Patient Preference and Adherence

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ORIGINAL RESEARCH

The Mediating Role of Treatment Adherence in the Relationship Between Health Literacy and Health Maintenance Efficacy Among Adults with Type 1 Diabetes

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Introduction: Health literacy is a key determinant of diabetes self-management; however, the behavioral mechanisms linking health literacy to health maintenance efficacy in adults with type 1 diabetes mellitus (T1DM) remain insufficiently explored. Health maintenance efficacy refers to individuals' perceived ability to sustain long-term diabetes care behaviors.

Methods: This cross-sectional analytical study was conducted with 368 adults diagnosed with T1DM in Turkey. Data were collected online using the European Health Literacy Survey Questionnaire (HLS-EU-Q6) and the treatment adherence and health maintenance efficacy subscales of the Chronic Illness Self-Management Scale. Descriptive statistics, Pearson correlation analysis, and mediation analysis were performed using Hayes' PROCESS Model 4 with 5000 bootstrap resamples.

Results: Health literacy was positively associated with both treatment adherence and health maintenance efficacy. Treatment adherence played a partial mediating role in the association between health literacy and health maintenance efficacy (indirect effect = 0.11; 95% CI: 0.06–0.17). The final model explained 38% of the variance in health maintenance efficacy.

Conclusion: Health literacy was strongly associated with health maintenance efficacy in adults with T1DM, both directly and indirectly through its association with treatment adherence. By conceptualizing health maintenance efficacy as a distinct construct reflecting the sustainability of diabetes care behaviors, the findings provide clearer insight into how health literacy relates to long-term self-management capacity. Given the cross-sectional design, these relationships should be interpreted as associative rather than causal.

Keywords: type 1 diabetes mellitus, health literacy, treatment adherence, health maintenance efficacy

Introduction

Diabetes remains one of the leading public health issues increasing global mortality and morbidity. According to the latest report by the International Diabetes Federation (IDF), as of 2024, 589 million adults aged 20–79 worldwide are living with diabetes, and this number is projected to reach 783 million by 2045.[1] Although T1DM accounts for a smaller percentage of the total diabetes burden, it is one of the most clinically complex disease models due to lifelong insulin dependence, high glycemic variability, risk of acute complications, and the need for intensive self-management.[2,3] Current T1DM Index modeling indicates that approximately 9.5 million people will be living with T1DM by 2025 and that serious management issues associated with early mortality will persist, particularly in low- and middle-income countries. In Turkey, it is estimated that approximately 210,000 individuals are living with T1DM, highlighting the growing national burden of long-term diabetes management.[2,4] The American Diabetes Association (ADA) 2024 care standards also emphasize that effective management of T1DM requires a combination of person-centered care, advanced glycemic monitoring technologies, behavioral support, and ongoing education.[5]

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T1DM management is a multidimensional self-management process that encompasses blood glucose monitoring, insulin dose adjustment, carbohydrate counting, physical activity, and screening for complications. In this process, individuals' perceived competence in planning and maintaining their own health behaviors and managing complication risks is explained by the concept of health maintenance efficacy.[6] While self-efficacy reflects confidence in performing specific diabetes-related tasks, health maintenance efficacy captures individuals' perceived ability to sustain diabetes care behaviors over time. Based on Social Cognitive Theory, this framework emphasizes not only the ability to initiate behavior but also the continuity of sustainable health behaviors over time, which is distinct from self-efficacy.[7,8] Recent studies have shown that care effectiveness in chronic disease management is a decisive factor in achieving glycemic control, preventing acute decompensations, and increasing the sustainability of self-care behaviors.[9–11] These findings suggest that health maintenance efficacy in chronic conditions requiring intensive self-management, such as T1DM, may be a fundamental construct that plays a central role in clinical outcomes and behavioral sustainability. In the Turkish healthcare context, challenges related to access to structured education, continuity of follow-up, and effective use of digital health resources may further complicate long-term T1DM management.

Health literacy is a multidimensional concept defined as the capacity of individuals to find, understand, evaluate, and use health-related information in clinical decision-making processes.[12] Current studies indicate that health literacy is an important determinant in T1DM management. High health literacy is associated with better glycemic control, increased treatment adherence, advanced self-care skills, and a better quality of life.[13,14] It has been demonstrated that sufficient literacy levels are required to benefit from advanced technologies such as continuous glucose monitoring, and that low health literacy can increase the risk of complications and emergency visit rates.[15] These findings indicate that improving health literacy in T1DM may provide tangible benefits at both the behavioral and clinical levels.

