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ASSOCIATION BETWEEN PATIENT SATISFACTION AND TREATMENT EFFICACY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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ABSTRACT

The objective of this study was to assess the relationship between treatment efficacy, and treatment satisfaction in patients on stable medication regimens for type 2 diabetes. Diabetes Treatment Satisfaction Questionnaire (DTSQ) was used to evaluate the treatment satisfaction in 515 T2DM patients. Treatment Efficacy was evaluated by comparing the glycosylated hemoglobin (HbA1c) values and the percentage of patients who achieved the glycemic control (HbA1c<7%). The relationship between DTSQ score and other socio-demographics and clinical variables was also evaluated. Only 33.7 % of patients have HbA1c<7%. A good glycemic control was observed in patients treated with sulfonylurea (mean HbA1c = 6.5±2.1%), the combination of metformin with SGLT2 inhibitors (mean HbA1c =6.6±1.4%), and the combination of metformin with sulfonylurea and SGLT2I with (6.9±3.4%) or without DPP4I (6.9±2.1%).The mean HbA1c value exceeded 7% in all other patterns of treatment. All patients in sulfonylurea group as well as in Metf+Sulf+SGLT2 group had (HbA1c<7%). Best DTSQ score was observed in patients treated with sulfonylurea (21.28±5.77) followed by that observed in patient treated with Metf+SGLT2 inhibitors (20.77±5.27). Patients with a higher DTSQ score had a lower associated HbA1c measurement (P<0.01). Presence of diabetic foot ulcer associated with significantly lower DTSQ score (P=0.038), while adherence to physical activity more than 3 times a week associated with higher DTSQ (P=0.017). In conclusion, the DTSQ score may be an efficient tool for identifying patients with poor treatment satisfaction who can then be targeted for interventions to promote glycemic control.

KEYWORDS: Type 2 diabetes, HbA1c, DTSQ, patient's satisfaction, treatment efficacy.

INTRODUCTION

Diabetes mellitus (DM) is a common chronic condition characterized by high blood glucose level. It is still one of the major worldwide, fastest growing health care emergencies in the 21st century.[1] There are two principal types of DM, type 1 which is associated with autoimmune beta-cell destruction, usually leading to absolute insulin deficiency, and type 2 diabetes (T2DM), due to a non-autoimmune progressive loss of adequate beta-cell insulin secretion and/or peripheral insulin resistance.[2] T2DM, previously referred to as “non-insulin-dependent diabetes” or “adult-onset diabetes”, accounts for 90–95% of all diabetes.[1]

T2DM management presents a challenge to not only the patient, but also to his family and to the health care system in each country. Optimal diabetes management requires an organized, systemic approach that includes lifestyle modifications including healthy eating, regular physical activity, stress management, smoking cessation and maintenance of healthy body weight. However, in most cases taking medication is inevitable to improve the management of T2DM. Metformin is usually the first-line medicine.[3] If treatment with a single antidiabetic medication is not sufficient, a range of combination therapy options are now available (e.g. sulphonylureas (Sulf), alpha glucosidase inhibitors, thiazolidinediones, dipeptidyl peptidase - 4 inhibitors (DPP4I), glucagon-like peptide 1 (GLP-1) agonists and sodium glucose co-transporter 2 inhibitors (SGLT2I). Insulin injections may be necessary to control hyperglycemia to recommended levels when noninsulin medications fail to achieve glycemic control. The effectiveness of management strategies plays a crucial role in achieving desired outcomes, and is tightly related to medication efficacy and safety. However, these long-term multifactorial strategies may meet with poor adherence and deterioration in glycemic control arising due to the inconvenience and poor patient treatment acceptability, multiple medications, self‑behavior changes efforts and

poor patient satisfaction with treatment.[4,5] Patient satisfaction was defined as " the agreement between what the patients expects from the treatment, and the results obtained from this treatment",[6] in other words the "confirmation of expectations" for a patient.[6,7]

Recently, it is widely demonstrated that patient satisfaction is a determinant factor for treatment adherence, thereby improving glycemic control and outcomes of treatment in T2DM patients.[8, 9] and raises quality of life.[10, 11] Moreover, enhancing treatment satisfaction in diabetes was demonstrated to reduce the costs of the disease. [12, 13]

There are many tools to evaluate patient satisfaction in DM; however, limited tools are available for use in the Arabic languages.[14] One tool is the Diabetes Treatment Satisfaction Questionnaire (DTSQ). The DTSQ was developed by Clare Bradley, an English health psychologist, in the 1990s for the purpose of assessing patient satisfaction with their diabetes medication.[15] DTSQ has been translated into more than 100 languages and is widely used in many countries, since it is internationally validated and officially approved by WHO and the International Diabetes Federation (IDF),[16] and has been used in many previous studies.[10,15]

Given the widespread use of DTSQ as a valid measure of treatment satisfaction in diabetes, the purpose of this study was to assess patient satisfaction score, using DTSQ questionnaire, in a group of Syrian diabetic patients and to analyze the association of DTSQ score with blood glucose control determined by HbA1c levels, as a marker for the efficacy of treatment regimens. The relationship between DTSQ and some socio-demographic and clinical parameters was also evaluated. If enhancing treatment satisfaction in diabetic patients leads to improvement in glycemic control and patient's quality of life, then treatment satisfaction should be targeted as an important area for improving treatment outcomes in this population.

