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Medication Adherence and Patient Outcomes: Investigating Strategies to Improve Patient Compliance

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Abstract - Medication adherence is defined as taking medications as advised and prescribed by health care professionals for stated duration. Diabetes mellitus (DM) is one of the most common chronic illnesses in Saudi Arabia. This study aimed to document medication adherence in Saudi patients with type 2 diabetes. A quantitative cross-sectional study was conducted in Saudi out-patients with type 2 DM in the city of Khobar, Saudi Arabia. The study used the General Medication Adherence Scale (GMAS) to document medication adherence in this population. Data was analyzed through SPSS version 23. Study was ethically approved. Data was collected from 212 patients. Few patients (35.8%) had high adherence to anti diabetic medications. The correlation between HbA1c level and adherence score was negative and significantly strong (ρ = -0.413, p < 0.0001). Most patients (N = 126, 59.4%) modified their medication therapy during month of Ramadan and on Eid occasion. Education level was not a determinant of adherence in this population. The medication adherence score for the entire indicating moderate adherence Medication-related factors such as the number of medications prescribed, medication complexity This study highlighted that medication adherence is influenced by religious and social factors. Patient counseling is required to improve patient beliefs and increase awareness of adhering to prescribed anti diabetic pharmacotherapy. A pharmacist can play constructive role of a disease educator and patient counselor.

Keywords - medication adherence and compliance; medication nonadherence; patient outcomes; health outcomes; providers' education; patients' education; communication

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INTRODUCTION

Medication adherence is a serious problem in healthcare today and it has an enormous impact on patient outcomes. Studies show that 50-60% of medication regimens are not followed correctly, with medicines taken too late or omitted completely (ANA, 2023). As healthcare leaders, we must understand the importance of addressing this issue if we want to improve our organizational outcomes for better patient care. We will look at the current state of medication adherence and explore various strategies, including utilizing pharmacy students, that can be used to increase patient compliance and ultimately drive better health outcomes.

In order to improve the health outcomes of patients, it is essential for patients to be aware of and practice medication adherence. Medication adherence focuses on how well a patient sticks to outpatient medication prescription dosage, timing, and frequency prescribed by healthcare providers (Gast & Mathes, 2019). Achieving good medication adherence requires careful planning and understanding of protocols, familiarity with diseases and their treatment, trust of providers, communication, support, and adequate resources, so it's critical that patients work closely with their healthcare team in order to ensure they're following the right advice (Kvarnstrom et al., 2021). The ever-expanding healthcare workforce shortage has added an additional layer of difficulty in ensuring patient medication adherence. A source hardly being utilized to help them gain knowledge and experience are the 1 million clinical students in the US.

Taking medications as prescribed is a key factor in managing chronic illnesses, and it benefits both patients and healthcare providers. Medication adherence allows patients to take ownership of their health by enabling them to understand their conditions better and recognize the importance of following through with medical treatment plans. As a result, benefits such as improved clinical outcomes, reduced hospitalizations, lower health costs, and

greater satisfaction for patients and providers are seen in individuals who properly adhere to medication regimens. It, therefore, benefits everyone to ensure that patients are actively engaged in their treatments and stay adherent to medication instructions given by healthcare providers.

Poor medication adherence among patients can be attributed to a variety of factors, such as confusion around prescription instructions, forgetfulness, inadequate communication between patient and practitioner, and environmental factors. For instance, low health literacy among patients presents an obstacle for them when understanding information about medication dosage and side effects. Additionally, factors such as poor access to healthcare or budgetary concerns may impact a patient's ability to adhere to their prescribed treatment plan (ANA, 2023). As a result of inadequate adherence, an individual's medical conditions may worsen and cause associated health risks or further financial burdens due to necessary hospital visits or medical procedures. Therefore, health practitioners should make every effort to ensure that the factors leading to poor medication adherence are properly addressed.

Improving medication adherence is an important part of healthcare, as it ensures that patients are getting the treatments they need. An innovative strategy for medication adherence is patient outreach utilizing pharmacy students to reach out to patients telephonically (Abughosh et al., 2017). Outreach by pharmacy students not only benefits the patients, but it helps the students become better clinicians in the future. Other strategies can be implemented to increase adherence, such as providing education and support for patients' healthcare needs, allowing for more simplified dosing regimens, using automated reminders, and telehealth (Bingham et al., 2020). Additionally, involving family members in patient care can help improve adherence; since they are often more closely connected to the patient in daily life, they may be better equipped to ensure medications are taken on time and as prescribed. Finally, proactive communication between provider and patient helps build trust for both parties and encourages self-management of medications. Taking these measures improves the chances that patients adhere to their treatment plans, leading to improved health outcomes.

