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RESEARCH ARTICLE

DIABETES MANAGEMENT IN MOROCCO: EXPLORING KNOWLEDGE LEVELS IN A NEIGHBORHOOD CONTEXT DIABETES COMPLICATIONS AND IT'S INFLUENCING FACTORS

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Abstract

Objective: This study aimed to identify factors influencing diabetes progression and evaluate patients' knowledge of their condition in a community pharmacy in Témara, Morocco.
Materials and Methods:A cross-sectional study was conducted from February 2021 to May 2022. Data were collected using structured forms with questions on nine diabetes knowledge criteria. Logistic regression was used to identify factors associated with complications.
Results: The study included 150 participants (median age 58 years, M/F ratio 0.97). Most had social coverage (82.7%) and were followed by specialists (62%). Among participants, 63% reported diabetes-related complications, and 35.1% had lived with diabetes for over 10 years. Blood glucose was well-controlled in 26.1%, with 74.8% using glucometers, mainly for weekly monitoring. Among participants, 70.3% were followed at private healthcare facilities, while 29.7% attended public institutions.Univariate analysis revealed significant associations between diabetes duration, alcohol consumption, and smoking with complications. For instance, participants with diabetes for over 10 years had a 2.7-fold higher risk (OR=2.66, 95% CI: 1.18–6.00, p=0.02). Multivariate analysis confirmed diabetes duration as a significant risk factor ($p<0.05$), while being followed by a private doctor was also associated with a higher risk of complications (p=0.04).
Conclusion: Therapeutic education tailored to patients' socio-cultural contexts is essential for better diabetes management. Future research should include larger, more diverse samples.

Introduction:-

Diabetes is a significant global burden, both in human and economic terms. Ranked among the top 10 leading causes of death in adults, it was responsible for 6.7 million deaths worldwide in 2021, equating to one death every 5 seconds(1). According to the International Diabetes Federation (IDF), one in ten individuals was diagnosed with diabetes in 2021, representing 537 million people globally. Among them, 10.5% were adults aged between 20 and 79 years, with projections indicating this number could rise to 783 million (12.2%) by 2045(1).

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The global cost of diabetes care was closed to one trillion USD in 2021, accounting for 11% of total healthcare expenditures worldwide, reflecting the escalating financial impact of the disease.Socio-cultural factors influence the prevalence of diabetes, with higher rates observed in high-income countries. However, better education levels in these regions contribute to the prevention of diabetes-related complications(2).

In Morocco, diabetes affects 9.1% of the adult population aged 20–79, with 2.3 million living with this condition. Among these cases, 90% have type 2 diabetes, which is closely associated with obesity and lifestyle factors. The disease is linked to an estimated 31.434 deaths annually(3).The objective of our study is to highlight the main factors contributing to the progression of diabetes in a group of patients visiting a neighborhood pharmacy in the city of Témara and to assess their level of knowledge regarding their illness

Materials and Methods:-

This descriptive and analytical cross-sectional observational study was conducted using forms completed by patients or their companions (when necessary). The forms consisted of closed multiple-choice and open-ended questions across various sections.

Data collection took place over one year, from February 11, 2021, to May 3, 2022. Participants were informed about the study's purpose and provided their consent before filling out the forms. The study included patients who self-reported as diabetic or presented a medical certificate confirming their condition, children and Non-consentingindividualswere excluded from this study.

The sampling method was non-probabilistic and based on convenience, as the study was conducted daily in a community pharmacy. All diabetic patients, regardless of sex, age, or diabetes type, were includeduntil the required sample size was reached, calculated using the "Riskcalc" tool with a diabetes prevalence of 12.4% and a precision level of 0.05.

To assess the patients' knowledge levels , we used closed-ended questions focusing on nine specific criteria :

- Normal blood glucose levels.
- Symptoms of hyperglycemia.
- Symptoms of hypoglycemia.
- Proper management of hypoglycemia.
- Major complications of diabetes.
- Importance of glycemic self-monitoring.
- Benefits of physical exercise.
- Handling hypoglycemic crises.
- The role of patient therapeutic education (PTE) in diabetes management.

Responses to the closed-ended questions (Yes/No) were scored and classified into three levels of knowledge: 'Insufficient' (score 0–3), 'Average' (score 3–6), and 'Good' (score above 6).The data collected were analyzed using Jamovi software (version 2.0.0.0). Qualitative variables were described in frequencies and percentages, while quantitative variables with Gaussian distribution were expressed as means and standard deviations.