MATERIALS AND METHODS

Study population and Procedure

This was a single‑center, cross‑sectional, observational study conducted in the National Center for Diabetes in Latakia/Syria. This center is the main public referral center for DM patients, which is responsible for conducting the screening, assessment and treatment of DM cases. The data were collected between 2022 and 2023. The study population included 515 Patients with T2DM, older than 18 years of age, who have taken antidiabetic medications for at least 3 months. A written informed consent was obtained from all the patients prior to enrolling them in the study. Exclusion criteria included gestational diabetes, type 1 diabetes, age <18 years, active changes in the drug regimen during the study.

All participants were interviewed to collect socio-demographic (age, sex, education, marital status, body mass index (BMI) and clinical variables (duration of diabetes, type of antidiabetic medications, exercise and diet, complications and comorbidities (Hypertension or dyslipidemia was considered present when the patient was being treated with antihypertensive or lipid-lowering drugs, respectively)). Participants were then asked to complete the DTSQ**.**

Evaluation of treatment satisfaction

Diabetes treatment satisfaction was evaluated using the 8-item Diabetes Treatment Satisfaction Questionnaire (DTSQ). This instrument has been previously validated for the Arabic population.[17] The DTSQ consists of a six items scale assessing treatment satisfaction (items 1, 4–8); and two items assessing perceived frequency of hyperglycemia and hypoglycemia (items 2 and 3).

Responses to treatment satisfaction used a 7-point scale ranging from 0 "very dissatisfied" to 6 "very satisfied".[18] The treatment satisfaction score is the sum of six of the items of the DTSQ for each respondent with a possible score of 0–36. This includes satisfaction with current treatment (item 1); treatment convenience (item 4); flexibility of treatment (item 5); understanding of diabetes (item 6); continuity of treatment (item 7); and recommending treatment to others with diabetes (item 8). The additional two items measure perceived frequency of hyperglycemia and hypoglycemia and also use a seven-point scale (0–6) where a score of 0 indicates lack of hypo- or hyperglycemia and a score of 6 indicates a higher frequency. Total DTSQ scores for treatment satisfaction (items 1, 4, 5, 6, 7, and 8), perception of hyperglycemia (item 2), and perception of hypoglycemia (item 3) were computed for all patients.

Assessment of treatment efficacy

The efficacy of treatment was assessed by measuring glycosylated hemoglobin (HbA1c) values and was compared among the different groups of treatment regimens. We also compared the percentage of patients who achieved HbA1c values <7% (as a measure of glycemic control).

Sample collection and handling

Blood samples were collected by standard procedure from each participant, placed in EDTA tube for HbA1c analysis and stored at 2-8 °c for no more than 7 days. HbA1c was measured using Fast Ion-Exchange Resin separation method (Human Diagnostics®, Wiesbaden, Germany) using semi-automated spectrophotometer (Biosystems BTS-310, Barcelona, Spain).

Statistical analysis

The SPSS (V.26) software program was used for the statistical analysis. Data were represented as percentage or mean ± standard deviation. Student test (T test) was used to compare tow means for quantitative variables and the chi-squared test for qualitative variables. The

ANOVA test was used for comparing the means of quantitative variables between three groups or more and LSD test for two dimensions comparison. Pearson's correlation coefficient (r) was used to analyze the correlation between two variables. Probability (*P*) value less than 0.05 was regarded as statistically significant.

RESULTS

Socio-demographic and clinical characteristics of the study population

Socio-demographic parameters and clinical diabetes-related data are shown in Table 1. A total of 515 T2DM Syrian patients were included in this study with mean ± SD age of 57.09 ± 9.2 years (ranged from 24 to 81), 56% were females and 39.4% were current smokers. Base line data showed a trend to overweight (defined as BMI: 25-29.9) in 53.8% of our population with a mean ± SD BMI of 27.90 ± 5.019); about 34% were well-educated and most of them were married (84.6%). Regarding the lifestyle, 48.1% of patients reported not being on diet, while about 44.2% of patients were adherent to practice physical activity more than 3 times weekly. About 68% of patients had a family history of diabetes in first degree relative. The mean ± SD duration of T2DM was 7 ± 2.5 years ranging from 1-25 year. Main comorbidities were hypertension (71%) and/or dyslipidemia (42.5%). Retinopathy was the most common diabetic complication seen in 48.1 % of patients, followed by neuropathy (45.2%), while nephropathy and diabetic foot were found in 4.8% and 1,9% of T2DM patients respectively**.** The mean value of HbA1c of all patients was 7.94% ± 2.10. Percentage of patients who achieved HbA1c<7% was only 33.7%.

Table 1: Socio-demographic parameters and clinical diabetes-related characteristics of the study population.

