

Patient Characteristics Associated with Medication Adherence Among Patients with Type 2 Diabetes Mellitus in Primary Care: A Cross-Sectional Study

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ABSTRACT

Medication adherence is essential for effective self-management in type 2 diabetes mellitus (T2DM), yet its association with routinely measured patient characteristics may vary across healthcare settings. This study examined sociodemographic and clinical characteristics associated with medication adherence among patients with T2DM receiving oral antidiabetic therapy in primary care. An analytical cross-sectional study was conducted among 84 patients at a primary care clinic in Cimahi, West Java, Indonesia, using accidental sampling. Medication adherence was assessed with the Indonesian version of the eight-item Morisky Medication Adherence Scale (MMAS-8) and categorized as low, moderate, or high. Bivariate associations were tested using chi-square analysis, followed by ordinal logistic regression. Participants had a mean age of 53.45 ± 11.75 years, and 69.0% were female. Low, moderate, and high adherence were reported by 29.8%, 39.3%, and 31.0% of participants, respectively. Adherence differed significantly across age groups ($p=0.032$) and diabetes-duration categories ($p=0.018$) in bivariate analyses. The proportional-odds assumption was satisfied ($p=0.092$), and the overall ordinal regression model was significant (likelihood-ratio $\chi^2=12.13$, $df=5$, $p=0.033$). However, no individual adjusted association reached statistical significance. Age ≥ 60 years ($aOR=2.55$; 95% CI: 0.90–7.27; $p=0.079$) and diabetes duration ≥ 5 years ($aOR=2.41$; 95% CI: 0.91–6.38; $p=0.077$) showed higher estimated odds of greater adherence. Routine patient characteristics alone may be insufficient to identify adherence difficulties, supporting individualized assessment of medication-taking barriers in primary care.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic condition that requires sustained self-management, ongoing clinical monitoring, and long-term pharmacological treatment to achieve individualized glycemic goals and reduce the risk of diabetes-related complications. Contemporary diabetes care emphasizes person-centered treatment, diabetes self-management education and support, and shared decision-making as integral components of long-term disease management (American Diabetes Association Professional Practice Committee for Diabetes, 2026a, 2026b). Pharmacological therapy remains central to T2DM management, but its effectiveness in routine care depends not only on the appropriateness of the prescribed regimen but also on whether patients are able and willing to implement that regimen consistently in daily life. Higher adherence to antidiabetic medication has been associated with better glycemic control and, in broader real-world evidence, with more favorable clinical and healthcare-utilization outcomes (Evans et al., 2022; Sendekie et al., 2022). Medication

adherence is therefore an important component of diabetes self-management, particularly in primary care, where long-term monitoring, medication management, and continuity of care commonly occur.

The World Health Organization defines adherence as the extent to which a person's behavior, including taking medication, corresponds with recommendations agreed with a healthcare provider (World Health Organization, 2003). This concept differs from the traditional notion of compliance, which may imply a more passive response to prescriber instructions. Contemporary adherence frameworks emphasize medication-taking as an active behavioral process and distinguish among treatment initiation, implementation of the prescribed regimen, and discontinuation (Vrijens et al., 2012). This distinction is particularly relevant in chronic conditions such as T2DM, in which medication-taking behavior occurs largely outside healthcare facilities and must be incorporated into everyday routines over prolonged periods. Thus, adherence should be understood not simply as obedience to a prescription, but as a dynamic component of patient participation in an agreed treatment plan.

Medication adherence in T2DM remains highly variable across populations and healthcare settings. A systematic review by Krass et al. (2015) found wide variation in adherence estimates across studies and concluded that medication-taking behavior in T2DM is influenced by multiple and often inconsistently associated factors. More recent evidence similarly demonstrates substantial heterogeneity: a systematic review and meta-analysis of oral antidiabetic medication adherence found considerable between-study variation in adherence estimates, reflecting differences in populations, measurement approaches, healthcare systems, and treatment characteristics (Boonpattharatthiti et al., 2024). Real-world studies have also reported substantial variation in both adherence and persistence across antidiabetic therapies (Evans et al., 2022). These findings indicate that medication adherence cannot be adequately understood through a single demographic or clinical characteristic and that differences in measurement methods and classification thresholds may substantially affect reported adherence prevalence.

