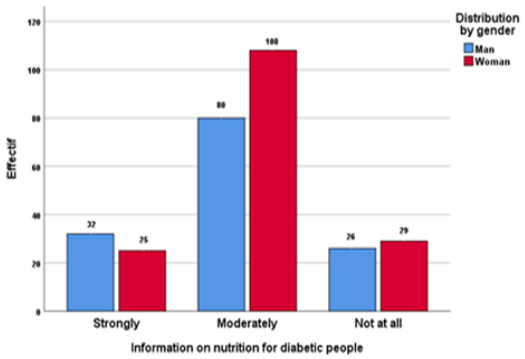
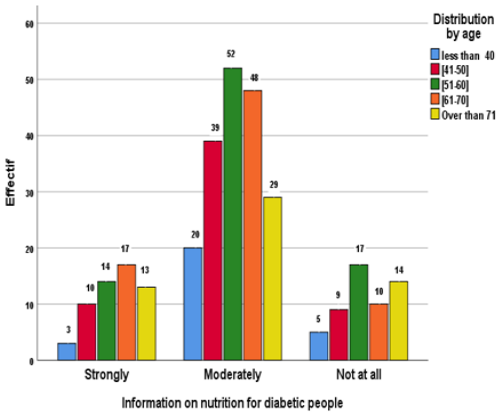


Figure 1: Distribution of patients with diabetes according to nutritional information by age and gender.



4. Discussion

To compare our results with the literature, we estimate that according to American Diabetes Association recommendations (ADA) and in order to prevent diabetes, it is essential to eat 2 to 3 meals a day, and possibly 1 to 3 snacks, drink at least 1.5 liters of water, preferably unsweetened, and above all to moderate meat consumption. Numerous studies have shown that type 2 diabetes can be delayed or even prevented in people at high risk of the disease **[12].** According to the Finnish Diabetes Prevention Study and the Diabetes Prevention Program, at the stage of glucose intolerance, lifestyle intervention (diet, increased physical activity and weight loss) reduces the incidence of T2DM **[13].** The Nutrient Sante study, which aims to decipher the eating habits of 500.000 French people, showed that 61% snack between the three meals of the day, 35% of them regularly. The majority of these are women (65% vs 57% of men) aged between 35 and 45 **[14].** Dietary modification reduces the risk of progression from prediabetes to T2DM **[15].** More specifically, increasing fiber intake to over 15gr/1000 kcal, reducing total fat intake to less than 30%, and limiting saturated fat to less than 10%, could reduce progression to T2DM in subjects at the glucose intolerance stage **[16].**

Along with dietary, lifestyle modification is also necessary part of diabetes management, even if it is difficult to achieve and maintain. In order to reduce cardiovascular risk, the ADA recommends that the treatment of diabetes should include major lifestyle changes, such as a low-fat and low-carbohydrate diet and also increasing insulin sensitivity **[17].** Indeed, meta-analyses of randomized controlled trials have shown that lifestyle intervention improves glycemic control T2D patients **[18].** Nutritional therapy has been shown to improve glycemic control by reducing HbA1c from 2.0% to 1.0%, combined with other components of diabetes care, it can significantly improve clinical and metabolic outcomes, leading to a reduction in hospitalization rates **[19].** Diet management can improve high HbA1c levels and enable T2DM to avoid diabetic complications **[20].** Other similar results from Sassor Odile Purifine et al. also revealed that respondents' eating habits were unsatisfactory, in fact, meals were not taken at fixed times by 88.5% of respondents, and 11.7% of them claimed to snack, while 56.8% were overweight (22.7% obese), hypertensive (45.3%) and dyslipidemia (18.2%). People with diabetes who ate 3 meals accounted for 99.2%, and patients with diabetes who had been diabetic for more than 10 years accounted for 38.8% **[21-22].** Also, the study conducted by Hallab in Morocco showed that 65.9% of T2DM frequently snack **[23].** This type of eating behavior can be a source of glycemic imbalance and lead to weight gain. There are several international organizations that insist on very precise recommendations for the nutritional care and management of diabetes. The International Diabetes Federation; Africa region recommends eating 3 meals a day, avoiding snacking, avoiding animal fats, salt and refined sugars, favoring foods rich in carbohydrates and fiber, and regular physical activity **[24].**

T2DM is closely linked to the development of overweight or obesity, most often associated with reduced physical activity. In our study, 53% of the population studied were not physically active (25% of men vs 29.3% of women). The therapeutic management

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of any diabetic patient requires the implementation of hygienic and dietary advice. Current recommendations are the same for people with diabetes as for the general population. Our clinical results show that 61% of T2DM are overweight and 10.6% are obese. Hygienic-dietary rules are generally prescribed as a first step in the diagnosis of new T2DM, and are strongly recommended by diabetologists as the first phase in the treatment of diabetes **[25].** Regarding the weekly food frequency among the T2DM. Our study showed that cereal consumption remains inadequate, with a percentage of 1 times/week: 58.2% or 2 times/ week: 35.2%. Similarly, fruit consumption (3 times /week: 50.9% and more than: 3 times/week: 22.6%), vegetables (3 times/week: 45.6% and More: 31.6%), dairy products (3 times/week: 45.9% and More: 9.9%) or eggs (2Times/week: 54.6% and 3 times/week: 25.3%). On the other hand, consumption of meat (1time/week: 50.6% and 2 times/week: 38.6%), fish (2 times /week: 54.3%) or fats (2 times/week: 38.2% and 3 times/week: 47.6%) appears to be approximately normal. As for physical activity, there is a significant association between physical inactivity and T2DM. Physical activity has been shown to reduce intra-abdominal fat, a known risk factor for insulin resistance **[26].**