To identify factors influencing the occurrence of diabetes complications, a multivariate logistic regression analysis was performed for variables with a p-value ≤ 0.4.The variable"Presenceof pathological medical history" was forcibly included in the analysis due to its relevance to the progression of diabetes.

Results:-

The study population (N=150) (Table 1) was evenly distributed between men and women, with a median age of 58 years. The majority of participants had social coverage (82.7%), were followed by a specialist (62%), and sought care at private healthcare facilities (70.3%). Nearly 63% reported diabetes-related complications affecting key systems such as the eyes (retinopathy, macular edema, cataracts, glaucoma)(4), the cardiovascular system (ischemic heart disease, stroke, peripheral artery disease, heart failure)(5), and the kidneys (nephropathy, proteinuria, chronic kidney disease)(6,7). Among them, 35.1% had been living with diabetes for more than 10 years.Blood glucose levels were balanced in 26.1% of participants, and 74.8% reported using a glucometer, primarily for weekly monitoring (63.3%). Regarding therapeutic education, 49% had received training, mostly provided by physicians. The majority

of participants demonstrated good knowledge of critical aspects of diabetes management, including the importance of diet and physical activity.

The statistical analysis of factors influencing the occurrence of micro and macro angiopathic complications in diabetes:

In Univariate Analysis:

- A longer duration of diabetes was significantly associated with a higher risk of complications:
- More than 10 years vs. less than 5 years: OR = 2.66, 95% CI: 1.184–6.007, P = 0.02.
- 5–10 years vs. less than 5 years: OR = 2.963, 95% CI: 1.241–7.075, P = 0.01.
- Patients who consumed alcohol had an increased risk of complications: OR = 2.815, 95% CI: 1.139–6.957, P = 0.03.
- Chronic smoking was significantly associated with a higher risk of complications: OR = 2.316, 95% CI: 1.097–4.888, P = 0.03.

Multivariate Analysis:

- A longer duration of diabetes was significantly associated with a higher risk of complications:
- More than 10 years vs. less than 5 years: OR = 2.66, 95% CI: 1.184–6.007, P = 0.02.
- 5–10 years vs. less than 5 years: OR = 2.963, 95% CI: 1.241–7.075, P = 0.01.
- Patients who consumed alcohol had an increased risk of complications: OR = 2.815, 95% CI: 1.139–6.957, P = 0.03.
- Chronic smoking was significantly associated with a higher risk of complications: OR = 2.316, 95% CI: 1.097–4.888, P = 0.03.

Discussion:-

Our study included 150 participants with a median age of 58 years [45.3–67], with 82.7% having social coverage, indicating that most had relatively easier access to medical care. The gender ratio was balanced (M/F = 0.97).

Self-monitoring of blood glucose using a glucometer positively influences glycemic control, as evidenced by significant reductions in HbA1c—a key marker in the effective management of diabetes(8). However, 33.6% of participants in our study did not own a glucometer, and 36.8% were unaware of its importance in maintaining glycemic balance, preventing treatment-related hypoglycemia, and achieving long-term control. These benefits have been demonstrated in both type 1 diabetes(9,10)and type 2 diabetes patients on insulin therapy(11–13). For type 2 diabetes, glucometer use has been associated with greater disease independence and improved quality of life(14).

Hypoglycemia, the most frequent side effect of antidiabetic medications(15), is a major concern for patients. Fear of hypoglycemia has been shown to reduce treatment adherence and lead to poorer glycemic control (p=0.001)(16). Proper management of hypoglycemia is critical due to its potential impact on patients' prognosis. In our study, 46% of participants experienced a hypoglycemic episode in the 12 months preceding the study, 26.5% could not identify its symptoms, and only 56% knew how to manage such episodes effectively.

The average HbA1c in our population was 7.67% (range: 5%–13%). While 70% of participants were up to date with their HbA1c monitoring (every three months), 50% had HbA1c levels exceeding the target range of 6.5%–6.9%, and 73% had levels above 6.9%. This indicates suboptimal glycemic control in a significant portion of the population. Only 53% were aware of the importance of HbA1c in preventing diabetes complications, a finding compounded by the region's illiteracy rate of 19.3%. Lower education levels remain a barrier to treatment adherence and effective disease management(17–19).

Lifestyle and dietary measures form the cornerstone of diabetes management, followed by medication if lifestyle changes prove insufficient. Metformin remains the first-line oral antidiabetic treatment(20). With advancements in antidiabetic therapies, care is becoming increasingly personalized, particularly for type 2 diabetes (T2D), which has reached epidemic proportions in Morocco. In our study, 63.2% of participants were on oral antidiabetics (OAD), of whom 65.8% were on metformin. Additionally, 29.37% were on insulin, 1.4% were on a combination of insulin and OAD, and 8.3% relied solely on lifestyle modifications.