Variable, (N= 515)	Categories	Mean ±SD or N (%)
Age(year)		57.09±9.156 (range: 24-81)
Gender	Male	223 (43.3)
	Female	292 (56.7)
BMI (kg\m^2)		27.90 ± 5.019 range (16-46)
	>18.5	5 (1)
	18.5-24.9	119 (23.1)
	25-29.9	277 (53.8)
	<30	114 (22.1)
Educational level	Uneducated	70 (13.5)
	Primary school	99 (19.2)
	Middle school	89 (17.3)
	High school	84 (16.3)
	University	173 (33.6)
Marital status	Single	25 (4.8)
	Married	436 (84.6)
	Divorced	5 (1)
	Widow\Widower	49 (9.6)
Family history	First degree relatives	351 (68.3)
	Second degree relatives	30 (5.8)
	No family history	134 (26.0)
Smoking	Yes	203 (39.4)
	No	312 (60.6)
Diet adherence	Very good	99 (19.2)
	good	94 (18.3)
	Not good	74 (14.4)
	Not on a diet	248 (48.1)
Physical activity	More than 3 times weekly	228 (44.2)
	Less than 3 times weekly	139 (26.9)
	I don't do any physical activity	148 (28.8)
The duration of diabetes (year)		7 ± 2.5 range (1-25)
Diabetic complications	Retinopathy	247 (48)
	Neuropathy	233 (45.2)
	Nephropathy	25 (4.8)
	Diabetic foot	10 (1.9)
Comorbidities	Hypertension	368 (71.4)
	Dyslipidaemia	219 (42.5)

	Others	59 (11.5)
HbA1c		7.94% ± 2.10
	< 7%	174 (33.7)
	> 7%	341 (66.3)

Distribution of study population according to antidiabetic treatment regimens

Distribution of study population according to antidiabetic treatment regimens is presented in Figure1. Ten different types of treatment regimens were seen in our population, with metformin being the most common medicine of these regimens. The majority of patients were taking a binary treatment of metformin and a sulfonylurea agent (Metf+sulf, (53.4%, N= 275). The monotherapy with metformin or a sulfonylurea agent was applied in 10.7% (Metf, N=55) and 1.9% (sulf, N= 10) respectively. In some patients, metformin was combined either with SGLT2I (Metf+SGLT2, 1.9 %, N= 10) or with DPP4I (Metf+DPPI, 5.8%, N= 30). Triple treatment regimens were also observed in our population, five patient were receiving a combination of metformin, sulfonylurea and SGLT2I (Metf+sulf+SGLT, 1%, N=5), while 55 patients were treated with a combination of metformin, sulfonylurea and DPP4I (Metf+sulf+DPPI, 10.7%). There were 15 patients treated with a combination of four medicines (Metf+sulf+SGLT+DPPI, 2.9%). Some patients were on a drug regimen containing insulin either as monotherapy (Insul, 10.7%, N=55) or in combination with metformin and sulfonylurea (Insul+Metf+Sulf, 1%, N=5). In all, 88.3% (N=455) of patients were on oral glucose lowering agents (OGLA), and 11,7% (N=60) were treated with insulin containing-regimens.

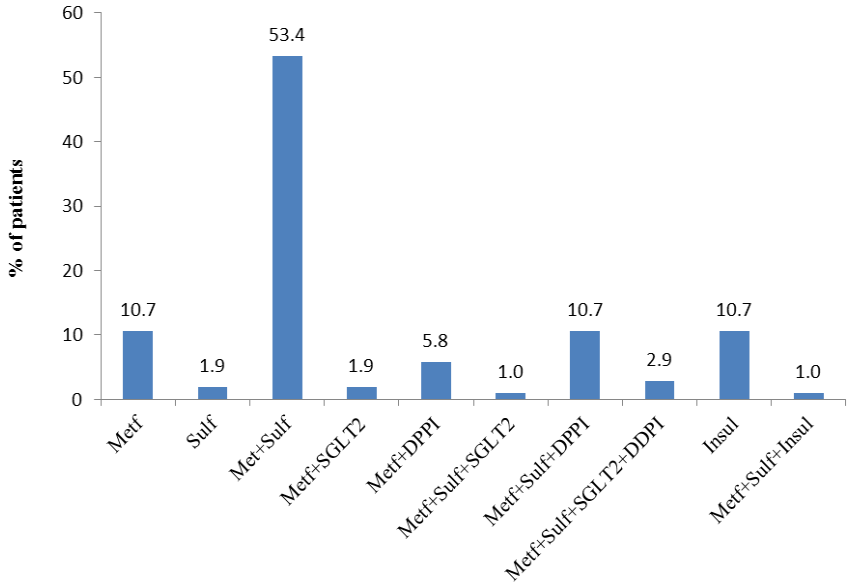

Figure 1: Percentage of T2DM patients according to antidiabetic treatment regimens, N=515.

Diabetes Treatment Satisfaction assessment

The mean overall DTSQ score (1, 4-8 items) of our study population was found to be (19.38± 6.38). The mean score of hyperglycemia (item 2) was 3.56±1.30 while that of hypoglycemia (item 3) was 0.48±0.84. The mean values of each DTSQ items are summarized in table 2.

Table 2: Descriptive statistics of the DTSQ scores.

