Research Article

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Factors Affecting Medication Adherence among Older Adults with Type 2 Diabetes Mellitus in Zhejiang, China

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Received:30 June 2026; Revised: 3 September 2026; Accepted: 1 October 2026

Abstract

Background: Medication adherence is essential for achieving optimal glycemic control and preventing complications among older adults with type 2 diabetes mellitus (T2DM). **Objective:** This study aimed to identify predictors of medication adherence among older adults with T2DM in Zhejiang Province, China. **Methods:** A predictive correlational study was conducted among 102 older adults with T2DM selected through simple random sampling from Zhuji Hospital of Traditional Chinese Medicine. Data were collected from May to December 2025 using validated Chinese-language questionnaires. Self-efficacy, perceived social support, and health literacy were assessed using the Chinese versions of the Diabetes Management Self-Efficacy Scale (DMSES), the Multidimensional Scale of Perceived Social Support (MSPSS), and the 12-item Health Literacy Short-Form Survey (HLS-SF12), respectively. Disease duration and glycated hemoglobin (HbA1c) were obtained from participants' diabetes health records. Data were analyzed using descriptive statistics, Pearson's correlation coefficients, and multiple linear regression analysis. **Results:** The mean medication adherence score indicated a moderate level of adherence (M = 6.07, SD = 1.63). The final regression model explained 86.6% of the variance in medication adherence (R^2 = .866, p < .001). Health literacy

(β = .383, p < .001) was the strongest predictor, followed by self-efficacy (β = .361, p < .01), whereas HbA1c was negatively associated with medication adherence (β = −.179, p < .05). **Conclusion:** These findings highlight the importance of health literacy and self-efficacy in promoting medication adherence among older adults with T2DM. Nursing interventions that strengthen health literacy, enhance self-efficacy, and support glycemic control may help promote medication adherence in this population.

Keywords: Medication adherence, Diabetes mellitus Type 2, Older adults, Health literacy, Self-efficacy

What was Know

- Medication adherence is essential for effective diabetes management in older adults with T2DM. Multiple factors have been linked to medication adherence; however, evidence from older Chinese populations remains limited.

What's New and Next

- This study is among the first to simultaneously quantify the predictive effects of self-efficacy, social support, health literacy, duration of disease and HbA1c on medication adherence specifically in older adults with T2DM in Zhejiang, China, and identifies health literacy as the strongest independent predictor.
- Future research should develop and test theory-based, culturally tailored interventions that prioritize health literacy enhancement and self-efficacy building, using longitudinal or randomized designs to confirm their causal effects on medication adherence and glycemic outcomes in this population.

Introduction

Type 2 diabetes mellitus (T2DM) is one of the most prevalent chronic diseases worldwide, accounting for more than 90% of all diabetes cases and predominantly affecting middle-aged and older adults [1,2]. China bears the largest global diabetes burden, with an estimated 148 million adults living with diabetes in 2024 [3]. Population aging has further intensified the burden of T2DM. China is experiencing one of the most rapid demographic transitions globally. In 2025, approximately 323 million people in China were aged 60 years and older, accounting for 23% of the total population [4]. Aging is accompanied by physiological and functional changes—including cognitive decline, memory impairment, and reduced physiological reserves—that increase vulnerability to chronic diseases,

including T2DM. As a lifelong condition associated with multiple complications, T2DM can adversely affect physical functioning, psychological well-being, quality of life, and life expectancy among older adults [5]. T2DM is associated with substantial morbidity, mortality, and healthcare expenditures [6,7], yet complete remission is uncommon after diagnosis [8]. Successful long-term management therefore requires sustained self-care behaviors, including appropriate medication use [9,10].

Medication adherence is a fundamental component of diabetes self-management, defined as the extent to which a person's medication-taking behavior corresponds with agreed recommendations from a healthcare provider [11]. Adequate adherence improves glycemic control and reduces complication risk, hospitalization, and mortality, whereas poor adherence is associated with adverse health outcomes and reduced quality of life (QoL) [12]. Despite its importance, medication nonadherence remains common, with prevalence ranging from 36% to 93% worldwide [13]. A recent study found that 36.5% of older adults with T2DM in Zhejiang Province demonstrated poor medication adherence [14].