LITERATURE REVIEW

Singh, Pooja. (2017). Adherence to a medication regimen is generally defined as the extent to which patients take medications as prescribed by their health care providers. Approximately 50% of patients do not take their medications as prescribed. Factors contributing to poor medication adherence include those that are related to patients (eg., suboptimal health literacy and lack of involvement in the treatment decision–making process), those that are related to physicians (eg., prescription of complex drug regimens, communication barriers, ineffective communication), and those that are related to health care systems (eg., limited access to care). Because barriers to medication adherence are complex and varied, solutions to improve adherence must be multifactorial.

Jeon, Hae & Chae, Myung-Ock & Kim, Ahrin. (2022). This systematic review and meta-analysis aimed to understand the characteristics of medication adherence interventions for older adults with chronic illnesses, and to investigate the average effect size by combining the individual effects of these interventions. Data from studies meeting the inclusion criteria were systematically collected in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. The results showed that the average effect size (Hedges' g) of the finally selected medication adherence interventions for older adults with chronic illnesses calculated using a random-effects model was 0.500 (95% confidence interval [CI], 0.342-0.659). Of the medication adherence interventions, an implementation intention intervention (using face-to-face meetings and telephone monitoring with personalized behavioral strategies) and a health belief model-based educational program were found to be highly effective. Face-to-face counseling was a significantly effective method of implementing medication adherence interventions for older adults with chronic illnesses (Hedges' g=0.531, 95% CI, 0.186-0.877), while medication adherence interventions through education and telehealth counseling were not effective. This study verified the effectiveness of personalized behavioral change strategies and cognitive behavioral therapy based on the health belief model, as well as face-to-face meetings, as medication adherence interventions for older adults with chronic illnesses.

Wilhelmsen, Nina & Eriksson, Tommy. (2018). Objective To present evidence for healthcare-provided medication adherence interventions on clinical, economic and humanistic outcomes among patients. Methods Literature search of systematic reviews in Medline, Embase and CINAHL (2007–2017), validation of quality using A Measurement Tool to Assess Systematic Reviews (AMSTAR) 2 and Preferred Reporting Items for Systematic Reviews and Meta-Analyses questionnaires and, finally, extraction, combination and tabulation of results for included studies. Results From eight systematic reviews with medium to high AMSTAR 2 score, 37 randomised controlled studies involving 28 600 participants were extracted. Patient education and counselling showed some positive effects on medication adherence. Patient education also showed some positive effects on morbidity, healthcare utilities and patient satisfaction. Counselling had some benefit on mortality and healthcare utilisation. Simplifying doses was shown to have some benefit on morbidity and patient satisfaction. Interventions delivered by pharmacists and nurses showed a better result in improving

adherence and outcomes than interventions delivered by general practitioners. Conclusions Some interventions were found to have positive effect on adherence and outcomes, but no single strategy showed improvement in all settings. For future research patients should be screened for non-adherence to reveal both if they are non-adherent and type of non-adherence, as well as bigger sample sizes and longer duration of follow-up.

T, prathyusha & b, prashanthi & fathima, ayesha & firdose, ayesha & naser, sara & begum, najma & begum, kauser. (2019). Objective: This study was conducted to determine the adherence of medications among type 2 diabetes mellitus (DM) patients. To evaluate adherence to therapy and study factors associated with non-adherence and adherence in patients with type II DM. Methods: A cross-sectional, observational study was conducted for 6 months in three hospitals. A total of 200 type II diabetic patients, who were on anti-diabetic drug therapy for at least 6 months, were enrolled. Blood glucose was measured and details of drug therapy were noted. Medication adherence was assessed using the Morisky Medication Adherence Scale and adherence scores were calculated. Results: Only 15% had high medication adherence, while 24% had moderate and 61% had low medication adherence. Only 30% were having optimally controlled glycemic levels, whereas 70% were having uncontrolled glycemic levels. Medication adherence scores were lower (reflecting lower adherence) in type II patients with uncontrolled glycemic levels than those having optimally controlled glycemic levels, but this difference was not statistically significant. Conclusion: Overall, medication adherence was low in type II diabetic patients. The study shows that to improve medication adherence, better counseling and health education of patients are required. Although several patients were adherent to therapy, adherent patients are more preferably to achieve glycemic control than nonadherent patients. Greater efforts are needed to facilitate diabetes self-management behaviors to improve patient outcomes.