Knowledge alone is insufficient for diabetes management; the translation of knowledge into behavior, ie, treatment adherence, is the most critical component of clinical outcomes. Accordingly, treatment adherence was conceptualized as a proximal behavioral mechanism through which health literacy may be associated with sustained diabetes care outcomes. Recent meta-analyses show that treatment adherence in T1DM significantly affects HbA1c levels, the risk of diabetic ketoacidosis, the frequency of hypoglycemia, and quality of life.[16] Furthermore, treatment adherence has been reported to function as a "mediating variable" between both cognitive and behavioral components in chronic disease management models.[17] Recent studies in the field of diabetes show that the majority of the effect of health literacy on self-care behaviors occurs indirectly through treatment adherence.[18] However, most of these findings have been obtained from individuals with T2DM; evidence regarding adults with T1DM is quite limited.

There is a significant gap in the current literature: Recent studies have mostly examined the interactions between health literacy, treatment adherence, and behavioral self-management outcomes in T2DM samples.[19] There are very few studies that address these variables within a single structural model in adults with T1DM. Furthermore, most studies conducted in Turkey focus on describing the level of health literacy; empirical models explaining which behavioral mechanisms influence health literacy in T1DM self-management have not been developed.

This study fills this gap in literature and makes an important original contribution. It is one of the first studies in Turkey to investigate the relationship between health literacy, treatment adherence, and health maintenance efficacy in adults with T1DM using a comprehensive mediation model. Furthermore, by explaining how health literacy shapes T1DM self-management through a behavioral pathway, it provides an evidence-based foundation for restructuring patient education, clinical follow-up, and management programs. In this respect, the study offers a unique contribution to both theoretical literature and practice-oriented healthcare planning.

This study aims to examine the effect of health literacy on health maintenance efficacy in patients with T1DM and to evaluate the mediating role of treatment adherence in this relationship. Based on this theoretical background and previous research, the present study proposed the following hypotheses and developed a mediation model in which Health Literacy served as the independent variable, Treatment Adherence as the mediating variable, and Health Maintenance Efficacy as the dependent variable (Figure 1).

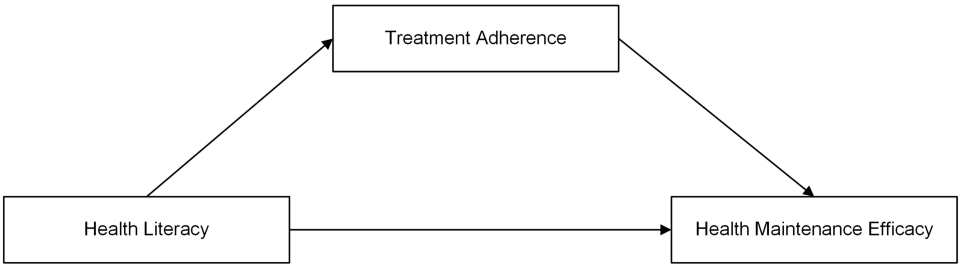

Figure 1 Conceptual mediation model of the study.
Note: → indicates the direction of the association.

H1: Health Literacy has a positive effect on Treatment Adherence.

H2: Health Literacy has a positive direct effect on Health Maintenance Efficacy.

H3: Treatment Adherence has a positive effect on Health Maintenance Efficacy.

H4: Treatment Adherence mediates the relationship between Health Literacy and Health Maintenance Efficacy.

Material and Methods

Study Design

This study was designed as a cross-sectional and analytical study to examine the relationships between health literacy, treatment adherence, and health maintenance efficacy among adults diagnosed with T1DM living in Turkey.

Participants and Sampling

The population of this study comprises approximately 210,000 T1DM patients residing in Turkey, according to data from the International Diabetes Federation (IDF).[1,20] Inclusion criteria for the study were: a) being 18 years of age or older, b) having been diagnosed with T1DM by a specialist physician for at least one year, and c) being able to read and understand Turkish and agreeing to complete the online survey voluntarily. Individuals with a history of serious complications requiring hospitalization in the last three months or with a health problem that could affect cognitive capacity were excluded from the study.

