Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

Evaluation of Medication Adherence Among Diabetic Patients and Assessing the Role of Pharmacist Interventions in Improving Adherence

Rosmin Jacob[1], Blessy Biju[2], Foicy Paul .K[3], Krishna Kumar K[4]

[1]Assistant Professor, Department of Pharmacy Practice, St James College of Pharmaceutical Sciences, Chalakudy, Kerala.

[2]Pharm D, St James College of Pharmaceutical Sciences, Chalakudy, Kerala.

[3]M pharm, St James College of Pharmaceutical Sciences, Chalakudy, Kerala.

[1,2,3,4]St James College of Pharmaceutical Sciences (NAAC Accredited), St James Hospital Trust Pharmaceutical Research Centre (DSIR Recognized) Chalakudy, Kerala.

(Received: 16 May 2025 Revised: 20 June 2025 Accepted: 02 July 2025)

KEYWORDS

medication adherence, diabetes, pharmacist counselling, health education

ABSTRACT:

Background; Diabetes, prevalent among Indians, presents significant management challenges and rising complications. Poor adherence leads to inadequate glycemic control and increased mortality risk.

Methods; A 9-month prospective observational study at a tertiary care hospital assessed medication adherence in 110 diabetic patients using the Morisky Medication Adherence Scale (MMAS). Patients were divided into Control and Intervention groups. The Control group received counseling and Patient Information Leaflets (PILs) after the initial evaluation and was then followed up after one month, effectively forming the Intervention group. The chi-square test analyzed adherence differences, and binary logistic regression identified predictors of adherence, with significance set at $p < 0.05$.

Result; The prevalence of low medication adherence was observed in 36% of patients, medium in 43%, and high in 31%. In the intervention group, adherence improved significantly: 20% low, 42% medium, and 48% high following pharmacist intervention ($\chi 2=7.505$, $p= 0.023$). Common barriers included forgetfulness, laziness, and polypharmacy. Predictors of low and medium adherence were rural living (low: AOR = 0.01, $p = 0.019$; medium: AOR = 0.12, $p = 0.020$), longer diabetes duration (low: AOR = 1.774, $p = 0.031$; medium: AOR = 1.42, $p = 0.003$), and comorbidities (low: AOR = 12.13, $p = 0.041$; medium: AOR = 2.04, $p = 0.029$). Additionally, low adherence was linked to unemployment and insulin therapy, while medium adherence was associated with alcohol consumption.

Conclusion; Pharmacist-led interventions significantly improved medication adherence. Enhanced communication between patients, doctors, and pharmacists is crucial for improving compliance, quality of life, and therapeutic outcomes.

1. Introduction

Diabetes mellitus encompasses a range of metabolic disorders marked by persistent hyperglycemia resulting from issues with insulin secretion, its action, or both. These complications lead to metabolic disturbances in carbohydrates, lipids, and proteins.[1] As of 2021, diabetes mellitus poses a significant global health challenge, affecting approximately 536.6 million individuals worldwide, with projections indicating an increase to 783.2 million by 2045.[2] In India alone, 77 million individuals aged 20-79 are living with diabetes, a figure expected to rise to 134.2 million by 2045, according to the International Diabetes Federation.[3] Effective diabetes management necessitates continuous medical care and strategies aimed at risk reduction that extend beyond merely controlling blood sugar levels. Ongoing self-management education and support are vital for preventing acute complications and minimizing long-term health risks.[4]

Adherence to medication is essential for enhancing health outcomes in diabetes care. This adherence reflects

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

how well an individual's actions—such as taking prescribed medications, adhering to dietary guidelines, and implementing lifestyle changes—align with the recommendations provided by healthcare professionals.[5] Insufficient adherence can result in poor glycemic control, thereby heightening the risk of complications and mortality associated with diabetes.[6] A systematic review and meta-analysis revealed that the overall rate of non-adherence to anti-diabetic medications was 43.4% when assessed using the MMAS-8 scale, 29.5% with the MMAS-4, and 29.1% based on an 80% or 90% adherence threshold.[7] Research indicates that enhancing medication adherence can lead to significant reductions in HbA1c levels. For instance, Schectman et al. identified a 0.16% decrease in HbA1c for every 10% increase in adherence[8], while Ho et al. noted a 0.05% reduction for each 25% increase in adherence to oral hypoglycemic agents[9]. Various factors contribute to low adherence rates, including age, social and psychological influences, educational background, and a lack of awareness regarding the long-term benefits of treatment. Additionally, the complexity and expense of medication regimens, negative perceptions of treatment, ineffective communication between doctors and patients, adverse effects such as weight gain and hypoglycemia, and inadequate adjustments to medication regimens can further hinder adherence.[10]