Item N^0	DTSQ items	mean±SD
1	Satisfaction with current treatment	3.13±1.63
2	**Perceived frequency of hyperglycemia**	**3.56±1.30**
3	**Perceived frequency of hypoglycemia**	**0.48±0.84**
4	Treatment convenience	3.22±1.55
5	Flexibility of treatment	2.78±1.24
6	Understanding of diabetes	2.63±1.72
7	Recommending treatment to others with diabetes	4.14±1.31
8	Continuity of treatment	3.48±1.80
1, 4-8	**Overall DTSQ**	**19.38±6.38**

The assessment of correlation between hyperglycemia or hypoglycemia and overall DTSQ score revealed the presence of a significant negative correlation between hyperglycemia and overall DTSQ (r= - 0.51, *P*=0.03). No significant correlation was observed between hypoglycemia and overall DTSQ. However, hypoglycemia was negatively correlated with hyperglycemia (r= - 0.43, *P*=0.04) (Table 3). These results suggest that treatment satisfaction was associated with fewer incidents of hyperglycemia and patients who experienced a greater incidence of hyperglycemia tended to experience a smaller incidence of hypoglycemia.

Table 3: Correlations between hyperglycemia or hypoglycemia and the total DTSQ scores.

Item	hyperglycemia	hypoglycemia	Overall DTSQ
hyperglycemia		-0.43*	-0.51*
hypoglycemia	-0.43*		0.33
Overall DTSQ	-0.51*	0.33	

*The values are Pearson correlation coefficients. * p <0.05.*

Assessment of treatment regimens efficacy in T2DM patients

The metabolic parameter (HbA1c) was used to evaluate the efficacy of applied antidiabetic treatment regimens. Both the mean value of HbA1c and the percentage of patients who achieved HbA1c <7%, were compared among the different treatment regimen groups. The mean value of HbA1c in all patients was 7.94% ± 2.10. Percentage of patients who achieved HbA1c<7% was only 33.7%.

As shown in figure 2, the best glycemic control was observed in patients treated with sulfonylurea (mean HbA1c = 6.5±2.1%), followed by the combination of metformin with SGLT2 inhibitors (mean HbA1c = 6.6±1.4%), then the triple treatment with Metf+sulf+SGLT2I (mean HbA1c=6.9±3.4%), and the quadric treatment with Metf+Sulf+SGLT2I+DDP4I (mean HbA1c = 6.9±2.1%). The mean HbA1c value exceed 7% in all other patterns of treatment reaching 7.24±2.7% in Metf group, 7.5±2.1% in Metf+Sulf+DPP4I group, 8.09±1.1% in Metf+sulf group, 8.6±1.2 % in Metf+DPP4I group, 9.3±1.7% in insulin group and 10.3±2.2% in Metf+Sulf+Insul group. Statistical analysis using ANOVA test showed a significant difference in mean HbA1c values among the treatment groups (P<0.05). We further analyzed the differences between each two groups using LSD sup-groups analysis. Sulfonylurea group had significantly lower HbA1c as compared to Metf+DPP4I group (P=0.043) and insulin containing regimens (insulin (P=0.035) and Metf+Sulf+Insul (P=0.029). A significant difference was also observed between Metf+SGLT2 group and insulin containing regimens (insulin (P=0.045) and Metf+Sulf+Insul (P=0.03)).

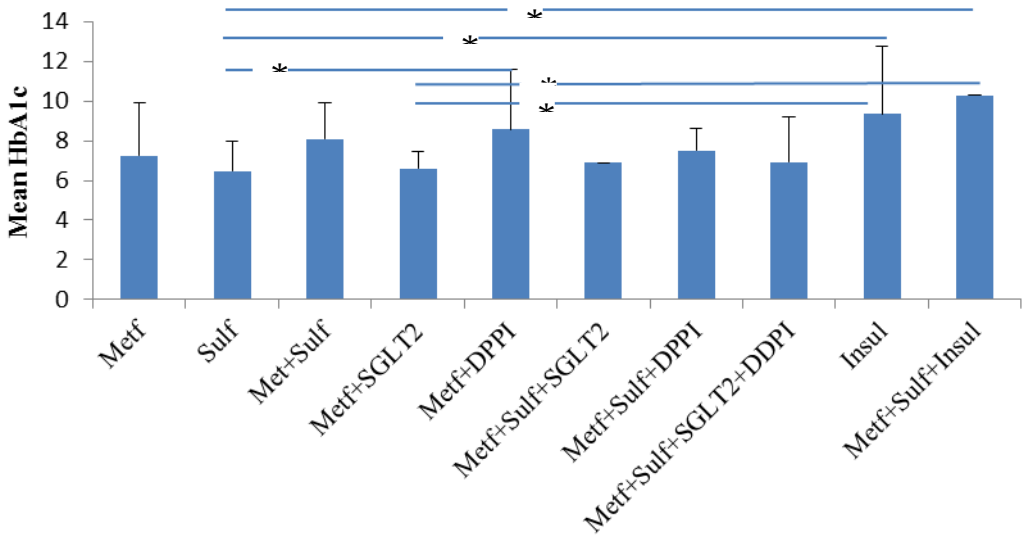

Figure 2: Mean levels of glycosylated hemoglobin (HbA1c) in the study population according to treatment regimens (N = 515). * P<0.05

The percentage of patients who achieved glycemic control (HbA1c <7%) % was also compared among the different groups of treatment. All patients in Sulf group as well as in Metf+Sulf+SGLT2 group had (HbA1c <7%). About 67% of patients in Metf+DPP4I group had HbA1c <7% followed by 50% in Metf+SGLT2I group. Fewer percentages were shown in the other treatment groups. No patients achieved HbA1c <7% in Metf+Sulf+Insul group. The significance of differences between the different treatments regimens are presented in table 4.

