



# Medication Adherence and its Predictors in Type 2 Diabetic Patients Referring to Urban Primary Health Care Centers in Kerman City, Southeastern Iran

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## Abstract

**Background:** Medication adherence (MA) is one of the crucial aspects in the management of chronic diseases such as diabetes.

**Objectives:** This study aimed to evaluate MA and its predictors in type 2 diabetic patients referring to urban primary health care centers.

**Methods:** This cross-sectional study was carried out among type 2 diabetic patients referring to urban primary health care centers in 2017. The data were collected by the Persian version of the eight-item Morisky MA scale. Demographic and disease-related data were also collected. The data were analyzed using SPSS version 22.

**Results:** Of 589 patients under study, more than 70% used oral hypoglycemic agents as the medication regimen and 29.2% received insulin as monotherapy or in combination with oral antidiabetic agents. Over half of the diabetic patients (51.1%) had other comorbid chronic diseases; moreover, 51.3% of them had at least one of diabetes-related complications. The mean MA score was  $6.27 \pm 1.81$ . One-third (33.3%,  $n = 196$ ) of the patients had a moderate level of MA while 35.4% ( $n = 208$ ) and 31.3% ( $n = 184$ ) showed low and high MA levels, respectively. Binary logistic regression analysis showed that education level, type of medication, age, and treatment duration were the predicting factors of MA.

**Conclusions:** MA was at a suboptimal level among diabetic patients referring to the urban primary health care centers. Poor medication adherence can have negative outcomes for diabetic patients. Thus, primary health care providers should consider self-care behaviors of patients and monitor their medication adherence, as well as other aspects of diabetes management.

**Keywords:** Medication Adherence, Diabetes, Primary Health Care, Iran

## 1. Background

Diabetes mellitus (DM) is a serious progressive disease with an increasing trend globally. Based on the WHO 2014 report, 422 million adult population had diabetes giving the prevalence of 8.5% in the world (1, 2). Annually, 1.5 million people worldwide die due to DM and its complications such as nephropathy, neuropathy, and cardiovascular complications. Thus, the disease is the eighth leading cause of mortality in the world (2). In Iran, 4.6 million people are estimated to live with DM. The prevalence of DM and its social and economic consequences have increased in recent decades in Iran (3).

Comprehensive care for a DM patient includes regular blood glucose monitoring, exercise, dietary modification, and the use of antidiabetic drugs, which are necessary for disease control (4). Good glycemic control is the corner-

stone of DM management and leads to the prevention or delayed onset of the DM-induced complications (5). Antidiabetic medication is one of the main components of blood glucose control and its subsequent positive effects (5). The proper control of DM and achieving optimal therapeutic outcomes require adherence to prescribed regimens, including regular and timely medication use. Therefore, medication adherence (MA) plays a crucial role in attaining optimal treatment results (2).

Haynes et al. defined adherence as the extent to which individuals follow their prescribed treatment instructions (6, 7). In diabetes management, there are factors that can decrease treatment adherence, including the complexity of treatment which requires drastic changes in different aspects of lifestyle such as diet, physical activity, and taking several medications or doses in a day. Moreover, many factors such as biological, sociodemographic, cognitive, and

psychological factors can influence the MA (6).

Studies have shown wide variations in the status of MA among type 2 diabetic patients (8-12). The results of five studies in Gaza Strip, Korea, India, Botswana, and Singapore have indicated good MA with the rates of 58%, 61%, 16.6%, 41.8%, and 42.9%, respectively (8-12). A systematic review in 2017 in Iran reported good MA indices ranging from 37.2% to 87% (13).

## 2. Objectives

As far as we know, there is no study of MA among diabetic patients at the first level of health delivery system in Iran. As MA is an essential part of diabetes management, this study was carried out to evaluate the MA and its predicting factors in urban primary health care centers.

## 3. Methods

This cross-sectional study was carried out among type 2 diabetic patients between April and July 2017. The study population included type 2 diabetic patients aged over 18 years referring to 42 urban health care centers in Kerman city. Kerman is located in the southeast of Iran with a population of about one million. Three urban health care centers were randomly selected from each of the four zones of the city. Therefore, 12 out of the total 42 urban health care centers were selected. A convenience sampling method was used to select 50 patients from each of the selected centers; hence, the study sample included 600 participants. The inclusion criteria were a diagnosis of type 2 diabetes according to the WHO guidelines with at least one-year disease duration and at least one-year use of antidiabetic medications (oral antidiabetic agents or insulin).

