Non-compliance on DM Treatment Among Diabetic Patients in Arar City, Northern Saudi Arabia

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ABSTRACT

Background: Various methods have been utilized to evaluate and test patient adherence to medications and there is no "gold standard" measure of adherence to medicines. **Objectives**: To investigate the extent of non-compliance to diabetes treatment and its contributing factors among diabetic patients attending the Diabetes Center at Arar city, Northern Saudi Arabia. **Methods**: A cross-sectional study was carried out among the target population. Patients already diagnosed to have type 2 DM for at least one-year duration and who were on antidiabetic medication for more than 6 months, aged at least 18 years, attending the diabetic center during the study period, and giving written informed consent to contribute in the study. The collection of data was via personal interviews with diabetic patients. The instrument of data assortment was a structured questionnaire that consists of three sections: section 1 for the Socio-demographic features of the patients as age, sex, marital state, and occupation; section 2 contained questions that assess the adherence patterns by eight-item Morisky Medication Adherence Scale (MMAS-8). **Results**: According to MMAS scores of DM treatment adherence, the majority (79.8%) of the respondents were poorly adherent, 14.6% were mediumly adherent, and only 5.6% were highly adherent. Significant factors affecting the poor adherence to DM medication were gender, glycosylated hemoglobin level, believing the medication is ineffective, suffering from side effects of the medication, and using alternative medicine ($P<0.05$). There was a statistically insignificant factor as, educational level, suffering DM complications, period of DM, route of drug administration, receiving DM health education in the last 6 months, understanding the drug regimens, and affordability of the prescribed drugs. **Conclusion:** In the current study in Arar, Saudi Arabia, the majority of the diabetic patients were poorly adherent to DM treatment.

Key Words: *diabetic patients, adherence to DM treatment, MMAS scores of DM treatment adherence, Arar, Saudi Arabia.*

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INTRODUCTION

WHO describes diabetes mellitus (DM) as a chronic disease, which happens when the pancreas does not secrete sufficient insulin, or when the body cannot use the insulin produced efficiently [1]. This leads to an increased accumulation of glucose in the plasma. [2, 3]

Type 1 diabetes occurs when the pancreas fails to secrete sufficient insulin owing to damage of beta cells, this type was formerly stated as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes" [4]. Type 2 diabetes instigates with insulin opposition, a disorder in which body cells cannot retort to insulin appropriately [2, 5]. As the disease progresses, a deficiency of insulin could also occur. This type was formerly mentioned to as "non-insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes", the utmost common reason is a mixture of increased body weight and deficient muscular workout [6]. Gestational diabetes occurs when pregnant women without a previous history of diabetes develop high blood sugar levels [2].

The prevalence of DM is rising speedily internationally and is getting epidemic extents. It is assessed that there are presently 285 million persons with diabetes internationally and this figure is established to rise to 438 billion by 2030 [7].

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Adherence to the treatment inflicts significant therapeutic and financial inferences in diabetics. Drug adherence is well-defined as the degree to which the patient administers the medicines approved by his/her physician [8].

Treatment compliance is well-defined as the degree to which an individual's medication use performance agrees with therapeutic advice and persistence as the duration of time from beginning to termination of therapy [9].

Despite the widespread treatment options existing for different phases of type 2 diabetes, researches have shown that fewer than 50% of patients accomplish the glycemic goals suggested by the American Diabetes Association (ADA) and nearly two-thirds die early of cardiovascular illness and complications [10].

Even though figures reported by a study in the USA showed a rise in the number of cases with identified diabetes who accomplished glycemic, cardiovascular and fat regulation from 7.0% to 12.2% throughout the period of 1999 to 2006, and adherence was quite low, with a significant level of improvement [11].

Non- adherence may be primary non-adherence or non-compliance during treatment. Primary non- adherence refers to those patients who receive prescription but fail to obtain medications from the beginning, its incidence has been reported to be 31% [12].

A WHO report has shown that in developed countries, the rate of non-compliance in patients with chronic diseases like DM is about 50% and it could be even higher in developing countries [13].