Pharmaceutical care is defined as “the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient’s quality of life”.[11] Interventions led by pharmacists to boost medication adherence among adults with diabetes encompass educational initiatives, behavioral strategies, and integrated methods. Pharmacists play a vital role by offering education, conducting medication reviews, providing consultations, making follow-up calls, and distributing informative materials. These efforts improve patients' comprehension of diabetes management, which includes monitoring treatment and implementing lifestyle modifications. Such interventions have effectively enhanced medication adherence and glycemic control, particularly when paired with group discussions or prolonged follow-up to evaluate long-term effectiveness.[12] Counseling directed by pharmacists, along with reminder messages, has notably increased medication adherence and improved glycemic control, blood pressure, and lipid profiles in diabetic patients, leading to a greater reduction in mean HbA1C levels in the intervention group compared to the control group[13]. A recent meta-analysis indicated that pharmacist-led interventions significantly enhance HbA1c, blood pressure, LDL-C levels, BMI, and medication adherence in individuals with type 2 diabetes.[14]

People-centered care, beliefs regarding medications, and adherence are interconnected in adults who regularly use at least three medications daily.[15] Effective communication techniques, such as asking questions thoughtfully and allowing patients to speak without interruption, can enhance adherence[16]. Research indicates that prioritizing patient involvement and fostering a strong patient-provider relationship leads to improved adherence and better health outcomes by personalizing treatment and engaging patients in their care.[17] Patient-centered care honors the unique needs and values of each individual, informing all clinical decisions. Additionally, collaborative care teams and telemedicine play a significant role in diabetes management, with studies demonstrating that telemedicine can effectively lower A1C levels. Facilitating behavior change through diabetes self-management education is essential for achieving successful care.[18]

The current study aimed to investigate medication adherence among diabetic patients and assess pharmacist interventions to improve compliance. It focused on identifying barriers to adherence, educating patients on medications and disease management, increasing awareness, and enhancing health outcomes through counseling.

2. Materials and methods

Study design and setting

A prospective observational study was conducted for 9 months among the diabetic population in the setting of a 450-bed tertiary care hospital attached to a Drug Information Center. The setting ensured a varied sample and facilitated access to medical records and patient interviews.

Inclusion and exclusion criteria

The study enrolled 110 patients diagnosed with diabetes at a tertiary care hospital, meeting specific inclusion criteria. Inclusion criteria consisted of patients admitted with a diabetes diagnosis in medical, cardiac, orthopaedic, surgical, and gynaecology wards, aged between 10 and 80 years, and able to participate in diabetic questionnaires and cooperate. Exclusion criteria included patients below 10 or above 80 years of age,

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

those unwilling to participate in the study, and psychiatric patients with diabetes in these wards.

Ethical clearance

The study was approved by the Institutional Ethics Committee (IEC) with Approval No. SJPCEC/P25/PP/2014/005 of the St James' College of Pharmaceutical Sciences, Chalakudy, Kerala, India.

Study procedure

Diabetic patients admitted to the hospital at the study site were reviewed daily. Patients meeting the study criteria were briefly informed about the research study. Those willing to participate provided informed consent, after which data were collected through interviews. Using a pre-formed questionnaire, the selected patients were interviewed regarding their socio-demographic characteristics, clinical and lifestyle behaviors, and barriers to adherence to pharmacotherapy. Medication adherence was assessed using the Morisky Medication Adherence Scale (MMAS). A total of 110 patients were included in the study and divided into two groups: Control and Intervention. Patients were divided into Control and Intervention groups. The Control group received counseling and Patient Information Leaflets (PILs) regarding diabetes and its management after the initial evaluation and was then followed up after one month, effectively forming the Intervention group. Adherence and barriers to treatment were assessed during personal patient interviews. Outcomes were recorded after one month via telephone for the Intervention group by assessing the medication adherence using Morisky Medication Adherence Scale (MMAS). Evaluation of patient compliance was measured by changes in their scores before and after counseling in both groups.

Study instruments

Data collection form

The data collection form included sections like demographic data, laboratory data, social habits, diagnosis, family history, duration of diabetes, barriers to adherence, past medical history, past medication history, current therapy, etc.