The data were collected through the Persian version of the eight-item Morisky Medication Adherence Scale (MMAS) (14). The MMAS is a general questionnaire with eight items for the assessment of medication-taking behavior. Seven items are yes/no questions whereas the last item is rated on a five-point Likert scale. The total MMAS score ranges from 0 to 8 and the adherence level could be categorized as high (score = 8), moderate (score = 6 to < 8), and low (score < 6) (14). Moreover, the original researchers suggested a cutoff point of six to categorize the MMAS scores and this method was applied by other researchers, as well (8, 15, 16). For data analysis, the patients were classified into two groups: non-adherent (MMAS score < 6) and adherent patients (MMAS score  $\geq$  6).

The validity and reliability of the MMAS were confirmed in Iran for chronic diseases such as hypertension (16, 17). Furthermore, we carried out a pilot study to assess

the reliability and validity of the MMAS by applying it twice among 30 diabetic patients with an interval duration of 10 to 14 days. The result of this assessment indicated the Cronbach's alpha and ICC values of 0.75 and 0.88, respectively.

Furthermore, we gathered the demographic data such as age, sex, marital status, education level, occupation, and income level, as well as disease-related characteristics including disease duration, type of medication, comorbidity with other chronic diseases, diabetes-related complications, and the number of follow-up visits for controlling diabetes by a general practitioner, internist, or endocrinologist during the previous year. The MMAS was completed by the participants. In the case of illiterate participants, a trained interviewer read the questions for the patients and completed the questionnaire. For each participant, the goals of the study and how to complete the questionnaire were explained. After obtaining written consent, the questionnaires were completed. Furthermore, the study was approved by the Ethics Committee of Kerman University of Medical Sciences (ethics code: IR.KMU.AH.REC.1396.1301).

The collected data were analyzed by SPSS version 22 software. The descriptive data were presented as frequency, percentage, mean, and standard deviation in tables. The chi-square, independent *t*-test, and ANOVA were also employed to determine differences between subgroups. Binary logistic regression analysis was performed to determine the predicting factors of MA.

## 4. Results

Out of the 600 gathered questionnaires, 11 were excluded due to incomplete data. Therefore, 589 questionnaires (response rate, 98.2%) were included in data analysis. The mean age of the participants was 56.40 years (SD = 11.97) whereas 72.3% ( $n = 426$ ) of the patients were aged 64 years or younger. More than two-thirds (67.9%,  $n = 400$ ) of the study group were female and 26.6% ( $n = 157$ ) were widowed or single. The majority of the participants were housewives (55.7%).

The mean values of disease duration and treatment duration were 8.63 years (SD = 6.17, median = 7) and 7.84 years (SD = 5.65, median = 6), respectively. More than 70% of the patients took oral antidiabetic agents; the rest of them took insulin as monotherapy or in combination with oral antidiabetic drugs in the medication regimen. Over half of the diabetic patients (51.1%) had other comorbid chronic diseases. Moreover, more than half of them (51.3%) suffered from at least one diabetes-related complications (Table 1). The mean number of patients' visits in the previous year by a general physician was  $4.26 \pm 3.51$  with an interquartile range of 3 - 6 in primary health care centers. The mean

number of visits in the previous year by a specialist (internist) or subspecialist (endocrinologist) was 2.44 with an interquartile of 2 - 4 (Table 2).

The mean MA score was 6.27 (SD = 1.81, median = 7, interquartile = 5.5 - 8). One-third (33.3%, n = 196) of the patients had a moderate level of MA, while 35.4% (n = 208) and 31.3% (n = 184) showed low and high MA levels, respectively. Considering the score of 6 as the cutoff point, 64.6% (n = 380) of the patients were categorized into the adherent group and 35.4% as the non-adherent group. Table 1 presents the frequencies of patients at different MA levels based on various variables. The frequency of adherent patients was significantly higher in the group with a monthly income of over 250 US dollars than the group with monthly income of 250 US dollars or less (68.2% vs. 56.6%,  $P = 0.004$ ). However, there were no significant differences in the frequency of adherent patients based on sex, marital status, education level, and occupation (Table 1). The frequency of adherent patients was higher in the group taking insulin (as monotherapy or in combination with oral antidiabetic drugs) than in the group receiving oral antidiabetic medications (78.5% vs. 58.9%,  $P < 0.001$ ). Comorbidity with another chronic disease (68.4% vs. 60.6%,  $P = 0.029$ ) and having diabetes-related complications (70.1% vs. 58.9%,  $P = 0.003$ ) were associated with more adherence.