Various factors influence non-compliance which may be patient-centered, therapy-related, health care system-related, societal, and financial issues or disease factors [14].

Patient-centered factors include sociodemographic factors (age, sex, and level of learning), psychosomatic factors comprising incentive to treatment compelling, patient-physician rapport, and patient information [15]. Therapy-related influences include route, form, and period of usage, difficulty of treatment particularly as patients may be on many prescriptions, price of prescription particularly if co-payment is an issue, and adverse effects. Healthcare system factors include presence and ease of access to health care, and the health provider-patient interactions [16].

Guidelines from the ADA and the European Association for the Study of Diabetes (EASD) stress the importance of diet and exercise in the treatment of all phases of type 2 diabetes [17].

However, with reverence to muscular exercise, diabetes counselors take into consideration that, lack of interest as well as somatic diseases to be the main obstacles to adherence, although patients stated obstacles to adherence are mostly related to convenience, comprising factors such as the climate; however, only near a quarter of the patients stated that they follow exercise plan [18].

Objective

The study aimed to investigate the extent of non-compliance to diabetes treatment and its precipitating factors among diabetic patients attending the Diabetes Center at Arar city, Northern area of Saudi Arabia.

METHODOLOGY

Studied population & locality

Patients already diagnosed to have type 2 DM for at least one year of duration and on treatment for at least 6 months, attending diabetes center at Arar city, Northern area of Saudi Arabia, were included in the study.

Study design

A descriptive cross-sectional study was conducted on the target population.

Inclusion criteria

The study included patients who were on antidiabetic medication for more than 6 months, aged at least 18 years, attending the diabetic center during the study period, and consented to be included in the study.

The study was conducted throughout the period from May 1, 2020 to August 31, 2020.

Exclusion criteria: Patients recently identified with diabetes (fewer than 6 months), age of less than 18 years, and unconscious and very ill patients.

Sample size

- According to the equation: $N=z^2 p (1- p) / d^2$.
- Where n=the desired sample size
- Z=the standard normal deviation (1.96).
- P= the prevalence of the problem.
- d =the degree of accuracy required (0.05).

Throughout the period from 1st of May, 2020 till the end of August, 2020. In our study, the desired sample was 400 patients.

Sampling Technique

The cases were selected using a systematic random sampling technique. First, one case was chosen randomly from the attendees of the center. Second, every 2nd case will be included until the end of the sample (400 cases).

Study tool

The collection of data was via personal interviews with diabetic patients. The instrument of data assortment was a structured questionnaire that consisted of three sections: section 1 for the Socio-demographic features of the patients as age, sex, marital state, and occupation; section 2 contained questions that assess the adherence patterns by eight-item Morisky Medication Adherence Scale (MMAS-8) [19]. A score of 8 indicates high adherence, a score of 6-7 indicates medium adherence, while a score of less than

6 indicates poor adherence, and section 3 included health education attendance, route of medication administration, patients self-rating of the extent of understanding of their medication regimens, antagonistic drug reactions, patients' ability to afford the recommended medicines, period of diabetes, and usage of alternative drugs.

Ethical considerations

Agreement to conduct the study was attained from the Research Ethics Committee of the Northern Border University. Data was anonymous for patient confidentiality and the questionnaires were kept safely.

Data management and Statistical analysis

The collected data was entered and analyzed using the Statistical Package for the Social Science (SPSS Inc. Chicago, IL, USA) version 23. Descriptive statistics will be performed. Percentages were given for qualitative variables. The determining factors were measured by means of the Chi-square test. P-value was considered significant if $P < 0.05$.

RESULTS

Table 1: Shows the socio-demographic features of the participants. 59.5% of the respondents were females, 42.4% were between 19 to 40 years old. Only 15.3% were elderly. 40.8% had a normal BMI. More than half (62.3%) of the respondents were married. Most of the respondents lived in urban areas (90.7%), and 53.0% had a university degree. 73.8% were nonsmokers. Regarding DM complications, 19.3% suffered from heart disease, and 12.1% reported eye complications.