In our study, we found statistical significance between blood glucose levels and physical activity (p=0.033). Physical activity consumes energy, and glucose in particular, which lowers blood glucose levels, as well as the glycogen reserves of the muscles involved. This depletion of muscle glycogen is a good stimulus for blood glucose to be taken up by the muscle, independently of insulin, resulting in a drop in blood glucose levels which is immediately compensated for by the release of glucose from liver glycogen to maintain blood glucose levels within normal limits **[27].** Physical activity also increases insulin sensitivity; after a single exercise session, glycogen depletion increases muscle sensitivity (for around 48 h) glucose uptake persisting for several hours even after the cessation of exercise to insulin. Regular exercise reduces HbA1c by 10-20%, with a greater effect in mild type 2 diabetes. Furthermore, moderate to intense physical activity and cardiorespiratory training are associated with significant reductions in morbidity and mortality in both men and women, in both type 1 and type 2 diabetes **[27].** However, before a physical activity program is recommended to a diabetic individual, it must be ensured that the person is not affected by any disorders that could heighten the risks associated with specific types of exercise or subject them to potential injury. For instance, T2DM individuals with heart failure should not be prescribed high-intensity physical activity **[28].**

Obviously, pharmacological treatment remains essential to accompany a balanced diet and regular physical activity. These results are alarming and are the consequences of bad habits undertaken by the population studied. Obesity is defined as an abnormal or excessive accumulation of fat in adipose tissue, which can lead to health problems. Obesity, with its predominantly abdominal distribution, has been recognized as a major risk factor for metabolic and cardiovascular diseases **[29].** Despite other views describing diabetes and obesity are direct consequence of a genetic predisposition **[30],** the dietary factors most incriminated in the genesis of diabetes remain high consumption of saturated fatty acids, foods with a high glycemic index and low consumption of whole grain products. In addition, the influence of a poor diet on the onset of diabetes and obesity is well established, as inflammatory mediators can induce diabetes. Overweight and obesity are major factors in the development of T2DM **[31].** In 2011, the randomized PREDIMED-Reus trial showed that the mediterranean diet reduced the incidence of T2DM **[32].** With regard to obesity among T2DM in our study, our results show that 61% of patients are overweight and 10.6% are obese. Appropriate dietary management is the central element in the treatment of all types of diabetes **[33].**

There are 4 dietary objectives for diabetic patients: to ensure a balanced nutritional intake adapted to each individual case, with a preference for foods with a low glycemic index; to avoid or minimize extreme glycemic fluctuations; to help control vascular risk factors, including hypertension; and to help reduce the progression of complications **[34].** Therapeutic nutrition education cannot be conceived without taking into account all the determinants of eating behavior. The act of eating is a complex phenomenon in which the symbolic, subjective, social, economic and cultural dimensions play just as important a role as the health dimension **[35].** Abdominal obesity leads to hyperinsulinemia, insulin resistance, impaired glucose tolerance, increased VLDL triglycerides and reduced

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HDL cholesterol. Regular physical activity reduces the need for insulin, limits blood sugar levels, reduces overweight and helps to effectively combat the pathologies associated with diabetes [**36].**

Finally, in our study, T2DM are unable to follow a proper diet. Their eating habits are not balanced and does not comply with international health recommendations. A minority of them believe that diet can be an important factor in diabetes control, and are not sufficiently informed about the nutritional habits of diabetics. More than half of patients are overweight and do not engage in regular physical activity **[37].**

Limitation

The study's limitations lie in the fact that we were unable to measure waist and hip circumferences due to women's customs. By omission, we did not count the number of diabetics living in rural areas. We would have counted more diabetic patients if the covid-19 pandemic had not existed. Some diabetic subjects came to have their glycemia checked without HbA1c. In this case, we noted the last medical analysis of glycemic hemoglobin, which was no more than three months old.

5. Conclusion

In conclusion, our study sheds light on various aspects of dietary behaviors and lifestyle choices among individuals with T2DM. These findings provide a foundation for designing targeted interventions aimed at improving dietary habits and overall diabetes management among this population.

What is already know on this topic

Type 2 diabetes is considered to be the most serious endocrine disease in Africa.

In Africa, this pathology is constantly on the increase and causes many deaths. Despite the strategies undertaken, diabetes continues to increase and to cause many deaths.

In Morocco, like all developing African countries, is suffering from the spread of type 2 diabetes as a result of lifestyle changes. Obesity resulting from overeating favors the onset of diabetes.

What this study adds

A balanced diet is the basis of a diabetic diet.

A good knowledge of food enables a balanced diet and regulates insulin resistance.

A good knowledge of eating habits is part of the plaining of good diabetes management

Competing interests

The authors declare no competing interest

Authors' contributions

All the authors took part in the conduct of this work. Meskini Nadia, Jaghror Imane, Taib Bouchra, Aroui Norelhoda and Youness Taboz. They participed in the collection, tabulation, acquisition, analysis and interpretation of the data. They adjudge that they have read and approved the final version of this article.

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