The determinants of medication-taking behavior are correspondingly multidimensional. Sociodemographic and clinical characteristics such as age, sex, educational attainment, employment, economic circumstances, and duration of diabetes may influence the resources, routines, treatment experience, and opportunities available to patients for managing long-term medication. However, associations between these factors and adherence have not been consistently demonstrated across studies. In a large pharmacy-claims analysis involving more than 200,000 patients receiving non-insulin diabetes medication, adherence was associated with age, sex, education, income, treatment experience, medication costs, and healthcare-delivery characteristics (Kirkman et al., 2015). Systematic reviews, however, have shown that many demographic associations vary across populations, whereas potentially modifiable factors such as medication costs, treatment complexity, depression, and medication-related beliefs may be particularly important (Krass et al., 2015; Polonsky & Henry, 2016). Patient beliefs also contribute to adherence behavior: meta-analytic evidence across chronic conditions indicates that stronger perceived necessity for treatment and fewer concerns about medicines are associated with better medication adherence (Horne et al., 2013). These findings reinforce the view that routinely collected patient characteristics may provide only a partial representation of the mechanisms underlying medication-taking behavior.

Evidence from Indonesia has documented medication adherence among people with T2DM in primary-care settings, although the research questions and measurement approaches have varied. In a study conducted across 63 primary healthcare centers in Surabaya, Zairina et al. (2022) emphasized patient-reported barriers and their relationship with medication adherence, demonstrating that adherence behavior cannot be adequately characterized by demographic characteristics alone. International primary-care studies have likewise reported variation in adherence levels and associated factors, including age, sex, socioeconomic characteristics, and duration of diabetes (Alsaidan et al., 2023; Kirkman et al., 2015). Moreover, differences in adherence instruments and analytical approaches complicate direct comparison across studies. Reviews of diabetes medication adherence have highlighted considerable methodological heterogeneity, including differences in self-report instruments, pharmacy-based measures, cut-off values, and binary versus multicategory adherence classifications (Boonpattharatthiti et al., 2024; Krass et al., 2015). Consequently, context-specific

evidence remains useful for understanding how routinely available patient characteristics relate to medication-taking behavior within particular primary-care populations.

A more specific question concerns whether routinely available sociodemographic and basic clinical characteristics remain independently associated with medication adherence when the ordered nature of adherence is preserved rather than reduced to a binary adherent/non-adherent classification. Dichotomization can simplify interpretation but may also obscure potentially meaningful distinctions among patients with low, moderate, and high levels of adherence. Conceptual work on medication adherence has emphasized the importance of clearly defining and measuring medication-taking behavior rather than treating adherence as a homogeneous construct (Vrijens et al., 2012). In the context of Indonesian primary care, relatively little is known about how routinely available characteristics differentiate ordered adherence levels among patients receiving oral antidiabetic therapy. Addressing this question may help determine whether basic demographic and clinical information is sufficient for identifying patients who may require more detailed assessment of medication-related barriers, or whether more proximal behavioral, psychosocial, and treatment-related factors should be considered.

This study was informed by Orem's Self-Care Deficit Nursing Theory (Orem et al., 2001). Within this framework, basic conditioning factors—including age, health state, sociocultural circumstances, patterns of living, and resource availability—may shape an individual's capacity to engage in self-care. Medication-taking may therefore be viewed as one component of therapeutic self-care required for chronic disease management. This theoretical perspective is compatible with contemporary person-centered diabetes care, which recognizes that treatment implementation is influenced by individual circumstances, behavioral capabilities, psychosocial needs, and available resources (American Diabetes Association Professional Practice Committee for Diabetes, 2026a). The sociodemographic and clinical characteristics examined in the present study represent selected conditioning factors that may be relevant to this process; however, self-care agency, therapeutic self-care demand, medication beliefs, health literacy, and other proximal behavioral mechanisms were not directly measured. Accordingly, Orem's theory was used to inform variable selection and interpretation rather than to test the complete theoretical pathway.

Therefore, this study aimed to examine the association between selected sociodemographic and clinical characteristics and medication adherence among patients with T2DM receiving oral antidiabetic therapy in a primary-care setting in Cimahi, West Java, Indonesia. By retaining medication adherence as an ordered outcome comprising low, moderate, and high adherence, the study sought to evaluate whether routinely available patient characteristics were independently associated with progressively higher levels of medication adherence.

METHODS

Study design and setting

This analytical cross-sectional study was conducted at Clinic X, a primary-care facility in Cimahi, West Java, Indonesia. The research process began in February 2026 with protocol preparation, administrative permission, and ethics

review. Participant recruitment and data collection commenced only after ethical approval was granted on 14 April 2026. The study examined the association between selected sociodemographic and clinical characteristics and medication adherence among patients with T2DM receiving oral antidiabetic therapy.