Medication adherence among older adults with T2DM is influenced by multiple factors, including social support, glycemic control (HbA1c), duration of disease, health literacy, and self-efficacy [15-17]. This study was guided by the World Health Organization Multidimensional Adherence Model (WHO-MAM), which conceptualizes adherence as shaped by patient-related, social and economic, therapy-related, condition-related, and healthcare system-related factors [11]. This study selected five key predictors mapped to this framework. Specifically, health literacy and self-efficacy represent patient-related factors. Health literacy enables individuals to understand and apply health information for effective self-management [18]. Self-efficacy, defined as confidence in one's ability to perform health-related behaviors and a consistent strong predictor of medication adherence in chronic diseases, including T2DM [19]. Social support [20], as a social/economic factor, may enhance adherence by reducing psychological distress and facilitating disease management. Duration of disease, a therapy-related factor, has shown inconsistent evidence. Some studies have linked longer diabetes duration to lower adherence, potentially reflecting treatment fatigue, whereas others have reported an association with higher adherence, possibly attributable to greater disease knowledge and more frequent interactions with healthcare providers [21, 22]. HbA1c, a condition-related factor, is similarly associated with adherence, with poorer glycemic control linked to lower adherence [23]. Although cognitive impairment, depression, and polypharmacy are important correlates of medication

adherence [24, 25], these variables were beyond the scope of the present study, which focused on selected predictors informed by the WHO-MAM framework and previous research.

Despite growing evidence on medication adherence, research specifically examining its predictors among older adults with T2DM in Zhejiang Province, China, remains limited. Zhejiang is an economically developed province with a rapidly aging population and a substantial diabetes burden [26]. Zhuji, a county-level city within Zhejiang, encompasses both urban and rural settings. However, evidence on the relative predictive strength of health literacy, self-efficacy, social support, HbA1c, and diabetes duration, examined jointly within a theory-informed model, remains limited in this population.

Guided by the WHO-MAM framework, this study aimed to identify significant predictors of medication adherence and examine their relative predictive strength among older adults with T2DM in Zhejiang Province, China. We hypothesized that higher health literacy, self-efficacy, and social support, together with shorter diabetes duration and lower HbA1c levels, would predict better medication adherence.

Materials and Methods

A predictive correlational study was conducted among older adults with T2DM attending the Internal Medicine Outpatient Department of Zhuji Hospital of Traditional Chinese Medicine in Zhejiang Province, China. Data was collected using self-administered questionnaires from May to December 2025.

Population

The population of this study was older adults with T2DM in Zhejiang, China aged 60 years and above who visited the internal medicine outpatient department of Zhuji Hospital of Traditional Chinese Medicine.

Participants and sample size

The required sample size was calculated using G*Power version 3.1.9.7 for multiple linear regression with five predictors, assuming a medium effect size (f^2 = 0.15), a significance level of α = .05, and 80% power [27]. After allowing for 10% incomplete or nonresponse data, the required sample size was 102 participants, all of whom were recruited. Participants were eligible if they (1) were aged ≥60 years; (2) had been diagnosed with type 2 diabetes mellitus (T2DM) for ≥6 months; (3) had an HbA1c measurement within the preceding 3 months; (4) had adequate cognitive function based on education-specific Mini-Mental State Examination (MMSE) cutoffs (≥24 for college

education or higher, ≥23 for middle school education, ≥21 for primary school education, and ≥18 for those who were illiterate); (5) were able to communicate verbally; and (6) were able and willing to provide informed consent. Patients were excluded if they had severe physical disabilities (e.g., hemiplegia), serious comorbid conditions (e.g., end-stage renal disease, severe heart failure, or active malignancy), or a documented diagnosis of a serious psychiatric disorder (e.g., schizophrenia or bipolar disorder).