Table 2: Shows MMAS scores and factors affecting DM adherence in the respondents. According to MMAS scores of DM treatment adherence, the majority (79.8%) of the respondents were poorly adherent, 14.6% were mediumly adherent and only 5.6% were highly adherent. The period of DM was between 2 and 10 years in more than half (53.3%) of the respondents. Glycosylated hemoglobin was good (less than 7%) in 57.9% of the respondents. Half of the respondents were previously admitted to the hospital due to DM cause. 68.8% only received one health education or none about DM in the last 6 months. 27.4% suffered from untoward effects of the medication, 44.9% thought it is unaffordable, and 18.7% believed it is ineffective.

According to MMAS scores of DM treatment adherence, the majority (79.8%) of the respondents were poorly adherent, 14.6% were mediumly adherent, and only 5.6% were highly adherent. Table 3 illustrates the relation between poor adherence to DM medication and factors affecting it. There was a statistically significant relation with gender, glycosylated hemoglobin, admission to the hospital because of DM cause, believing that medication is ineffective, suffering from untoward effects of the medication, and using alternative medicines. There was a statistically insignificant relation with the academic level, suffering DM complications, period of DM, route of drug administration, receiving DM health education in the last 6 months, understanding the drug regimens, and affordability of the prescribed drugs.

Table 1. Socio-demographic characteristics of the participants, 2020 (N=321).

Variables	Frequency (N=321)	Percent (%)
Sex		
Male	130	40.5
Female	191	59.5
Age group		
18 years or younger	21	6.5
19 – 40 years	136	42.4
41 – 60 years	115	35.8
61 years or older	49	15.3
BMI group		
Low	11	3.4
Normal	131	40.8
Overweight	81	25.2
Obese	98	30.5
Marital status		
Single	83	25.9
Married	200	62.3
Divorced	11	3.4
Widowed	27	8.4
Residence		
Urban area	291	90.7

Rural area	30	9.3
Educational level		
Introductory	37	11.5
Secondary	76	23.7
University degree	170	53.0
Illiterate	38	11.8
Employment		
Employed	140	43.6
Non-employed	117	36.4
Student	64	19.9
Residence		
Urban area	291	90.7
Rural area	30	9.3
Smoking status		
Smoker	75	23.4
Heavy smoker (25 cigarettes or more	9	2.8
Non-smoker	237	73.8
Alcoholism		
Yes	10	3.1
No	311	96.9
Complications		
Heart disease	62	19.3
Eye complications	39	12.1
Renal disease	11	3.4
Limb paralysis	5	1.6
Others	19	5.9

Table 2. MMAS score and factors affecting DM adherence in the participants, 2020. (N=321)

Variables	Frequency (N=321)	Percent (%)
MMAS score		
High adherence	18	5.6
Medium adherence	47	14.6
Poor adherence	256	79.8
Period of DM		
Less than 2 years	90	28.0
2 – 10 years	171	53.3
More than 10 years	60	18.7
Glycosylated hemoglobin		
Good (less than 7%)	186	57.9
Bad (higher than 7%)	135	42.1
Blood glucose monitoring at home		
Yes	270	84.1
No	51	15.9
Route of drug administration		
Oral pills	160	49.8
Injection	139	43.3
Both	22	6.9
Admission to the hospital because of DM		
Yes	162	50.5
No	159	49.5
Health educations about DM in the last 6 months		
Two or more	100	31.2
1 or less	221	68.8

Understanding the drug regimens		
Yes	273	85.0
No	48	15.0
Believing the medication is ineffective		
Yes	60	18.7
No	261	81.3
Suffering from side effects of the medication		
Yes	88	27.4
No	233	72.6
Affordability of the prescribed drugs		
Yes	177	55.1
No	144	44.9
Using alternative medicine		
Yes	101	31.5
No	220	68.5

Table 3. Relation between poor adherence to DM medication and factors affecting it.