Morisky Medication Adherence Scale (MMAS)

Medication adherence to diabetes medicine was determined by using a modified version of the eight-item validated self–reported Morisky Medication Adherence Scale (MMAS) for both control and intervention groups. In this scale, the first seven questions had binary response categories (yes/no) where 0 is given to a 'yes' response and 1 is given to a 'no' response. while the eighth item had a five-point Likert response. Total MMAS-8 scores can range from 0 to 8 and have been categorized into three levels of adherence: high adherence (score = 8), medium adherence (score of 6 to < 8), and low adherence (score< 6).[19]

Statistical analysis

The documented data were analyzed using simple statistical methods. The chi-square test was done to find out the association between medication adherence between the control group and intervention group. Binary logistic regression analysis was performed to identify the predictors of low and medium medication adherence, with comparisons made against high adherence (low vs. high and medium vs. high). A P-value of less than 0.05 was considered statistically significant.

3. Results

Sociodemographic Characteristics of Diabetic Patients

The study included 110 participants, with a distribution of males (45%) and females (55%). Most participants were aged 51-60 years (33%). The majority were employed (62%) and came from a middle socioeconomic status (76%). A significant portion were married (81%) and had high school education (50%). Urban residents comprised 60% of the participants.

Table 1: Sociodemographic Characteristics of Diabetic Patients

Variable	Frequency (n)	Percentage (%)
Gender		
Male	49	45
Female	61	55
Age		
10-20	2	2
21-30	8	7
31-40	10	9
41-50	13	12
51-60	36	33
61-70	28	25
71-80	13	12
Employment status		
Employed	68	62
Un employed	42	38

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

Socio economic status		
Higher middle	4	4
Middle	84	76
Lower middle	22	20
Marital status		
Married	89	81
Unmarried	21	19
Educational status		
Primary	12	11
High school	55	50
Above high school	43	39
Place of residence		
Urban	66	60
Rural	44	40

Clinical characteristics and lifestyle behaviours of the diabetes patients

Among the participants, 30% had hypertension, 13% had cardiovascular disease, and 15% had no comorbidities. Most had a family history of diabetes (74%) and were diagnosed with Type II diabetes (80%). The majority had diabetes for less than 10 years (75%). Socially, 39% had no significant social history, while 29% were alcoholics other than that, 21% were both smokers and alcoholics. In terms of treatment, 44% were on insulin, oral hypoglycemic agents (10%), insulin plus OHA (7%), lifestyle modifications (21%), and OHA combined with lifestyle modifications (18%). Commonly used drugs were insulin (44%) and a combination of Glimepiride and Metformin (33%). Physical activity levels are low, with more than half (52%) engaging in less than 30 minutes per week.

Table 2: Clinical characteristics and lifestyle behaviours of the diabetes patients

Variable	Frequency (n)	Percentage (%)
Comorbidities		
Hypertension	33	30
RTI	5	4
Renal impairment	1	1
Hepatic dysfunction	1	1
UTI	9	8
Stress	4	4
Visual impairment	10	9
Obesity	4	4
Diabetic foot	12	11
CVD	14	13
No comorbidities	17	15
Family history of diabetes		
Yes	82	74
No	28	26
Types of DM		
Type I	2	2
Type II	88	80
Gestational diabetes	20	18
Duration of DM		
<10	83	75
10-20	23	21
>20	4	4
Social history		
Smoker	9	8
Alcoholic	32	29
Smoker+ alcoholic	22	21
Tobacco in any form	2	2
No social history	43	39
Treatment regimen		
Insulin	48	44
Oral hypoglycemic agents	11	10
Insulin+ OHA	8	7
Lifestyle modifications	23	21
OHA+ lifestyle modifications	20	18
Current medications		
Insulin	48	44
Glimepiride	20	18
Metformin	16	14
Glibenclamide	6	5
Glipizide	3	3
Gliclazide	3	3
Glimepiride+ metformin	36	33
Gliclazide + metformin	8	7
Sitagliptin + metformin	5	4
Glipizide + metformin	12	12
Glimepiride+metformin +voglibose	1	1
Physical activity (minutes per week)		
None	57	52
<30 (mild)	19	17
30–45 (moderate)	8	7
>45 (vigorous)	26	24

Distribution of patients based on barriers to medication adherence

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

Among the 110 individuals with diabetes, various barriers to medication adherence were observed. The most prevalent barrier was laziness for taking drugs, affecting 29% of the participants. Forgetfulness was another significant barrier, reported by 23% of individuals. Polypharmacy, or managing multiple medications, was a challenge for 15% of participants. The presence of other diseases and lack of knowledge were each cited by 11% of participants as barriers to adherence. Additionally, the cost of medications was a concern for 6% of individuals, while fear of side effects was reported by 4% of participants. Helping individuals remember to take their medication and finding ways to simplify the process could significantly improve diabetes management for these individuals.