Regarding diabetes-related complications, 74% of participants were aware of the short-, medium-, and long-term consequences of poor glycemic control. Early detection and effective management remain essential to preventing complications(21).

The univariate analysis revealed several significant factors influencing the risk of diabetes-related complications. Participants with diabetes for over 10 years exhibited a 2.7-fold higher risk of complications compared to those with less than 5 years of diabetes (OR=2.66, 95% CI: 1.18–6.00, p=0.02). Similarly, those with diabetes for 5–10 years had a threefold higher risk (OR=2.96, 95% CI: 1.24–7.08, p=0.01). Alcohol consumption was also associated with a 2.8-fold increase in the risk of complications (OR=2.8, 95% CI: 1.14–6.96, p=0.02).

In contrast, participants with health insurance demonstrated a slightly lower risk of complications, though this finding was not statistically significant (OR=0.7, 95% CI: 0.299–1.79, p=0.49). Additionally, being followed by a private doctor was linked to a slightly increased risk of complications compared to being followed by a public doctor; however, this result was also not statistically significant (OR=0.56, 95% CI: 0.273–1.17, p=0.126).

The multivariate analysis, which adjusted for factors such as alcohol consumption, duration of diabetes, participation in diabetes education, health insurance, education level, type of doctor, prior illnesses, chronic smoking, and regular HbA1c monitoring, highlighted two significant findings. A longer duration of diabetes remained strongly associated with an increased risk of complications (more than 10 years: p=0.003; 5–10 years: p=0.015). Additionally, being followed by a private doctor was significantly linked to an elevated risk of complications (p=0.04).

Insulin resistance has been linked to several neurodegenerative diseases, It is also the main pathological feature of obesity and metabolic syndrome, and the key defect in type 2 diabetes. This is a complex, multi-step process influenced by both genetics and environment (22,23).

Although its exact cause is not fully understood, several mechanisms are involved: problems in the insulin signaling pathway, abnormal fat storage in organs (ectopic lipids), chronic low-grade inflammation, mitochondrial dysfunction, oxidative stress, and stress in the endoplasmic reticulum (24–26).

Sirtuins are a family of NAD^+-dependent enzymes that regulate many cell processes such as metabolism, mitochondrial health, oxidative stress, inflammation, autophagy, and programmed cell death (27). They play important roles in aging and age-related diseases like obesity, type 2 diabetes, cardiovascular diseases, cancer, and neurodegenerative disorders (28).

In the context of insulin resistance, sirtuins regulate inflammatory pathways inside target cells such as liver cells, skeletal muscle cells, and fat cells, improving their insulin sensitivity. They also act on immune cells that infiltrate organs, reducing the inflammatory and metabolic damage. This regulation can happen in many cell types at once during inflammation-related insulin resistance (29–32).

Lifestyle measures like calorie restriction can activate sirtuins, improving blood glucose control in people with type 2 diabetes (33,34). Anti-diabetic medications such as metformin can indirectly activate SIRT1 through pathways like AMPK, which enhances the positive effects of diet(35,36). This combined effect lowers liver glucose production, cholesterol, and triglycerides, while increasing fat burning(37).

In the brain, neuronal SIRT1 influences food choices by reducing preference for simple sugars and increasing preference for fats(38), It also helps control body weight by reducing food intake, increasing energy expenditure, and promoting heat production in brown fat tissue (39).These results underscore the need for further research to better understand diabetes knowledge and its management in this region. Future studies with larger, randomized samples, including rural populations, are essential to gain a more comprehensive perspective.

Conclusion:-

Therapeutic education is a vital tool that helps healthcare professionals support diabetic patients in truly understanding and managing their condition. It plays a key role in encouraging patients to adopt healthy habits and behaviors. When tailored to the individual—by observing the patient closely and considering specific markers—this approach allows care and communication to fit their unique social and cultural background. This leads to better interactions, stronger treatment adherence, and ultimately, better outcomes in managing diabetes.

Tables:

Table 1: Population discription.

