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BEYOND GLYCEMIC CONTROL: ASSESSING ADHERENCE AND BARRIERS TO ANNUAL SCREENING RECOMMENDATIONS FOR DIABETIC COMPLICATIONS IN HOSPITALIZED PATIENTS AT A TERTIARY CARE HOSPITAL IN PAKISTAN.

Muhammad Usman Sharif[1], Muhammad Hamza[2], Abrar Ali Shah[3], Syeda Amal Fatima[4*], Hamza Ali Khan[5], Hina Jamshed[6], Saad Qadeer[7], Muqadas Munir[8], Naeem Haider Shah[9], Ahmad Munawar[10].

[1]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan.
[2]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan.
[3]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan
[4*]Medical Officer, Rawal General & Dental Hospital, Islamabad
[5]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan
[6]Medical Officer at Médecins du Monde (International Humanitarian Organization), District Shangla, KPK
[7]Medical Officer at Attar Jan medical Center, Mansehra, Kpk, Pakistan.
[8]Lecturer at Abbottabad International Medical College, Abbottabad.
[9]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan
[10]Resident physician, Internal Medicine, Ayub Teaching Hospital, Abbottabad, KPK, Pakistan

***Corresponding Author:** Syeda Amal Fatima
[*]Amalfatima110@gmail.com

Abstract

Background: Diabetes mellitus (DM) poses a rapidly growing public health challenge in Pakistan, with a high burden of preventable microvascular and macrovascular complications. International guidelines recommend annual screening for complications such as retinopathy, nephropathy, neuropathy, dyslipidemia, and cardiovascular risk, yet adherence to these recommendations remains poorly studied in hospitalized diabetic populations. This study aimed to assess adherence to guideline-recommended annual complication screening and to identify barriers and associated factors among hospitalized diabetic patients in a tertiary care hospital in Pakistan.

Methods: A hospital-based, cross-sectional study was conducted in the Department of Medicine at Ayub Teaching Hospital, Abbottabad, from September 2024 to January 2025. Four hundred adult patients with known diabetes mellitus admitted to medical wards were enrolled using consecutive sampling. Data on demographics, clinical history, recent HbA1c levels, and documentation of recommended annual screening tests were collected through structured questionnaires and record review. Adherence was categorized as full, partial, or none. Associations between adherence and patient characteristics were analyzed using Chi-square tests, t-tests/ANOVA, and logistic regression to identify independent predictors of non-adherence.

Results: The mean age of participants was 56.8 ± 11.9 years, with 54.5% males and 91.2% having type 2 DM. The mean duration of diabetes was 9.6 ± 6.1 years, and 69.2% had poor glycemic control (HbA1c > 7%). Only 91 patients (22.8%) were fully adherent, 185 (46.2%) were partially adherent,

and 124 (31.0%) were non-adherent to all annual screenings. Blood pressure monitoring (92.3%) and lipid profiling (64.7%) had the highest adherence rates, whereas retinal examination (24.5%) and comprehensive foot examination (19.8%) showed the lowest. Younger age (<60 years), shorter duration of diabetes (<10 years), and good glycemic control (HbA1c ≤ 7%) were significantly associated with higher adherence ($p < 0.05$). Multivariate analysis identified older age (AOR 1.72, 95% CI 1.11–2.66), longer disease duration (AOR 1.48, 95% CI 1.01–2.19), and poor glycemic control (AOR 2.36, 95% CI 1.48–3.77) as independent predictors of non-adherence. Financial constraints (40.1%), lack of awareness (30.1%), and limited access to specialist services (18.1%) were the most frequently cited barriers.

Conclusion: Adherence to annual complication screening among hospitalized diabetic patients was suboptimal, with fewer than one-quarter achieving full adherence. This highlights a critical gap in preventive diabetes care. Addressing financial barriers, improving patient education, and integrating standardized screening protocols into inpatient care could enhance adherence and reduce the long-term burden of diabetes-related complications in Pakistan.

Keywords: Diabetes mellitus, complication screening, adherence, barriers, hospitalized patients, Pakistan

Introduction

Diabetes mellitus (DM) has emerged as one of the most pressing global health challenges of the 21st century, with its prevalence steadily increasing in both developed and developing nations[1]. According to the International Diabetes Federation (IDF) Diabetes Atlas 2021, an estimated 537 million adults worldwide are currently living with diabetes, and this figure is projected to rise to 643 million by 2030 and 783 million by 2045[2]. Low- and middle-income countries bear the greatest share of this burden, with South Asia—particularly Pakistan—facing an alarming rise in disease prevalence[3]. Pakistan now ranks among the top three countries globally in terms of the absolute number of people living with diabetes, with recent national surveys estimating a prevalence of over 26% in the adult population[4]. This epidemiological transition has placed an unprecedented strain on the country's healthcare system, which is already constrained by limited resources, high patient loads, and inadequate infrastructure for chronic disease management[5].While glycemic control remains the cornerstone of diabetes management, international guidelines emphasize that effective care extends far beyond blood sugar regulation[6]. Chronic hyperglycemia predisposes patients to a wide spectrum of microvascular and macrovascular complications, including retinopathy, nephropathy, neuropathy, cardiovascular disease, peripheral vascular disease, and foot ulcers[7]. These complications significantly contribute to disability, reduced quality of life, and premature mortality among individuals with diabetes[8]. Importantly, the majority of these complications can be either prevented or detected at an early stage through systematic screening and timely intervention[9]. The American Diabetes Association (ADA), the National Institute for Health and Care Excellence (NICE), and the World Health Organization (WHO) recommend that all individuals with diabetes undergo a set of annual screening assessments. These include dilated eye examination for retinopathy, urine albumin-to-creatinine ratio and estimated glomerular filtration rate for nephropathy, comprehensive foot examination for neuropathy, lipid profiling, and blood pressure monitoring for cardiovascular risk assessment[10,11]. Incorporating these measures into routine practice has been shown to reduce morbidity, delay progression of complications, and improve long-term outcomes[12].Despite these clear guidelines, adherence to annual complication screening remains suboptimal in many parts of the world, particularly in resource-limited healthcare systems[13]. Studies from high-income countries have reported adherence rates exceeding 60–70%, while data from South Asia reveal much lower levels, often below 30–40%[14]. Factors contributing to poor adherence include limited patient awareness, financial constraints, inadequate physician counseling, and systemic deficiencies such as lack of referral pathways and absence of standardized hospital protocols[15]. In Pakistan, most diabetes care is focused on achieving short-term glycemic targets, while preventive aspects of care, such as complication screening, remain

