AUCTORES
Globalize your Research

Journal of General Medicine and Clinical Practice
ABID Mohamed*

Open Access

Research Article

Management of Diabetes in Tunisia: Results from a Cross-Sectional Study of the International Diabetes Management Practices Study (IDMPS) – Wave 7

Mohamed Abid [1*], Emna Ben Aissa [2]

[1] Diabetes Endocrinology Department, UHC Hospital Hédi CHAKER, Sfax, Tunisia.

[2] Sanofi medical department, 34 Av de Paris, Tunis, Tunisia. Sanofi Morocco-Tunisia.

***Corresponding Author:** ABID Mohamed, Diabetes Endocrinology Department, UHC Hospital Hédi CHAKER, Route El Ain, Sfax, Tunisia.

Received date: January 27, 2023; **Accepted date:** April 12, 2023; **Published date:** April 19, 2023

Citation: Mohamed Abid, Emna Ben Aissa (2023), Management of Diabetes in Tunisia: Results from a Cross-Sectional Study of the International Diabetes Management Practices Study (IDMPS) – Wave 7. *J. General Medicine and Clinical Practice.* 6(1); DOI:**10.31579/2639-4162/081**

Abstract

Aims/Background: Diabetes is a serious health condition requiring a range of interventions and self-management education to reduce the risk of complications. The aim of the present study was to assess the care management of people with diabetes in medical practice in Tunisia and its efficiency on HbA1c target.

Materials and methods: The International Diabetes Management Practices Study (IDMPS) is an international, multicentre, non-interventional observational study on care management of diabetes. The data collected from Tunisia in 2016 during the 7th wave was analysed, including 423 patients (people with type1: n=127, with type 2: n=296).

Results: The recommended target of HbA1c <7% was achieved by only 15.5% of type 1 diabetes patients and 24.7% of type 2 diabetes patients. The majority of type 2 diabetes patients (63.3%) received only OGLD (oral glycaemic lowering drug) therapy alone. For type 1 diabetes patients, receiving insulin treatment, more than two-thirds experienced symptomatic episodes of hypoglycemia in the past 3 months, against 24.6% for type 2 diabetes patients. Hospitalizations due to diabetes were reported during the past 12 months for 22.0% and 6.8% of type 1 and type 2 diabetes patients, respectively.

Conclusions/interpretation: The clinical burden of diabetes in Tunisia is unsettling, highlighting the need for more awareness of the disease and its complications. Clinicians probably need to be more careful about intensification of the treatment, even to some therapeutic inertia for type 2 diabetes patients, and global cardiovascular risk approach including the triple pooled targets as recommended in the last guidelines.

Kew Words: basal–prandial; cardiovascular risk; complications; diabetes; glycemic control; insulin; management

Abbreviations

IDF: International Diabetes Federation

IDMPS: International Diabetes Management Practices Study

LDL-CS: Low-Density Lipoprotein-Cholesterol

MENA: Middle East and North Africa

OGLD: Oral Glycaemic Lowering Drug

SBP/DBP: Systolic Blood Pressure/Diastolic Blood Pressure

Research in Context

What is already known about this subject?

- The Middle East and North Africa (MENA) region, including Tunisia, records in 2021 the second highest increase in diabetes among all world regions.
- The burden of diabetes in Tunisia is found to be underestimated with a proportion of more than 40% of undiagnosed diabetes.
- Previous IDMPS waves conducted in Tunisia had reported poor glycemic control in diabetic patients.

What is the key question?

- What is the current care management of diabetic patients in medical practice in Tunisia and what are the predictive factors of reaching the target HbA_{1c} for these patients?

What are the new findings?

- Most diabetic patients still do not meet recommended glycemic and HbA_{1c} targets.
- Among patients who do not achieve glycemic goals as targeted, the reasons for non-achievement were mostly the lack of titration of insulin (57.1%), the second main reason was the lack of diabetes education (49.5%).
- Inappropriate management of insulin therapy was highly demonstrated.

How might this impact on clinical practice in the foreseeable future?

- The worrying outcomes will raise awareness for the establishment of an effective healthcare strategy in Tunisia to improve the quality of care for diabetic patients, including the strengthening of therapeutic education programs.

Introduction

Diabetes is a major health issue that has shown alarming increases across the world, driven by increasing obesity, sedentary lifestyle, and population aging [1]. According to estimates, more than a half a billion people are living with diabetes worldwide and the prevalence of type 2 diabetes is set to increase from its present level of 537 million (2021) to 783 million by the year 2045 [2]. This rise is predicted to occur virtually in every nation, with the greatest increases expected in developing countries. Furthermore, the Middle East and North Africa (MENA) region has the second highest increase of all regions reviewed by the International Diabetes Federation (IDF), with a diabetes prevalence of 18.1% in 2021, the number of people with diabetes is expected to increase by 87% by 2045. However, the prevalence of diabetes in the MENA region may be underestimated, with a proportion of undiagnosed diabetes close to 37.6% (27.3 million) [3].

Diabetic patients are at risk of developing serious complications, which if not well managed, can result in hospitalizations and even premature death. It turns out that diabetes and its complications caused 428,600 deaths in adults aged less than 60 years in 2021 (24.5% of all-cause mortality) in MENA region [3].

In addition, diabetes also imposes a significant economic impact on countries, health systems and individuals with an estimated annual cost of diagnosed diabetes in 2017 of $327 billion, including $237 billion in direct medical costs and $90 billion in reduced productivity [4]. Indirect costs including loss of production (labour-force drop out from disability), mortality, absenteeism and presenteeism (reduced productivity when at work).

The Diabetes Control and Complications Trial (DCCT) in subjects with type 1 diabetes and the United Kingdom Prospective Diabetes Study (UKPDS) in subjects with type 2 diabetes have supported the position that early treatment of diabetes with tight glycemic control can reduce the morbidity and mortality of the disease by decreasing its chronic complications [5,6]. Therefore, the goal of treatment for patients with diabetes is to achieve metabolic goals, thus preventing or delaying complications and optimizing quality of life. Moreover, this should be personalized according to individual preferences, values, and goals [7].