In this study, the sample size was determined based on the "item number x 20 rule," a common approach used in behavioral sciences.[21,22] The total number of items in the scales used in the study is 15. Accordingly, the minimum sample size was calculated as n = 15×20 = 300 individuals. To prevent potential losses due to data loss, incomplete filling, or cleaning, the aim was to recruit 20% more participants than the initial target. Data collected from 368 individuals were used in the study. Convenience sampling was employed as the sampling method; the survey link was shared through social media groups, online patient communities, and relevant communication networks targeting individuals with T1DM. This method provided broad access to adult individuals with T1DM living in various regions of Turkey. With a sample size of 368 participants, the study had sufficient power to detect small-to-moderate indirect effects in bootstrapped mediation models, as recommended in contemporary methodological literature.

Data Collection Procedures

Data were collected online via Google Forms between February and October 2025. Following ethics committee approval, the survey link was distributed through moderated social media groups, diabetes-focused patient communities, local health networks, and publicly accessible online platforms. Individuals were eligible if they had a diagnosis of T1DM, were 18 years or older, lived in Turkey, and could read Turkish. Participation was voluntary, and informed consent was obtained electronically. No incentives were offered. The survey required approximately 8 minutes to complete and included an informed consent form, a sociodemographic form, and three validated scales assessing health literacy,

treatment adherence, and health maintenance efficacy. Data security was ensured through Google's GDPR-compliant infrastructure, and no IP addresses, identifying information, or geolocation data were collected.[23]

Measures

Personal Information Form

The personal information form consisted of several questions regarding the demographic characteristics of the participants, including age, sex, marital status, education level, monthly net income, body mass index (BMI) and HbA1c. Participants reported their most recent HbA1c value obtained within the past three months. Values were recorded as continuous percentages and categorized as <7.0%, 7.0–8.9%, or ≥9.0% according to ADA criteria.[5]

Health Literacy Survey (HLS-EU-Q6)

Health literacy was measured using the European Health Literacy Survey Questionnaire—Short Form (HLS-EU-Q6), which consists of six items derived from the original 47-item HLS-EU-Q47 instrument.[24] The Turkish adaptation and validation of the HLS-EU-Q6 was conducted in Türkiye.[25] Items are rated on a 4-point Likert scale (1 = very difficult to 4 = very easy), and total scores are calculated as the mean of valid responses (range: 1–4). Participants who completed at least five items were included. Health literacy levels were classified according to standard HLS-EU thresholds: inadequate (≤ 2), problematic (> 2 to ≤ 3), and adequate (> 3). Higher scores represent better health literacy. Cronbach's alpha for this study was 0.81, indicating satisfactory internal consistency.

Treatment Adherence

Treatment adherence was assessed using the treatment adherence subscale of the chronic illness self-management scale.[26] The Turkish adaptation of the scale was subsequently conducted to support its use in clinical and research settings.[27] This four-item subscale measures the extent to which individuals follow recommended diabetes self-management behaviors, including medication use and glucose monitoring. Items are rated on a 5-point Likert scale (1 = Never to 5 = Always), with higher scores indicating stronger adherence. In this study, this subscale demonstrated high internal consistency ($\alpha = 0.88$).

Health Maintenance Efficacy

Health maintenance efficacy was measured using the health maintenance efficacy subscale of the chronic illness self-management scale.[26] The scale was later adapted into Turkish for use in clinical research and practice.[27] This four-item subscale assesses individuals' perceived ability to sustain routine diabetes care behaviors such as regular monitoring and follow-up. All items are rated on a 5-point Likert scale, and higher scores reflect stronger self-management capacity. Internal reliability in the present study was excellent ($\alpha = 0.87$).

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics version 29 and the PROCESS macro version 5.0 developed by Hayes.[28,29] Before the main analyses, the dataset was examined for missing values, outliers, and normality assumptions. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were calculated to characterize the sociodemographic and health-related variables of the participants. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test and by inspecting the skewness and kurtosis values, which were within the acceptable range of ±1.0.[21,22] Internal consistency reliability of the scales was evaluated using Cronbach's alpha coefficients. Pearson correlation analysis was used to determine the bivariate relationships among health literacy, treatment adherence, and health maintenance efficacy, as all variables demonstrated approximate normal distribution. Prior to the mediation analysis, age, sex, and self-reported HbA1c were examined as potential covariates; however, none showed a meaningful impact on the mediation paths, and they were therefore not retained in the final model to preserve parsimony. To test the hypothesized mediation model, PROCESS Model 4 was applied, with treatment adherence specified as the mediator between health literacy (the independent variable) and health maintenance efficacy (the dependent variable). Bootstrapping with 5000 resamples was employed to estimate the indirect effects and their 95% bias-corrected confidence intervals. Mediation was considered statistically significant when the confidence interval did

not include zero. Effect sizes (β), standard errors, and z-statistics were reported for direct, indirect, and total effects. The level of statistical significance was set at $p < 0.05$ for all analyses.