The mean disease duration was 1.74 years higher in the adherent group than in the non-adherent group ( $P = 0.002$ ). In addition, the mean treatment duration was 1.65 years higher in the adherent group than in the non-adherent group ( $P = 0.001$ ). The mean age and the mean number of visits in health care centers did not show any significant difference between adherent and non-adherent groups ( $P = 0.824$ ), while the mean number of follow-up visits by specialist/subspecialist was higher in the adherent group ( $P < 0.0001$ ) (Table 2).

Based on the binary logistic regression analysis, education level, type of medication, age, and treatment duration were the predicting factors of adherence. The odds of adherence for patients with "secondary or high school" and university education levels were 2.43 ( $P < 0.0001$ ) and 5.86 ( $P < 0.0001$ ) times more than those of patients with primary school or illiterate patients, respectively. The odds of adherence for patients who took insulin as monotherapy or in combination with oral antidiabetic agents was 2.38 ( $P = 0.019$ ) times more than those of patients who took oral antidiabetic drugs. By every unit increase in age and treatment duration (in years), the odds of adherence increased by 1.026 ( $P = 0.035$ ) and 1.045 ( $P < 0.0001$ ) times, respectively (Table 3). As a result, the education level and treatment type were the most important predicting factors of MA.

## 5. Discussion

In this study, the mean MA score was 6.27 out of 8 and 35.4% of the patients were non-adherent. Thus, MA was at a suboptimal level among patients referring to the first level of the health care system. Studies in other countries reported various MA scores ranging from 16% to 86% (8-12). Moreover, studies in Iran demonstrated that 37% - 87% of type 2 diabetic patients had good MA. In line with other studies, our results showed that MA was not satisfactory among diabetic patients. Non-adherence to medication can lead to negative consequences such as inadequate glycemic control, waste of medication, disease progression, increased morbidity and mortality, reduced functional abilities, and decreased quality of life (8, 10, 18). In addition, non-adherence to medication can result in the increased demand for outpatient care, complex health care services, emergency departments' visits, hospitalization, and the use of medical resources, which all impose a significant financial burden on patients and the health care system (4, 19).

The results of the current study showed that education level was the most important predicting factor of adherence to medication. The odds of adherence in patients with university education and high school education were 5.86 and 2.43 times more than those of patients with primary or lower education levels, respectively. Consistent with this finding, a study in the USA and another study in Turkey showed that education level was associated with compliance to treatment so that diabetic patients with higher education levels had better compliance with medication (20, 21). On the other hand, in contrast to our results, several studies have not found any association between patients' education level and adherence to medication (22-24). One explanation for better adherence rate in patients with higher education level can be that the more educated patients usually have more knowledge about the importance and positive effects of medication to attain glycemic control and prevent diabetes complications (25).

The results of the present study showed that age was a predictor of medication adherence. However, there was no significant difference between male and female patients in medication adherence. In accordance with our results, studies in Malaysia, Singapore, USA, and France showed that older patients had better MA status (18, 26-28). In contrast, some studies reported that the age of patients was not a determining factor for MA (8, 29). Overall, we can conclude that older patients have higher MA in any chronic conditions including diabetes (8). Better MA in older people could be attributed to their greater awareness of the disease and its complications, more positive attitudes toward treatment, higher frequency of diabetes complica-

**Table 1.** The Frequency Distribution of Patients at Various MA Levels Based on Demographic and Diabetes-Related Variables in the Study Sample<sup>a</sup>