Participants, sample size, and recruitment

The source population consisted of 107 patients with T2DM registered at the study site. A diagnosis of T2DM was confirmed from the diagnosis documented in each patient's medical record before eligibility assessment. Participants were eligible if they were aged ≥ 18 years, were receiving oral antidiabetic medication, were able to participate in a face-to-face interview, and provided written informed consent. Patients receiving insulin-based therapy were not included; therefore, the findings are limited to patients receiving oral antidiabetic therapy.

The sample size was estimated using Slovin's formula, $n = N/[1 + N(e^2)]$, with a source population (N) of 107 and a 5% margin of error ($e=0.05$). The calculation yielded 84.42 participants. In the original study protocol, this value was rounded to 84, which was used as the target sample size. This calculation was an approximate sample-size estimate for the cross-sectional study and was not specifically designed to establish adequate statistical power for multivariable ordinal logistic regression.

Participants were recruited using accidental sampling among eligible patients attending the clinic during the recruitment period. Of the 107 registered patients, 15 did not attend the clinic during recruitment and therefore could not be approached. The remaining 92 patients were approached for participation; eight declined, primarily because of limited time availability. A total of 84 participants completed the study and were included in the final analysis, corresponding to a participation rate of 91.3% among those approached (see Figure 1).

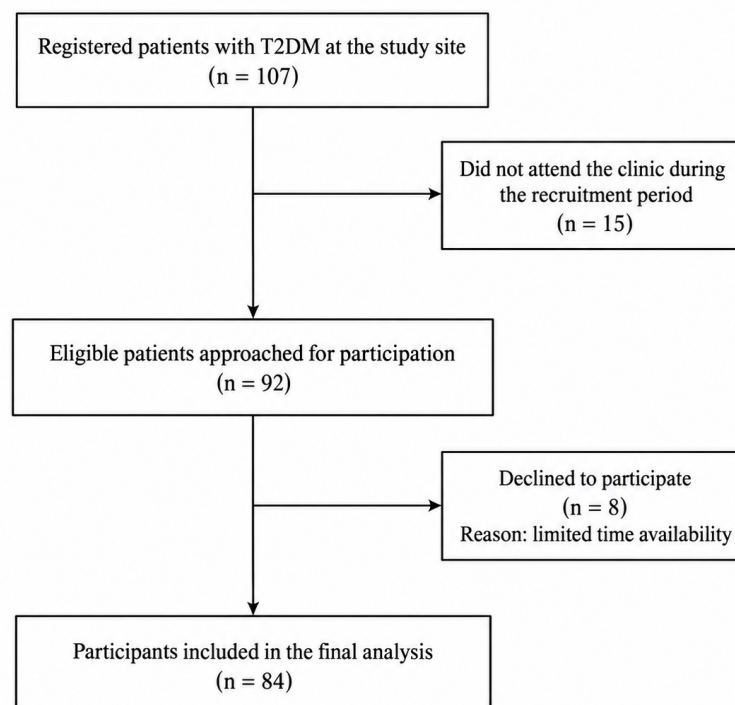


Figure 1. Participant flow from the registered source population to the final analytical sample.

Measurement of medication adherence and covariates

Medication adherence was assessed through face-to-face interviews using the Indonesian version of the eight-item Morisky Medication Adherence Scale (MMAS-8). The Indonesian version was previously validated among 250 patients with T2DM attending primary healthcare centers in Sleman Regency and Yogyakarta City, with reported internal consistency (Cronbach's $\alpha=0.806$), test-retest reliability ($r=0.77$), and convergent validity ($r=0.869$) (Riastienanda, 2017). Medication adherence was retained as an ordered outcome comprising low, moderate, and high adherence categories. Formal permission or licensing for the MMAS-8 was not obtained before data collection. This has been disclosed transparently to the Editorial Team; the questionnaire items and proprietary scoring algorithm are not reproduced in this manuscript.

The explanatory variables were age, sex, education, employment status, duration of diabetes, and economic status. These variables were selected as sociodemographic and clinical characteristics potentially relevant to the context and capacity for diabetes self-care. Age was categorized as 18–44, 45–59, and ≥ 60 years. Educational level was classified as low (completed primary school or lower), middle (completed junior or senior high school), and high (completed higher education). Employment status was classified as working when the participant had a paid job at the time of data collection and not working otherwise. Duration of diabetes was categorized as <5 years and ≥ 5 years. Economic status was classified according to reported monthly income relative to the 2026 Cimahi Regional Minimum Wage (IDR 4,000,000 per month).