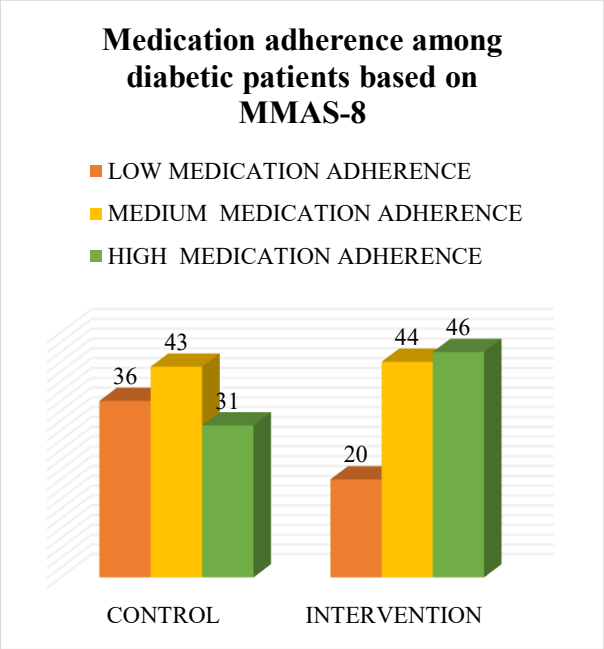
Table 3: Distribution of patients based on barriers to medication adherence

Various barriers	Frequency %
Forgetfulness	25(23)
Fear of side-effects	5(4)
Presence of other disease	12(11)
Laziness for taking drugs	32(29)
Cost of medications	7(6)
Lack of knowledge	12(11)
Polypharmacy	17(15)

Adherence level in control and intervention group

Medication adherence was evaluated using the MMAS-8 scale. In the control group, 36% of patients had low adherence, 43% had medium adherence, and 31% achieved high adherence. Conversely, in the intervention group, 20% of patients exhibited low adherence, 42% had medium adherence, and a notable 48% reached high adherence. This significant improvement in the intervention group suggests that the measures taken, such as patient counselling and educational support, positively influenced medication adherence among diabetic patients.

Figure 1: Adherence level in control and intervention group



Association of adherence levels in control and intervention group

The study assessed the impact of pharmacist counseling on medication adherence levels between control and intervention groups. In the control group, adherence levels were low for 36 participants, medium for 43 participants, and high for 31 participants, totaling 110. In the intervention group, which received pharmacist counseling, adherence levels improved with 20 participants at low adherence, 44 at medium adherence, and 46 at high adherence, also totaling 110. The chi-square test (p=0.023*) indicated a significant improvement in adherence levels in the intervention group compared to the control group.

Table 4: Association of adherence levels in control and intervention group

Group	Adherence level			Total	χ^2 test
	Low	Medium	High		
Control	36	43	31	110	χ^2=7.505, df=2, p= 0.023*
Intervention	20	44	46	110	

*Significant at 0.05 level

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

Predictors of low medication adherence among the control group

The study results indicate that adherence to medication among diabetic patients varied based on several factors using binary logistic regression analysis. In the case of low vs. high levels of adherence, employment status and urban residency positively impacted adherence, whereas rural residency and unemployment were linked to lower adherence rates (COR = 29.00, AOR = 0.01, p = 0.019 for residence; COR = 9.20, AOR = 0.002, p = 0.030 for occupation). Patients on oral therapy alone showed better adherence compared to those on insulin therapy (COR = 7.33, AOR = 8.14, p = 0.017). In contrast, those with longer durations of diabetes (over 5 years) and those with comorbidities were associated with lower adherence (COR = 2.27, AOR = 1.774, p = 0.031 for duration; COR = 1.11, AOR = 12.13, p = 0.041 for comorbidities).

For medium vs. high adherence levels, urban residency positively impacted adherence, whereas rural residency was linked to lower adherence rates (COR = 10.44, AOR = 0.12, p = 0.020 for residence). Patients with longer durations of diabetes (over 5 years) and those with comorbidities were associated with medium adherence (COR = 0.34, AOR = 1.42, p = 0.003 for duration; COR = 1.54, AOR = 2.04, p = 0.029 for comorbidities). Additionally, alcohol consumption was linked to medium level of adherence rates (COR = 0.28, AOR = 4.31, p = 0.018).