Table 4: Difference in percentage of patients who achieved glycemic control (HbA1c <7%) among treatment regimens.

Treatment regimen (N)	Percentage of patients who achieved HbA1c <7%, N (%)	P value
Metf (55)	15 (27.3)[c]	**0.014**
Sulf (10)	10 (100.0)[a]	
Met+Sulf (275)	45 (27.3)[c]	
Metf+SGLT2 (10)	5 (50.0)[d]	
Metf+DPPI (30)	20 (66.7)[b]	
Metf+Sulf+SGLT2 (5)	5 (100.0)[a]	
Metf+Sulf+DPPI (55)	25 (45.5)[d]	
Metf+Sulf+SGLT2+DDPI (15)	5 (33.3)[e]	
Insul (55)	5 (9.1)[f]	
Metf+Sulf+Insul (5)	0 (0.0)[g]	

Percentages with different letter (a-g) are significantly different (P<0.05)

The relationship between DTSQ score and socio-demographic and clinical characteristics of the study population

The mean value of DTSQ score were compared according to socio-demographic and clinical parameters of study population presented in table 5. No significant difference was observed in DTSQ score according to age categories, sex, BMI, educational level, or marital status. Similarly, no significant difference in DTSQ scores was observed between smokers and non-smokers. Once more, no difference was found in DTSQ score according to duration of diabetes, presence of family history or comorbidities. However, DTSQ scores were significantly different according to the type of diabetes complications (P=0.038); the mean score of DTSQ was the lowest in patients with diabetic foot ulcer compared to patients with neuropathy, nephropathy, and retinopathy.

DTSQ score was not associated with higher adherence to following recommended meal plane. However, when we investigated the relationship between DTSQ score and adherence to physical activity, we found that patients with higher adherence to doing exercise more than three times weekly had the highest DTSQ score compared to patients who exercise 3 times weekly or those who do not practice any physical activity (P=0.017).

When comparing DTSQ among all types of treatment, a significant difference was observed in mean DTSQ scores among patients taking the different regimens of antidiabetic treatment (*P*=0.023). Best DTSQ score was observed in patients treated with sulfonylurea (21.28±5.77) followed by that observed in patient treated with Metf +SGLT2I (20.77±5.27), While the lowest DTSQ score was found in patients receiving insulin-containing regimens.

In addition to the cut off value of HbA1c = 7%, the patients were further subdivided, according to the HbA1c cutoff values suggested by American Diabetes Association (ADA), into excellent controlled glycaemia (HbA1c: 4.5-6.5, 19.2%), good controlled glycaemia (HbA1c: 6.5-7, 14.4%), acceptable controlled glycaemia (HbA1c: 7.1-8, 31.7%) and poor controlled glycaemia (HbA1c >8, 34.6%).

Interestingly, the strongest association was found between DTSQ score and HbA1c levels, DTSQ scores were significantly lower (P<0.01) in patients with higher HbA1c values (>7 %), and the mean score of DTSQ decreased with the increase of the levels of HbA1c, in other words, with the deterioration of glycemic control.

Table 5: Comparison of DTSQ total scores among subgroups of socio-demographic and clinical parameters.

Variable	categories	N (%)	DTSQ score	P value
Age (year)	24-35	32 (6.21 %)	20.31±5.36	0.933
	36-45	92 (17.86%)	19.18±9.28	
	46-55	184 (35.73%)	20.28±3.17	
	56-65	176 (34.17%))	19. 84±4.17	
	>65	31 (6.02%)	19.38±8.38	
Gender	Male	223 (43.3)	20.35±5.39	0.236
	Female	292 (56.7)	19.85±7.33	
BMI (kg\m^2)	<18.5	5 (1)	20.27±5.27	0.519
	18.5-24.9	119 (23.1)	20.78±4.97	
	25-29.9	277 (53.8)	19.69±5.96	
	>30	114 (22.1)	19.28±6.34	
Educational level	Uneducated	70 (13.5)	19.29±6.26	0.632
	Primary school	99 (19.2)	19.48±7.28	
	Middle school	89 (17.3)	20.18±5.18	