Kanyongo, Wellington & Ezugwu, Absalom. (2023). Non-adherence to prescribed medication is a major public health concern that escalates the risk of morbidity and death as well as incurring extra expenses associated with hospitalisation. According to the World Health Organization (WHO), only 50% of people suffering from chronic diseases follow the treatment recommendations despite the counsel provided to patients on the importance of medication adherence (MA). Early detection of non-communicable disease (NCD) patients poorly adhering to recommended medications using analytics based on machine learning (ML) may improve the outcomes of NCD patients positively. This paper presents a systematic review of literature involving the application of ML in evaluating MA amongst NCD patients. The articles considered in this study were extracted from Web of Science, Google Scholar, PubMed, and IEEE Explore. Twenty-five articles in total met the criteria for inclusion. These were articles that utilised ML techniques to analyse MA in NCDs, with patients suffering from diabetes (n = 8), hypertension (n = 3), cardiovascular disease (CVD) and statin adherence (n = 6), cancer (n = 3), respiratory diseases (n = 2), and other NCD conditions (n = 3). The proportion of days covered (PDC) was typically used to evaluate MA. It emerged from the study that for MA to be considered high, the adherence threshold should be at least 75% of the PDC, a universally accepted threshold. In MA analytics research and practice, a PDC ≥80% threshold is typically regarded as a high level of adherence to prescription medication. Logistic regression (LR) (n = 12), random forest (RF) (n = 11), support vector machine (SVM) (n = 7), neural net (n = 6), ensemble learning (n = 6), MLPs (n = 4), XGBoost (n = 3), Bayesian network (BN) (n = 3), and gradient boosting (n = 3) were the most frequently applied ML techniques in the analytics of MA amongst NCD patients. It should be underscored that leveraging standard ML, deep learning (DL), and ensemble learning has enormous potential for measuring MA amongst NCD patients based on various analytics such as prediction, regression, classification, and clustering. Moreover, a further study could be conducted to comprehend how the application of alternative ML-based techniques can be used to measure MA among patients with chronic infectious diseases.

METHODOLOGY

A quantitative cross-sectional study was conducted in a random sample of Saudi patients with type II diabetes, using a validated survey questionnaire to document medication adherence.

The venue of the study was the city of Khobar which is located in the Eastern Province of Saudi Arabia. The Eastern Province is the largest province by area. The city of Khobar is located in the third largest metropolitan area in Saudi Arabia with an estimated population of over 4 million (General Authority for Statistics. Kingdom of Saudi Arabia, 2016). The study was conducted in the out-patient endocrine and diabetic clinics at King Fahd University Hospital which is the largest public-sector tertiary care health facility in the city. The study began in March 2019 and was completed in April 2019.

The target population for the study was type II DM out-patients. Out-patients who had established diagnosis of type 2 DM (T2DM) and prescribed with oral medications were included in the study. This was done by verification either by medical record, a valid prescription or lab reports. Patients suffering from T2DM alone or with comorbidities such as hypertension, hyperlipidemia, obesity, etc. were included. Comorbidities were identified by an established diagnosis of an illness apart from diabetes. Only Saudi patients were invited to participate, and expatriates were excluded. Patients

admitted in hospitals (in-patients) at the time of survey as well as those suffering with acute illnesses were left out. Patients suffering from other phenotypes such as pre-diabetes, type 1 DM and gestational diabetes were also excluded from the study. In addition, patient who were on injectables and those who did not consent to participate in the study and incomplete questionnaires were also not included.

Patients enrolled at the hospital who had appointments in the out-patient endocrine clinics were selected randomly by help of a computer-generated list from hospital's database. Selected patients were invited to participate in the study by signing a patient consent form. The presence of diabetes was first confirmed from patients and then re-confirmed by their medical record, prescription containing oral hypoglycemic drugs and/or lab results. Following confirmation of illness presence, the patients were asked to provide a random blood sugar (RBS) test for the record. According to official figures from Saudi Ministry of Health, the prevalence of type II DM is 13.4% (Saudi Health Information 2013). Thus, sample size was calculated using the prevalence-based formula:

$$n=Z2P(1-P)/d2.$$

The symbol (n) is the sample size, (P) is the prevalence, (Z) denotes confidence level and (d) is precision (Naing et al., 2006). Substituting the values in the formula we obtained a sample size of 178.