		Adherence		Total (N=321)	P-value
		Poor (N=256)	High or medium (N=65)		
Gender	Male	97	33	130	0.041
		37.9%	50.8%	40.5%	
	Female	159	32	191	
		62.1%	49.2%	59.5%	
Academic level	Introductory	31	6	37	0.774
		12.1%	9.2%	11.5%	
	Secondary	60	16	76	
		23.4%	24.6%	23.7%	
	University degree	133	37	170	
		52.0%	56.9%	53.0%	
	Illiterate	32	6	38	
		12.5%	9.2%	11.8%	
Glycosylated hemoglobin	Good (less than 7%)	158	28	186	0.005
		61.7%	43.1%	57.9%	
	Bad (higher than 7%)	98	37	135	
		38.3%	56.9%	42.1%	
Suffering from DM complications	Yes	110	26	136	0.387
		43.0%	40.0%	42.4%	
	No	146	39	185	
		57.0%	60.0%	57.6%	
Period of DM	Less than 2 years	73	17	90	0.609
		28.5%	26.2%	28.0%	
	2 – 10 years	133	38	171	
		52.0%	58.5%	53.3%	
	More than 10 years	50	10	60	
		19.5%	15.4%	18.7%	
Route of drug administration	Oral pills	125	35	160	0.769
		48.8%	53.8%	49.8%	
	Injection	113	26	139	
		44.1%	40.0%	43.3%	
	Both	18	4	22	
		7.0%	6.2%	6.9%	
Admission to the hospital because of DM	Yes	121	41	162	0.016
		47.3%	63.1%	50.5%	
	No	135	24	159	
		52.7%	36.9%	49.5%	
Receiving DM health education in the last 6 months	Yes	82	18	100	0.303
		32.0%	27.7%	31.2%	
	No	174	47	221	
		68.0%	72.3%	68.8%	
Understanding the drug regimens	Yes	221	52	273	0.140
		86.3%	80.0%	85.0%	
	No	35	13	48	

		13.7%	20.0%	15.0%	
Believing the medication is ineffective	Yes	38	22	60	0.001
		14.8%	33.8%	18.7%	
	No	218	43	261	
		85.2%	66.2%	81.3%	
Suffering from side effects of the medication	Yes	61	27	88	0.004
		23.8%	41.5%	27.4%	
	No	195	38	233	
		76.2%	58.5%	72.6%	
Affordability of the prescribed drugs	Yes	140	37	177	0.428
		54.7%	56.9%	55.1%	
	No	116	28	144	
		45.3%	43.1%	44.9%	
Using alternative medicine	Yes	73	28	101	0.019
		28.5%	43.1%	31.5%	
	No	183	37	220	
		71.5%	56.9%	68.5%	

DISCUSSION

Several variables influence glycemic regulation in patients with diabetes, who are proven to increase adherence to DM drugs, and medication effectiveness is reduced by lack of adherence [20]. Various methods have been used to evaluate and test patient adherence to medications and there is no "gold standard" measure of adherence to medicines. Morisky et al. recently created an 8-item self-reported scale called the Morisky Medication Adherence Scale (MMAS) [21].

Our study was conducted to investigate the extent of non-compliance to diabetes treatment and its precipitating factors among diabetic patients attending the diabetes center at Arar city, Northern area of Saudi Arabia. We found that 5.6% of our participants scored high adherence (n= 18), 14.6% scored medium adherence (n= 47) and 79.8% scored poor adherence (n= 256). A similar study in the KSA found high (MMAS = 8) levels of OHA adherence in 40% (n = 158), moderate (6≤ MMAS <8) levels in 37% (n = 145) and low (MMAS <6) adherence in 23% (n = 92) [22]. Another study reported that (58%) were reflected highly adherent (MMAS = 0), (39.5%) were medially adherent (MMAS = 1–2), and nine (2.5%) had low adherence (MMAS ≥ 3) [23]. According to the findings of Elsous et al., it was revealed that 279 (84.5%) were adherent while 51 (15.5%) were non-adherent [24].