Variable/Categories	Total Sample	Adherent	Non-Adherent	P Value
<b>Gender</b>				0.097
Female	400 (67.9)	251 (62.7)	149 (37.3)	
Male	189 (32.1)	129 (68.6)	59 (31.4)	
<b>Marital status</b>				0.442
With spouse	423 (73.4)	277 (64.3)	154 (34.7)	
Without spouse	157 (26.6)	103 (65.6)	54 (34.4)	
<b>Education level</b>				0.060
Primary school or less	224 (38.0)	132 (58.9)	92 (41.1)	
Secondary or high school	301 (51.1)	202 (67.3)	98 (32.7)	
University	64 (10.9)	46 (71.9)	18 (28.1)	
<b>Job category</b>				0.258
Housewife	328 (55.7)	203 (61.9)	125 (38.1)	
Government employee	77 (13.1)	52 (67.5)	25 (32.5)	
Non-government employee	87 (14.7)	55 (64.0)	31 (36.0)	
Retired	97 (16.5)	70 (72.2)	27 (27.8)	
<b>Monthly income (US dollars), \$</b>				0.004
< 250	161 (27.3)	89 (56.6)	71 (44.4)	
> 250	428 (72.2)	262 (68.2)	122 (31.8)	
<b>Type of medication</b>				< 0.001
Insulin <sup>b</sup>	172 (29.2)	135 (78.5)	37 (21.5)	
Oral hypoglycemic agents	417 (70.8)	245 (58.9)	171 (41.1)	
<b>Comorbidity of chronic diseases</b>				0.029
Yes	301 (51.1)	206 (68.4)	95 (31.6)	
No	288 (48.9)	174 (60.6)	113 (39.4)	
<b>Diabetes complication</b>				0.003
Yes	302 (51.3)	211 (70.1)	90 (29.9)	
No	287 (48.7)	169 (58.9)	118 (41.1)	

<sup>a</sup>Values are expressed as No. (%).<sup>b</sup>Insulin monotherapy or insulin in combination with oral hypoglycemic agents.**Table 2.** Comparison of the Mean Age, Disease Duration, Treatment Duration, and Number of Visits in the Health Care Centers by a Specialist/Subspecialist Between Adherent and Non-adherent Groups<sup>a</sup>

Variable	Total Sample	Adherent	Non-Adherent	P Value
Age, y	56.40 ± 11.97	56.93 ± 11.76	55.42 ± 12.33	0.143
Disease duration, y	8.63 ± 6.17	9.21 ± 6.21	7.57 ± 5.96	0.002
Treatment duration	7.84 ± 5.66	8.42 ± 5.76	6.77 ± 5.33	0.001
Number of visits in health care center	4.26 ± 3.52	4.22 ± 3.75	4.28 ± 3.40	0.824
Number of visits by specialist/subspecialist	2.44 ± 1.93	2.65 ± 2.00	2.06 ± 1.72	< 0.001

<sup>a</sup>Values are expressed as mean ± SD.

tions, and comorbidity with other chronic diseases, as well as less concern about drug side effects (8).

The findings of this study disclosed that MA was associated with disease-related factors including disease and

**Table 3.** Binary Logistic Regression for Determining the Predictors of MA in the Study Sample

Predictor	B	SE	Exp (B)	95% CI for Exp (B)
<b>Education level</b>				
Primary school or illiterate	Reference			
Secondary or high school	0.891	0.235	2.43	1.53 - 3.87
University	1.760	0.491	5.86	2.24 - 15.32
<b>Type of medication</b>				
Oral antidiabetic medication	Reference			
Insulin	0.870	0.236	2.38	1.50 - 3.78
<b>Treatment duration</b>	0.044	0.021	1.045	1.002 - 1.089
<b>Age</b>	0.026	0.021	1.026	1.003 - 1.049
<b>Constant</b>	-1.960	0.688	0.140	

treatment duration, the presence of insulin in antidiabetic regimen, suffering from diabetes complications, the presence of other comorbid chronic diseases, and the number of annual follow-up visits by specialists or subspecialists. Treatment duration and the presence of insulin in antidiabetic regimen were the predictors of MA in the binary logistic regression model. Patients with longer treatment duration usually have longer diagnosis duration; hence, such patients are more aware of the disease and positive effects of treatment; they are also more likely to have diabetes complications; so, they have better attitudes toward the need for treatment, leading to better MA (30, 31).

Our findings showed that having insulin in antidiabetic regimen was associated with higher MA. In general, due to pain and fear of injection, as well as difficulties of injection preparation, poor MA is expected in insulin-injecting patients (32). Insulin is commonly used in patients with the more severe and prolonged disease and those who do not have satisfactory blood glucose control by oral antidiabetic agents; thus, in these advanced stages of the disease, the recommendation and prescribed drugs by health care providers will comply better (32). Several studies did not report such associations; however, consistent with our results, a study reported better MA in insulin-receiving diabetic patients (8, 9, 28, 33). In contrast to these results, a study in India showed that patients taking oral antidiabetic drugs had more MA (34). The contradictory results of various studies could be attributed to the differences in the study populations, study settings, and patterns of insulin prescription.