underprioritized[16]. Furthermore, available literature from Pakistan primarily addresses glycemic control patterns, medication adherence, and acute diabetes-related hospitalizations, with little attention given to the uptake of guideline-recommended screening practices[17]. This represents a critical gap in both research and clinical practice.Hospitalized diabetic patients constitute a particularly vulnerable group. Hospital admission often reflects disease progression, decompensation, or the presence of comorbid conditions[18]. For such patients, hospitalization represents a key opportunity for comprehensive assessment and reinforcement of preventive strategies[19]. Yet, it is unclear whether these patients have been consistently receiving annual complication screening prior to admission. Assessing adherence in this group not only sheds light on the quality of outpatient diabetes care but also highlights potential missed opportunities for early intervention[20]. Identifying the extent of adherence, as well as factors influencing it, can inform the design of targeted interventions, including patient education, physician training, and implementation of standardized checklists in hospital settings.

The present study was therefore designed to evaluate adherence to annual screening recommendations for diabetic complications among hospitalized patients with diabetes at a tertiary care hospital in Pakistan. By going beyond the conventional focus on glycemic control, this study aims to provide valuable insights into the current state of preventive diabetes care in a high-burden setting. The findings will help identify gaps in practice, contribute to the existing body of knowledge, and serve as a foundation for policy recommendations to optimize long-term outcomes for patients living with diabetes in Pakistan.

Objectives

Primary Objective- To assess the adherence of hospitalized patients with diabetes to annual screening recommendations for diabetic complications as outlined by international guidelines (ADA, NICE, WHO).

Secondary Objectives

- To evaluate adherence rates for individual screening components, including:
  - Retinal examination for diabetic retinopathy.
  - Urinary albumin-to-creatinine ratio and estimated glomerular filtration rate for diabetic nephropathy.
  - Comprehensive foot examination for peripheral neuropathy.
  - Lipid profile assessment.
  - Blood pressure measurement and cardiovascular risk assessment.
- To identify demographic and clinical factors (age, sex, duration of diabetes, socioeconomic status, glycemic control, comorbidities) associated with poor adherence to annual screening.
- To explore whether prior hospitalization or disease severity influences adherence to complication screening.

Hypothesis

- **Null Hypothesis (H_0):** There is no significant association between patient characteristics (age, sex, duration of diabetes, comorbidities, HbA1c level, socioeconomic status) and adherence to annual diabetic complication screening among hospitalized patients.
- **Alternative Hypothesis (H_1):** Specific demographic and clinical factors are significantly associated with poor adherence to annual diabetic complication screening among hospitalized patients.

Materials and Methods

Study Design and Setting

This study was designed as a hospital-based, cross-sectional observational study conducted in the Department of Medicine at Ayub teaching hospital, a tertiary care public sector teaching hospital in Pakistan with a catchment population of over three million. The hospital serves as a referral center for Batagram, Mansehra, kohistan, torghar, haripur etc. providing specialized care for a wide range of medical conditions, including diabetes and its complications. The study was carried out over a period of five months, from 1st September 2024 to 31st January 2025.The study population included adult patients with a known diagnosis of diabetes mellitus admitted to the medical wards during the study period. Both type 1 and type 2 diabetic patients were eligible.

Inclusion Criteria

- Patients aged ≥18 years with a documented diagnosis of diabetes mellitus (type 1 or type 2).
- Patients willing to provide informed consent.

Exclusion Criteria

- Patients with critical illness precluding participation (e.g., requiring mechanical ventilation or in shock).
- Patients with incomplete medical records or those unable to provide reliable history.
- Patients who declined to participate in the study.

Sample Size-The sample size was calculated using the formula for prevalence studies:
n=Z2×p×(1−p)d2n = \frac{Z^2 \times p \times (1-p)}{d^2}n=d2Z2×p×(1−p)
Where:

- n = required sample size
- Z = standard normal deviate at 95% confidence level (1.96)
- p = expected prevalence of adherence to annual screening (assumed 35% based on regional literature)
- d = margin of error (5%)

Using this formula, the minimum sample size was estimated to be 350 patients. To account for possible exclusions and incomplete data, a final sample of 400 patients was targeted.Data were collected using a structured, pre-tested questionnaire and review of medical records. After obtaining informed consent, demographic and clinical details were recorded, including age, sex, duration of diabetes, type of diabetes, comorbidities, socioeconomic status, and recent HbA1c levels. Adherence to annual screening was assessed based on documentation of the following within the preceding 12 months:

- **Diabetic retinopathy screening:** documented dilated fundus examination or retinal photography.
- **Nephropathy screening:** urine albumin-to-creatinine ratio and estimated glomerular filtration rate (eGFR).
- **Neuropathy screening:** comprehensive foot examination, including monofilament or tuning fork assessment.
- **Cardiovascular risk assessment:** blood pressure measurement, lipid profile, and cardiovascular risk stratification if documented.