Table 5: Predictors of low medication adherence among the control group

Variable	Low vs High			Medium vs High		
	COR (95% Cl)	AOR (95% Cl)	P Value	COR (95% Cl)	AOR (95% Cl)	P Value
Age (≤ 55 vs >55)	0.67 (0.26-1.76)	0.02 (0-1.05)	0.053	0.56 (0.22-1.42)	0.59 (0.18-1.91)	0.378
Sex (female vs male)	0.52 (0.20-1.37)	0.67 (0.08-5.88)	0.714	1.35 (0.52-3.49)	0.58 (0.16-1.96)	0.363
Residence (rural vs urban)	29.00 (5.90-142.45)	0.01 (0-0.44)	0.019*	10.44 (2.20-49.47)	0.12 (0.02-0.72)	0.020*
Education (Above High school vs below)	0.61 (0.23-1.63)	0.55 (0.28-10.85)	0.695	0.79 (0.31-2.02)	1.04 (0.27-4.02)	0.957
Occupation (employed vs not employed)	9.20 (2.84-29.77)	0.002 (0-0.54)	0.030*	2.51 (0.80-7.93)	0.45 (0.099-2.059)	0.304
Marital status (married vs unmarried)	1.71 (0.58-5.10)	0.13 (0.01-2.68)	0.186	0.17 (0.03-0.87)	5.10 (0.70-37.09)	0.108
Type of medication (oral vs insulin with/ without oral)	7.33 (2.49-21.64)	8.14 (2.20-30.19)	0.017*	2.81 (1.06 7.49)	3.01 (0.87-10.47)	0.083
Comorbidities (yes vs no)	1.11 (1.21-5.32)	12.13 (0.36-41.34)	0.041*	1.54 (1.07-3.56)	2.04 (1.26-4.17)	0.029*
Duration of DM (>5 vs ≤5)	2.27 (1.12-3.74)	1.774 (0.13-24.65)	0.031*	0.34 (0.13-0.90)	1.42 (1.12-2.53)	0.003*
Alcohol (yes vs no)	0.13 (0.43-0.39)	0.55 (0.04-7.70)	0.659	0.28 (0.099-0.78)	4.31 (1.88-12.52)	0.018*

*Significant at 0.05 level

4. Discussion

This study aimed to evaluate barriers to adherence in diabetic patients and improve health outcomes through pharmacist counselling. Non-adherence to diabetes management can result in inadequate disease control and an increased burden of illness. Enhanced adherence is anticipated to contribute to lower glycosylated A1C levels, diminishing complications risks and reducing healthcare expenditures. Essential behaviors associated

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

with diabetic adherence encompass medication intake, adherence to dietary guidelines, increased physical activity, self-monitoring of blood glucose levels, and proper foot care.[20] Effective medication adherence is also linked to a decreased risk of mortality and hospitalization among individuals with type 2 diabetes.[21]

In our study, the majority of participants fell within the 51-60 age range, with 93 individuals presenting comorbid conditions alongside diabetes. The primary barriers to medication adherence identified were laziness (29%), forgetfulness (23%), and polypharmacy (15%). These findings are consistent with those of Scarton et al. (2019)[22] and Wheat et al. (2020)[23], who identified forgetfulness, laziness, adverse effects, and knowledge deficits as significant impediments. Smaje A. et al. (2018) noted that polypharmacy and elevated levels of comorbidity correlate with increased instances of poor to non-adherence in older populations[24]. Type 2 diabetes mellitus was notably prevalent in our sample, accounting for 80% of the participants. Our results indicated that 28.2% (31/110) of patients exhibited high medication adherence, while 39.1% (43/110) demonstrated moderate adherence, and 32.7% (36/110) showed low adherence according to the MMAS-8 scale. This underscores that a significant proportion of respondents experience low adherence levels, with 32.7% classified as having poor adherence. This figure is lower than the rates of 36.7%, 39.8%, 42.8%, and 45.2% reported in studies from Tanzania[25], Bangladesh[26], Ethiopia[27], and China[28], respectively, yet higher than the 27% reported in the United States[29]. The prevalence of good or high adherence levels in our study was found to be 28.2%, which surpasses the 16.6% reported by Sharma et al. (2014)[30] but is lower than the 34.14% reported by Epari V et al. (2022)[31] in research conducted in India. The discrepancies in adherence rates may be attributed to variations in contextual factors.