International diabetes societies (ADA, EASD) have made global recommendations aiming to achieve optimal levels of glycemic control HbA_{1c} <7% (53 mmol/mol) for nonpregnant adult without hypoglycemia. However, less stringent HbA_{1c} goals <8% (64 mmol/mol) may be appropriate for patients with limited life expectancy, or where the harms of treatment are greater than the benefits [8,9]. However, it turns out that several patients are still not well controlled and do not achieve the HbA_{1c} goal, a fact that seems to be related to all the insulin therapy issues, from initiation of insulin therapy to proper insulin titration [10]. Therefore, there is a need to better assess the current practices in diabetes management and put in place some actions to improve the quality of care of these patients.

The standardization of the data collection process and the data analysis will justify international comparisons. This very large database will provide supportive data for international recommendations in terms of insulin therapy, in order to improve quality of medicine usage. It will also support future exploratory research.

In this article, we focused on Tunisian data collected during the 7th wave of the IDMPS to assess the management of diabetic patients in medical practice in Tunisia and the predictive factors of reaching the target HbA_{1c} for these patients.

Materials and methods

Study design and recruitment of patients

This is an international, multicentre, non-interventional, observational on management care study of people with type 1 or type 2 diabetes mellitus. The study was composed of a cross-sectional study to assess current practices in the management of subjects with type 1 and type 2 diabetes mellitus. The cross-sectional phase was composed of yearly surveys of 2 weeks duration each.

The IDMPS study is composed of yearly surveys (cross-sectional studies and/or longitudinal studies). The first wave of the study was performed in 2005. Six waves have already been performed. This cross-sectional study has been implemented for the seventh wave, which was carried out in 24 countries. In total, 4 regions were defined: Africa (Algeria, Cameroon, Madagascar, Democratic Republic of Congo, Egypt, Tunisia, Morocco, South Africa, Senegal, Ivory Coast, Nigeria, Kenya), Eurasia (Ukraine, Russia), Middle East (Iran, Iraq, Jordan, Kuwait, Lebanon, Pakistan, UAE, Saudi Arabia), and South Asia (Bangladesh, India).

As variables collected during each study were analysed on a yearly basis, by country, and in an independent manner, the Statistical Analysis Plan (SAP) was updated before each analysis.

All the patients who met the eligibility criteria of the cross-sectional study were included. The eligible population considered is: treated with insulin (T1DM only), with type of diabetes recorded (Type1 or type 2), and without missing data concerning the treatment of diabetes ("Does the patient receive oral glycaemic lowering drug (Yes/No)" and "Is the patient currently treated with insulin (Yes/No)").

Exclusion criteria were: patients enrolled in ongoing clinical trials, or those undergoing temporary insulin therapy (due to other medical issues including gestational diabetes, pancreatic cancer or surgery at baseline).

Survey data was collected by physicians on a standardized IDMPS case report form. The analysis population was constituted after database cleaning.

The sample size was determined on a country basis, based on the primary objective, which was to assess the management of care of T2DM patients, and on the relative precision that was expected.

Based on the assumption that insulin was the least prescribed therapy in terms of proportions, the sample size was determined in order to establish the frequency of insulin-treated patients. It was estimated to give an estimation of proportions with an absolute precision of 20% and a confidence interval of 95%.

$$n = p\,(1-p) \times (\varepsilon\alpha / e)^2$$

with: n = the per country sample size, p = the estimated proportion of type 2 DM patients treated with insulin, $\varepsilon\alpha = 1.96$ for $\alpha = 5$ %, e = the absolute precision (20%) x p = the relative precision.

Ethics

The IDMPS study protocol was approved, all followed procedures were compliant with the appropriate regulatory and ethical committees of the participating countries and centers, as well as those in Tunisia.

Study objectives

The purpose of this diabetes registry is to collect, analyse and disseminate data on people living with diabetes mellitus to improve the quality of care of these patients.

The primary objective of the study was to assess the management of care of people with type 2 diabetes in current medical practice.

The secondary study objectives were: to assess the management of care of patients with type 1 diabetes in current medical practice, and to evaluate the predictive factors for reaching target HbA_{1c} in patients with type 1 and type 2 diabetes.

Statistical analysis

Quantitative variables are described by: the number of missing data, extreme values, mean, standard deviation, median and quartiles. Qualitative variables are described by: the number of missing data, the different modalities of the variable, the corresponding numbers and percentages, and the 95% confidence interval (95% CI).

The modality "Unknown" was considered as missing data regarding "Yes/No/Unknown" answers.

Several comparative analyses were performed. The relationship between categorical variables was investigated using the Chi2 test or Fisher's exact test, depending on the expected values. For categorical variables, comparisons of means were made using the Student t-test or the Wilcoxon/Mann-Whitney test, depending on the normality of the distribution.

Statistical analysis was carried out using SAS® software version 9-2. There was no intermediate analysis.

Results

Study population

In Tunisia, 423 diabetes mellitus patients were recruited in the 7th wave of IDMPS. All of them met the eligibility criteria for analysis, distributed in 127 T1DM patients and 296 T2DM patients (Table 1).