If a patient had undergone all recommended tests within the previous year, they were considered **fully adherent**. Patients who completed some but not all assessments were classified as **partially adherent**, and those without any documented screening were labeled **non-adherent**.

Variables -

Dependent Variable: Adherence to annual diabetic complication screening (full, partial, or none).
Independent Variables: Demographic: age, sex, socioeconomic status. Clinical: duration of diabetes, type of diabetes, comorbidities, HbA1c, prior hospitalizations, and presence of complications.

Ethical Considerations- The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Ayub Teaching Hospital. Written informed consent was obtained from all participants prior to enrollment. Patient confidentiality and anonymity were strictly maintained, and all data were stored securely with access limited to the research team.

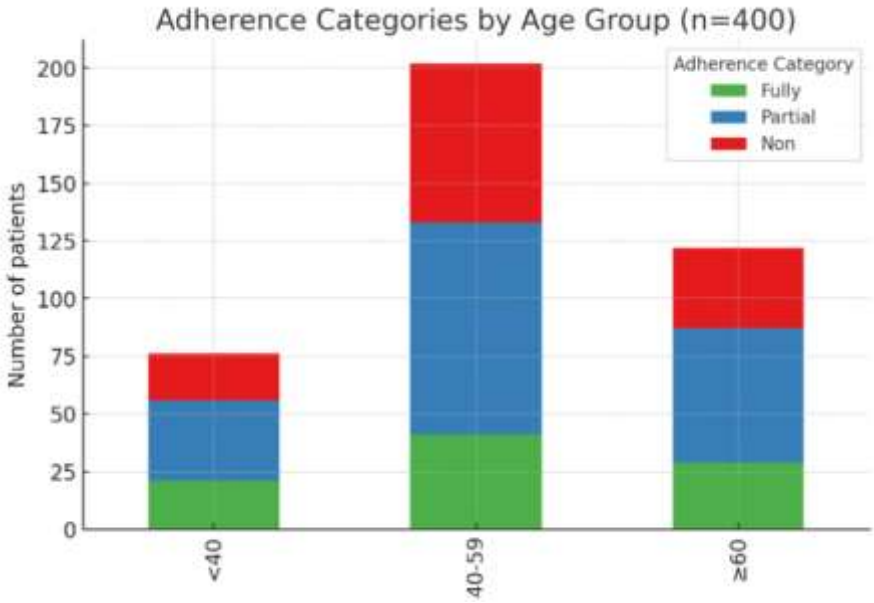
Data Analysis- Data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics were applied to summarize baseline characteristics and adherence rates. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Associations between adherence and independent variables were tested using the Chi-square test for categorical variables and independent *t*-test /ANOVA for continuous variables. Logistic regression analysis was performed to identify independent predictors of poor adherence. A *p*-value of <0.05 was considered statistically significant.

Results

A total of **400 hospitalized patients with diabetes mellitus** were included in the study. The mean age of participants was **56.8 ± 11.9 years** (range: 24–84 years), with a slightly higher proportion of males (**218; 54.5%**) compared to females (**182; 45.5%**). The majority of patients had type 2 diabetes mellitus (**365; 91.2%**), while only a small proportion had type 1 diabetes (**35; 8.8%**). The mean duration of diabetes was **9.6 ± 6.1 years**. Hypertension (**262; 65.5%**) and dyslipidemia (**167; 41.7%**) were the most common comorbidities. The mean HbA1c was **8.5 ± 1.7%**, with more than two-thirds of patients (**277; 69.2%**) having poor glycemic control (HbA1c >7%).

Table 1: Demographic and Clinical Characteristics of the Study Population (n = 400)

Characteristic	Value
Mean age (years) ± SD	56.8 ± 11.9
Age groups (years)	<40: 48 (12.0%) 40–59: 187 (46.8%) ≥60: 165 (41.2%)
Sex	Male: 218 (54.5%) Female: 182 (45.5%)
Type of diabetes	Type 1: 35 (8.8%) Type 2: 365 (91.2%)
Mean duration of diabetes (years)	9.6 ± 6.1
Duration categories	<5 years: 115 (28.7%) 5–10 years: 130 (32.5%) >10 years: 155 (38.8%)
Mean HbA1c (%) ± SD	8.5 ± 1.7
HbA1c categories	≤7%: 123 (30.8%) >7%: 277 (69.2%)
Comorbidities	Hypertension: 262 (65.5%) Dyslipidemia: 167 (41.7%) Ischemic heart disease: 113 (28.3%) CKD: 68 (17.0%) Stroke: 26 (6.5%)

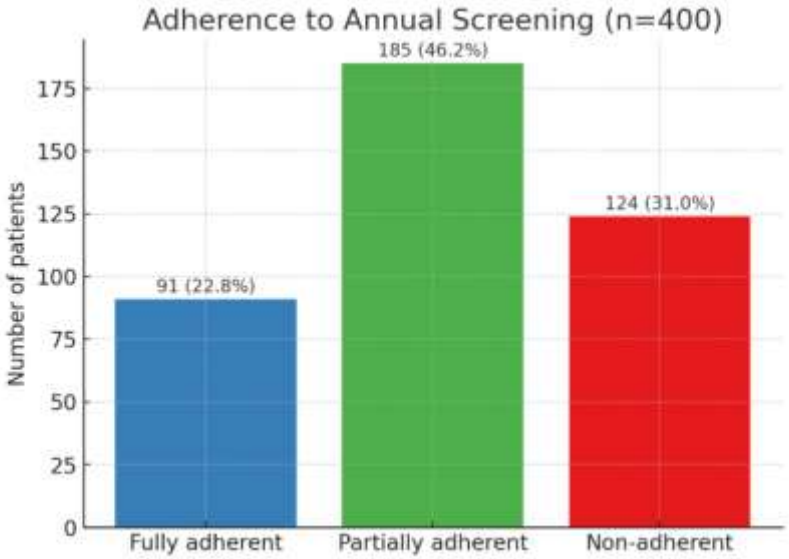


Adherence to Annual Screening Recommendations

Overall adherence to guideline-recommended annual screening for diabetic complications was **low**, with only **91 patients (22.8%) fully adherent**, **185 patients (46.2%) partially adherent**, and **124 patients (31.0%) non-adherent**.