Ethical Considerations

This study was approved by the Selçuk University Faculty of Health Sciences Ethics Committee (Decision Date: 27.11.2024, Decision No: 2024/1095). All participants provided written informed consent before data collection. The study adhered to the ethical principles of the Declaration of Helsinki and complied with national regulations governing research involving human participants.

Results

As shown in Table 1, the average age of the 368 individuals participating in the study was 31.50 ± 11.81 years, with 31.0% of participants aged 18–24, 46.2% aged 25–39, and 22.8% aged 40 and above. When examining the gender distribution, it was determined that 66.0% of the individuals were female and 34.0% were male. Of the participants, 55.7% were single and 44.3% were married. In terms of educational level, 37.0% of the participants had a high school education or below, 30.7% held an associate's degree, and 32.3% had a bachelor's degree. The average monthly net income was 41,805.03 ± 25,455.22 TL. When the income level distribution was examined, 41.0% of participants earned between 15,000 and 29,999 TL, 22.6% earned between 30,000 and 49,999 TL, and 36.4% earned 50,000 TL or more. The average body mass index was 24.20 ± 3.68 kg/m^2, with 57.6% of individuals being of normal weight, 35.1% overweight, 7.3% obese, and 2.4% underweight. In terms of health literacy, 11.7% of participants were found to have inadequate health literacy, 60.6% had problematic health literacy, and 27.7% had adequate health literacy. These findings indicate that the sample is demographically heterogeneous and that there is a significant need for improvement in health literacy levels. The mean HbA1c level was 8.4±1.6, indicating suboptimal glycemic control in the overall sample. Approximately 19.6% of participants achieved the recommended target (<7.0%), while 30.4% exhibited poor glycemic control (≥9.0%).

Table 1 Sociodemographic and Health Characteristics of Participants (N = 368)

Variables	**n**	**%**
Age (years) (M ± SD: 31.50±11.81)		
18 – 24	114	31.0
25 – 39	170	46.2
≥ 40	84	22.8
Sex		
Male	125	34.0
Female	243	66.0
Marital status		
Not married	205	55.7
Married	163	44.3
Education level		
High school or below	130	37.0
Associate degree	113	30.7
Bachelor's degree	119	32.3

(*Continued*)

Table 1 (Continued).

Variables	n	%
Monthly net income (TRY) (M ± SD: 41,805.03±25,455.22)		
15,000 – 29,999	151	41.0
30,000 – 49,999	83	22.6
50,000 ≥	134	36.4
BMI (kg/m^2) (M ± SD: 24.20±3.68)		
< 18.5	9	2.4
18.5–24.9	203	57.6
25.0–29.9	129	35.1
≥ 30.0	27	7.3
Health literacy level		
Inadequate	43	11.7
Problematic	223	60.6
Sufficient	102	27.7
HbA1c (%) (M ± SD) (8.4 ±1.6)		
<7.0	72	19.6
7.0–8.9	184	50.0
≥ 9.0	112	30.4

Abbreviations: BMI, body mass index; HbA1c, glycated hemoglobin; M, Mean; SD, Standard Deviation; TRY, Turkish Lira.

As shown in Table 2, when examining the descriptive statistics and correlation coefficients for the variables, health literacy (M = 2.84, SD = 0.58) was found to be significantly and positively correlated with treatment adherence (M = 4.09, SD = 0.83) and health maintenance efficacy (M = 3.94, SD = 0.82). The correlation coefficients between health literacy and treatment adherence (r = 0.35) and health literacy and health maintenance efficacy (r = 0.58) are both statistically significant ($p < 0.01$). Furthermore, a positive and significant relationship exists between treatment adherence and health maintenance efficacy (r = 0.41, $p < 0.01$). These findings reveal that health literacy is a crucial variable that enhances both individuals' adherence to treatment and their perceptions of the effectiveness of maintaining their health.