	Type 1		Type 2								Total	
			Diet and exercise alone		OGLD treatment		Insulin treatment		OGLD treatment + Insulin treatment		Total	
	N=127		N=1		N=171		N=25		N=99		N=296		N=423	
Age (years)	35.47 ± 12.16		45 ± .		59.84 ± 10.15		61.40 ± 12.50		60.46 ± 9.50		60.13 ± 10.15		52.73 ± 15.63	
Age in class (years)														
≤40	89	(70.1%)	0		5	(2.9%)	1	(4.0%)	2	(2.0%)	8	(2.7%)	97	(22.9%)
]40;65]	37	(29.1%)	1	(100.0%)	124	(72.5%)	13	(52.0%)	67	(67.7%)	205	(69.3%)	242	(57.2%)
]65;85]	1	(0.8%)	0		41	(24.0%)	11	(44.0%)	30	(30.3%)	82	(27.7%)	83	(19.6%)
>85	0		0		1	(0.6%)	0		0		1	(0.3%)	1	(0.2%)
Gender														
Male	68	(53.5%)	1	(100.0%)	94	(55.0%)	14	(56.0%)	57	(57.6%)	166	(56.1%)	234	(55.3%)
Female	59	(46.5%)	0		77	(45.0%)	11	(44.0%)	42	(42.4%)	130	(43.9%)	189	(44.7%)
Ethnicity														
Caucasian	105	(82.7%)	1	(100.0%)	135	(78.9%)	22	(88.0%)	80	(80.8%)	238	(80.4%)	343	(81.1%)
Black	1	(0.8%)	0		0		0		0		0		1	(0.2%)
Oriental, Arab, Persian	21	(16.5%)	0		36	(21.1%)	3	(12.0%)	19	(19.2%)	58	(19.6%)	79	(18.7%)
Living area														
Urban area	107	(84.3%)	0		159	(93.0%)	19	(76.0%)	83	(83.8%)	261	(88.2%)	368	(87.0%)
Rural area	12	(9.4%)	1	(100.0%)	5	(2.9%)	4	(16.0%)	6	(6.1%)	16	(5.4%)	28	(6.6%)
Sub-urban area	8	(6.3%)	0		7	(4.1%)	2	(8.0%)	10	(10.1%)	19	(6.4%)	27	(6.4%)
Education level														
Missing	1		0		0		0		0		0		1	
Illiterate	2	(1.6%)	0		11	(6.4%)	4	(16.0%)	7	(7.1%)	22	(7.4%)	24	(5.7%)
Primary	16	(12.7%)	0		47	(27.5%)	6	(24.0%)	25	(25.3%)	78	(26.4%)	94	(22.3%)
Secondary	57	(45.2%)	1	(100.0%)	70	(40.9%)	12	(48.0%)	53	(53.5%)	136	(45.9%)	193	(45.7%)
University/Higher education	51	(40.5%)	0		43	(25.1%)	3	(12.0%)	14	(14.1%)	60	(20.3%)	111	(26.3%)
Health Insurance *	117	(92.1%)	1	(100.0%)	161	(94.2%)	23	(92.0%)	95	(96.0%)	280	(94.6%)	397	(93.9%)
Type of health insurance														
Public	102	(87.2%)	1	(100.0%)	138	(85.7%)	23	(100.0%)	89	(93.7%)	251	(89.6%)	353	(88.9%)
Private	5	(4.3%)	0		10	(6.2%)	0		1	(1.1%)	11	(3.9%)	16	(4.0%)
Public + Private	10	(8.5%)	0		13	(8.1%)	0		5	(5.3%)	18	(6.4%)	28	(7.1%)

* Health insurance is defined as National Public Health Insurance and/or Private Health Insurance.

Table 1: Patient demography by type of diabetes

30 physicians included at least one patient in the study: 21 (70%) were specialists (endocrinologists or diabetologists) and 9 were non-specialists (4 (13.3%) General practitioners and 5 (16.7%) internists/cardiologists). All patients met the eligibility criteria for analysis (inclusion/exclusion criteria met, without any other reason of exclusion), distributed in 127 T1DM patients and 296 T2DM patients. All patients were included in the eligible population for analysis.

Characteristics of people with type 1 diabetes

Demographic and clinical features of the T1DM cohort (N = 127) are presented in Tables 1 and 2. The average duration of diabetes was 15.29 ± 10.17 years.

Hospitalizations due to diabetes were reported for 22% of patients during the past 12 months.

Treatment of people with T1DM, attainment of targets and self-care

Most people with T1DM (95.3%) were treated with insulin while only 6.3% received OGLD therapy (Table 3). 85.8% received either basal + prandial insulin (Table 4); while 9.4% received basal alone and 3.9% premix alone. The average duration of insulin therapy was approximately 15.18 ± 10.16 years. 85.7% of T1DM patients had a glucose meter.

HbA_{1c} mean was 8.94%. 15.5% of them achieved the glycaemic target HbA_{1c} <7%. Glycaemic goals as targeted by the treating physician were achieved in 15.9% of patients. Comparing the last HbA_{1c} measurement with the HbA_{1c} target value considered by the physician, 9.5% of patients had an HbA_{1c} below the targeted value.

Characteristics of people with type 2 diabetes

Demographic and clinical features of the T2DM cohort (N = 296) are exposed in Tables 1 and 2. The average duration of diabetes was 11.74 ± 8.17 years. Diabetes-related complications were experienced by 49.1% of patients: microvascular complications in 41.6% and macrovascular complications in 14.8%. 6.8% had been hospitalized due to their diabetes in the previous 12 months.

Treatment of people with T2DM, attainment of targets and self-care

Regarding lifestyle, 38.6% of the people with T2DM followed healthy diet and exercise plan. Concerning treatment, 171 (63.3%) patients received only OGLD therapy alone, while 99 (36.66%) patients received a combination of OGLD with insulin, and 25 (9.25%) patients received insulin treatment alone.

For those treated with OGLD drugs only, 56.2% were treated with Metformin + sulfonylureas (+/- others), and 27.8% with Metformin alone. For those who received insulin therapy, basal prandial combination was the most frequently (52.0%) used regimen. Basal alone (32.0%) and Premix alone (12.0%) were the following most preferred regimens respectively. For those who received insulin and OGLD drugs, basal alone was the most frequently (52.5%) used regimen, followed by basal prandial combination (36.4%) and premix alone (10.1%).

In T2DM, the premixed insulin dose was higher than basal/ basal+ prandial regimen, mean basal insulin dose was 34.01 IU (0.41 IU/kg), the mean prandial insulin dose was 18.42 IU (0.21 IU/kg) and the mean premixed insulin dose was 54.43 IU (0.67 IU/kg). Self-adjustment of insulin was performed in 23.6% of patients.