The study found that living in rural areas and unemployment are key predictors of low to medium medication adherence. Rural residents often face limited healthcare access and information, while unemployed individuals may struggle due to financial constraints and reduced healthcare resources. Patients on oral therapy alone showed better adherence compared to those on insulin therapy. A 2015 study indicated that as many as 44.3% of patients with Type 2 Diabetes (T2D) may not adhere to their insulin treatment plan, resulting in suboptimal blood sugar management and an increased likelihood of microvascular complications.[32] The presence of comorbidities was significantly associated with medication adherence. Diabetes patients who had comorbidities were 2.04 times more likely to have low medication adherence compared with patients who had no comorbidities. Patients suffering from a longer duration of diabetes had 1.77 times the odds of low medication adherence. Alcohol also increases the odds of having low adherence by 4.31 times compared to non-alcoholics. In previous studies, it was shown that the presence of comorbidities and alcoholism among patients with T2DM was significantly associated with low medication adherence.[25,31,33,34]

The study highlighted significant improvements in medication adherence among diabetes patients through pharmacist-led education such as counselling and providing them with patient information leaflets about diabetes and its management, with 44% in the intervention group achieving high adherence compared to 4% in the control group using MMAS-8. This underscores the crucial role of pharmacists in patient education, enhancing therapeutic outcomes and quality of life. Various studies have demonstrated the effectiveness of pharmacist interventions in improving adherence. For instance, a study in India showed that pharmacist-directed counseling and message reminders significantly improved medication adherence, glycemia, blood pressure, and lipid profiles in diabetes patients compared to usual care. The intervention group showed greater increases in adherence ($12.2 \pm 7.1\%$ vs. $0.75 \pm 10.2\%$, $P < 0.001$) and reductions in HbA1C, SBP, and LDL cholesterol ($P < 0.01$).[35] Similarly, in Indonesia, both pharmacists and patients favored educational services, preferring direct consultations and counselling along with alternatives like reminders, seminars, or home care. However, barriers such as limited resources, high patient volumes, and administrative duties need addressing to enhance pharmaceutical care.[36]

Pharmacist-led interventions, including the use of mobile telephony for health education, have been shown to enhance medication refills, glycemic control, knowledge, and adherence.[37] Innovative approaches like SMS reminders and pillboxes have significantly improved adherence, leading to better blood sugar management, fewer complications, reduced hospitalizations, lower healthcare costs, and decreased mortality rates.[38] Additionally, a pharmacist-led smartphone app enhanced medication compliance, insulin use, and glycemic control in women with gestational diabetes using multiple daily insulin

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

injections, reducing insulin needs and NICU admissions by 22.9% and enhancing both antepartum and postpartum glycemic management.[39] Pharmacist interventions not only improve patient compliance and satisfaction with care but also contribute to overall quality of life by reducing blood sugar and blood pressure levels.[40]

A limitation of the study is the unavailability of HbA1C data, which prevented the assessment of the full impact of counseling on glycemic control in diabetes management.

5. Conclusion

Patient compliance is crucial in managing chronic diseases like diabetes. Patients must adhere to medication, diet control, lifestyle changes, and regular blood glucose monitoring and complications for full therapeutic benefit. Barriers to medication adherence include forgetfulness, laziness, and polypharmacy. Predictors of poor adherence are rural living, unemployment, insulin use, comorbidities, long-term diabetes, and alcoholism. Effective counselling enhances compliance. Pharmacists improve adherence by educating patients and families on disease management, diet, and lifestyle changes and using tools like pill boxes and reminders. Better communication between patients, doctors, and pharmacists improves compliance, quality of life, and therapeutic outcomes.