Sampling technique

Simple random sampling was used to recruit participants from daily lists of eligible patients. Each weekday between 8:00 and 9:00 a.m., a registered nurse who was independent of the research team screened consecutive clinic attendees and compiled a list of eligible patients. Three to five patients were then selected each day by drawing numbered, identical slips from a container without replacement. Recruitment continued until the target sample of 102 participants was reached.

Data collection

The study was approved by the Institutional Review Board of Burapha University (Approval No. G-HS143/2567). Permission for data collection was obtained from the hospital administration following a formal request from the Graduate School of Burapha University. A total of 102 eligible participants were enrolled. Before data collection, the researcher explained the study, provided a participant information sheet, and obtained written informed consent. Participants completed the questionnaires in a private room at the hospital, taking approximately 30 minutes. The researcher provided assistance as needed, including reading questionnaire items aloud to participants with visual difficulties or limited literacy. Rest breaks were offered to participants experiencing fatigue. All participants completed the questionnaires at the hospital. Completed questionnaires were checked for completeness and assigned identification codes to protect confidentiality. Data were entered into a password-protected database accessible only to the research team.

Research Instruments

Permission to use the study instruments was obtained from the original authors and the developers of the Chinese versions before data collection. Cognitive function was screened using the MMSE. The study data were collected using the following five instruments:

1. Demographic and clinical characteristics. A nine-item form developed by the researchers was used to record demographic and clinical data. Demographic information included age,

gender, marital status, educational level, occupation, and monthly income. Clinical data included diabetes duration (years), current treatment regimen (oral medications, insulin, or both), and the most recent HbA1c value obtained within the preceding 3 months. Clinical data were extracted from participants' electronic medical records.

2. Medication adherence was assessed using the Chinese version of the 8-item Morisky Medication Adherence Scale (MMAS-8) [28]. The scale comprises seven dichotomous items scored 0 or 1, with reverse scoring for item 5, and one five-point item scored 0, 0.25, 0.5, 0.75, or 1. Total scores range from 0 to 8, with higher scores indicating better adherence. Adherence was classified as high (8), moderate (6 to <8), or low (<6). Cronbach's alpha in the present study was .70.
3. Social support was assessed using the Chinese version of the Multidimensional Scale of Perceived Social Support (MSPSS) [29]. This 12-item scale measures support from family, friends, and others. Items are rated on a seven-point Likert scale, ranging from 1 (very strongly disagree) to 7 (very strongly agree). Total scores range from 12 to 84, with higher scores indicating greater perceived social support. Cronbach's alpha in the present study was .89.
4. Health literacy was assessed using the Chinese version of the Health Literacy Scale Short-Form (HLS-SF12) [30]. The scale comprises 12 items covering three domains: health care, disease prevention, and health promotion. Items are rated on a four-point Likert scale, ranging from 1 (very difficult) to 4 (very easy). Total scores range from 12 to 48, with higher scores indicating greater health literacy. Cronbach's alpha in the present study was .94.
5. Self-efficacy was assessed using the Chinese version of the Diabetes Management Self-Efficacy Scale (DMSES) [31]. The scale comprises 20 items assessing confidence in performing diabetes self-care activities, each rated from 0 (cannot do at all) to 10 (certainly can do). Total scores range from 0 to 200, with higher scores indicating greater self-efficacy. Cronbach's alpha was .93 in the present study.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 32.0. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize participant characteristics and study variables, while Pearson's correlations examined bivariate associations. Multiple linear regression (enter method) identified predictors of medication adherence. Regression

assumptions were assessed using residual histograms, Q–Q plots, scatterplots, variance inflation factors (VIFs), and the Durbin–Watson statistic. Social support was excluded because of severe multicollinearity (VIF = 33.289; threshold = 10). Duration of disease, HbA1c, health literacy, and self-efficacy were entered simultaneously into the final model. Unstandardized coefficients (b), standard errors, standardized coefficients (β), t statistics, and p values were reported. Statistical significance was set at $p < .05$ (two-tailed).