56.1% patients had a glucose meter. Self-management of both blood glucose and insulin was performed in 20.0% of patients. 82.4% of T2DM patients ever received diabetes education and 77.2% were involved in an educational program provided by the physician or his/her clinical staff.

HbA_{1c} mean was 8.16%. Only 24.7% of the T2DM patients achieved the glycemic target HbA_{1c} <7%, and 26.6% the glycemic goals as targeted by the treating physician. Table 5 summarizes the glycemic control according to insulin regimen. The mean value at the last measurement of HbA_{1c} for patients with insulin therapy was lower with the basal regimen or basal+ postprandial regimen than with the premix regimen: 8.73, 8.62 and 9.44 respectively. Among the patients who did not achieve glycemic goals as targeted, the reasons for non-achievement were mostly the lack of titration of insulin (57.1%) and the lack of diabetes education (49.5%).

	Type 1	Type 2				Total
		Diet and exercise alone	OGLD treatment	Insulin treatment	OGLD treatment + Insulin treatment	Total	
	N=127	N=1	N=171	N=25	N=99	N=296	N=423
Time since diabetes diagnosis (years)	15.29 ± 10.17	2 ± .	8.96 ± 6.77	15.40 ± 9.66	15.76 ± 8.03	11.74 ± 8.17	12.81 ± 8.95
Time since diabetes diagnosis in class (years)							
≤ 1	6 (4.7%)	0	8 (4.7%)	2 (8.0%)	0	10 (3.4%)	16 (3.8%)
]1;5]	19 (15.0%)	1 (100.0%)	59 (34.5%)	2 (8.0%)	7 (7.1%)	69 (23.4%)	88 (20.9%)
]5;10]	25 (19.7%)	0	50 (29.2%)	3 (12.0%)	17 (17.3%)	70 (23.7%)	95 (22.5%)
]10;20]	37 (29.1%)	0	42 (24.6%)	11 (44.0%)	55 (56.1%)	108 (36.6%)	145 (34.4%)
> 20	40 (31.5%)	0	12 (7.0%)	7 (28.0%)	19 (19.4%)	38 (12.9%)	78 (18.5%)
Family history of diabetes	75 (60.0%)	0	110 (71.4%)	18 (81.8%)	76 (80.0%)	204 (75.0%)	279 (70.3%)
Family members diabetes-diagnosed before the age of 40 years	35 (51.5%)		20 (21.1%)	1 (6.3%)	6 (10.7%)	27 (16.2%)	62 (26.4%)
Weight at diagnosis of diabetes (kg)	63.71 ± 14.78	95 ± .	84.57 ± 15.23	76.46 ± 13.02	82.05 ± 14.60	83.30 ± 14.97	78.08 ± 17.23
Weight (kg)	70.94 ± 13.72	96 ± .	80.03 ± 13.79	75.10 ± 12.63	85.22 ± 16.82	81.40 ± 15.05	78.26 ± 15.42

BMI at diagnosis (kg/m²)*	23 ± 3.89		33.70 ± .		30.35 ± 5.71		27.23 ± 4.79		30.72 ± 4.79		30.23 ± 5.43	28.55 ± 5.95
BMI at diagnosis in class (kg/m²)*												
≤ 18.5	8	(15.7%)	0		1	(0.9%)	1	(7.7%)	0		2 (1.2%)	10 (4.6%)
]18.5;25]	30	(58.8%)	0		19	(17.8%)	1	(7.7%)	6	(12.8%)	26 (15.5%)	56 (25.6%)
]25;30]	11	(21.6%)	0		32	(29.9%)	8	(61.5%)	15	(31.9%)	55 (32.7%)	66 (30.1%)
]30;35]	2	(3.9%)	1	(100.0%)	35	(32.7%)	3	(23.1%)	16	(34.0%)	55 (32.7%)	57 (26.0%)
> 35	0		0		20	(18.7%)	0		10	(21.3%)	30 (17.9%)	30 (13.7%)
BMI at inclusion (kg/m²)	25.04 ± 4.20		34 ± .		29.03 ± 4.73		27.54 ± 4.74		31.07 ± 5.66		29.60 ± 5.16	28.24 ± 5.32
Tendinous xanthomata	0		0		0		0		2	(2.0%)	2 (0.7%)	2 (0.5%)
Arcus cornealis	1	(0.8%)	0		2	(1.2%)	0		5	(5.2%)	7 (2.4%)	8 (1.9%)
Systolic Blood Pressure (mmHg)	120.57 ± 14.82		120 ± .		129.74 ± 14.64		132.60 ± 10.42		134.20 ± 14.93		131.44 ± 14.53	128.18 ± 15.43
SBP in class												
SBP < 130 mmHg	92	(72.4%)	1	(100.0%)	77	(45.0%)	7	(28.0%)	31	(31.3%)	116 (39.2%)	208 (49.2%)
SBP ≥ 130 mmHg	35	(27.6%)	0		94	(55.0%)	18	(72.0%)	68	(68.7%)	180 (60.8%)	215 (50.8%)
Screening for any diabetes-related complications	121	(96.0%)	1	(100.0%)	164	(96.5%)	23	(92.0%)	98	(99.0%)	286 (96.9%)	407 (96.7%)
Cardiovascular disease	57	(45.6%)	1	(100.0%)	117	(68.4%)	21	(84.0%)	69	(71.9%)	208 (71.0%)	265 (63.4%)
Retinopathy	85	(68.0%)	0		124	(72.5%)	20	(80.0%)	80	(80.8%)	224 (75.7%)	309 (73.4%)
Neuropathy	82	(65.6%)	0		111	(65.3%)	17	(68.0%)	67	(69.1%)	195 (66.6%)	277 (66.3%)
Kidney damage (renal function)	106	(84.8%)	0		152	(89.9%)	21	(84.0%)	91	(92.9%)	264 (90.1%)	370 (88.5%)
Kidney damage (microalbumin/proteinuria)	83	(66.4%)	0		121	(71.6%)	20	(80.0%)	81	(83.5%)	222 (76.0%)	305 (73.1%)
Diabetic foot	86	(69.4%)	0		114	(66.7%)	19	(76.0%)	75	(77.3%)	208 (70.7%)	294 (70.3%)
Lipid abnormalities	94	(75.2%)	1	(100.0%)	153	(90.0%)	22	(88.0%)	94	(95.9%)	270 (91.8%)	364 (86.9%)
Blood pressure control	111	(88.8%)	1	(100.0%)	158	(93.5%)	22	(88.0%)	96	(98.0%)	277 (94.5%)	388 (92.8%)