Table 2 Descriptive Statistics and Pearson Correlation Matrix for Key Study Variables

Variable	M	SD	1	2	3
1. Health literacy	2.84	0.58	–		
2. Treatment adherence	4.09	0.83	0.35*	–	
3. Health maintenance efficacy	3.94	0.82	0.58*	0.41*	–

Note: *p < 0.01.
Abbreviations: M, Mean; SD, Standard Deviation.

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Table 3 Indirect, Direct, and Total Effects for the Mediation Model

Type	Effect	Estimate	SE	95% C.I.		β	z	p
				Lower	Upper			
Indirect	**HL → TA → HME**	0.11	0.03	0.06	0.17	0.08	4.28	<0.001
Component	**HL → TA**	0.50	0.07	0.36	0.63	0.35	7.17	<0.001
	TA → HME	0.23	0.04	0.15	0.31	0.23	5.33	<0.001
Direct	**HL→ HME**	0.70	0.06	0.58	0.82	0.50	11.40	<0.001
Total	**HL → HME**	0.82	0.06	0.70	0.93	0.58	13.62	<0.001

Notes: → indicates the direction of the association; SE, standard error; β, standardized coefficient; z, z-value. Model 1 (HL → TA): R^2 = 0.12, f^2 = 0.14. Model 2 (HL + TA → HME): R^2 = 0.38, f^2 = 0.62.
Abbreviations: HL, Health literacy; HME, Health maintenance efficacy; TA, Treatment adherence.

As shown in Table 3, the path coefficients of the mediation model examining the association between health literacy and health maintenance efficacy show that both direct and indirect paths are statistically significant. The indirect effect of health literacy on health maintenance efficacy through treatment adherence is 0.11, which is statistically significant (95% CI: 0.06–0.17, β=0.08, p<0.001). When examining the component paths, the effect of health literacy on treatment adherence was found to be 0.50 (95% CI: 0.36–0.63, β=0.35, p<0.001), while the effect of treatment adherence on health maintenance efficacy was 0.23 (95% CI: 0.15–0.31, β=0.23, p<0.001). The direct effect of health literacy on health maintenance efficacy was 0.70 (95% CI: 0.58–0.82, β = 0.50, p <0.001), indicating a very strong relationship. The total effect of the model was calculated to be 0.82 (95% CI: 0.70–0.93, β = 0.58, p <0.001). These findings suggest that treatment adherence partially explains the relationship between health literacy and health maintenance efficacy, indicating that health literacy is strongly associated with health maintenance efficacy, both directly and indirectly through treatment adherence. The model accounted for 12% of the variance in treatment adherence (R^2 = 0.12) and 38% of the variance in health maintenance efficacy (R^2 = 0.38), indicating a medium and a large explanatory power, respectively. The effect size for the HL → TA path was f^2 = 0.14, indicating a medium effect. The combined model predicting HME from HL and TA produced a large effect size (f^2 = 0.62), reflecting strong overall model performance. The mediation model with standardized coefficients is presented in Figure 2.

The analysis confirmed that Health Literacy has a significant positive effect on both Treatment Adherence and Health Maintenance Efficacy. Furthermore, Treatment Adherence was found to positively influence Health Maintenance Efficacy and significantly mediate the relationship between Health Literacy and efficacy. Therefore, hypotheses H1, H2, H3, and H4 are fully supported.

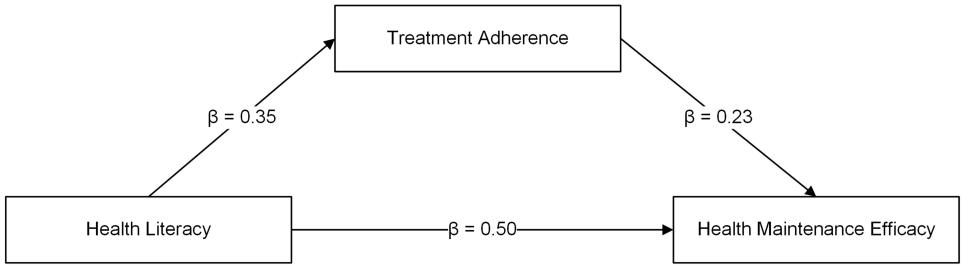

Figure 2 Mediation analysis results.
Note: → indicates the direction of the association; β, standardized coefficient.