	High school	84 (16.3)	19. 94±5.27	
	University	173 (33.6)	19.38±7.38	
Marital status	Single	25 (4.8)	18.99±6.26	0.365
	Married	436 (84.6)	19.58±5.27	
	Divorced	5 (1)	19.38±5.15	
	Widow\Widower	49 (9.6)	20. 14±3.28	
Family history	First degree relatives	351 (68.3)	18.99±6.26	0.514
	Second degree relatives	30 (5.8)	19.48±5.37	
	No family history	134 (26.0)	19.38±5.15	
Smoking	Yes	203 (39.4)	18.99±6.16	0.903
	No	312 (60.6)	19.18±5.47	
Diet adherence	Very good	99 (19.2)	19.28±5.26	0.832
	good	94 (18.3)	19.48±4.37	
	Not good	74 (14.4)	19.19±6.26	
	Not on a diet	248 (48.1)	19.38±5.37	
Physical activity	More than 3 times weekly	228 (44.2)	20.97±5.27	**0.017**
	Less than 3 times weekly	139 (26.9)	19.28±4.77	
	Don't do any physical activity	148 (28.8)	18.19±4.66	
The duration of diabetes (year)	7 ± 2.5>	263 (51)	19.79±6.28	0.723
	>7 ± 2.5	252 (49)	20.28±5.27	
Diabetic complications	Retinopathy	247 (48)	19.27±5.25	**0.038**
	Neuropathy	233 (45.2)	20.58±4.87	
	Nephropathy	25 (4.8)	20.89±5.93	
	Diabetic foot	10 (1.9)	18.28±6.34	
Comorbidities	Hypertension	368 (71.4)	19.38±4.47	0.737
	Dyslipidaemia	219 (42.5)	19.18±6.36	
	Others	59 (11.5)	19.28±5.35	
Treatment regimens	Metf	55 (10.7)	18.57±3.27	**0.023**
	Sulf	10 (1.9)	21.28±5.77	
	Met+Sulf	275 (53.4)	18.19±4.66	
	Metf+SGLT2I	10 (1.9)	20.77±5.27	
	Metf+DPP4I	30 (5.8)	18.18±3.67	
	Metf+Sulf+SGLT2I	5 (1.0)	20.10±4.66	
	Metf+Sulf+DPP4I	55 (10.75)	18.17±3.28	
	Metf+Sulf+SGLT2I+DDP4I	15 (2.9)	19.28±4.77	
	Insul	55 (10.7)	17.89±3.66	
	Metf+Sulf+Insul	5 (1.0)	17.37±3.22	
HbA1c	< 7%	174 (33.7)	21.45±5.82	**<0.01**
	> 7%	341 (66.3)	18.33±4.27	
HbA1c	4.5-6.5%	99 (19.2)	21.55±5.72	**<0.01**
	6.5-7%	75 (14.5)	20.43±4.77	
	7.1-8%	163 (31.7)	19.25±3.92	
	8%<	178 (34.6)	18.13±3.87	

DISCUSSION

The outcome of diabetes treatments should not be evaluated only by HbA1c levels. Treatment satisfaction is now widely recommended as an important indicator for treatment compliance; and it is suggested that improving treatment satisfaction is likely to improve health status[10,19] and treatment efficacy in patients with diabetes.[20,21] To the best of our knowledge, this is the first study in Syria which evaluated the efficacy of medical antidiabetic therapy and treatment satisfaction among patients with T2DM in relation to treatment regimens and different socio-demographic and clinical characteristics.

As recommended,[22] HbA1c values <7% were assessed for comparing the efficacy among the different regimens of treatment. Our results showed that the best glycemic control (lower HbA1c mean values) was achieved with sulfonylurea, followed by metformin combined with SGLT2I. However, the combination of metformin with sulfonylurea and SGLT2I with or without DPP4I also achieved a good glycemic control (HbA1c <7%). Surprisingly, the dual treatment with Metf+sulf was the most common regimens in our study although it did not achieve the targeted glycemic control. We don't have a clear explanation for the lack of efficacy of this regimen which could be affected by various factors related to the patients or to the disease itself. Despite that, this regimen

is still the most prescribed in our population. This could be contributed to the fact that metformin and sulfonylurea agents are the most available antidiabetic medicines in the center where the study was performed, and they are provided to patients free of charge. Furthermore; it is likely because other drug classes are costlier and recently commercialized.

Many previous studies have compared the efficacy of antidiabetic drugs but with different study design from ours. Contrary to our results, in the study of Hayashi et al, HbA1c levels were significantly higher in patients using Sulfonylurea than those not using them.[23] The difference in the used sulfonylurea agent, the used doses and duration of treatment could explain this disagreement. Schweizer et al. observed a significant reduction in HbA1c in geriatric patients with vildagliptin (a DPP4I) as add-on therapy to metformin.[24] In the study of Singh et al., they compared HbA1c values between two groups of T2DM, receiving or no DPP4 inhibitors that were mainly prescribed in combination with other antidiabetic drugs (mainly metformin), they observed better glycemic control (low HbA1c levels) among patients taking DPP4 inhibitor-containing regimens as compared to other patients.[25] Kim et al. and Kadowaki et al. assessed the efficacy of teneligliptin (a DPP4I) in combination with metformin[26] and glimepiride[27] in patients who were inadequately controlled with metformin and glimepiride monotherapy. They found a significant improvement in HbA1c with addition of teneligliptin. In addition, our finding demonstrated that patients on an insulin-containing regimen had higher HbA1c scores than those without insulin; this finding is in line with a general understanding that patients with severe disease need more medical attention than those with mild disease. That is, based on the literature as well as customary clinical practice, oral hypoglycemics and insulin are generally added as a result of worsening metabolic control. So, it is expected that a strong association would exist between required intensity of therapy and HbA1c level. Such an association has been demonstrated previously for oral agents and insulin in general.[4,28,29]