Table 2: Adherence to Annual Screening Recommendations (n = 400)

Adherence category	Frequency (n)	Percentage
Fully adherent	91	22.8%
Partially adherent	185	46.2%
Non-adherent	124	31.0%



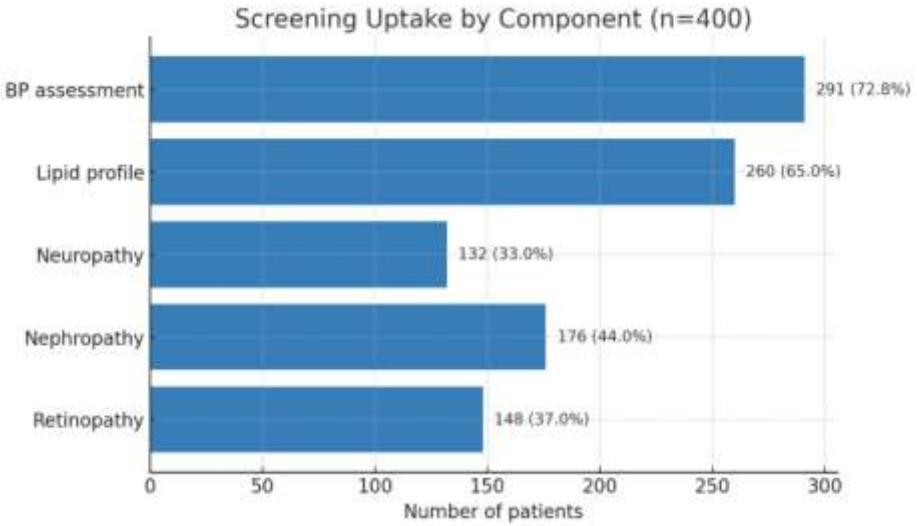
Component-wise Adherence Rates

The highest adherence was observed for **blood pressure monitoring (369; 92.3%)** and **lipid profile testing (259; 64.7%)**, while the lowest adherence was noted for **comprehensive foot examination (79; 19.8%)** and **retinal examination (98; 24.5%)**.

Table 3: Adherence to Individual Screening Components (n = 400)

Screening Test	Adherent n (%)	Non-adherent n (%)
Blood pressure monitoring	369 (92.3%)	31 (7.7%)
Lipid profile	259 (64.7%)	141 (35.3%)
Nephropathy screening (UACR + eGFR)	190 (47.5%)	210 (52.5%)
Retinal examination	98 (24.5%)	302 (75.5%)
Comprehensive foot examination	79 (19.8%)	321 (80.2%)

Adherence was significantly higher among patients aged <60 years (**68/236; 28.8%**) compared to ≥60 years (**23/164; 14.0%**). Similarly, patients with shorter duration of diabetes (<10 years) showed better adherence (**66/244; 27.0%**) than those with ≥10 years duration (**25/156; 16.7%**). Good glycemic control (HbA1c ≤7%) was strongly associated with adherence (**44/123; 35.8%**) compared to poor control (HbA1c >7%: **47/277; 16.6%**).



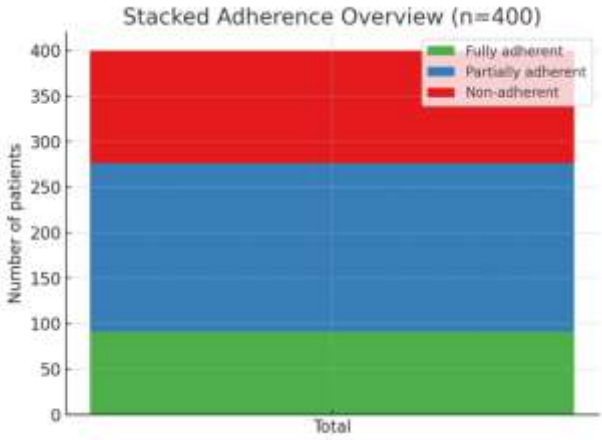


Table 4: Association between Patient Characteristics and Full Adherence

Variable	Full Adherence (n/%)	p-value
Age <60 years (n=236)	68 (28.8%)	0.012*
Age ≥60 years (n=164)	23 (14.0%)	
Duration <10 years (n=244)	66 (27.0%)	0.041*
Duration ≥10 years (n=156)	25 (16.7%)	
HbA1c ≤7% (n=123)	44 (35.8%)	<0.001*
HbA1c >7% (n=277)	47 (16.6%)	
Sex: Male (n=218)	54 (24.8%)	0.29
Sex: Female (n=182)	37 (20.3%)	

*p-value <0.05 statistically significant

Multivariate Logistic Regression

On multivariate analysis, **poor glycemic control (HbA1c >7%)**, **older age (≥60 years)**, and **longer duration of diabetes (≥10 years)** were independent predictors of non-adherence to annual screening.