Data collection and ethical considerations

Data were collected through face-to-face interviews using a structured questionnaire administered by trained data collectors. All 84 participants had complete data for the variables included in the analysis. Ethical approval was obtained from the Health Research Ethics Committee of STIKes Budi Luhur Cimahi on 14 April 2026 (Approval No. 001970/STIKes Budi Luhur Cimahi/2026), before participant recruitment and data collection commenced. All participants provided written informed consent before participation.

Statistical analysis

Participant characteristics and medication adherence were summarized using frequencies and percentages for categorical variables. Age was additionally summarized using the mean and standard deviation, median and interquartile range, and minimum and maximum values. Bivariate associations between participant characteristics and the three ordered adherence categories were examined using Pearson chi-square tests when expected-cell assumptions were satisfied. For education and economic status, which contained small expected cell counts, the Fisher-Freeman-Halton exact test was approximated using Monte Carlo resampling (200,000 resamples; fixed random seed 20260923). Cramér's V was reported as an effect-size measure.

The primary adjusted analysis used a proportional-odds ordinal logistic regression model because medication adherence was measured as an ordered outcome. The outcome was coded as low=0, moderate=1, and high=2, so adjusted odds ratios (aORs) greater than 1 indicate higher odds of being in a higher adherence category. The primary model included age group (reference: 45–59 years), sex (reference: male), employment status (reference: working), and duration of diabetes (reference: <5 years). These variables were prespecified on conceptual and clinical grounds while maintaining model parsimony for the available sample; selection was not based solely on bivariate p-values. Education and economic status, which included sparse categories, were added in a sensitivity model to assess robustness. The proportional-odds assumption was assessed using a likelihood-ratio comparison of the proportional-odds model with an unconstrained multinomial logistic model. Overall model fit was evaluated using a likelihood-ratio test against the intercept-only model and McFadden pseudo-R². Analyses were performed in IBM SPSS 26. Two-sided p<0.05 was considered statistically significant. Complete model output is provided in the Supplementary Statistical Output.

RESULTS OF STUDY

The source population comprised 107 patients with T2DM registered at the study site. Fifteen patients did not attend the clinic during the recruitment period and therefore were not approached. Of the 92 patients approached, eight declined participation, primarily because of limited time availability. Consequently, 84 participants completed the study and were included in the final analysis, corresponding to a participation rate of 91.3% among those approached.

The mean age of participants was 53.45 years (SD=11.75), with a median of 54 years (IQR=45–63) and a range of 29–75 years. The largest age group was 45–59 years (44.0%), followed by participants aged ≥60 years (32.1%). Most participants were female (69.0%), had completed higher

education (70.2%), were not working at the time of data collection (58.3%), had lived with diabetes for <5 years (64.3%), and reported monthly income below the regional minimum wage (85.7%). Medication adherence was distributed across all three MMAS-8 categories. Of the 84 participants, 25 (29.8%) had low adherence, 33 (39.3%) had moderate adherence, and 26 (31.0%) had high adherence. Moderate adherence was therefore the most frequently observed category. Participant characteristics and the distribution of medication adherence are summarized in Table 1.

Table 1. Characteristics and Medication Adherence of Study Participants (n=84)

Characteristic	n (%)
Age	
Mean ± SD, years	53.45 ± 11.75
Median (IQR), years	54 (45–63)
Range, years	29–75
18–44 years	20 (23.8)
45–59 years	37 (44.0)
≥60 years	27 (32.1)
Sex	
Male	26 (31.0)
Female	58 (69.0)
Educational level	
Low	6 (7.1)
Middle	19 (22.6)
High	59 (70.2)
Employment status	
Working	35 (41.7)
Not working	49 (58.3)
Duration of diabetes	
<5 years	54 (64.3)
≥5 years	30 (35.7)
Economic status	
< Regional minimum wage	72 (85.7)
≥ Regional minimum wage	12 (14.3)
Medication adherence (MMAS-8)	
Low	25 (29.8)
Moderate	33 (39.3)
High	26 (31.0)

Note. Values are presented as n (%) unless otherwise indicated. SD=standard deviation; IQR=interquartile range; MMAS-8=eight-item Morisky Medication Adherence Scale.

Bivariate analyses indicated that medication adherence differed significantly across age groups ($\chi^2=10.534$, df=4, p=0.032; Cramér's V=0.250) and categories of diabetes duration ($\chi^2=8.010$, df=2, p=0.018; Cramér's V=0.309). Participants aged 45–59 years had the highest proportion of low adherence (45.9%), whereas participants aged ≥60 years had the highest combined proportions of moderate and high adherence. Similarly, high adherence was more frequent among participants with diabetes duration ≥5 years (50.0%) than among those with duration <5 years (20.4%).