Refrences

1. Kharroubi AT. Diabetes mellitus: the epidemic of the century. World J Diabetes. 2015;6(6):850.
2. Sun H, Saeedi P, Karuranga S, et al. IDF diabetes atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022;183:109119. doi:10.1016/j.diabres.2021.109119
3. IDF. IDF Diabetes Atlas [Internet]. Vol 9. IDF: 2019. Available from: https://www.diabetesatlas.org/upload/resources/material/20200302_133351_IDFATLAS9e-final-web.pdf
4. ElSayed NA, Aleppo G, Aroda VR, et al. Introduction and Methodology: Standards of Care in Diabetes-2023. Diabetes Care. 2023;46(Suppl 1):S1-S4. doi:10.2337/dc23-Sint
5. World Health Organization. Adherence to long-term therapies: evidence for action. Geneva: World Health Organization. 2003. Available at: http://apps.who.int/medicinedocs/pdf/s4883e/s4883e.pdf
6. Khunti, N., Khunti, N., & Khunti, K. (2019). Adherence to type 2 diabetes management. British Journal of Diabetes, 19(2), 99-104. https://doi.org/10.15277/bjd.2019.223
7. Azharuddin M, Adil M, Sharma M, Gyawali B. A systematic review and meta-analysis of non-adherence to anti-diabetic medication: Evidence from low- and middle-income countries. Int J Clin Pract. 2021 Nov;75(11):e14717. doi: 10.1111/ijcp.14717.
8. Schectman JM, Nadkarni MM, Voss JD. The association between diabetes metabolic control and drug adherence in an indigent population. Diabetes Care 2002;25:1015–21. 10.2337/diacare.25.6.1015
9. Ho PM, Rumsfeld JS, Masoudi FA, et al.. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. Arch Intern Med 2006;166:1836–41. 10.1001/archinte.166.17.1836
10. García-Pérez LE, Alvarez M, Dilla T, Gil-Guillén V, Orozco-Beltrán D. Adherence to therapies in patients with type 2 diabetes. Diabetes Ther. 2013;4(2):175-194. doi:10.1007/s13300-013-0034-y
11. Helper CD, Strand LM. Opportunities and responsibilities in pharmaceutical care. *Am J Hosp Pharm.* 1990;47(3):533–543.
12. Presley B, Groot W, Pavlova M. Pharmacy-led interventions to improve medication adherence among adults with diabetes: A systematic review and meta-analysis. Res Social Adm Pharm. 2019 Sep;15(9):1057-1067.
13. Goruntla N, Mallela V, Nayakanti D. Impact of Pharmacist-directed Counseling and Message Reminder Services on Medication Adherence and Clinical Outcomes in Type 2 Diabetes Mellitus. J Pharm Bioallied Sci. 2019;11(1):69-76.
14. Zhang L, Lin H, Wu W, Zhuang J, Huang L, Wang Y, Liu J, Hu C, Wei X. A meta-analysis of the impact of pharmacist interventions on clinical outcomes in patients with type-2 diabetes. Patient Educ Couns. 2024 Mar;120:108091.
15. Dilles T, Mortelmans L, Loots E, Sabbe K, Feyen H, Wauters M, Haegdorens F, De Baetselier E. People-centered care and patients' beliefs about medicines and adherence: A cross-sectional study. Heliyon. 2023 May 2;9(5):e15795.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(4), 617-626 | ISSN:2251-6727