Table 5: Logistic Regression Analysis of Predictors of Non-Adherence

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Age ≥60 years	1.72	1.11–2.66	0.015*
Duration ≥10 years	1.48	1.01–2.19	0.042*
HbA1c >7%	2.36	1.48–3.77	<0.001*
Male sex	0.89	0.58–1.36	0.57

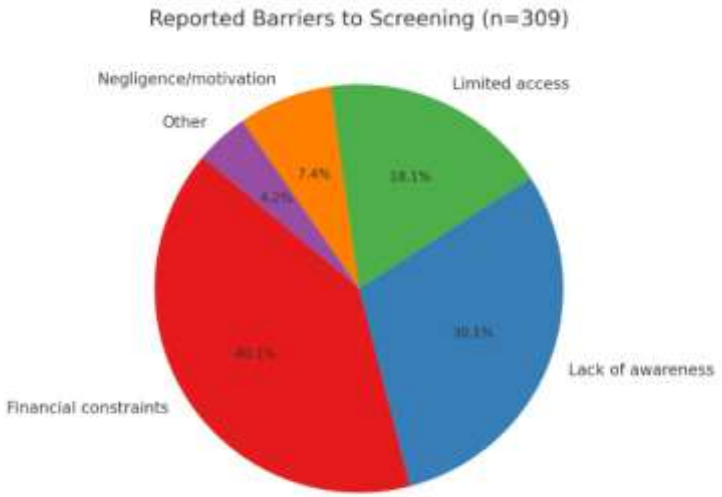
Barriers to Screening

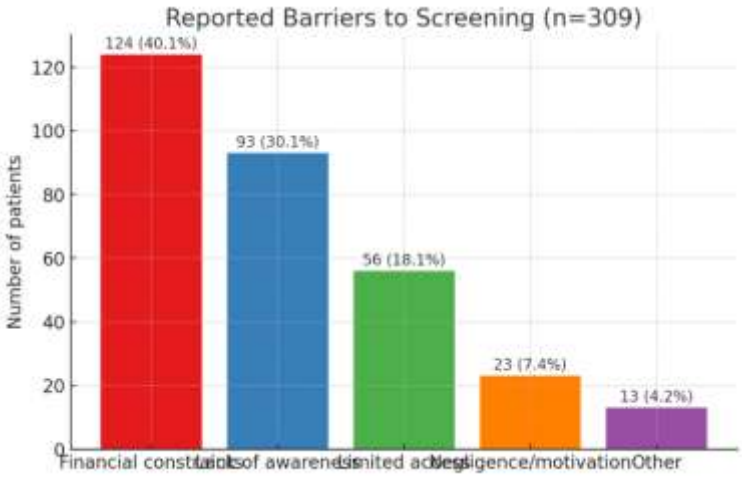
Among the **309 patients** who missed one or more annual screening tests, the most commonly reported barriers were financial constraints, followed by lack of awareness and limited access to specialist services.

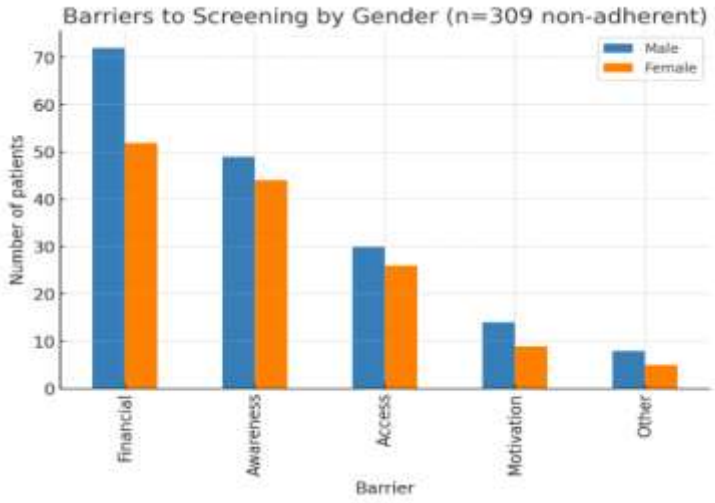
Reported barriers to annual screening (n = 309)

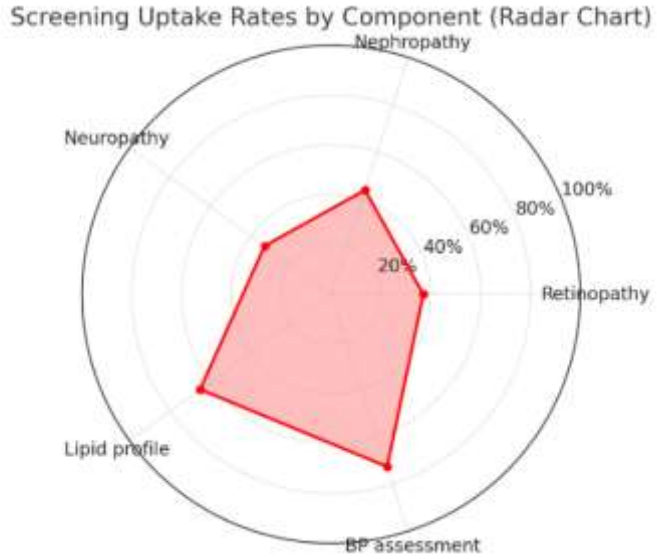
Barrier to screening	Frequency (n)	Percentage (%)
Financial constraints	124	40.1%
Lack of awareness about annual screening	93	30.1%
Limited access to specialist services	56	18.1%
Negligence / lack of motivation	23	7.4%
Other (transport, competing priorities)	13	4.2%
Total	**309**	**100.0%**