Results

1. General characteristics

Among the 102 participants, the mean age was 70.5 years (SD = 6.31), and 59.8% were female. Most were married (61.8%), no single and separated, had completed secondary education (46.1%), and were retired (75.5%). The mean monthly income was 3,980.4 RMB (SD = 2,138.7), and the mean duration of T2DM was 11.56 years (SD = 7.84). Most participants (85.3%) were receiving oral antidiabetic medications only, and the mean HbA1c level was 7.47% (SD = 1.43) (Table 1).

Table 1 General Characteristics (n=102)

Characteristics	Number	Percentage
Age (years)		
60-65	25	24.5
66-70	30	29.4
71-75	28	27.5
76-80	11	10.8
Over 80	8	7.8
Mean =70.5, SD =6.31, Min =60, Max =87		
Gender		
Male	41	40.2
Female	61	59.8

Table 1 General Characteristics (n=102) (Cont.)

Characteristics	Number	Percentage
Marital Status		
Married	63	61.8
Divorced	18	17.6
Widowed	21	20.6
Education Level		
Primary school	36	35.3
Secondary school	47	46.1
High school	15	14.7
University	4	3.9
Occupation		
Retired	77	75.5
Government service/state enterprise employee	10	9.8
Agriculturist	15	14.7
Monthly Income (RMB)		
Below 3000	30	29.4
3001-5000	36	35.3
5001-8000	29	28.4
Over 8000	7	6.9
Mean=3980.40, SD=2138.70, Min=0.00, Max=10000.00		
Duration of the T2DM (years)		
1-5	30	29.4
6-10	36	35.3
11-15	29	28.4
16-20	7	6.9
20-25	30	29.4
Over 25	36	35.3
Mean =11.56, SD=7.84, Min=1, Max=30		

Table 1 General Characteristics (n=102) (Cont.)

Characteristics	Number	Percentage
Treatment		
Medicine	87	85.3
Insulin	12	11.8
Medicine and Insulin	3	2.9
HbA1c (%)		
Less than 7	48	47.1
7.01-7.5	11	10.8
7.51-8	12	11.8
More than 8	31	30.3
Mean =7.47, SD=1.43, Min=4.93, Max=13.47		

2. Level of Medication Adherence

The mean medication adherence score among the 102 participants was 6.07 (SD = 1.63), indicating a moderate level of medication adherence. Based on the MMAS-8 classification, 46.1% of participants demonstrated moderate adherence, 38.2% demonstrated low adherence, and 15.7% demonstrated high adherence (Table 2).

Table 2 Level of Medication adherence (n = 102)

Variables	n (%)	Mean	SD
Medication adherence (overall)	102 (100%)	6.07	1.63
Medication adherence (classified by levels)			
High (8)	16 (15.7%)	8	0.00
Moderate (6 to <8)	47 (46.1%)	6.88	0.49
Low (< 6)	39 (38.2%)	4.30	1.15

3. Descriptive Statistics of Study Variables

The mean score for social support was 61.41 (SD = 13.47), health literacy had a mean of 33.18 (SD = 8.75), and self-efficacy showed a mean of 148.58 (SD = 36.77). The mean duration of disease was 11.56 years (SD=7.84), and the mean HbA1c level was 7.47% (SD=1.43) (Table 3).

Table 3 Descriptive Statistics of Study Variables (N = 102)

Variables	Mean	SD	Range	
			Actual score	Possible score
Duration of disease	11.56	7.84	-	-
HbA1c	7.47	1.43	-	-
Social support	61.41	13.47	32-82	12-84
Health literacy	33.18	8.75	13-48	12-48
Self-efficacy	148.58	36.77	70-199	0-200

4. Correlations Among Study Variables

Medication adherence was significantly and positively correlated with social support (r = .931, p < .01), health literacy (r = .904, p < .01), and self-efficacy (r = .919, p < .01), and negatively correlated with diabetes duration (r = —.692, p < .01) and HbA1c (r = —.831, p < .01). Among the independent predictors, social support was highly correlated with health literacy (r = .949, p < .01) and self-efficacy (r = .982, p < .01). These high intercorrelations indicated potential multicollinearity and warranted further diagnostic assessment before multiple regression analysis (Table 4).