No statistically significant differences in adherence levels were observed according to sex (p=0.144) or employment status (p=0.065). Because the education and economic-status cross-tabulations contained small expected cell counts, these variables were evaluated using Fisher–Freeman–Halton exact tests with Monte Carlo approximation. Neither educational level (Monte Carlo p=0.471) nor economic status (Monte Carlo p=0.358) was significantly associated with medication adherence. The complete bivariate results are presented in Table 2.

The primary proportional-odds ordinal logistic regression model was statistically significant overall (likelihood-ratio $\chi^2=12.127$, $df=5$, $p=0.033$), indicating that the included covariates jointly improved model fit compared with the intercept-only model. The proportional-odds assumption was not statistically rejected (Test of Parallel Lines: $\chi^2=9.448$, $df=5$, $p=0.092$), supporting the use of the ordinal logistic model. Pearson and deviance goodness-of-fit tests were also non-significant ($p=0.179$ and $p=0.159$, respectively).

Despite the significant overall model, none of the individual adjusted associations reached the conventional threshold for statistical significance. Compared with participants aged 45–59 years, those aged ≥ 60 years had an estimated 2.55-fold higher odds of being in a higher medication-adherence category (aOR=2.55; 95% CI: 0.90–

7.27; $p=0.079$). Participants with diabetes duration ≥ 5 years similarly had higher estimated odds of being in a higher adherence category than those with duration < 5 years (aOR=2.41; 95% CI: 0.91–6.38; $p=0.077$). However, the confidence intervals for both estimates were wide and included the null value, indicating limited precision. Neither age 18–44 years (aOR=1.77; 95% CI: 0.60–5.21; $p=0.299$), female sex (aOR=0.75; 95% CI: 0.25–2.27; $p=0.608$), nor not working (aOR=0.67; 95% CI: 0.24–1.88; $p=0.451$) showed statistically significant adjusted associations with medication adherence. The McFadden pseudo- R^2 was 0.066, suggesting modest overall explanatory performance of the selected routinely measured characteristics. Detailed model estimates are presented in Table 3.

Table 2. Medication adherence levels according to participant characteristics (n=84)

Characteristic	Low n (%)	Moderate n (%)	High n (%)	Statistical test	Cramér's V
Age				$\chi^2=10.534$; $df=4$; $p=0.032$	
18–44 years	5 (25.0)	10 (50.0)	5 (25.0)		0.250
45–59 years	17 (45.9)	11 (29.7)	9 (24.3)		
≥ 60 years	3 (11.1)	12 (44.4)	12 (44.4)		
Sex				$\chi^2=3.879$; $df=2$; $p=0.144$	
Male	4 (15.4)	13 (50.0)	9 (34.6)		0.215
Female	21 (36.2)	20 (34.5)	17 (29.3)		
Educational level				Fisher–Freeman–Halton, Monte Carlo $p=0.471^a$	
Low	2 (33.3)	1 (16.7)	3 (50.0)		0.147
Middle	8 (42.1)	6 (31.6)	5 (26.3)		
High	15 (25.4)	26 (44.1)	18 (30.5)		
Employment status				$\chi^2=5.467$; $df=2$; $p=0.065$	
Working	6 (17.1)	18 (51.4)	11 (31.4)		0.255
Not working	19 (38.8)	15 (30.6)	15 (30.6)		
Duration of diabetes				$\chi^2=8.010$; $df=2$; $p=0.018$	
< 5 years	18 (33.3)	25 (46.3)	11 (20.4)		0.309
≥ 5 years	7 (23.3)	8 (26.7)	15 (50.0)		
Economic status				Fisher–Freeman–Halton, Monte Carlo $p=0.358^b$	
$<$ Regional minimum wage	22 (30.6)	26 (36.1)	24 (33.3)		0.166
$\geq$ Regional minimum wage	3 (25.0)	7 (58.3)	2 (16.7)		

Note: Percentages are row percentages. Pearson chi-square tests were used. Statistical significance was set at $p<0.05$. Cramér's V is presented as an effect-size measure.

^a Three cells (33.3%) had expected counts < 5 ; minimum expected count=1.79.

^b Three cells (50.0%) had expected counts < 5 ; minimum expected count=3.57. Therefore, findings for educational and economic status should be interpreted cautiously.