Another study reported that the percentages of cases with low, medium, and high adherence to their prescribed medicines were 24.9 %, 37.9 %, and 37.2 %, respectively [25]. This was on the line with results of another study reported that 64.6 % of the studied cases were found not adherent (MMAS-8© adherence score < 6), 26.5 % and 9.0 % had low adherence (MMAS-8© adherence score < 6) and medium adherence (MMAS-8© adherence scores of 6 to 7) to the prescribed drugs, respectively [26]. This agreed with the results of a previously reported study that the percentage of cases that lowly adherent to their medicine (MMAS-8 ≤ 6) was 32.2% [27]. Another Malaysian study reported the mean ± SD of MMAS scores was 6.13 ± 1.72 [28].

Educational websites have been set up to increase health awareness in which patients may discuss any concerns that may prevent adherence to medications.

According to our results, we found a statistically significant relation between gender and medication adherence (males had higher adherence). The level of education was not associated with medication adherence. A previous study revealed that younger age and lower education were the two independent factors that were significantly related to non-adherence to medication. The same study reported that gender, education, marital status, income, BMI, diabetes duration, completion of the diabetes education program, and enrollment in the home blood glucose monitoring were not statistically significant predictors of medication adherence [22].

In another study, the participants aged ≥70 years were 79% more adherent than those below 50 years (P= 0.016). Respondents who graduated from senior high schools were 3.7 times less adherent to their medications than those who graduated from tertiary schools [24]. This agreed with the study results reported that respondents having low adherence to their medicines, 55.8 % had a lower degree of knowledge about diabetes, 63.6 % had deprived self-care activities and 16.9 % had a lower level of glycemic control [25]. In a cohort of patients, the strongest independent predictor of adherence was the patient's education level [26]. In another study, the MMAS-8 score had a negative weak correlation with the level of HbA1c [27].

According to our study results, unlike expected, good glycemic control was associated with poor medication adherence (less than 7%) and bad (higher than 7%) was associated with high medication control. This may be explained by the severity of diabetes in poorly adherent patients was less than in high adherence patients.

Unlike our results, many previous studies reported that the enhancement and improvement of patients' adherence may lead to the improvement of their diabetes control. Another

study reported that in cases with a medium degree of adherence to drugs, 17.9 % were found to have medium degree of knowledge on diabetes, 41.9 % had poor self-care performances and in 21.4 % the glycemic control was bad and those respondents who had a high level of adherence to medications, 35.7 % had a high level of diabetes knowledge, 53.9 % had sufficient self-care performances, and 54.8 % of the glycemic control was good [25]. Al Mazroui reported a significant decrease in HbA1c level among diabetics getting a rigorous health educational program along a period of 12 months, of HbA1c 8.5 % (8.3, 8.7) vs. 6.9 % (6.7, 7.1) [29]. Reed showed the essential role of chronic diabetes clinics in the UAE in optimizing diabetes outcomes as measured by HbA1c levels and blood pressure. However, none of the earlier 'UAE-based' research was intended to research opioid adherence standards among diabetics [30].

In another local hospital-based sample of diabetes patients participating in a pharmacist-controlled treatment program, the median compliance rate and the average glycemic control were 41.3% and 7.4%, respectively. [31]. In another research, glycemic regulation represented by HbA1c was shown to be substantially linked to MMAS scores in which lower HbA1c (better glycemic regulation) was correlated with higher adherence scores in the sample group. A strong correlation was found between the 8-item MMAS scores and the diabetic regulation represented by HbA1c, with a sensitivity and specificity of 77.6% and 45.3%, respectively [28]. Schectman et al. found that for each 10% increment in medication adherence HbA1c level decreased by 0.16% [32]. Ho et al. found that every 25% increase in adherence to oral hypoglycemic was associated with a −0.05% reduction in HbA1C [33]. In another study, it was found that higher non-adherence of drugs was associated with poorer glycemic control. Patients with PDC of <40% had a 0.38 (about 5%) increase in HbA1c while those with PDC of >40% had no significant change in HbA1c [34].

CONCLUSION AND RECOMMENDATIONS

In the present study in Arar, Saudi Arabia, the majority of the diabetic patients were poorly adherent to DM treatment. The study also revealed that health education for diabetic patients is necessary to guard against non-adherence and prompt management should be provided to patients with glycosylated hemoglobin levels. Large-scale national researches are needed to include all diabetic patients in Saudi Arabia.