Table 2: Clinical profile of patients by type of diabetes

	Type 1 N=127	Type 2 N=296			Total N=423
		OGLD treatment	OGLD treatment + Insulin treatment	Total	
		N=171	N=99	N=270	N=397
Patient received Oral Glycaemic Lowering Drug	**8** (6.3%)	**171** (100.0%)	**99** (100.0%)	**270** (100.0%)	**278** (70.0%)
OGLD therapy					
1 OGLD	7 (5.5%)	58 (34.3%)	63 (63.6%)	121 (45.1%)	128 (32.4%)
Duration of treatment for 1 OGLD (months)	24.86 ± 32.67	57.36 ± 72.87	154.40 ± 122.82	107.88 ± 112.63	103.34 ± 111.34
2 OGLDs	1 (0.8%)	87 (51.5%)	24 (24.2%)	111 (41.4%)	112 (28.4%)
Duration of treatment for 2 OGLDs (months)	12.00 (.)	83.66 ± 71.97	122.88 ± 86.02	92.21 ± 76.58	91.49 ± 76.61
More than 2 OGLDs	0	24 (14.2%)	12 (12.1%)	36 (13.4%)	36 (9.1%)
Duration of treatment for more than 2 OGLDs (months)		121.88 ± 89.63	112.83 ± 71.76	118.86 ± 83.16	118.86 ± 83.16
Class of OGLDs					
Metformin alone	4 (3.1%)	47 (27.8%)	56 (56.6%)	103 (38.4%)	107 (27.1%)
Sulphonylureas alone	0	8 (4.7%)	1 (1.0%)	9 (3.4%)	9 (2.3%)

Metformin + Sulphonylureas (+/- others)	1	(0.8%)	95	(56.2%)	29	(29.3%)	124	(46.3%)	125	(31.6%)
Other	3	(2.4%)	19	(11.2%)	13	(13.1%)	32	(11.9%)	35	(8.9%)

Table 3: Oral glucose-lowering drugs treatment by type of diabetes

	Type 1 N=127		Type 2 N=296						Total N=423	
			Insulin treatment alone		OGLD treatment + Insulin treatment		Total			
			N=25		N=99		N=124		N=251	
Patient currently treated with insulin	**127**	(100.0%)	**25**	(100.0%)	**99**	(100.0%)	**124**	(100.0%)	**251**	(100.0%)
Duration of insulin treatment (years)	15.18 ± 10.16		6.88 ± 6.36		4.51 ± 4.49		4.99 ± 4.99		10.17 ± 9.51	
Basal insulin	121	(95.3%)	21	(84.0%)	89	(89.9%)	110	(88.7%)	231	(92.0%)
Type of basal insulin*										
Long acting insulin analog	70	(58.3%)	15	(71.4%)	51	(57.3%)	66	(60.0%)	136	(59.1%)
Intermediate human insulin	50	(41.7%)	6	(28.6%)	38	(42.7%)	44	(40.0%)	94	(40.9%)
Basal insulin daily dose (IU)	36.10 ± 18.16		30.76 ± 12.48		34.78 ± 19.28		34.01 ± 18.20		35.10 ± 18.17	
Basal insulin daily dose (IU/kg)	0.52 ± 0.26		0.41 ± 0.16		0.41 ± 0.23		0.41 ± 0.22		0.47 ± 0.25	
Basal insulin number of injections	1.58 ± 0.50		1.35 ± 0.49		1.42 ± 0.50		1.41 ± 0.49		1.50 ± 0.50	
Prandial insulin	110	(86.6%)	14	(56.0%)	36	(36.4%)	50	(40.3%)	160	(63.7%)
Type of prandial insulin*										
Short acting insulin analog	68	(61.8%)	8	(57.1%)	19	(52.8%)	27	(54.0%)	95	(59.4%)
Rapid acting human insulin	42	(38.2%)	6	(42.9%)	17	(47.2%)	23	(46.0%)	65	(40.6%)
Biosimilar insulin	1	(0.9%)	0		0		0		1	(0.6%)
Prandial insulin daily dose (IU)	23.30 ± 13.89		19.14 ± 12.75		18.42 ± 11.51		18.62 ± 11.74		21.84 ± 13.40	
Prandial insulin daily dose (IU/kg)	0.33 ± 0.20		0.25 ± 0.16		0.21 ± 0.13		0.22 ± 0.14		0.30 ± 0.19	
Prandial insulin number of injections	2.46 ± 0.67		2.14 ± 0.66		2.26 ± 0.71		2.23 ± 0.69		2.39 ± 0.69	
Premix insulin	6	(4.7%)	3	(12.0%)	11	(11.1%)	14	(11.3%)	20	(8.0%)
Type of Premix insulin*										
Premixed analog insulin	5	(83.3%)	2	(66.7%)	8	(80.0%)	10	(76.9%)	15	(78.9%)
Premixed human insulin	1	(16.7%)	1	(33.3%)	2	(20.0%)	3	(23.1%)	4	(21.1%)
Premix insulin daily dose (IU)	62.33 ± 15.87		62.00 ± 7.21		52.36 ± 18.44		54.43 ± 16.92		56.80 ± 16.61	
Premix insulin daily dose (IU/kg)	0.95 ± 0.29		0.88 ± 0.16		0.62 ± 0.23		0.67 ± 0.24		0.76 ± 0.28	
Premix insulin number of injections	2.33 ± 0.52		2.00		2.00 ± 0.45		2.00 ± 0.39		2.10 ± 0.45	
Devices used by the patient**										
Reusable pen	7	(5.5%)	1	(4.0%)	3	(3.0%)	4	(3.2%)	11	(4.4%)
Disposable pen	69	(54.3%)	14	(56.0%)	55	(55.6%)	69	(55.6%)	138	(55.0%)
Vials	54	(42.5%)	11	(44.0%)	42	(42.4%)	53	(42.7%)	107	(42.6%)
Pump	1	(0.8%)	0		0		0		1	(0.4%)
Patient self-adjust insulin dose	76	(59.8%)	5	(20.0%)	24	(24.5%)	29	(23.6%)	105	(42.0%)
Combination of insulin treatment										
Basal alone	12	(9.4%)	8	(32.0%)	52	(52.5%)	60	(48.4%)	72	(28.7%)
Prandial alone	0		1	(4.0%)	0		1	(0.8%)	1	(0.4%)