Concerning the proportion of patients with HbA1c < 7%, we found that all patients in sulfonylurea group as well as in Metf+Sulf+SGLT2 group had HbA1c <7%. However, the small numbers of patients in these groups make any conclusion drawn on the basis of this will not be highly meaningful and need more verification. All the percentages of patients with HbA1c < 7% observed in other group of treatment were lower than 70%, and no patient had HbA1c <7% in Insul+Metf+Sulf group pointing to the inefficacy of this regimen. In the study of Singh et al., they also assessed the proportions of patients meeting the recommended goal of antidiabetic treatment (HbA1c < 7%) as a marker of treatment efficacy. They found that significantly higher percentage of patients taking DPP4 inhibitor-based regimens had achieved HbA1c target of <7% as compared to the other group not taking DPP4 inhibitors. However, most patients in the two groups received a co-treatment with metformin.[25]

DTSQ scores were used to evaluate patient satisfaction with the treatment pattern that they received. The mean value of DTSQ score in our population was about 19.38 (±6.38) out of 36, pointing to a dissatisfaction with the applied treatment and its convenience. Previous studies also found low treatment satisfaction in patients with T2DM diabetes.[30,31] This finding indicates that most patients with diabetes may have insufficient quality of care. Furthermore, the DTSQ score in the current study is much lower than those seen in other earlier studies. A study conducted in Egypt showed that most of the patients (60%) were satisfied.[32] But in this study different measuring tool was used **(**Patient Satisfaction Questionnaire (PSQ-18)). In addition, the difference in healthcare services might be another cause of the discrepancy. Similarly, a good satisfaction was observed in the study conducted by Boels et al., but this study included European population, which may have different circumstances concerning their management and medical conditions, as the developed nations could have varying healthcare settings and management options.[33]

Patients having lower score of satisfaction with their treatment were found to have higher perceived hyperglycaemia frequency. This finding is consistent with previous studies.[10, 33, 34] It is highly acceptable that frequent hyperglycaemia can accelerate the progression of patients' disease and diabetes-associated complications and cause deterioration of patient's quality of care. Therefore, maintaining blood glucose levels at the glycemic target can delay diabetes progression, which keeps the quality of care and thereby patients' treatment satisfaction at an optimum level.

One of the main finding of our study was that the use of Sulf and MET+SGLT2I, was associated with the better treatment satisfaction comparing to others regimens of treatment. This satisfaction was independent of perceived frequency of hypoglycemia but inversely correlated with perceived frequency of hyperglycemia.

Globally, there is controversy on whether treatment of T2DM with OGLAs correlates positively or negatively with treatment satisfaction.[35,36]

In the study of Hayashi et al, the treatment satisfaction scores were lower in patients with use of sulfonylurea than in those without it. However, they explained that no such negative association was observed after adjustment for HbA1c values. Thus, they proposed that negative association between sulfonylurea and treatment satisfaction is probably mainly due to the differences in HbA1c among patients treated with and without sulfonylurea. In the same study, they demonstrated that SGLT2I, but not other OGLAs, was associated with significant treatment satisfaction independent of perceived frequency of hyperglycemia or

hypoglycemia.[23] Singh, et al. observed higher treatment satisfaction as indicated by significantly higher DTSQ scores among patients taking DPP4 inhibitor-based regimens as compared to other patients taking other regimens.[25]

In an attempt to determine factors that could affect patient satisfaction with antidiabetic treatment, we evaluated the relationship between DTSQ and HbA1c level. Our Findings indicated that DTSQ score was negatively associated with HbA1c values: the better the satisfaction to the medical regimen, the lower the patient's HbA1c values. This finding indicates that the DTSQ could be informative to some extent regarding HbA1c levels as a glyco-metabolic parameter. Moreover, this finding has also an important clinical impact for the patients concerning the associated reduction in risks of diabetes complications, as a previous study suggested that a one-percentage point reduction in HbA1c (eg, from 9.0% to 8.0%) results in a 35% reduction in complications of T2DM.[37]

A possible explanation for the demonstrated association is that, clearly, more satisfaction with applied pharmacologic management of T2DM will lead to more adherences to such therapy which in turn should generally lead to better glycemic control, showed by lower HbA1c levels. Another possible alternative or contributory explanation for the invers association between treatment satisfaction and glycemic control is that higher treatment satisfaction may be a marker for better diabetes self-management practices with respect to diet, exercise, and blood glucose monitoring. Our study confirms the findings of earlier reports. Singh et al., also found significantly better DTSQ scores among patients having lower HbA1c levels as compared to those having higher HbA1c levels.[25] Similarly in the study of Ozmen et al., findings indicated that each of the metabolic control indicators HbA1c as well as fast blood glucose (FBG) could independently explain the variation in the treatment satisfaction score.[38] Furthermore, the study of Kontodimopoulos et al. indicated that higher HbA1c levels were also linked to lower treatment satisfaction and were also significant predictors of satisfaction, as well as hyper- and hypoglycemia.[21]

In any case, there is disagreement in the literature on the association of this parameter and patient satisfaction as some studies have not demonstrated the existence of such relationship.[39,40] For exemple, Yoshifumi Saisho et al. did not observe any significant correlation between HbA1c level and total DTSQ score.[41] Furthermore, no or only modest associations between HbA1c levels and DTSQ score have also been reported in other studies.[42, 43] This indicates that treatment satisfaction is not only related to glycemic control and could be influenced by different factors.