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REFERENCES

[1] Ahmed IA, Alosaimi ME, Alkhathami SM, Alkhurayb NT, Alrasheed MS, Alanazi ZM, Alshehri MA, Alazwary MN. Knowledge, attitude, and practices towards diabetes mellitus among non-diabetes community members of Riyadh, Kingdom of Saudi Arabia. Int. J. Pharm. Res. Allied Sci. 2020; 9(1):41-51.

[2] WHO. 2018. Diabetes Fact Sheet [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/diabetes [Accessed 25/5 2019].

[3] Sindi HA. Evidence that supports the antidiabetic, antihypertensive, and antihyperlipidemic effects of olive (Olea europaea L.) leaves extract and its active constituents (oleuropein) in human. J. Biochem. Technol. 2020; 11(2):41-5.

[4] Domenyuk DA, Zelensky VA, Dmitrienko SV, Anfinogenova OI, Pushkin SV. Peculiarities of phosphorine calcium exchange in the pathogenesis of dental caries in children with diabetes of the first type. Entomol. appl. sci. Lett. 2018; 5(4):49-64.

[5] Priyadi A, Muhtadi A, Suwantika AA, Sumiwi SA. An economic evaluation of diabetes mellitus management in South East Asia. J. Adv. Pharm. Educ. Res. 2019; 9(2):53-74.

[6] TRIPATHY B, CHANDALIA H, KUMAR A, RAO P, MADHU S. RSSDI textbook of diabetes mellitus, Jaypee Brothers Medical Publishers. 2012.

[7] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes care. 2004 May 1;27(5):1047-53.

[8] Ho PM, Bryson CL, Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation. 2009 Jun 16;119(23):3028-35.

[9] Charan Kumar C, Murthy SD. A review on management of blood glucose in type 2 diabetes mellitus. Int J Plant Sciences. 2016;6:114-20.

[10] Bailey CJ, Kodack M. Patient adherence to medication requirements for therapy of type 2 diabetes. International journal of clinical practice. 2011 Mar;65(3):314-22.

[11] Cheung BM, Ong KL, Cherny SS, Sham PC, Tso AW, Lam KS. Diabetes prevalence and therapeutic target achievement in the United States, 1999 to 2006. The American journal of medicine. 2009 May 1;122(5):443-53.

[12] Shin J, McCombs JS, Sanchez RJ, Udall M, Deminski MC, Cheetham TC. Primary nonadherence to medications in an integrated healthcare setting. The American journal of managed care. 2012 Aug;18(8):426-34.

[13] Manobharathi M, Kalyani P, Felix JW, Arulmani A. Factors associated with therapeutic non compliance

among type 2 diabetes mellitus patients in Chidambaram, Tamilnadu, India. Int J Community Med Public Health. 2017 Feb 22;4(3):787-91.

[14] Jansiraninatarajan M. Diabetic compliance: A qualitative study from the patient's perspective in developing countries. IOSR. J Nurs Health Sci. 2013;1:29-38.

[15] Wong MC, Kong AP, So WY, Jiang JY, Chan JC, Griffiths SM. Adherence to oral hypoglycemic agents in 26 782 Chinese patients: a cohort study. The Journal of Clinical Pharmacology. 2011 Oct;51(10):1474-82.

[16] Rwegerera GM. Adherence to anti-diabetic drugs among patients with Type 2 diabetes mellitus at Muhimbili National Hospital, Dar es Salaam, Tanzania-A cross-sectional study. The Pan African Medical Journal. 2014; 17.

[17] Inzucchi SE, Bergenstal RM, Buse JB, Diamant M, Ferrannini E, Nauck M, Peters AL, Tsapas A, Wender R, Matthews DR. Management of hyperglycaemia in type 2 diabetes: a patient-centered approach. Position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. 2012 Jun 1;55(6):1577-96.

[18] Praet SF, van Loon LJ. Exercise therapy in type 2 diabetes. Acta diabetologica. 2009 Dec 1;46(4):263-78.