	(N=150)
Gender**	
Male	74 (49)
Female	76 (51)
Age (Years)*	58[45.3-67]
Availability of health insurance **	
Yes	124 (82.7)
No	26 (17.3)
Presence of pathological antecedents **	
Yes	80 (53)
No	70 (47)
Medical following**	
None	5 (3.33)
Specialist doctor	93 (62)
Family doctor	52 (34.67)
Following healthcare facility **	
Public	43 (29.7)
Private	102 (70.3)
**Alcoholconsumption **	
Yes	24 (16)
No	126 (84)
Smoking**	
Yes	39 (26)
No	111 (74)
Follow up of HBA1C up in date**	
Yes	83 (70.9)

No	34 (29.1)
Last HBA1C value**	
balanced	53 (51.5)
unbalanced	50 (48.5)
Last bloodsugarlevel **	
balanced	29 (26.1)
unbalanced	82 (73.9)
Diabetes duration (years)**	
<5	47 (31.8)
[5-10]	49 (33.1)
>10	52 (35.1)
Antidiabetictreatment **	
Oral antidiabetics (ODA)	91 (63.2)
Insuline	39 (27.1)
ODA/Insuline association	2 (1.4)
None	12 (8.3)
Level of education **	
Analphabets	29 (19.3)
Primary	15 (10.0)
Secondary	34(22.7)
Baccalaureate	18 (12.0)
University	54 (36.0)
Using a glucometer for self-monitoring**	
Yes	92 (74.8)
No	31 (25.2)
Diabetes Complications **	
Yes	109 (73.6)
No	39 (26.4)

Glucometerowner**	
Yes	92 (74.8)
No	31 (25.2)
Self-monitoring blood glucose (SMB): Rhythm**	
Never	2 (2)
Whenever possible	1 (1)
Daily	23 (23.5)
Weekly	62 (63.3)
Monthly	10 (10.2)
Patient under Therapeutic Education (PTE) **	
Yes	70 (49)
No	73 (51)
PTE supervisor **	
Doctor	36 (50.7)
Pharmacist	26 (36.6)
Other : (Family, Friends…)	2 (2.8)
Pharmacist + Doctor	6 (8.5)
Participants state of knowledge	
Awareness of the interest of SMB**	
Yes	91 (63.2)
No	53 (36.8)
Knowledge of the interest of diet in the management of diabetes **	
Yes	134 (92.4)
No	11 (7.6)
Knowledge of the importance of physical activity in the management of diabetes**	
Yes	124 (84.9)
No	22 (15.1)
*Median (Quartiles)	** Headcount (percentages)

Table 2: Univariate and Multivariate analysis of factors influencing the occurrence of micro and macro angiopathic complications in diabetes.

	Univariate analysis				Multivariate analysis			
Variables	OR	CI 95%		P	OR	CI 95%		P
		Lowerlimit	Upperlimit			LowerLimit	Upperlimit	
Follow up a PTE Yes-No	0.556	0.282	1.09	0.089	1.790	0.839	3.82	0.132
Diabetes duration (years)								
>10 - <5	2.66	1.184	6.007	0.018	2.541	1.050	6.15	0.039
[5-10] -<5	2.963	1.241	7.075	0.014	3.377	1.269	8.99	0.015
Alcohol								
Yes – No	2.815	1.139	6.957	0.025	2.538	0.950	6.78	0.063
Availability of HI*								
Yes – No	0.732	0.299	1.79	0.495	0.695	0.252	1.91	0.481
level of education								
Baccalaureate – illiterate	2.024	0.600	6.83	0.256	2.354	0.596	9.30	0.222
Primary – illiterate	0.944	0.265	3.36	0.930	0.716	0.180	2.85	0.636
Secondary– illiterate	1.181	0.431	3.23	0.747	1.257	0.415	3.81	0.686
University – illiterate	0.708	0.276	1.81	0.472	0.652	0.212	2.01	0.456
Sector of activity of the following doctor								
Private- public	0.566	0.273	1.17	0.126	0.400	0.166	0.965	0.041
Presence of pathologicalantecedents								
Yes-No	0.783	0.403			1.52	0.470 0.563 0.229	1.38	0.211
Chronic smoking								
Yes-No	2.316	1.097	4.888	0.028	1.707	0.532	5.484	0.369
HBA1C Up to date								
Yes- No	0.900	0.396	2.05	0.801	0.787	0.308	2.01	0.617

***HI : health insurance.**

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Author contributions:

Achraf RACHID: Bibliographic research,Statistical analysis, redaction.
JihaneChougred: Data collection.
Khadija LECHHEB: Reviewing.
Yassir BOUSLIMAN: Supervision, Reviewing and Correction.

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The original contributions presented in this study are included in the article, and any further inquiries can be directed to the author.

Competing interests:

The authors declare that they have no conflict of interest related to this manuscript.

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