Table 3. Ordinal logistic regression of characteristics associated with medication adherence (n=84)

Predictor	B	SE	Wald χ^2	aOR	95% CI for aOR	p-value
Age group						
18–44 vs 45–59 years	0.572	0.551	1.079	1.77	0.60–5.21	0.299
≥ 60 vs 45–59 years	0.937	0.534	3.077	2.55	0.90–7.27	0.079
Sex						
Female vs male	–0.291	0.567	0.263	0.75	0.25–2.27	0.608
Employment status						
Not working vs working	–0.393	0.522	0.568	0.67	0.24–1.88	0.451
Duration of diabetes						
≥ 5 vs < 5 years	0.879	0.497	3.124	2.41	0.91–6.38	0.077

Model statistics: Likelihood-ratio $\chi^2=12.127$, $df=5$, $p=0.033$; Pearson goodness-of-fit $\chi^2=35.830$, $df=29$, $p=0.179$; Deviance $\chi^2=36.524$, $df=29$, $p=0.159$; McFadden pseudo- $R^2=0.066$. Test of Parallel Lines: $\chi^2=9.448$, $df=5$, $p=0.092$.

Notes: Medication adherence was modeled as an ordered outcome: low (0) $<$ moderate (1) $<$ high (2). The model estimates the odds of membership in a higher adherence category. Reference categories were age 45–59 years, male sex, working status, and diabetes duration < 5 years. aOR=adjusted odds ratio; CI=confidence interval. The proportional-odds assumption was not statistically rejected ($p=0.092$).

DISCUSSION

This study examined medication adherence and its association with selected sociodemographic and clinical characteristics among patients with T2DM receiving oral antidiabetic therapy in primary care. Approximately three in ten participants had low adherence, while the remaining participants were distributed between moderate and high adherence. Bivariate analyses showed differences across age groups and diabetes-duration categories. Importantly, the primary ordinal regression model was statistically significant overall (likelihood-ratio $p=0.033$), indicating that the covariates jointly improved model fit compared with the intercept-only model. Nevertheless, no individual adjusted association reached conventional statistical significance, and the estimates for older age and longer diabetes duration had wide confidence intervals that included the null value. This combination of an overall model signal with imprecise individual coefficients should be interpreted as evidence of limited precision rather than as proof that the measured characteristics are collectively unrelated to medication adherence. This interpretation is consistent with broader evidence showing that medication adherence in T2DM is multifactorial and that associations with individual demographic and clinical characteristics are often heterogeneous across populations and healthcare contexts (Krass et al., 2015; Polonsky & Henry, 2016). PubMed

Low medication adherence was identified in 29.8% of participants, while 39.3% had moderate adherence and 31.0% had high adherence. The proportion of low or non-adherence reported in other settings varies substantially. For example, Alsaïdan et al. (2023) reported low medication adherence in 21.5% of patients attending primary health centers in Saudi Arabia, whereas a recent systematic review and meta-analysis from India reported a pooled non-adherence prevalence of 48% among studies using MMAS-8, with substantial between-study variability (Basu et al., 2026). Additional international evidence confirms this heterogeneity. A 2024 systematic review and meta-analysis involving 26 studies and 69,366 patients estimated the pooled prevalence of adherence to oral antidiabetic drugs at 55.53%, with marked between-study heterogeneity (Boonpattharathiti et al., 2024). Similarly, a systematic review of 92 real-world studies found wide variation in adherence estimates across treatment settings and measurement approaches (Evans et al., 2022). Direct comparison of adherence proportions across studies should therefore be undertaken cautiously because estimates may differ according to the instrument, scoring thresholds, study population, treatment regimen, healthcare setting, and whether adherence is analyzed as a binary or ordered outcome. Retaining the three ordered categories in the present analysis avoids the additional loss of information that would result from combining moderate and high adherence into a single category. Wiley Online Library

Medication adherence differed across age groups in the bivariate analysis. Low adherence was most frequent among participants aged 45–59 years, whereas participants aged ≥ 60 years more frequently fell within the moderate or high adherence categories. Previous evidence regarding age is not uniform: a meta-analysis from Ethiopia identified older age as a determinant of better antidiabetic medication adherence (Yazew et al., 2019), whereas a recent review from India identified older age among factors associated with poor adherence in included studies (Basu et al., 2026). In a large pharmacy-claims study involving more than 200,000 patients receiving non-insulin diabetes medication, older age was independently associated with greater adherence, but

adherence was also associated with education, income, treatment characteristics, pharmacy access, and out-of-pocket costs (Kirkman et al., 2015). Systematic-review evidence further indicates that the relationship between demographic characteristics and adherence is generally inconsistent across studies (Krass et al., 2015). Several mechanisms could potentially contribute to age-related differences, including experience managing chronic illness, established medication routines, competing occupational and family responsibilities, polypharmacy, or functional limitations. These mechanisms were not directly measured in the present study and should therefore be regarded as possible explanations rather than demonstrated pathways. Diabetes Journals