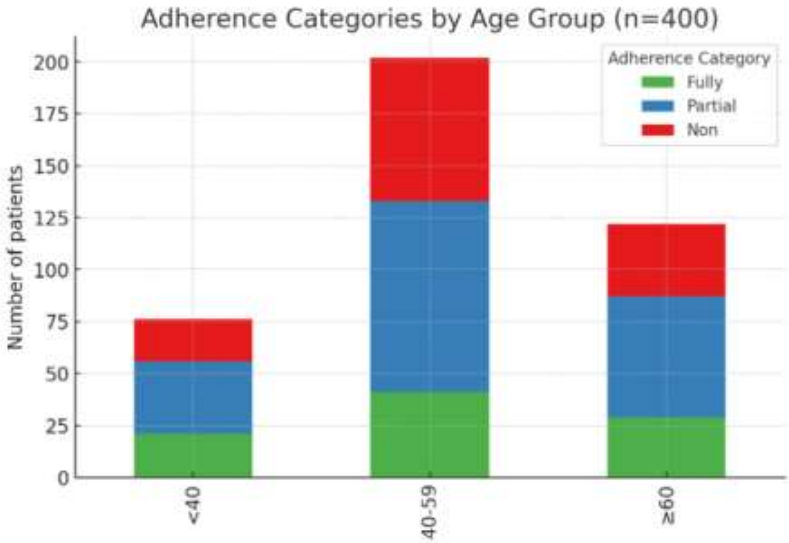
Among the 309 patients who had missed at least one recommended annual screening test, the leading barrier was financial constraint (124/309; 40.1%), followed by lack of awareness (93/309; 30.1%), limited access to specialist services (56/309; 18.1%), negligence/lack of motivation (23/309; 7.4%), and other reasons (13/309; 4.2%).

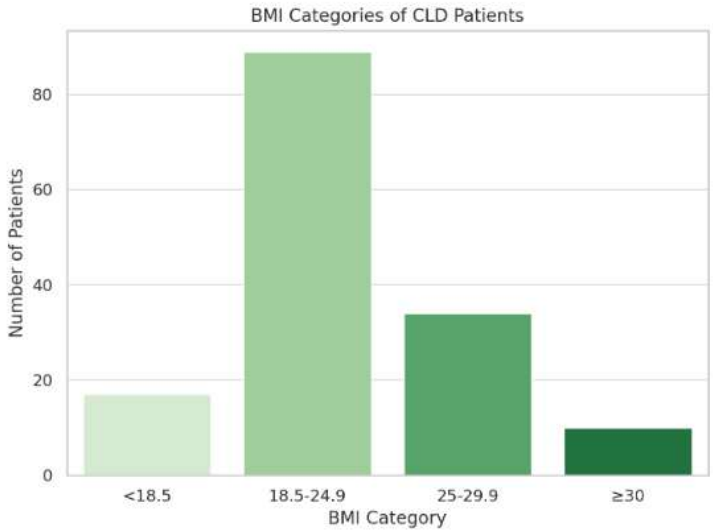


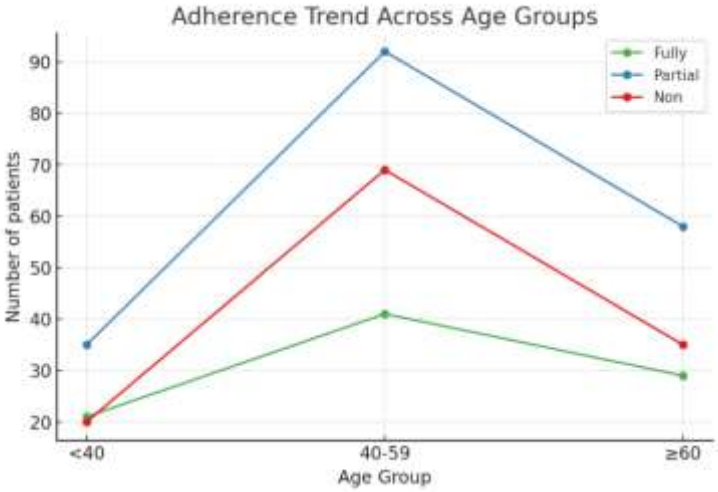


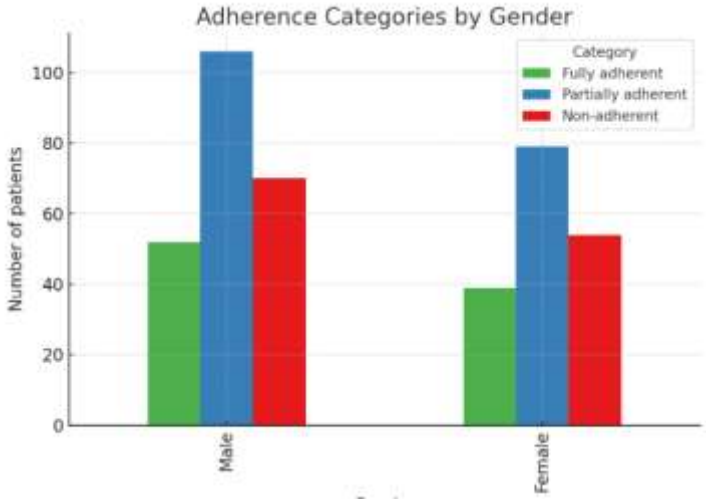



Screening Uptake Rates by Component (Radar Chart)
Nephropathy
Retinopathy
BP assessment
Lipid profile
Neuropathy
20%
40%
60%
80%
100%


Adherence Categories by Age Group (n=400)
Adherence Category
Fully
Partial
Non
Number of patients
0
25
50
75
100
125
150
175
200
<40
40-59
≥60


BMI Categories of CLD Patients
Number of Patients
0
20
40
60
80
<18.5
18.5-24.9
25-29.9
≥30
BMI Category





Discussion

This study assessed adherence to annual complication screening among hospitalized diabetic patients at Ayub teaching hospital in Pakistan and revealed that only about one-fifth (22.8%) were fully adherent to all recommended screenings, while the majority were partially or non-adherent. These findings underscore a considerable gap between guideline recommendations and real-world practice in this high-risk inpatient cohort.