Premix alone	5	(3.9%)	3	(12.0%)	10	(10.1%)	13	(10.5%)	18	(7.2%)
Basal + Prandial	109	(85.8%)	13	(52.0%)	36	(36.4%)	49	(39.5%)	158	(62.9%)
Basal + Premix	0		0		1	(1.0%)	1	(0.8%)	1	(0.4%)

Table 4: Current insulin treatment by type of diabetes

	Type 1 N=127	Type 2 N=296			Total N=423
		Insulin treatment alone	OGLD treatment + Insulin treatment	Total	
	N=127	N=25	N=99	N=124	N=251
Basal alone (N)	12	8	52	60	72
Value of last HbA_{1c} measurement (%) – Mean (SD)	9.34 (1.87)	9.24 (3.59)	8.65 (1.43)	8.73 (1.83)	8.81 (1.83)
HbA1c < 7%	1 (12.5%)	2 (25.0%)	4 (7.8%)	6 (10.2%)	7 (10.4%)
Basal + Prandial (N)	109	13	36	49	158
Value of last HbA_{1c} measurement (%) – Mean (SD)	8.88 (1.81)	8.57 (2.05)	8.64 (1.59)	8.62 (1.70)	8.79 (1.78)
HbA_{1c} < 7%	15 (14.7%)	2 (15.4%)	4 (11.8%)	6 (12.8%)	21 (14.1%)
Premix alone (N)	5	3	10	13	18
Value of last HbA_{1c} measurement (%) – Mean (SD)	9.62 (2.91)	9.90 (2.72)	9.30 (1.42)	9.44 (1.68)	9.49 (2.00)
HbA_{1c} < 7%	2 (40.0%)	1 (33.3%)	1 (10.0%)	2 (15.4%)	4 (22.2%)

Table 5: Glycaemic control per current insulin treatment by type of diabetes

Hypoglycemia

More than one out of three people living with diabetes mellitus has shown signs of hypoglycemia during the last three months, mainly in patients treated with insulin, 67.7% for T1DM, 24.6% for T2DM (33.3% in patients treated with insulins and 41.8% in patients treated with OGLD plus insulin treatment). One in ten patients experienced severe hypoglycemia in the past of 12 months, mainly in patients treated with insulin, 27.2% for T1DM and 12.5% for T2DM (Table 6). In 95.2% of cases, one of the causes is an inappropriate management of insulin therapy, whether it is the timing of the injection or the adaptation of doses: in case of physical exercise in 42.5% of cases, or relative to food intake, particularly for T2DM patients, in whom it is overestimated by one patient in three (33.3%). Thus, 11.4% required hospitalization due to the diabetes during last 12 months and in 14.6% of cases reason of hospitalization was hypoglycemia.

	Type 1	Type 2				Total
		OGLD treatment alone	Insulin treatment alone	OGLD treatment + Insulin treatment	Total	
	N = 127	N=171	N=25	N=99	N=295	N=422
Patient experienced any symptomatic episodes of hypoglycemia in the past 3 months						
N	124	170	24	98	292	416
Yes (n, %)	84 (67.7%)	23 (13.5%)	8 (33.3%)	41 (41.8%)	72 (24.6%)	156 (37.4%)
Patient experienced any severe episodes of hypoglycemia (requiring assistance) in the past 12 months						
N	125	170	24	99	293	418
Yes (n, %)	34 (27.2%)	4 (2.4%)	3 (12,5%)	4 (4.0%)	11 (3,7%)	45 (10.7%)

Table 6: Symptomatic episodes of hypoglycemia

Adherence to insulin therapy and support programs

11.1% of diabetic patients interrupted their insulin treatment, for durations ranging from 2 to 20 months, with an average of 1.68 months for T1DM patients and 4.36 months for T2DM patients with OGLD plus insulin treatment. The main causes for this non-adherence were impact on social life for 58.6% of patients, the fear of hypoglycemia for 27.6%, episodes of hypoglycemia for 24.1%, lack of experience in insulin management for 31% and lack of support for 24.1% of patients (Table 7).

	Type 1	Type 2			Total
		OGLD treatment	OGLD treatment + Insulin treatment	Total	
	N=127	N=171	N=99	N=270	N=397
Reason of discontinuation* (N)	20	2	7	9	29
Lack of efficacy	0	1 (50.0%)	0	1 (11.1%)	1 (3.4%)
Fear of hypoglycaemia	6 (30.0%)	0	2 (28.6%)	2 (22.2%)	8 (27.6%)
Episodes of hypoglycaemia	7 (35.0%)	0	0	0	7 (24.1%)
Occurrence of side effects	3 (15.0%)	0	1 (14.3%)	1 (11.1%)	4 (13.8%)
Impact on social life	12 (60.0%)	2 (100.0%)	3 (42.9%)	5 (55.6%)	17 (58.6%)
Lack of experience in the management of insulin dosing or insulin administration	6 (30.0%)	2 (100.0%)	1 (14.3%)	3 (33.3%)	9 (31,0%)
Cost of medications / strips	6 (30.0%)	0	2 (28.6%)	2 (22.2%)	8 (27.6%)
Absence of dose flexibility	3 (15.0%)	0	0	0	3 (10.3%)
Weight gain	3 (15.0%)	0	0	0	3 (10.3%)
Lack of support	5 (25.0%)	1 (50.0%)	1 (14.3%)	2 (22.2%)	7 (24.1%)
Other reason(s) for discontinuation of insulin therapy	4 (20.0%)	1 (50.0%)	1 (14.3%)	2 (22.2%)	6 (20.7%)

* A patient may have several reasons of discontinuation.