We noted that the mean number of visits by a specialist or subspecialist was significantly higher in the adherent group, while the mean number of visits in primary health care centers did not make such differences. In a study in the USA, there was no difference in MA between

patients who referred to primary health care centers and those referring to endocrinologists (20). Another study demonstrated that being less engaged with a physician or other health care professionals was associated with poor MA. Furthermore, MA is better when patients report a sense of trust in their physician (35). Physicians can help diabetic patients improve their self-care behaviors by scheduling frequent follow-up visits and discussing self-care challenges with their patients (36). It is expected that primary health care providers play a significant role in the management of diabetes and its various aspects such as MA, but our results did not show this relationship.

This study faced two limitations. First, we enrolled patients attending primary health care centers. These patients may have different patterns of behaviors, including treatment adherence, compared to those who did not refer to primary health care centers. Moreover, measuring human behaviors via self-report methods usually results in underestimation than the actual status.

### 5.1. Conclusions

This study showed that medication adherence was at a suboptimal level among diabetic patients referring to primary health care centers. We found that more than half of the patients had at least one diabetes complication and 51% had other comorbid chronic diseases; thus, diabetes management was not satisfactory in urban primary health care centers. Moreover, the study showed that age, having insulin in antidiabetic regimen, treatment duration, higher education level, and the number of follow-up visits by a specialist/subspecialist were the predictors of MA. Primary health care centers are the first level of the health delivery system and the majority of diabetic patients receive health care in these centers. Therefore, improving patients' knowledge of the disease and their self-care behav-

iors by a trained health care provider is necessary for better diabetes self-management and enhancement of MA.

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## Footnotes

**Authors' Contribution:** Study concept and design: Ali Khalooei and Lila Benrazavy. Analysis and interpretation of data: Ali Khalooei and Lila Benrazavy. Drafting of the manuscript: Lila Benrazavy. Critical revision of the manuscript for important intellectual content: Ali Khalooei. Statistical analysis: Ali Khalooei.