16. Lowes R. Patient-centered care for better patient adherence. Fam Pract Manag. 1998 Mar;5(3):46-7, 51-4, 57. PMID: 10178365.
17. Robinson JH, Callister LC, Berry JA, Dearing KA. Patient-centered care and adherence: definitions and applications to improve outcomes. J Am Acad Nurse Pract. 2008 Dec;20(12):600-7.
18. American Diabetes Association; Standards of Medical Care in Diabetes—2022 Abridged for Primary Care Providers. Clin Diabetes 1 January 2022; 40 (1): 10–38. https://doi.org/10.2337/cd22-as01
19. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting [retracted in: J Clin Hypertens (Greenwich). 2023 Sep;25(9):889. doi: 10.1111/jch.14718 J Clin Hypertens (Greenwich). 2023 Sep;25(9):890. doi: 10.1111/jch.14712]. J Clin Hypertens (Greenwich). 2008;10(5):348-354. doi:10.1111/j.1751-7176.2008.07572.x
20. Gonzalez JS, McCarl LA, Wexler D DD, et al. Cognitive Behavioral Therapy for Adherence and Depression (CBT-AD) in Type 2 Diabetes. J Cogn Psychother. 2010;24(4):329-343. doi:10.1891/0889-8391.24.4.329
21. Kamlesh Khunti, Samuel Seidu, Setor Kunutsor, Melanie Davies; Association Between Adherence to Pharmacotherapy and Outcomes in Type 2 Diabetes: A Meta-analysis. Diabetes Care 1 November 2017; 40 (11): 1588–1596. https://doi.org/10.2337/dc16-1925
22. Scarton L, Velazquez I, O'Neal LJ, et al. Developing a culturally tailored multigenerational intervention to prevent and manage type 2 diabetes in American Indian families living in rural settings: Findings from a focus group study. Res Nurs Health. 2019;42(3):226-233. doi:10.1002/nur.21941
23. Wheat L, Roane TE, Connelly A, Zeigler M, Wallace J, Kim JH, Segal R. Using a pharmacist-community health worker collaboration to address medication adherence barriers. J Am Pharm Assoc (2003). 2020 Nov-Dec;60(6):1009-1014. doi: 10.1016/j.japh.2020.08.021.
24. Smaje A, Weston-Clark M, Raj R, Orlu M, Davis D, Rawle M. Factors associated with medication adherence in older patients: A systematic review. Aging Med (Milton). 2018 Dec;1(3):254-266. doi: 10.1002/agm2.12045. Epub 2018 Nov 30.
25. Irene F Doya, James J Yahaya, Advera I Ngaiza, Deogratius Bintabara, Low medication adherence and its associated factors among patients with type 2 diabetes mellitus attending Amana Hospital in Dar es Salaam, Tanzania: a cross-sectional study, International Health, Volume 16, Issue 2, March 2024, Pages 200–207, https://doi.org/10.1093/inthealth/ihad042
26. Huang J, Ding S, Xiong S et al. Medication adherence and associated factors in patients with type 2 diabetes: a structural equation model. Front Public Health. 2021;9:730845.
27. Islam SMS, Islam MT, Uddin R et al. Factors associated with low medication adherence in patients with type 2 diabetes mellitus attending a tertiary hospital in Bangladesh. Lifestyle Med. 2021;2(4):e47.
28. Ali M, Alemu T, Sada O. Medication adherence and its associated factors among diabetic patients at Zewditu Memorial Hospital, Addis Ababa, Ethiopia. BMC Res Notes. 2017;10(1):676.
29. Krapek K, King K, Warren SS et al. Medication adherence and associated hemoglobin A1c in type 2 diabetes. Ann Pharmacother. 2004;38(9):1357–62.
30. Sharma, Taruna & Kalra, Juhi & Dhasmana, Dilipchander & Basera, H.. (2014). Poor adherence to treatment: A major challenge in diabetes. Journal, Indian Academy of Clinical Medicine. 15.
31. Sahoo J, Mohanty S, Kundu A, Epari V. Medication Adherence Among Patients of Type II Diabetes Mellitus and Its Associated Risk Factors: A Cross-Sectional Study in a Tertiary Care Hospital of Eastern India. Cureus. 2022;14(12):e33074. Published 2022 Dec 29. doi:10.7759/cureus.33074
32. Yavuz DG, Ozcan S, Deyneli O. Adherence to insulin treatment in insulin-naïve type 2 diabetic patients initiated on different insulin regimens. Patient Prefer Adherence. 2015;9:1225-1231.
33. Alqarni AM, Alrahbeni T, Al Qarni A et al. Adherence to diabetes medication among diabetic patients in the Bisha governorate of Saudi Arabia – a cross-sectional survey. Patient Prefer Adherence. 2019;13:63–71.
34. Sendekie AK, Netere AK, Kasahun AE et al. Medication adherence and its impact on glycemic control in type 2 diabetes mellitus patients with comorbidity: a multicenter cross-sectional study in northwest Ethiopia. PLoS One. 2022;17(9):e0274971.
35. Goruntla N, Mallela V, Nayakanti D. Impact of Pharmacist-directed Counseling and Message Reminder Services on Medication Adherence and Clinical Outcomes in Type 2 Diabetes Mellitus. J

Pharm Bioallied Sci. 2019;11(1):69-76. doi:10.4103/jpbs.JPBS_211_18

36. Presley, Bobby & Groot, Wim & Setiawan, Eko & Pavlova, Milena. (2023). Perspectives of pharmacists and patients on pharmacist services to improve medication adherence among patients with diabetes in Indonesia. Journal of Pharmaceutical Health Services Research. 14. 10.1093/jphsr/rmad025.
37. Maduabuchi Romanus Ihekoronye, Kanayo Patrick Osemene, Theophilus Ehidiamen Oamen, Pharmacist-led intervention to improve treatment outcomes in type 2 diabetes: a randomized controlled trial, Journal of Pharmaceutical Health Services Research, Volume 15, Issue 2, June 2024, rmae005, https://doi.org/10.1093/jphsr/rmae005
38. Determinants of medication adherence and impact of mobile telephony, pillbox interventions on compliance and glycemic control among patients with type 2 diabetes Journal of Diabetology 15(1):p 70-78, January-March 2024. | DOI: 10.4103/jod.jod_64_23
39. Zhuo Y, Pan Y, Lin K, Yin G, Wu Y, Xu J, Cai D, Xu L. Effectiveness of clinical pharmacist-led smartphone application on medication adherence, insulin injection technique and glycemic control for women with gestational diabetes receiving multiple daily insulin injection: A randomized clinical trial. Prim Care Diabetes. 2022 Apr;16(2):264-270. doi: 10.1016/j.pcd.2022.02.003.
40. Simon MA, Raja BY, Varughese PC, Daniel LM, Sowjanya K, S KJ, S S, Rathinam KK, Kumar J P. Pharmacist led intervention towards management of type 2 diabetes mellitus and assessment of patient satisfaction of care - A prospective, randomized controlled study. Diabetes Metab Syndr. 2021 Sep-Oct;15(5):102208. doi: 10.1016/j.dsx.2021.102208.