Table 7: Adherence to insulin therapy by type of diabetes

While 81.2% of clinicians consider patients may benefit from any support and that support programs exist, reaching 83.9% of diabetic people, the impact on insulin therapy management remains insufficient, as well as on dietary habits and physical activity level: 61.4% of patients did not modify them.

Cardiovascular risk

63.4% of people with type 2 diabetes had associated hypertension and 60.8% dyslipidemia.

A positive point to note: Tunisians seems to be little smokers. 65% have never smoked, 16.8% have stopped when the diagnosis was announced and therefore 18.2% continue to smoke despite knowing their diabetes.

Regarding the high cardiovascular risk, the triple targets pooled together HbA_{1c} < 7%, and normal blood pressure (SBP/DBP: 130/80mmHg) and LDL-CS < 100 mg/dL is strongly recommended. In Tunisia, these triple targets were reached by only 2.4% of the people T2DM. The non-achievement of the triple targets was due to HbA_{1c} level ≥ 7% in 78.8%, abnormal blood pressure for 76.4% and LDL level ≥ 100 mg/dL for 50.8%.

Discussion

According to the IDF 2021 estimates, the prevalence of diabetes in Tunisia reaches 10.8% among adults aged 20 to 79 years. However, this percentage does not reflect the real situation in the country with a proportion of 40.2% of undiagnosed diabetes [3]. Diabetic patients are at risk of developing complications that reduce quality of life, undue stress on families, and can even be life-threatening if not well managed, thus the need for stringent disease management and individualized medical care [11].

The findings of the present IDMPS wave 7 reveal a worrying clinical burden of diabetes in Tunisia, with the presence of a high cardiovascular risk in diabetic patients, particularly related to the non-achievement of the recommended target value of HbA1c, of blood pressure and of LDL by most of diabetic patients. These outcomes are consistent with the reports of the Tunisian national coronary heart disease registry, where diabetes is significantly associated with coronary heart disease, mostly in women: 50.5% vs 28.7% in men [12].

In Tunisia, according to IDMPS wave 7 results, only 24.7% of the people with T2DM reached the recommended target value of HbA1c < 7%. These results are worse than the IDMPS wave 7 Africa results, which demonstrated 33.1% of the total population reached their glycaemic target (HbA_{1c} < 7%) [10]. In the other hand, the proportion of the people with T2DM reaching the HbA_{1c} targeted value was like that reported in a previous wave of IDMPS conducted in Tunisia, wave 1 in 2004 Wave 2 in 2006 and wave 3 in 2008 [13] where the percentage of the people with T2DM who reach HbA_{1c} value <7% was 24.1%, 22.6% and 22.4% respectively. The absence of change in glycaemic control between 2010 [12] and the recent results (2017) [14] resonates well with the description reported in Diabetologia (2020) [15] that reports the persistent poor glycaemic control observed over the 12 years' experience of IDMPS (2005-2017).

In the people with T2DM, those treated with insulin alone or with OGLD alone were more likely to have an HbA_{1c} < HbA_{1c} target value (36.0% and 32.7%, respectively) than patients treated with OGLD plus insulin (14.6%). This situation highlights a certain therapeutic inertia in Tunisia while nearly 2/3 of the people with T2DM receive only OGLD without insulin.

In insulin-treated patients, the glycaemic goals as targeted by the treating physician were achieved in 26.6% of the people with T2DM. Among the patients who do not achieve glycaemic goals as targeted, the reasons for non-achievement were mostly first the lack of titration of insulin (57.1%), probably due to fear from hypoglycemia more than one in three patients with diabetes mellitus has shown signs of hypoglycemia during the last three months (37.4%), mainly in patients treated with insulin, one of the causes expressed by the patients is an inappropriate management of insulin therapy. In another local registry (Hypo G study) [16] whose objective was to assess the proportion of the people with T2MD with hypoglycemia in inadequately controlled with basal insulin with high risk of hypoglycemia, 73% of them presented a hypoglycaemia event during the last month.

The results of Hypo G study may join IDMPS wave 7 results regarding hypoglycaemia as main issue for optimisation of insulin treatment and achievement of glycemic control. Although more than 8 out of 10 patients with diabetes mellitus participated in support programs, it seems that the level of knowledge and acquisition of self-care skills is still insufficient. These data should raise questions about the quality of these programs. Moreover, we must note that the majority of these programs are carried out in less than 2 hours.

Consequently, physicians should ask their patients about hypoglycemia at each visit to try to find the principal reasons involved and implement a therapeutic strategy to decrease this risk. Also, there is a need to provide more patient support and patient education to improve patient knowledge in diabetes complication and self-care skills in insulin management [17,18].

Conclusion

After comparison with the international recommendations (EASD, ADA, and IDF), it appeared that the clinical burden of diabetes in Tunisia is unsettling especially because of the non-achievement of the recommended target value of HbA_{1c} by most patients, highlighting the need for better education of patients and more awareness of the disease particularly its complications. Moreover, clinicians probably also need to explain to them that reaching glycemic targets requires adaptation of treatment, often leading to treatment intensification and insulin optimization taking account minimisation of hypoglycemia risk. Furthermore, the high cardiovascular risk of Tunisian diabetic patients, glycemic targets need to be extended to a more global approach, including the control of any associated hypertension or dyslipidemia.

Limitations

The information presented in the study is reflective of patients accessing healthcare at the selected study site and may not be representative of the general diabetes population. Due to the descriptive nature of the data, it was not possible to determine the specific impact of variables such as medication change over time. Nevertheless, the data provide some valuable insights into diabetes management in Tunisia.