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## References

- World Health Organization. *Global report on diabetes*. 2016. Available from: <http://www.who.int/diabetes/global-report/en/>.
- Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nat Rev Endocrinol*. 2018;**14**(2):88–98. doi: [10.1038/nrendo.2017.151](https://doi.org/10.1038/nrendo.2017.151). [PubMed: [29219149](https://pubmed.ncbi.nlm.nih.gov/29219149/)].
- Noshad S, Afarideh M, Heidari B, Mechanick JI, Esteghamati A. Diabetes care in Iran: Where we stand and where we are headed. *Ann Glob Health*. 2015;**81**(6):839–50. doi: [10.1016/j.aogh.2015.10.003](https://doi.org/10.1016/j.aogh.2015.10.003). [PubMed: [27108151](https://pubmed.ncbi.nlm.nih.gov/27108151/)].
- Inamdar SZ, Kulkarni RV, Karajgi SR, Manvi FV, Ganachari MS, Kumar BM. Medication adherence in diabetes mellitus: An overview on pharmacist role. *Open J Adv Drug Delivery*. 2013;**1**(3):238–50.
- Chaudhury A, Duvoor C, Reddy Dendi VS, Kraleti S, Chada A, Ravilla R, et al. Clinical review of antidiabetic drugs: Implications for type 2 diabetes mellitus management. *Front Endocrinol (Lausanne)*. 2017;**8**:6. doi: [10.3389/fendo.2017.00006](https://doi.org/10.3389/fendo.2017.00006). [PubMed: [28167928](https://pubmed.ncbi.nlm.nih.gov/28167928/)]. [PubMed Central: [PMC5256065](https://pubmed.ncbi.nlm.nih.gov/PMC5256065/)].
- Nash J. Understanding barriers to medication adherence in people with diabetes. *J Diabetes Nurs*. 2013;**17**(7):263–7.
- Lam WY, Fresco P. Medication adherence measures: An overview. *Biomed Res Int*. 2015;**2015**:217047. doi: [10.1155/2015/217047](https://doi.org/10.1155/2015/217047). [PubMed: [26539470](https://pubmed.ncbi.nlm.nih.gov/26539470/)]. [PubMed Central: [PMC4619779](https://pubmed.ncbi.nlm.nih.gov/PMC4619779/)].
- 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. *Front Endocrinol (Lausanne)*. 2017;**8**:100. doi: [10.3389/fendo.2017.00100](https://doi.org/10.3389/fendo.2017.00100). [PubMed: [28649231](https://pubmed.ncbi.nlm.nih.gov/28649231/)]. [PubMed Central: [PMC5465265](https://pubmed.ncbi.nlm.nih.gov/PMC5465265/)].
- Park KA, Kim JG, Kim BW, Kam S, Kim KY, Ha SW, et al. Factors that affect medication adherence in elderly patients with diabetes mellitus. *Korean Diabetes J*. 2010;**34**(1):55–65. doi: [10.4093/kdj.2010.34.1.55](https://doi.org/10.4093/kdj.2010.34.1.55). [PubMed: [20532021](https://pubmed.ncbi.nlm.nih.gov/20532021/)]. [PubMed Central: [PMC2879904](https://pubmed.ncbi.nlm.nih.gov/PMC2879904/)].
- Sharma T, Kalra J, Dhasmana DC, Basera H. Poor adherence to treatment: A major challenge in diabetes. *J Indian Acad Clin Med*. 2014;**15**(1):26–9.
- Rweegerera GM, Moshomo T, Gaenamang M, Oyewo TA, Gollakota S, Mhimbira FA, et al. Antidiabetic medication adherence and associated factors among patients in Botswana; implications for the future. *Alexandria J Med*. 2018;**54**(2):103–9. doi: [10.1016/j.ajme.2017.01.005](https://doi.org/10.1016/j.ajme.2017.01.005).
- Lee CS, Tan JHM, Sankari U, Koh YLE, Tan NC. Assessing oral medication adherence among patients with type 2 diabetes mellitus treated with polytherapy in a developed Asian community: A cross-sectional study. *BMJ Open*. 2017;**7**(9). e016317. doi: [10.1136/bmjopen-2017-016317](https://doi.org/10.1136/bmjopen-2017-016317). [PubMed: [28912194](https://pubmed.ncbi.nlm.nih.gov/28912194/)]. [PubMed Central: [PMC5640112](https://pubmed.ncbi.nlm.nih.gov/PMC5640112/)].
- Mashrouteh M, Khanjani N. Evaluation of oral medication adherence and its related factors in type II diabetic patients in Iran: A systematic review. *Int J Diabet Res*. 2017;**6**(1):24–33. doi: [10.5923/j.diabetes.20170601.04](https://doi.org/10.5923/j.diabetes.20170601.04).