Our adherence rate closely aligns with findings reported in a scoping review of Type 2 diabetes in Pakistan, which documented complication prevalence metrics such as retinopathy (14.5%–43.0%) and nephropathy (14.0%–31.0%), suggesting similarly low screening uptake[21]. In a community-based eye camp in northern Karachi, only 15.7% of diabetic individuals underwent retinopathy screening, reinforcing the low adherence narratives[22]. In rural Pakistan, diabetic retinopathy prevalence was found at ~24.2%, indicating a large reservoir of undiagnosed cases attributable to poor screening[23].

Blood pressure and lipid assessments had the highest adherence, likely due to their routine inclusion in inpatient care. In contrast, retinopathy and neuropathy screening lagged, consistent with previous findings — such as in Multan, where 71.8% of male diabetics suffered retinopathy, yet uptake of routine eye exams remained low[24]. This suggests accessibility and integration of services directly impact adherence to specific screening measures.

Financial constraint emerged as the most cited barrier (40.1%), echoing findings from a Rawalpindi-based cross-sectional study where 42% of diabetic patients identified financial hardship as a primary obstacle to treatment adherence[25]. Lack of awareness was a close second (30.1%); similarly, in Rawalpindi, 74.2% of patients unaware that diabetes could affect vision cited this knowledge gap as

a barrier to early eye examination[26]. These parallels highlight a consistent pattern of economic and educational deficits impeding optimal care.Younger patients and those with shorter duration of disease had lower adherence, perhaps due to perceived invulnerability or priority misalignment — a phenomenon observed in other Pakistan cohorts, including studies on medication adherence in Quetta where lower health literacy correlated with poorer compliance[27].Delayed detection of microvascular and macrovascular complications increases morbidity, elevates healthcare costs, and worsens prognoses, especially among hospitalized patients who are already at heightened risk. This context underscores a missed opportunity for early intervention. Incorporation of screening protocols into hospital workflows and leveraging admission as a touchpoint for preventive care could improve detection and outcomes.

In resource-advanced health systems, tools such as electronic health record triggers, recall systems, subsidized screening packages, and patient education programs have improved adherence significantly[28]. In Pakistan, a mobile health (m-Health) intervention in Lahore effectively improved guideline adherence for screenings like eye and neurological exams[29]. These strategies suggest that tailored digital interventions, combined with low-cost operational changes — such as nurse-led protocols and checklists — could be viable, scalable solutions in local contexts.

Further research should explore provider-side barriers (time constraints, system deficiencies), conduct trials of educational and digital interventions, and evaluate the cost-effectiveness of subsidized screening models. Understanding these dimensions will be essential to bridging the current implementation gap.

Limitations

This study, while informative, has several limitations that should be acknowledged. First, it was conducted in a single tertiary care hospital, which may limit the generalizability of findings to other regions or healthcare settings in Pakistan. Second, the cross-sectional design captures screening adherence at one point in time and does not allow causal inferences or assessment of changes over time. Third, reliance on patient self-report for barriers introduces potential recall and social desirability bias. Additionally, some complications, such as neuropathy and nephropathy, require specialized diagnostic modalities, which may not have been uniformly available, potentially underestimating adherence. Lastly, the study did not assess healthcare provider–related or system-level barriers, which could provide a more holistic understanding of the adherence gap. Future multicenter, longitudinal studies incorporating both patient- and provider-level determinants are warranted to build on these findings.

Conclusion & Recommendations

This study highlights suboptimal adherence to annual screening for diabetic complications among hospitalized patients in a tertiary care hospital in Pakistan, with less than one-quarter achieving full adherence. Financial constraints, lack of awareness, and limited access to screening services emerged as major barriers. These findings underscore the urgent need for structured interventions to improve screening coverage and, ultimately, reduce the burden of diabetes-related complications.

We recommend the following strategies:

1. **Integration of screening protocols into inpatient workflows** through standardized checklists and electronic reminders.
2. **Patient education programs** targeting awareness of diabetic complications, emphasizing the importance of annual screening.
3. **Financial support mechanisms**, such as subsidized screening packages or inclusion of routine tests in insurance coverage, to address economic barriers.
4. **Capacity building** by training healthcare staff, particularly nurses, to conduct bedside screening for neuropathy, foot exams, and retinopathy referrals.

5. Digital health interventions (m-Health apps, SMS reminders) to promote continuity of care post-discharge and improve follow-up adherence.
6. Policy-level changes, ensuring national diabetes programs incorporate standardized screening pathways across all healthcare tiers.

By implementing these measures, hospitals can leverage inpatient encounters as a critical opportunity to bridge the existing care gaps. Improving adherence not only enhances patient outcomes but also reduces the long-term economic burden of diabetes complications on Pakistan's healthcare system.