The study used the General Medication Adherence Scale (GMAS) to document medication adherence in this population (Naqvi et al., 2018a; Naqvi & Hassali, 2018b; Naqvi et al, 2019c). The GMAS was recently validated in Saudi patients with chronic illness (Naqvi et al., 2019b). The scale is subcategorized into 3 subscales namely, patient behavior related non-adherence (PBNA), additional disease and pill burden related non-adherence (ADPB), and cost related non-adherence (CRNA). The scale has 11 items of multiple-choice type (MCQ), and four possible options for each item. Each item awards a score. Each domain of the scale measures a specific dimension of non-adherence. Moreover, GMAS also measures overall adherence to medications. The grading is done based on the scoring criteria, i.e., high adherence, good adherence, partial adherence, low and poor adherence. The scale can provide overall grading as well as grading for each domain for a patient that helps in understanding individual adherence issues. The tool was subjected to reliability analysis using Cronbach alpha and a value of >0.5 was considered satisfactory (Cronbach, 1951; Nunnaly, 1978; Hatcher, 1994). The GMAS with scoring is available from Naqvi and colleagues on request (Naqvi et al., 2018a; Naqvi et al., 2019c).

The data obtained was entered in IBM SPSS, i.e., Statistical Package for Social Sciences version 23 (SPSS Inc. Chicago, IL, USA) software and analyzed. Demographic data was expressed in frequency counts (N), percentages (%). Statistical tests were selected based on data normality. Shapiro Wilk test for normality was conducted to determine data distribution (Shapiro & Wilk, 1965). For non-parametric data, chi square $\chi 2$ test, and Spearman's correlation (ρ) were used to report any association of patients' variables with medication adherence. Significant associations were reported in p values less than 0.05 and correlation coefficients between (-1.0 and +1.0).

The participants were sought consent before handing the questionnaire. They were briefed about the study objectives and procedure. The participation was voluntary and only those who consented to participate were handed the questionnaire. The study was approved by the Institutional Review Board of Imam Abdulrahman Bin Faisal University, Dammam. (IRB-UGS-2019-05-001).

DATA ANALYSIS

The reliability of GMAS was above 0.5, i.e., Cronbach alpha (α) = 0.816. A total of 212 patients responded to the study. The demographic information of respondents revealed that most of the patients were male (N = 142, 67%) and a third were females (N = 70, 33%). Mean age of patients was 44 years (44.17 ± 15.6 years). Besides, most of them were married (N = 156, 73.6%) and had education up to graduation level, i.e., 16 years of education (N = 98, 46.2%). Most patients had a monthly family income above SAR 10,000 (N = 114, 53.8%) and full insurance (N = 126, 59.4%). Half proportion of patients (N = 114, 53.8%) had no comorbidity. Mean HbA1c was 8.57 ± 2.3. Mean random blood sugar at the time of data collection was 193.4 ± 78.4 mg/dl. Patients had an average of two anti-diabetic medicines per prescription (Table 1).

Table 1: Demographic information.

Demographic information	Total (N/%)	Male (N)	Female (N)
Marital status			
Married	156/73.6	118	38
Single	44/20.8	22	22
Other (Divorced, widowed)	12/5.7	2	10
Years of education			
Up to 6 years (Primary)	20/9.4	12	8
Up to 10 years (Secondary)	74/34.9	10	10
Up to 12 years (Intermediate)	20/9.4	52	22
Up to 16 years (Graduation)	98/46.2	68	30
Monthly family income			
Less than SAR 5000, i.e., < USD 1332.88	36/17	24	12
Between SAR 5000 to 7500, i.e., between USD 1332.88 to 1999.31.	24/11.3	10	14
Between SAR 7500 to 10000, i.e., between USD 1999.31 to 2665.75.	38/17.9	24	14
Above SAR 10000, i.e., > USD 2666.75	114/53.8	84	30
Co-morbidity			
No comorbidity	114/53.8	64	50
Comorbidity present	98/46.2	78	20
Insurance			
Full insurance	126/59.4	80	46
Partial insurance	46/21.7	28	18
No insurance	40/18.9	34	6