Duration of diabetes was also associated with adherence level in the bivariate analysis. Half of participants with longer diabetes duration were classified as having high adherence, compared with approximately one fifth of those with diabetes duration < 5 years. Duration of diabetes has also been associated with medication adherence in primary-care populations elsewhere, although the direction and magnitude of the association may vary according to population and measurement approach (Alsaïdan et al., 2023). Large-scale observational evidence indicates that patients who are new to diabetes pharmacotherapy may be less adherent than those with greater treatment experience, although treatment initiation and duration of diabetes represent related but distinct constructs (Kirkman et al., 2015). Longer experience with diabetes could plausibly facilitate medication routines and familiarity with treatment, while prolonged treatment may also contribute to treatment fatigue, medication burden, or regimen complexity. Systematic-review evidence suggests that increased medication-regimen complexity is frequently associated with poorer pharmacotherapy adherence, although findings are not entirely uniform (Pantuzzi et al., 2017). Because these mechanisms were not measured, the present study cannot establish why adherence patterns differed by disease duration. The wide confidence interval around the adjusted estimate also indicates limited precision. Diabetes Journals

Sex, education, employment status, and economic status did not show statistically significant independent associations with adherence in the analyses in which they were evaluated. These findings should not be interpreted as evidence that socioeconomic circumstances are irrelevant. Large observational studies have associated medication adherence with education, income, medication costs, and healthcare-delivery factors (Kirkman et al., 2015), while systematic-review evidence has identified medication cost as one of the more consistently reported potentially modifiable influences on diabetes medication-taking behavior (Krass et al., 2015). Moreover, medication adherence is influenced by mechanisms that are not adequately represented by broad demographic categories. A meta-analysis across long-term conditions demonstrated that stronger perceived necessity for medication and fewer medication-related concerns were consistently associated with better adherence (Horne et al., 2013). Greater regimen complexity has also generally been associated with poorer adherence (Pantuzzi et al., 2017). Health literacy may represent another relevant mechanism, although a recent systematic review among ethnic-minority adults with T2DM found the evidence linking health literacy directly to medication adherence to be limited and inconsistent, underscoring the need to avoid overly simple assumptions regarding educational attainment and adherence behavior (Parmar et al., 2025). Diabetes Journals

Broad categories such as education, employment, and income may therefore fail to capture more proximal determinants, including medication affordability, transportation, household responsibilities, medication beliefs, health literacy, treatment complexity, and access to healthcare. Family and social environments may also influence medication-taking behavior. Among adults with T2DM, diabetes-specific nonsupportive family behaviors have been associated with poorer medication adherence, illustrating that the quality of interpersonal support may be more informative than the mere presence of family members (Mayberry & Osborn, 2012). Small numbers in several educational and economic categories in the present study further limited statistical precision. Routinely measured demographic characteristics alone may therefore be insufficient to distinguish adherence levels within this sample. PubMed

Within Orem's Self-Care Deficit Nursing Theory, age, socioeconomic circumstances, and health-related experience may be considered basic conditioning factors that shape the context in which self-care occurs. Their influence on medication-taking may operate through self-care agency, knowledge, skills, motivation, resources, family support, and therapeutic demands. The present study measured selected basic conditioning factors but did not directly assess self-care agency or therapeutic self-care demand; it should therefore not be interpreted as a test of the complete Orem theoretical pathway. Rather, the findings suggest that distal demographic characteristics may provide only a partial representation of the processes through which patients implement medication-taking as part of daily diabetes self-management.

The findings support a patient-centered approach to adherence assessment in primary care. Healthcare professionals should directly explore missed doses, difficulties maintaining medication schedules, perceived treatment necessity, medication-related concerns, understanding of therapy, treatment burden, competing responsibilities, affordability, and available family support rather than relying solely on demographic profiles. This is supported by Indonesian primary-care evidence showing that patient-reported barriers are relevant to medication adherence (Zairina et al., 2022). More broadly, treatment beliefs and perceived medication burden are recognized as potentially modifiable contributors to non-adherence in T2DM (Horne et al., 2013; Polonsky & Henry, 2016). The clinical importance of adherence is also supported by evidence linking higher adherence with better glycemic control among patients with T2DM (Sendekie et al., 2022), as well as systematic evidence associating greater adherence and persistence with improved clinical outcomes and lower hospitalization or healthcare utilization in several studies (Evans et al., 2022). PubMed