- Plos One Staff. Correction: Validity and reliability of a self-reported measure of antihypertensive medication adherence in Uganda. *PLoS One*. 2017;**12**(10). e0187620. doi: [10.1371/journal.pone.0187620](https://doi.org/10.1371/journal.pone.0187620). [PubMed: [29088305](https://pubmed.ncbi.nlm.nih.gov/29088305/)]. [PubMed Central: [PMC5663509](https://pubmed.ncbi.nlm.nih.gov/PMC5663509/)].
- Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. *J Clin Hypertens (Greenwich)*. 2008;**10**(5):348–54. [PubMed: [18453793](https://pubmed.ncbi.nlm.nih.gov/18453793/)]. [PubMed Central: [PMC2562622](https://pubmed.ncbi.nlm.nih.gov/PMC2562622/)].
- Moharamzad Y, Saadat H, Nakhjavan Shahraki B, Rai A, Saadat Z, Aerab-Sheibani H, et al. Validation of the Persian version of the 8-item morisky medication adherence scale (MMAS-8) in Iranian hypertensive patients. *Glob J Health Sci*. 2015;**7**(4):173–83. doi: [10.5539/gjhs.v7n4p173](https://doi.org/10.5539/gjhs.v7n4p173). [PubMed: [25946926](https://pubmed.ncbi.nlm.nih.gov/25946926/)]. [PubMed Central: [PMC4802120](https://pubmed.ncbi.nlm.nih.gov/PMC4802120/)].
- Dehghan M, Nayeri N, Karimzadeh P, Iranmanesh S. Psychometric properties of the Persian version of the morisky medication adherence scale-8. *Brit J Med Res*. 2015;**9**(9):1–10. doi: [10.9734/bjmmr/2015/17345](https://doi.org/10.9734/bjmmr/2015/17345).
- Jimmy B, Jose J. Patient medication adherence: Measures in daily practice. *Oman Med J*. 2011;**26**(3):155–9. doi: [10.5001/omj.2011.38](https://doi.org/10.5001/omj.2011.38). [PubMed: [22043406](https://pubmed.ncbi.nlm.nih.gov/22043406/)]. [PubMed Central: [PMC3191684](https://pubmed.ncbi.nlm.nih.gov/PMC3191684/)].
- Lin LK, Sun Y, Heng BH, Chew DEK, Chong PN. Medication adherence and glycemic control among newly diagnosed diabetes patients. *BMJ Open Diabetes Res Care*. 2017;**5**(1). e000429. doi: [10.1136/bmjopen-2017-000429](https://doi.org/10.1136/bmjopen-2017-000429). [PubMed: [28878942](https://pubmed.ncbi.nlm.nih.gov/28878942/)]. [PubMed Central: [PMC5574459](https://pubmed.ncbi.nlm.nih.gov/PMC5574459/)].
- Kirkman MS, Rowan-Martin MT, Levin R, Fonseca VA, Schmitt DJ, Herman WH, et al. Determinants of adherence to diabetes medications: Findings from a large pharmacy claims database. *Diabetes Care*. 2015;**38**(4):604–9. doi: [10.2337/dci4-2098](https://doi.org/10.2337/dci4-2098). [PubMed: [25573883](https://pubmed.ncbi.nlm.nih.gov/25573883/)]. [PubMed Central: [PMC4370331](https://pubmed.ncbi.nlm.nih.gov/PMC4370331/)].
- Serap T, Bayram S. Factors influencing adherence to diabetes medication in Turkey. *Sch J Appl Med Sci*. 2015;**3**(2A):602–7.
- Goh BQ, Tay AHP, Khoo RSY, Goh BK, Lo PFL, Lim CJF. Effectiveness of medication review in improving medication knowledge and adherence in primary care patients. *Proc Singapore Healthcare*. 2014;**23**(2):134–41. doi: [10.1177/201010581402300207](https://doi.org/10.1177/201010581402300207).
- Bazargan M, Smith J, Yazdanshenas H, Movassaghi M, Martins D, Orum G. Non-adherence to medication regimens among older African-American adults. *BMC Geriatr*. 2017;**17**(1):163. doi: [10.1186/s12877-017-0558-5](https://doi.org/10.1186/s12877-017-0558-5). [PubMed: [28743244](https://pubmed.ncbi.nlm.nih.gov/28743244/)]. [PubMed Central: [PMC5526276](https://pubmed.ncbi.nlm.nih.gov/PMC5526276/)].
- Katz LL, Anderson BJ, McKay SV, Izquierdo R, Casey TL, Higgins LA, et al. Correlates of medication adherence in the TODAY cohort of youth with type 2 diabetes. *Diabetes Care*. 2016;**39**(11):1956–62. doi: [10.2337/dci5-2296](https://doi.org/10.2337/dci5-2296). [PubMed: [27352955](https://pubmed.ncbi.nlm.nih.gov/27352955/)]. [PubMed Central: [PMC5079608](https://pubmed.ncbi.nlm.nih.gov/PMC5079608/)].
- El-Khawaga G, Abdel-Wahab F. Knowledge, attitudes, practice and compliance of diabetic patients in Dakahlia, Egypt. *Europ J Res Med Sci*. 2015;**3**(1).