Patient Medication Adherence

The mean score for overall adherence to anti-diabetic medications was 26.34 ± 5.6 out of 33. A third of patients were highly adherent (N = 76, 35.8%). Besides, the mean score for patients behavior related non-adherence (PBNA), was 11.61 ± 3.3 out of 15. Half of patients (N = 108, 50.9%) had high adherence. Additionally, the mean score for comorbidity and pill burden related non-adherence (ADPB), was 9.63 ± 2.4 out of 12. Slightly less than half of patients (N = 100, 47.2%) had high adherence. Moreover, the mean score for cost related non-adherence (CRNA), was 5 ± 1.2. More than half of patients (N = 116, 54.7%) had high adherence (Table 2).

Table 2: Adherence results.

GMAS Adherence scores	Total (N/%)	Male (N)	Female
PBNA score			
High adherence (13–15)	108/50.9	74	34
Good adherence (11–12)	32/15.1	20	12
Partial adherence (8–10)	48/22.6	34	14
Low adherence (5–7)	18/8.5	10	8
Poor adherence (0–4)	6/2.8	4	2
ADPB score			
High adherence (11–12)	100/47.2	70	30
Good adherence (9–10)	56/26.4	36	20
Partial adherence (6–8)	42/19.8	26	16
Low adherence (4–5)	8/3.8	6	2
Poor adherence (0–3)	6/2.8	4	2
CRNA score			
High adherence (6)	116/54.7	86	30
Good adherence (5)	40/18.9	16	24
Partial adherence (3–4)	46/21.7	30	16
Low adherence (2)	10/4.7	10	0
Poor adherence (0–1)	0/0	0	0
Overall adherence			
High adherence (30–33)	76/35.8	54	22
Good adherence (27–29)	48/22.6	28	20
Partial adherence (17–26)	74/34.9	52	22
Low adherence (11–16)	10/4.7	4	6
Poor adherence (0–10)	4/1.9	4	0

There was no statistical association of gender with adherence scores ($p > 0.05$) except for cost-related non-adherence (CRNA) score, where p value was less than 0.01, ($\chi 2 = 20.84$, $p = 0.000$). In this domain of adherence most male patients had slightly better adherence score compared to females.

Relationship Between HbA1c and Adherence Scores

There was a negative relationship as a significantly moderate-to-strong correlation between HbA1c and PBNA score ($\rho = –0.326$, $p < 0.01$) was reported. Besides, the correlation between glycated hemoglobin and ADPB score was significantly moderate ($\rho = –0.231$, $p < 0.01$). Moreover, the correlation between CRNA score and glycated hemoglobin level was significantly moderate-to-strong ($\rho = –0.273$, $p < 0.01$). Figure 1 depicts the relationship between HbA1c (%) and adherence scores of PBNA, ADPB, and CRNA. The linear line represents relationship while dotted lines represent 95% confidence interval range. The colored circles represent individual patient data. The charts in the diagonal matrices show data distribution.

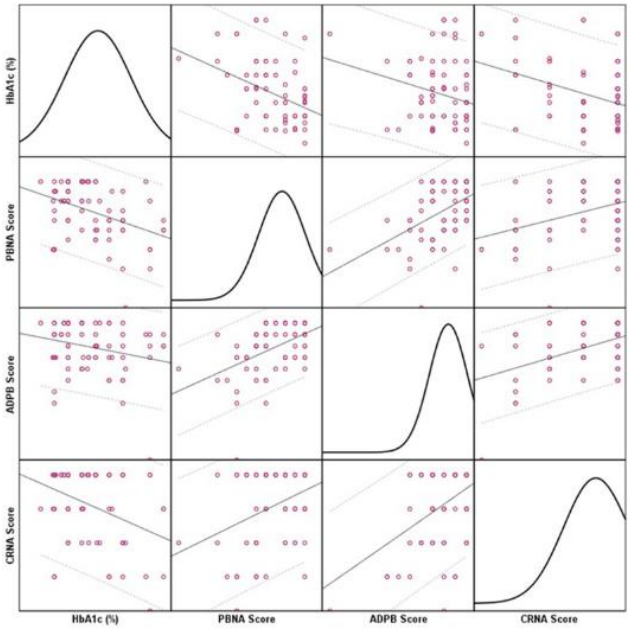

Figure 1: Correlations Between HbA1c and Individual Adherence Scores.