When the relationship between the DTSQ score and socio-demographic and clinical parameters were examined, there was a weak negative correlation between treatment satisfaction and diabetic complications, lower levels of satisfaction were observed in patients with diabetic foot. Although the number of patients with foot ulcers was quite small (N = 10), the DTSQ reduction was sufficiently large to provide statistical power for comparisons.

These findings are consistent with the results of numerous previous studies having reported a negative effect of the presence of any diabetic complications on patient satisfaction.[10,11,38,44] For example, in the study of Alcubierre et al., lower levels of satisfaction were observed in patients with diabetic retinopathy.[7] This finding may implicate that patients with diabetic complication might have less quality of care. Diabetic complications could greatly affect patients' social, psychological and environmental conditions and induce changes in their lifestyle. These physical, environmental, social and psychological issues result in less treatment satisfaction. In addition, patients with complications may have a bad glycemic control which results in poor quality of life which, in turn, result in poor treatment satisfaction. However, and in line with previous study,[21] no association between comorbidities and treatment satisfaction was found in our study. A possible explanation is that the most common comorbid conditions were hyperlipidemia and hypertension, which are "silent" diseases. In contrast, previous evidence reported that patients having higher number of comorbidities had a lower degree of satisfaction. They postulated that the presence of comorbidities results in multiple burdens on patients' health conditions and negatively affect care quality and in consequence treatment satisfaction.[10,36,44]

Furthermore, in accordance with results reported elsewhere, our results showed that age,[41] gender, disease duration and BMI (obesity) were apparently not related to treatment satisfaction.[21] However, in the study of Redekop et al., they found that individuals of young ages were less satisfied.[11] Furthermore, although some studies could not find gender effects on DTSQ,[38, 45] most studies have indicated lower satisfaction among women compared to men.[10, 40, 46] It is not surprising as that, women are more emotional and easier to be depressed or anxious and thereby less satisfied with their treatment.

Similarly, contradicting results were published for the relationship of duration of diabetes and treatment satisfaction in the literature. While some papers reported positive relationships between treatment satisfaction and duration of diabetes,[46, 47] some others did not.[40]

The role of obesity in treatment satisfaction is not clear and some studies have confirmed it as a disadvantage,[11,46] whereas other have not.[40, 45] In our study, BMI was a non-relevant factor for treatment satisfaction. It is worth mentioning that the mean BMI in

the sample was 27.90 ± 5.019 Kgr/m^2, which is relatively high but not unusual in this type of population.

When the associations between the DTSQ score and other clinical parameters were examined, there was no association between the total score of DTSQ and smoking, familial history, education level, or adherence to diet. However, Biderman et al demonstrated that low satisfaction with treatment was reported among individuals with low educational level.[44] Furthermore, different from our results, in previous studies adherence to diet therapy was correlated with better satisfaction.[10, 44, 47] It is of note that, patients who reported having better adherence to lifestyle modification concerning the regular physical activity, showed higher scores in DTSQ. This suggests that patients with higher treatment satisfaction also experience higher and more effective self-care, resulting in better adherence to therapy and thereby better glycemic control and treatment satisfaction. This result was also observed in previous studies.[10, 44, 47] Thus, it could be recommended that patients comply with lifestyle modifications especially physical exercise.

LIMITATIONS

This study has some limitations. First is that samples size was not homogenous and relatively small in some groups of treatment regimens especially Sulfonylurea and SGLT2 inhibitor-based therapies, so this requires caution when generalized the results and require further validation. Second, treatment satisfaction is a subjective parameter that is measured based on patients' self-reported measurements and may vary with many factors. Therefore, one might claim that this may have weakened the quality of completion, as patients tend to give socially desirable responses, so scores may be overestimated or underestimated. However, the Arabic version of DTSQ was previously proved to be a reasonable choice for measuring diabetes treatment satisfaction.[17] Finally, due to the cross-sectional design of the study, we cannot establish a causal relationship between treatment satisfaction and analyzed parameters.

CONCLUSION

This study concluded that most patients with diabetes had a lower degree of satisfaction with the current treatment. Treatment satisfaction was lower in patients with frequent hyperglycemia and patients with diabetic complications.

DTSQ can serve as a tool to measure outcomes in diabetes treatment and to explore the association between treatment satisfaction and glycemic control. This can help healthcare professionals in identifying patients with low treatment satisfaction and those who are at higher risk for poor compliance with treatment and need more interventions to promote glycemic control.

We propose that treatment satisfaction is a crucial component that would be evaluated as a standard part of diabetes management in a wide range of clinical settings of the country, and should be taken into account in clinical practice when treating patients with type 2 diabetes mellitus for improvement of DM management and achieving optimal clinical effectiveness.

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