26. Polonsky WH, Henry RR. Poor medication adherence in type 2 diabetes: Recognizing the scope of the problem and its key contributors. *Patient Prefer Adherence*. 2016;**10**:1299–307. doi: [10.2147/PPA.S106821](https://doi.org/10.2147/PPA.S106821). [PubMed: [27524885](https://pubmed.ncbi.nlm.nih.gov/27524885/)]. [PubMed Central: [PMC4966497](https://pubmed.ncbi.nlm.nih.gov/PMC4966497/)].
27. Ahmad NS, Ramli A, Islahudin F, Paraidathathu T. Medication adherence in patients with type 2 diabetes mellitus treated at primary health clinics in Malaysia. *Patient Prefer Adherence*. 2013;**7**:525–30. doi: [10.2147/PPA.S44698](https://doi.org/10.2147/PPA.S44698). [PubMed: [23814461](https://pubmed.ncbi.nlm.nih.gov/23814461/)]. [PubMed Central: [PMC3693921](https://pubmed.ncbi.nlm.nih.gov/PMC3693921/)].
28. Tiv M, Viel JF, Mauny F, Eschwege E, Weill A, Fournier C, et al. Medication adherence in type 2 diabetes: The ENTRED study 2007, a French population-based study. *PLoS One*. 2012;**7**(3). e32412. doi: [10.1371/journal.pone.0032412](https://doi.org/10.1371/journal.pone.0032412). [PubMed: [22403654](https://pubmed.ncbi.nlm.nih.gov/22403654/)]. [PubMed Central: [PMC3293796](https://pubmed.ncbi.nlm.nih.gov/PMC3293796/)].
29. Farsaei S, Sabzghabae AM, Amini M, Zargarzadeh AH. Adherence to statin therapy in patients with type 2 diabetes: An important dilemma. *J Res Med Sci*. 2015;**20**(2):109–14. [PubMed: [25983760](https://pubmed.ncbi.nlm.nih.gov/25983760/)]. [PubMed Central: [PMC4400702](https://pubmed.ncbi.nlm.nih.gov/PMC4400702/)].
30. Jimmy B, Jose J, Al-Hinai ZA, Wadair IK, Al-Amri GH. Adherence to medications among type 2 diabetes mellitus patients in three districts of Al Dakhliyah Governorate, Oman: A cross-sectional pilot study. *Sultan Qaboos Univ Med J*. 2014;**14**(2):e231–5. [PubMed: [24790747](https://pubmed.ncbi.nlm.nih.gov/24790747/)]. [PubMed Central: [PMC3997541](https://pubmed.ncbi.nlm.nih.gov/PMC3997541/)].
31. Sweileh WM, Zyoud SH, Abu Nab'a RJ, Deleq MI, Enaia MI, Nassar SM, et al. Influence of patients' disease knowledge and beliefs about medicines on medication adherence: Findings from a cross-sectional survey among patients with type 2 diabetes mellitus in Palestine. *BMC Public Health*. 2014;**14**:94. doi: [10.1186/1471-2458-14-94](https://doi.org/10.1186/1471-2458-14-94). [PubMed: [24479638](https://pubmed.ncbi.nlm.nih.gov/24479638/)]. [PubMed Central: [PMC3909379](https://pubmed.ncbi.nlm.nih.gov/PMC3909379/)].
32. Sarbacker GB, Urteaga EM. Adherence to insulin therapy. *Diabetes Spectr*. 2016;**29**(3):166–70. doi: [10.2337/diaspect.29.3.166](https://doi.org/10.2337/diaspect.29.3.166). [PubMed: [27574371](https://pubmed.ncbi.nlm.nih.gov/27574371/)]. [PubMed Central: [PMC5001221](https://pubmed.ncbi.nlm.nih.gov/PMC5001221/)].
33. Donnelly LA, Morris AD, Evans JM, Darts Memo collaboration . Adherence to insulin and its association with glycaemic control in patients with type 2 diabetes. *QJM*. 2007;**100**(6):345–50. doi: [10.1093/qjmed/hcm031](https://doi.org/10.1093/qjmed/hcm031). [PubMed: [17504861](https://pubmed.ncbi.nlm.nih.gov/17504861/)].
34. Mukherjee S. Compliance to anti-diabetic drugs: Observations from the diabetic clinic of a medical college in Kolkata, India. *J Clin Diagn Res*. 2013. doi: [10.7860/jcdr/2013/5352.2876](https://doi.org/10.7860/jcdr/2013/5352.2876).
35. Polonsky WH. Poor medication adherence in diabetes: What's the problem? *J Diabetes*. 2015;**7**(6):777–8. doi: [10.1111/1753-0407.12306](https://doi.org/10.1111/1753-0407.12306). [PubMed: [25929829](https://pubmed.ncbi.nlm.nih.gov/25929829/)].
36. Ivanov NN. Patient-physician communication and diabetes self-care. *J Clin Outcomes Manag*. 2016;**23**(11):509–18.