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Discussion

The high prevalence of inadequate or problematic health literacy in this study reflects a critical barrier to effective diabetes self-management. Given the cross-sectional design of the study, these findings should be interpreted as associations rather than causal relationships. This finding is consistent with national evidence showing that most individuals with chronic diseases in Turkey exhibit limited health literacy, including 81.5% of adults with T2DM and nearly 60% of hemodialysis patients, both groups demonstrating worse clinical outcomes and greater complication risks.[30,31] Recent literature similarly indicates that sociodemographic disadvantages—particularly lower education and socioeconomic status—remain strong determinants of limited health literacy among chronically ill populations.[32] In the context of T1DM, socioeconomic disadvantage may also indirectly influence health outcomes by limiting access to healthcare services, diabetes education, digital health technologies, and regular professional guidance. Restricted access to these resources may hinder effective treatment adherence and long-term disease management, even among individuals with adequate baseline knowledge. From a practical perspective, digital health tools should be tailored to users' age, educational background, and health literacy levels, with simplified interfaces and professionally curated content to ensure safe and effective use across diverse T1DM populations. Because health literacy is a well-established predictor of treatment adherence and self-care behaviors, these patterns collectively point to a broader systemic challenge: low health literacy contributes to suboptimal disease management and increased morbidity.[33] Accordingly, the inadequate health literacy levels observed in our sample align with current evidence and underscore the necessity of integrating structured, literacy-focused interventions into routine chronic disease care. The contribution of this study lies primarily in the analytical integration of health literacy, treatment adherence, and health maintenance efficacy within a single mediation framework, rather than in the novelty of the individual associations.

The strong association between health literacy and treatment adherence underscores that individuals' ability to understand, evaluate, and implement diabetes-related information is fundamental to effective self-management in T1DM. Evidence indicates that higher levels of e-health literacy—particularly among parents—are linked to improved disease management and clinical outcomes in young patients, highlighting the broader influence of family health literacy on adherence behaviors.[34] Digital health technologies offer substantial potential to strengthen treatment adherence; however, adolescents' reliance on unverified online sources necessitates professional guidance and structured educational support to ensure safe and accurate information use.[35] Meta-analytic findings further demonstrate that digital interventions can reduce HbA1c by approximately 0.56%, largely by enhancing health literacy and promoting adherence.[36] Education-focused strategies, including nutrition education integrated with insulin management, have also been shown to significantly improve glycemic control and time-in-range outcomes.[37] Conversely, limited health literacy, misinformation, and misunderstanding of treatment protocols continue to pose substantial barriers to adherence.[35,38] Collectively, these findings emphasize that improving treatment adherence in T1DM requires a combination of structured education, literacy-enhancing interventions, and professionally guided digital tools. Unlike standard education programs that primarily focus on information provision, health literacy–focused interventions should emphasize comprehension, critical appraisal of information, and the practical application of knowledge to support sustained treatment adherence.

Improved treatment adherence substantially increases health maintenance efficacy, demonstrating that consistent engagement in diabetes care strengthens individuals' overall capacity for long-term self-management. This relationship reflects the combined influence of health literacy and self-efficacy, both of which are central determinants of adherence in T1DM. Higher health literacy enables individuals to correctly interpret and apply treatment recommendations, resulting in better adherence and improved glycemic control.[39] Adherence also varies across sociodemographic groups, indicating that contextual factors shape individuals' capacity to sustain treatment behaviors.[40] Self-efficacy further reinforces adherence by enhancing confidence in managing insulin, diet, and daily self-care tasks, consistent with Bandura's framework.[41–43] Regular self-care behaviors—one of the strongest predictors of glycemic control—are strengthened when both health literacy and self-efficacy are adequate, producing meaningful improvements in clinical outcomes.[44] Additionally, effective communication and structured patient education improve medication adherence by supporting accurate understanding of treatment processes.[45,46] Collectively, these findings highlight the need for integrated

interventions that simultaneously target health literacy and self-efficacy to optimize treatment adherence and long-term health maintenance in individuals with T1DM.