Primary-care adherence support should therefore be individualized according to the barriers identified rather than uniformly applied according to demographic risk categories. Potential strategies include individualized education, medication counseling, feasible medication routines, reminder or action-planning strategies, family or practical social support, and appropriate follow-up. A systematic review of 55 medication-adherence intervention studies among people with T2DM found that successful interventions commonly incorporated elements such as credible sources, instruction on how to perform the target behavior, practical social support, action planning, and information about health consequences, although intervention effectiveness was not uniform across studies (Teo et al., 2024). These findings reinforce the importance of tailoring adherence interventions

to specific behavioral and contextual barriers rather than assuming that a single intervention is appropriate for all patients. OUP Academic

Several limitations should be considered. The cross-sectional design prevents assessment of temporality and causal relationships and cannot capture changes in adherence over time. This is relevant because longitudinal literature indicates that medication adherence can follow distinct trajectories, including consistently high adherence, declining adherence, persistent non-adherence, and improving adherence patterns (Alhazami et al., 2020). The study was conducted in a single primary-care setting with a relatively small sample and accidental sampling, limiting generalizability and statistical precision. Medication adherence was assessed using self-report and may therefore have been affected by recall and social-desirability bias. Evidence from adherence-measurement research indicates that self-report instruments may overestimate medication-taking behavior relative to some other assessment methods and can be influenced by recall and socially desirable responding, although validated self-report measures remain useful and feasible in clinical research (Stirratt et al., 2015). PubMed

The study was also restricted to patients receiving oral antidiabetic therapy and should not be generalized to insulin-treated populations. Potentially important determinants such as health literacy, self-efficacy, medication beliefs, regimen complexity, adverse effects, glycemic control, psychological factors, family support, and healthcare access were not measured. Evidence regarding several of these constructs indicates that their relationships with adherence may themselves be complex and context dependent; for example, health-literacy findings in T2DM are inconsistent (Parmar et al., 2025), while medication beliefs and treatment concerns demonstrate more consistent relationships with adherence across chronic conditions (Horne et al., 2013). Finally, the Slovin calculation used in the original protocol was not a power-based calculation for ordinal logistic regression, and the calculated value of 84.42 was rounded to a target of 84 in the original study planning. These features, together with sparse categories, may have contributed to the wide confidence intervals and limited precision of the adjusted estimates.

CONCLUSIONS AND RECOMMENDATION

Among patients with T2DM receiving oral antidiabetic therapy in this primary-care setting, 29.8% had low medication adherence, 39.3% had moderate adherence, and 31.0% had high adherence. Adherence levels differed across age groups and categories of diabetes duration in bivariate analyses. However, after adjustment, no statistically significant independent associations were identified for the selected sociodemographic and clinical characteristics, and several estimates remained imprecise. Routinely measured demographic and clinical characteristics alone may therefore be insufficient to distinguish patients across adherence levels.

Primary-care providers should assess medication-taking behavior and individual barriers directly rather than relying solely on demographic profiles. Future studies with larger and more diverse populations should incorporate more proximal determinants of self-care, including health literacy, self-efficacy, medication beliefs, treatment complexity, psychological factors, and family support.

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DECLARATION

Ethics approval and consent to participate

Ethical approval was obtained from the Health Research Ethics Committee of STIKes Budi Luhur Cimahi on 14 April 2026 (Approval No. 001970/STIKes Budi Luhur Cimahi/2026), before participant recruitment and data collection commenced. All participants provided written informed consent before participation.

Consent for publication

Not applicable. The manuscript does not contain any individual person's data in any form, including personal details, images, or videos.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. The study was conducted independently without any financial, institutional, or personal influences that could have affected the study design, data collection, analysis, interpretation of findings, or manuscript preparation.

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During manuscript revision, the authors used ChatGPT (OpenAI, GPT-5.6 Sol) to assist with English-language editing and manuscript restructuring. Generative AI was not used to generate or alter the primary research data. The authors take full responsibility for the final content of the manuscript.

Authors' contributions

Andi Hasram: Conceptualization, Data Collection, Investigation, Data Curation, Formal Analysis, Writing – Original Draft. Hardini Tri Indarti: Conceptualization, Methodology, Supervision, Validation, Writing – Review & Editing. Oman Hendi: Methodology, Supervision, Validation, Writing – Review & Editing. Briefman Tampubolon: Validation, Writing – Review & Editing. All authors read and approved of the final manuscript.

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ADDITIONAL INFORMATION

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