Table 4 Pearson Correlations among studied variables (n = 102)

Variables	1	2	3	4	5	6
Duration	1.000					
HbA1c	.601**	1.000				
Social support	-.692**	-.854**	1.000			
Health literacy	-.689**	-.773**	.949**	1.000		
Self-efficacy	-.379**	-.805**	.982**	.838**	1.000	
Medication adherence	-.692**	-.831**	.931**	.904**	.919**	1.000

Note: **p<0.01

5. Predictors of Medication Adherence

Social support was excluded from the multiple linear regression model because of severe multicollinearity (VIF = 33.289), with high correlations with health literacy (r = .949) and self-efficacy (r = .982). The final four-predictor model was statistically significant and explained 86.6% of the variance in medication adherence (R^2 = .866, adjusted R^2 = .860, F = 156.72, p < .001). Health literacy (β = .383, p < .001) and self-efficacy (β = .361, p < .01) were significant positive predictors, whereas HbA1c was a significant negative predictor (β = -.179, p < .05). Duration of disease was not statistically significant (β = -.071, p > .05) (Table 5).

Table 5 Factors Influencing Medication Adherence

Variables	b	SE	Standardized Beta (β)	t	p-value	95% CI for b
Constant	2.928	1.141		2.567		
Duration of disease	-.015	.011	-.071	-.1.334	.185	[-.037, .007]
HbA1c	-.202	.085	-.179	-2.384	.019*	[-.371, -.033]
Health literacy	.073	.018	.383	4.001	< .001***	[.037, .109]
Self-efficacy	.016	.005	.361	2.981	.004**	[.006, .026]

Note: R= .930, R^2= .866, Adjust R^2= .860, F= 156.72, *p <.05, **p <.01, ***p <.001

Discussion

This study examined medication adherence and its predictors among older adults with T2DM in Zhejiang, China. The findings showed a moderate level of medication adherence, with a mean score of 6.07 (SD = 1.63). Nearly half of the participants demonstrated moderate adherence, whereas only a small proportion achieved high adherence. This finding is consistent with previous studies reporting suboptimal medication adherence among older adults with chronic diseases [32, 33].

The moderate level of medication adherence observed in this study may be partly explained by the complex cognitive and psychological demands of long-term diabetes management. Although participants demonstrated normal global cognitive function based on the MMSE, T2DM may be

associated with subtle difficulties in executive functioning that could affect medication planning, organization, and consistency [10]. Moreover, the relatively long duration of diabetes in this sample (M = 11.56 years) may be associated with greater psychological distress arising from the prolonged burden of disease management [34] and concerns about diabetes-related complications, which could potentially affect consistent medication-taking behaviors [10, 19]. Interestingly, despite relatively high levels of social support and self-efficacy in this sample, medication adherence remained moderate. This suggests that these protective factors may not fully compensate for the cognitive and psychological challenges associated with long-standing diabetes. Comprehensive adherence-promoting interventions should therefore address not only self-efficacy and social support but also cognitive and psychological factors, particularly among older adults with a long duration of T2DM.

The final four-predictor model accounted for 86.6% of the variance in medication adherence, with health literacy, self-efficacy, and HbA1c remaining statistically significant.

Health literacy had the largest standardized regression coefficient in the final model (β = .383, $p < .001$), consistent with the patient-related dimension of the WHO-MAM framework. Greater health literacy may facilitate understanding of medication instructions and engagement in diabetes self-management [18]. Previous intervention studies have also reported improvements in medication adherence and glycemic outcomes following health education programs among people with T2DM [35, 36]. These findings suggest that enhancing health literacy may be an effective primary strategy for improving medication adherence in older adults with T2DM.