The correlation between HbA1c level and overall adherence score was significantly strong ($\rho = –0.409$, $p < 0.01$) Additionally, patient age was positively correlated with overall adherence score ($\rho = 0.193$, $p < 0.01$). The age of patients was also positively correlated with number of medicines per prescription ($\rho = 0.183$, $p < 0.01$). Figure 2 depicts the relationships among age, medicines per prescription, HbA1c (%) and overall adherence score. The linear line represents relationship while dotted lines represent 95% confidence interval range. The colored circles represent individual patient data. The charts in the diagonal matrices show data distribution.

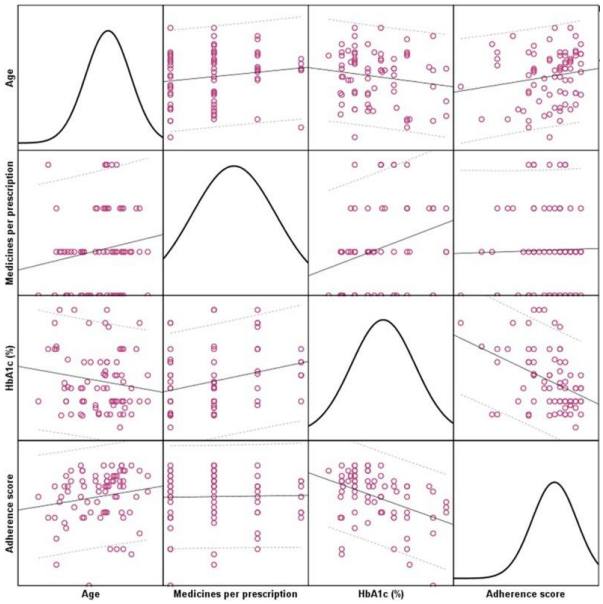

Figure 2: Correlations among age, medicines per prescription, HbA1c (%) and overall adherence score.

Medication adherence score

Figure 3 shows the distribution of medication adherence scores. Of the 178 participants, 34.3% had high adherence (score of eight), 42.8% had moderate adherence (score of 6-7), and 22.9% had low adherence (score less than six). These categories were based on established cutoff scores for the scale.

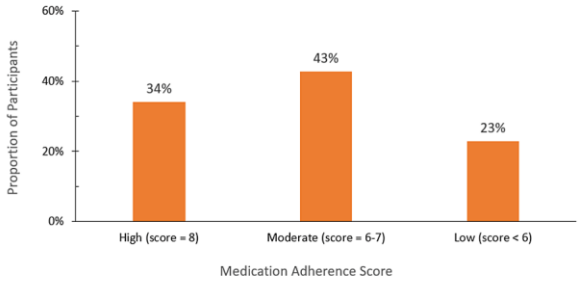

Figure 3: Medication adherence score distribution

Medication-related factors associated with medication adherence

Medication-related factors that were significantly associated with medication adherence included the number of medications prescribed, medication complexity, and medication cost. Patients who were prescribed more medications were less likely to adhere to their medications (p = 0.04). Patients who perceived their medication regimen as complex were also less likely to adhere to their medications (p = 0.03). Patients who reported that the cost of their medications was a financial burden were also less likely to adhere to their medications (p = 0.01) (Table 3).

Table 3: Bivariate analysis results for medication-related factors

Characteristics		Medication Adherence Score Mean	p-value
Number of Medications	<3	7.2	0.04
	3-5	4.5	
	>5	3.2	
Frequency of Medication	Once daily	6.8	0.03
	Twice daily	7.1	
	Three times daily	4.8	
	Four times daily	5.2	

CONCLUSION

Majority of patients had unsatisfactory levels of adherence to anti diabetic medicines. Based on results, it was observed that experience with disease and medication regimen may promote adherence. Patients tended to modify their regimen during festivities such as Ramadan and Eid. Educated and un-educated patients had equal chance of being adherent/non-adherent. There was no relationship between monthly family income and adherence as medicines were available to patients without any out-of-pocket expenditure. This study highlights that medication adherence may be affected by religious and social events in this population. Patient counseling is required to improve patient beliefs and increase awareness of sticking to prescribed therapy. medication-related factors such as the number of prescribed medications, medication complexity, and medication cost were found to be significant predictors of medication adherence

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