The strong direct effect of health literacy on health maintenance efficacy indicates that individuals' overall capacity for diabetes self-management is closely tied to their ability to understand and use health information. This relationship is particularly evident in T1DM, where adequate health literacy contributes to better glycemic control, more effective self-management behaviors, and improved treatment outcomes. Studies using measures such as the s-TOFHLA have consistently shown that individuals with higher health knowledge achieve more favorable HbA1c levels.[47] E-health literacy further shapes this process; although digital information is widely accessed by families of children with T1DM, limited ability to evaluate and apply online content can negatively affect disease management.[34] Because health literacy encompasses access, understanding, appraisal, and application of health information, related factors—such as self-management attitudes, problem-solving skills, and resource availability—serve as important mechanisms strengthening this association.[48] Evidence from randomized controlled trials also demonstrates that literacy-sensitive interventions improve patients' engagement with treatment and enhance clinical outcomes.[46,49] Digital health tools similarly offer scalable methods for enhancing both health literacy and self-management competencies in T1DM populations.[48] Moreover, health literacy is linked to broader health behaviors—including diet quality, physical activity, and obesity risk—suggesting that inadequate literacy reduces the ability to utilize disease-management resources and impairs metabolic control.[50,51] Collectively, this evidence underscores health literacy as a central determinant of glycemic regulation, self-management capacity, and long-term health outcomes in T1DM. Accordingly, literacy-focused education, digital support systems, and health literacy–sensitive clinical practices should be prioritized to strengthen health maintenance efficacy in this population.

The significant indirect effect of health literacy on health maintenance efficacy in T1DM indicates that treatment adherence partially mediates this relationship. Health literacy forms the foundation of diabetes self-management by shaping individuals' ability to understand disease information and make appropriate self-care decisions.[35,38] Although the direct association between health literacy and health maintenance efficacy remained substantial, the mediating role of treatment adherence represents a meaningful behavioral pathway through which health literacy may be reflected in sustained care practices rather than a purely statistical artifact. Individuals with higher health literacy tend to achieve better glycemic control and lower HbA1c levels. Parental e-health literacy has also been shown to directly influence treatment adherence and clinical outcomes in children with T1DM.[34] As a key behavioral mechanism, treatment adherence links health literacy to health maintenance efficacy, while non-adherence to insulin regimens increases complications and healthcare costs.[52] However, it should be noted that even individuals with sufficient health literacy may encounter challenges with medication adherence, which underscores the necessity of maintaining consistent self-management behaviors.[44] In this context, recent evidence suggests that digital health interventions and telemedicine can bridge this gap; these tools enhance both health literacy and adherence by providing better access to reliable information and supporting psychosocial well-being.[35,53] Overall, strengthening health literacy and treatment adherence appears essential for improving health maintenance efficacy in adults with T1DM.

Limitations

This study has several limitations that should be considered when interpreting the findings. Cross-sectional design prevents causal inferences between health literacy, treatment adherence, and health maintenance efficacy. Data were collected through an online self-report survey, which may introduce recall bias, social desirability bias, and self-selection bias. Because data collection relied on online platforms and social media channels, the sample may be skewed toward younger and more educated individuals, which could influence health literacy levels and limit generalizability. Specifically, the reliance on self-reported HbA1c values may lack the precision of laboratory-verified data due to potential recall bias. The use of convenience sampling limits representativeness and restricts generalizability to all adults with T1DM in Turkey. Clinical indicators, including diabetes duration, hypoglycemia frequency, and insulin regimen, were not assessed, preventing evaluation of how clinical status interacts with health literacy and adherence. Future longitudinal, multi-center studies incorporating objective clinical measures are needed to deepen understanding of the mechanisms identified in this research.

Strengths

This study offers several strengths that enhance its methodological rigor and scientific contribution. It is one of the few investigations in Turkey to evaluate the mediating role of treatment adherence in the relationship between health literacy and health maintenance efficacy among adults with T1DM. The use of internationally validated and psychometrically strong instruments with high internal reliability reinforces the robustness of the measurements. The large and geographically diverse sample (n = 368) increases statistical power and supports the stability of the mediation findings. The theory-driven mediation model provides clear empirical insight into the behavioral pathways linking health literacy to diabetes-related outcomes. The inclusion of contemporary digital health literacy perspectives and current challenges in diabetes management strengthens the study's relevance and offers evidence to guide targeted interventions in chronic disease care.

Conclusion

This study demonstrates that health literacy is strongly associated with health maintenance efficacy in adults with type 1 diabetes mellitus, both directly and indirectly through its association with treatment adherence. Higher health literacy levels were linked to better treatment adherence and a greater perceived capacity to sustain long-term diabetes care behaviors. These findings highlight the importance of health literacy–sensitive approaches in diabetes care; however, the observed relationships should be interpreted as associative rather than causal due to the cross-sectional design of the study. Strengthening health literacy, together with supporting treatment adherence, may contribute to improved long-term self-management capacity among adults with T1DM.

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Disclosure

The authors report no conflicts of interest in this work.

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