Self-efficacy was the second strongest predictor (β = 0.361, $p < .01$), consistent with previous research. According to the WHO Multidimensional Adherence Model, self-efficacy influences individuals' confidence in performing health-related behaviors. Older adults with higher self-efficacy are more likely to overcome barriers to medication use and maintain adherence over time. Previous studies have similarly reported positive associations between self-efficacy and medication adherence among individuals with diabetes [37].

HbA1c was a significant negative predictor of medication adherence (β = -.179, $p < .05$), indicating that poorer glycemic control was associated with lower medication adherence. This finding is consistent with previous evidence linking suboptimal glycemic control with poorer medication adherence among individuals with T2DM [10, 23]. Although inadequate medication adherence may

contribute to poorer glycemic control, HbA1c is also influenced by multiple clinical, treatment-related, and behavioral factors. Therefore, the observed association should not be interpreted as evidence of a causal relationship. Given the cross-sectional design of this study, the temporal direction of the association cannot be determined. Longitudinal studies are needed to further clarify the relationship between medication adherence and glycemic control.

Although duration of disease was negatively correlated with medication adherence ($r = -.692$, $p < .01$), it was not a significant independent predictor in the final model ($\beta = -.071$, $p > .05$), suggesting that its contribution diminished after accounting for other predictors. This finding highlights the potentially greater role of modifiable patient-related factors, particularly health literacy and self-efficacy, in medication adherence.

Social support was strongly correlated with medication adherence ($r = .931$, $p < .01$) but was excluded from the final model because of severe multicollinearity with health literacy ($r = .949$) and self-efficacy ($r = .982$; VIF = 33.289). Thus, the independent contribution of social support to medication adherence could not be reliably estimated because of substantial multicollinearity with health literacy and self-efficacy.

Overall, the findings indicate that health literacy and self-efficacy were the most prominent predictors of medication adherence in this sample, while poorer glycemic control was associated with lower adherence and duration of disease was not independently associated with adherence. These findings highlight potentially modifiable factors that may be particularly relevant to nursing practice. Interventions that enhance older adults with T2DM' understanding of medication management and strengthen their confidence in diabetes self-management may help promote medication adherence. However, because of the cross-sectional design, the findings should be interpreted as predictive associations rather than causal relationships.

Limitation

This study has several limitations. First, the single-center, cross-sectional design limits the generalizability of the findings and precludes causal inference. Second, the use of self-reported measures may have introduced recall and social desirability biases. Third, multicollinearity among social support, health literacy, and self-efficacy necessitated the exclusion of social support from the final regression model, thereby limiting the assessment of its independent contribution to medication

adherence. Future multicenter and longitudinal studies with larger and more diverse samples are warranted to validate these findings and further clarify the independent contributions of these factors to medication adherence.

Conclusion

Medication adherence among older adults with T2DM in Zhejiang, China, was moderate. Health literacy and self-efficacy were significant positive predictors of medication adherence, whereas higher HbA1c levels were associated with lower adherence. Given the cross-sectional design, these associations should not be interpreted as causal. The findings support nursing strategies that enhance health literacy and self-efficacy to promote medication adherence and diabetes self-management among older adults with T2DM.

Ethical Approval Statement

This research was approved by the Burapha University Institutional Review Board, on March 2, 2025 (Project Code: G-HS143/2567) and the Ethics Committee of Zhuji Hospital of Traditional Chinese Medicine in Zhejiang Province on April 13, 2025. Written informed consent was obtained from all participants prior to data collection. Participants were informed that their participation was voluntary and that they could withdraw at any time without affecting their access to healthcare services. Confidentiality was maintained throughout the study, with data access restricted to the research team. Data were analyzed and reported in aggregate form to protect participants' privacy.

Author Contributions

All authors contributed significantly to this work. LC and CN were involved in the study design, data collection, data analysis, and writing of the main manuscript text. CN, PJ and YG contributed to the study design, discussion, as well as the editing and revision of the manuscript.

Acknowledgements

The authors sincerely thank all the participants for their contributions, as well as the responsible persons of the relevant hospitals for approving the data collection work. We also thank all the other personnel who provided assistance for this research.

Source of Funding

This research received no external funding.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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