Declarations

Acknowledgement

The authors would like to thank Charfi Nadia, Professor in endocrinology university of Sfax Tunisia and Ramzy Hala, employee of Sanofi and potential shareholder of Sanofi for their great support and contribution to the study.

The authors would like to thank all the physicians and People who participated in this study.

Editorial assistance and medical writing were provided by Better Being Health SARL, Marrakech, Morocco, and was funded by Sanofi.

Availability of data and materials

"Qualified researchers may request access to patient level data and related study documents including the clinical study report, study protocol with any amendments, blank case report form, statistical analysis plan, and dataset specifications. Patient level data will be anonymized, and study documents will be redacted to protect the privacy of trial participants. Further details on Sanofi's data sharing criteria, eligible studies, and process for requesting access can be found at: https://www.vivli.org/.

Ethics approval and consent to participate

The IDMPS study protocol was approved, all followed procedures were compliant with the appropriate regulatory and ethical committees of the participating countries and centers, as well as those in Tunisia.

Funding

The study was sponsored and funded by Sanofi.

Consent for publication

All participants provided written informed consent before entering the study.

Competing interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Abid Mohamed declares that there is no conflict of interest. Ben Aissa Emna is an employee of Sanofi and potential shareholder of Sanofi.

Contribution statement

Both authors Professor Mohamed ABID and Emna BEN AISSA have enssured the study concept, design, data analysis and interpretation of the current manuscript.

Drafting and critical revision of the manuscript was provided by scientific writing agency Better Being Health SARL based in Morocco.

The authors assume full responsibility for the present study, and state having approved the latest version of the manuscript for publication.

References

1. World Health Organization (2019) Classification of diabetes mellitus. Available from https://www.who.int/health-topics/diabetes
2. Sun H, Saeed P, Karuranga S et al. (2022) IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes research and clinical practice 183, 109119. https://doi.org/10.1016/j.diabres.2021.109119
3. International Diabetes Federation (2021) IDF Diabetes Atlas, 10th Edition. Available from https://www.diabetesatlas.org
4. American Diabetes Association (ADA) (2021) Improving Care and Promoting Health in Populations: Standards of Medical Care in Diabetes – 2021. Diabetes Care 44(Suppl. 1): S7–S14. DOI: 10.2337/dc21-S001.
5. The Diabetes Control and Complications Trial Research Group; Nathan D M, Genuth S, Lachin J, Cleary P, Crofford O et al. (1993) The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. New England Journal of Medicine 329: 977-986. DOI: 10.1056/NEJM199309303291401.
6. UK Prospective Diabetes Study (UKPDS) group (1998) Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications with patients with type 2 diabetes (UKPDS 33). The Lancet 352: 837-853. DOI: https://doi.org/10.1016/S0140-6736(98)07019-6

7. American Diabetes Association (ADA) (2021) Standards of Medical Care in Diabetes - 2021 Abridged for Primary Care Providers. Clin Diabetes 39(1): 14–43. https://doi.org/10.2337/cd21-as01
8. Davies MJ, D'Alessio DA, Fradkin J et *al.* (2018) Management of Hyperglycemia in Type 2 Diabetes, 2018. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care 41(12): 2669-2701. DOI: 10.2337/dci18-0033.
9. American Diabetes Association (ADA) (2021) Glycemic Targets: Standards of Medical Care in Diabetes – 2021. Diabetes Care 44 (1): S73–S84. https://doi.org/10.2337/dc21-S006
10. Kaplan H, Amod A, Chadli A et *al.* (2021) IDMPS Wave 7 Africa. Journal of Endocrinology, Metabolism and Diabetes of South Africa 26(3): 76-81. https://doi.org/10.1080/16089677.2021.1897230
11. Tomic D, Shaw J E, and Magliano D J. (2022) The burden and risks of emerging complications of diabetes mellitus. Nature Reviews Endocrinology 18: 525-539. https://doi.org/10.1038/s41574-022-00690-7
12. Jarraya F, Kammoun K, Mahfoudh H *et al.* (2012) Prise en charge de l'hypertension artérielle en Tunisie : le défi d'un pays en voie de développement. Rev Med Suisse 2012 ; 8 : 1725-30.
13. Ben Salem L (2012) L'étude IDMPS (International Diabetes Management Practices Study) : Résultats Tunisiens. Revue Maghrébine d'Endocrinologie-Diabète et de Reproduction 17(1-2): 52-58.
14. Gagliardino J J, Atanasov P K, Chan J CN *et al.* (2017) Resource use associated with type 2 diabetes in Africa, the Middle East, South Asia, Eurasia and Turkey: results from the International Diabetes Management Practice Study (IDMPS). BMJ Open Diabetes Research and Care 5: e000297. DOI: 10.1136/bmjdrc-2016-000297
15. Aschner P, Gagliardino J, Ilkova H et *al.* (2020) Persistent poor glycaemic control in individuals with type 2 diabetes in developing countries: 12 years of real-world evidence of the International Diabetes Management Practices Study (IDMPS). Diabetologia 63(5): 1088-1089. DOI: 10.1007/s00125-020-05118-3.
16. Abid M, Gharbi ME, Ben Aissa E, Jamaa S (2020) Pattern of care of people with T2DM on basal insulin with high risk of hypoglycemia (Hypo G Study). International Scientific Researches Journal 76(10). DOI: 10.21506/j.ponte.2020.10.1.
17. McCall A L, Lieb D C, Gianchandani R et al. (2023) Management of Individuals With Diabetes at High Risk for Hypoglycemia: An Endocrine Society Clinical Practice Guideline. The Journal of Clinical Endocrinology & Metabolism 108: 529–562. https://doi.org/10.1210/clinem/dgac596
18. American Diabetes Association (ADA) (2023) Improving Care and Promoting Health in Populations: Standards of Care in Diabetes—2023. Diabetes Care 48: Supplement 1. https://doi.org/10.2337/dc23-S001

DOI:10.31579/2693-7247/081