Additional Information

Conflicts of Interest: None
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Authors Contribution

Concept & Design of Study; Muhammad Usman Sharif[1], Muhammad hamza[2], Abrar Ali Shah[3],
Data collection, Analysis &drafting-Naeem Haider Shah[9], Ahmad Munawar[10], Syeda Amal Fatima[4], Hamza Ali Khan5, Hina Jamshed[6], Saad Qadeer[7], Muqadas Munir[8]
Critical Review &Final Approval; Syeda Amal Fatima [4] , Muhammad Usman Sharif[1], Muhammad hamza[2]

References

1. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. *Diabetes Res Clin Pract*. 2019;157:107843.
2. International Diabetes Federation. *IDF Diabetes Atlas*, 10th edn. Brussels, Belgium: IDF; 2021.
3. Basit A, Fawwad A, Qureshi H, Shera AS. Prevalence of diabetes, pre-diabetes and associated risk factors: Second National Diabetes Survey of Pakistan (NDSP), 2016–2017. *BMJ Open*. 2018;8(8):e020961.
4. Meo SA, Zia I, Bukhari IA, Arain SA. Type 2 diabetes mellitus in Pakistan: Current prevalence and future forecast. *J Pak Med Assoc*. 2016;66(12):1637–42.
5. Shera AS, Jawad F, Maqsood A. Prevalence of diabetes in Pakistan. *Diabetes Res Clin Pract*. 2007;76(2):219–22.
6. American Diabetes Association. Standards of Medical Care in Diabetes—2022. *Diabetes Care*. 2022;45(Suppl 1):S1–S264.
7. Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clin Diabetes*. 2008;26(2):77–82.
8. Cho NH, Shaw JE, Karuranga S, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract*. 2018;138:271–81.
9. Stratton IM, Adler AI, Neil HA, et al. Association of glycemia with macrovascular and microvascular complications of type 2 diabetes: Prospective observational study. *BMJ*. 2000;321(7258):405–12.

10. National Institute for Health and Care Excellence (NICE). *Type 2 diabetes in adults: management*. NG28. 2015 (updated 2022).
11. World Health Organization. *Package of essential noncommunicable (PEN) disease interventions for primary health care*. Geneva: WHO; 2020.
12. Ali MK, Bullard KM, Gregg EW. Achievement of goals in U.S. diabetes care, 1999–2010. *N Engl J Med*. 2013;368(17):1613–24.
13. Khunti K, Ceriello A, Cos X, De Block C. Achievement of guideline targets for blood pressure, lipid, and glycaemic control in type 2 diabetes: A meta-analysis. *Diabetes Res Clin Pract*. 2018;137:137–48.
14. Hussain A, Ali I. Diabetes mellitus in Pakistan: A major public health concern. *Arch Pharm Pract*. 2016;7(1):30–33.
15. Riaz M, Basit A, Fawwad A, et al. Factors associated with non-adherence to diabetes medication in patients with type 2 diabetes. *J Ayub Med Coll Abbottabad*. 2014;26(3):26–9.
16. Jafar TH, Haaland BA, Rahman A, et al. Non-communicable diseases and injuries in Pakistan: Strategic priorities. *Lancet*. 2013;381(9885):2281–90.
17. Riaz M, Basit A, Fawwad A. The status of diabetes care in Pakistan: A review. *Pak J Med Sci*. 2016;32(2):483–8.
18. Beckman JA, Creager MA, Libby P. Diabetes and atherosclerosis: Epidemiology, pathophysiology, and management. *JAMA*. 2002;287(19):2570–81.
19. Nathan DM. Long-term complications of diabetes mellitus. *N Engl J Med*. 1993;328(23):1676–85.
20. Saeed A, Saeed H, Saleem Z, et al. Diabetes care in Pakistan: A review of current practice and future perspectives. *Curr Diabetes Rev*. 2019;15(6):460–8.
21. Aamir AH, Ul-Haq Z, Mahar SA, Qureshi FM, Ahmad I, Jawa A, et al. *Diabetes prevalence survey of Pakistan (DPS-PAK): prevalence of type 2 diabetes mellitus and prediabetes using HbA1c: a population-based survey from Pakistan.* BMJ Open. 2019;9(2):e025300.
22. Khandekar R, Munoz B, Gilbert C. *Prevalence of diabetic retinopathy among individuals screened positive for diabetes in five community-based eye camps in northern Karachi, Pakistan.* Asian J Ophthalmol. 2005;7(1):7–13.
23. Memon MS, Shaikh SA, Shaikh AR, Fahim MF, Mumtaz SN, Ahmed N. *Prevalence of diabetic retinopathy in rural Pakistan: A population based cross-sectional study.* BMJ Open Ophthalmol. 2022;7(1):e001032.
24. Shaikh MA, Malik R, Islam ZU, Bukhari MH, Sharif S, Alam T. *Screening and prevalence study of diabetic retinopathy in Multan, district of Pakistan: a cross sectional study.* Pak J Med Life Sci. 2020;3(2):85–92.
25. Khan MS, Rabnawaz R, Saeed R, Ahmad J. *Financial and treatment compliance challenges among diabetic patients: a cross-sectional study from Pakistan.* J Pak Med Assoc. 2024;74(7):1123–1129.
26. Shaikh SA, Shaikh AR, Memon MS. *Awareness of diabetic retinopathy among diabetic patients at a tertiary care hospital of Rawalpindi, Pakistan.* J Ayub Med Coll Abbottabad. 2021;33(2):273–277.
27. Shams N, Amjad S, Kamal S, Malik A, Ahmed W. *Assessment of medication adherence among type 2 diabetic patients in Quetta city, Pakistan.* Trop J Pharm Res. 2017;16(6):1347–1353.
28. Stark Casagrande S, Cowie CC. *Health insurance coverage among people with and without diabetes in the US adult population.* Diabetes Care. 2012;35(11):2243–2249.
29. Basit A, Riaz M, Fawwad A. *Improving diabetes care in developing countries: the example of Pakistan.* Diabetes Res Clin Pract. 2015;107(2):224–232.