[19] Al-Qazaz HK, Hassali MA, Shafie AA, Sulaiman SA, Sundram S, Morisky DE. The eight-item Morisky Medication Adherence Scale MMAS: translation and validation of the Malaysian version. Diabetes research and clinical practice. 2010 Nov 1;90(2):216-21.

[20] Rubin RR. Adherence to pharmacologic therapy in patients with type 2 diabetes mellitus. The American journal of medicine. 2005 May 1;118(5):27-34.

[21] Morisky DE, Ang A, Krousel-Wood M, Ward H. Predictive validity of a medication adherence measure for hypertension control. J Clin Hypertens. 2008;10:348–54.

[22] Aloudah NM, Scott NW, Aljadhey HS, Araujo-Soares V, Alrubeaan KA, Watson MC. Medication adherence among patients with Type 2 diabetes: A mixed methods study. PloS one. 2018 Dec 11;13(12):e0207583.

[23] Elsous A, Radwan M, Al-Sharif H, Abu Mustafa A. Medications adherence and associated factors among patients with type 2 diabetes mellitus in the Gaza Strip, Palestine. Frontiers in endocrinology. 2017 Jun 9;8:100.

[24] Afaya RA, Bam V, Azongo TB, Afaya A, Kusi-Amponsah A, Ajusiyine JM, Abdul Hamid T. Medication adherence and self-care behaviours among patients with type 2 diabetes mellitus in Ghana. PloS one. 2020 Aug 21;15(8):e0237710.

[25] Kassahun T, Gesesew H, Mwanri L, & Eshetie T. Diabetes related knowledge, self-care behaviours and adherence to medications among diabetic patients in Southwest Ethiopia: A cross-sectional survey. BMC Endocrine Disorders. 2016; 16(1):1–11. 10.1186/s12902-016-0114-x

[26] Al-Haj Mohd MM, Phung H, Sun J, Morisky DE. The predictors to medication adherence among adults with diabetes in the United Arab Emirates. J Diabetes Metab Disord (2015) 15(1):30. 10.1186/s40200-016-0254-6

[27] Wong MC, Wu CH, Wang HH, et al. Association between the 8-item Morisky medication adherence scale (MMAS-8) score and glycaemic control among Chinese diabetes patients [published correction appears in J Clin Pharmacol. 2017 Sep;57(9):1231]. J Clin Pharmacol. 2015; 55(3):279-287. doi:10.1002/jcph.408

[28] Al-Qazaz HK, Hassali MA, Shafie AA, Sulaiman SA, Sundram S, Morisky DE. The eight-item Morisky Medication Adherence Scale MMAS: translation and validation of the Malaysian version. Diabetes research and clinical practice. 2010 Nov 1;90(2):216-21.

[29] Al Mazroui NR, Kamal MM, Ghabash NM, Yacout TA, Kole PL, McElnay JC. Influence of pharmaceutical care on health outcomes in patients with Type 2 diabetes mellitus. British journal of clinical pharmacology. 2009 May;67(5):547-57.

[30] Reed RL, Revel AD, Carter AO, Saadi HF, Dunn EV. A controlled before–after trial of structured diabetes care in primary health centres in a newly developed country. International Journal for Quality in Health Care. 2005 Aug 1;17(4):281-6.

[31] Lee VW, Leung PY. Glycemic control and medication compliance in diabetic patients in a pharmacist-managed clinic in Hong Kong. American Journal of health-system Pharmacy. 2003 Dec 15;60(24):2593-6.

[32] Schectman JM, Nadkarni MM, Voss JD. The association between diabetes metabolic control and drug adherence in an indigent population. Diabetes care. 2002 Jun 1;25(6):1015-21.

[33] Ho PM, Rumsfeld JS, Masoudi FA, McClure DL, Plomondon ME, Steiner JF, Magid DJ. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. Archives of internal medicine. 2006 Sep 25;166(17):1836-41.

[34] Lin LK, Sun Y, Heng BH, Chew DE, Chong PN. Medication adherence and glycemic control among newly diagnosed diabetes patients. BMJ Open Diabetes Research and Care. 2017 Jul 1;5(1); e000429.