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ORIGINAL RESEARCH **OPEN ACCESS**

Lifestyle and Medication Adherence in Adults with Type 2 Diabetes in Trujillo Peru

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ABSTRACT

Background: Sustained diabetes care requires attention to everyday health behaviors and medication use. **Objective:** To evaluate the association between lifestyle and medication adherence in adults with type 2 diabetes attending a hospital in Trujillo, Peru. **Methods:** An analytical cross-sectional study included 208 adults who had received treatment for more than six months. Lifestyle was assessed using the 25-item IMEVID questionnaire, and medication adherence was classified as high, moderate, or low using the four-item Morisky–Green questionnaire. Categorical associations were assessed using Pearson's chi-square test; conditional Monte Carlo tests supplemented sociodemographic comparisons with sparse categories. **Results:** Overall, 116 participants (55.8%) were older than 60 years and 131 (63.0%) were female. Lifestyle was classified as inadequate in 167 participants (80.3%) and adequate in 41 (19.7%). Medication adherence was high in 30 (14.4%), moderate in 74 (35.6%), and low in 104 (50.0%). Lifestyle category was associated with adherence category ($p < 0.001$). Associations with educational level, age group, and gender were not statistically significant (Pearson $p = 0.380$, 0.684, and 0.794, respectively), consistent with the conditional analyses. **Conclusions:** Inadequate lifestyle and low medication adherence were frequent in this hospital population. Their assessment should be integrated into diabetes follow-up, while the cross-sectional findings should not be interpreted as evidence that changing lifestyle causes improved adherence.

Keywords: Diabetes Mellitus, Type 2; Life Style; Medication Adherence; Cross-Sectional Studies; Peru.

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Introduction

Type 2 diabetes mellitus requires sustained treatment and daily self-management to reduce its clinical burden. The Global Burden of Disease Study estimated that type 2 diabetes accounted for 96.0% of diabetes cases worldwide in 2021. A separate population-based analysis estimated that 828 million adults were living with diabetes in 2022 and identified substantial gaps in treatment coverage, particularly in low- and middle-income countries. These findings emphasize the need to examine what happens after diagnosis and treatment initiation, including whether patients can maintain the behaviors required for continuing care. [1,2]

Medication use, nutrition, physical activity, and psychosocial support are complementary components of diabetes management. An international consensus recommends individualized care that considers treatment burden and social circumstances, while the 2026 Standards of Care emphasize diabetes self-management education and support. Physical activity recommendations also recognize that sustaining activity depends on functional capacity, complications, and practical barriers. A lifestyle assessment can therefore identify needs that are not captured by a medication prescription alone. [3-5]

Medication adherence remains variable across populations and measurement approaches. A meta-analysis of 26 studies estimated adherence to oral antidiabetic drugs at 55.5%, whereas a separate review estimated adherence to insulin therapy among people with type 2 diabetes at 52.6%. These estimates describe different treatment groups and should not be treated as interchangeable thresholds. Recent evidence also identifies patient beliefs, treatment complexity, affordability, and health-system factors as relevant to medication-taking behavior. [6-8]

Peruvian evidence supports the importance of examining adherence within its care context. A pooled analysis of national surveys identified poor medication adherence in 29.2% of participants with diabetes and found differences across sociodemographic groups. In Puno, the ANDES formative study examined antihypertensive medication use and found greater adherence among participants with comorbid diabetes than among those with hypertension alone. The different outcomes and instruments in these studies illustrate why local estimates require careful interpretation. [9,10]

Illness perceptions may influence how patients engage with treatment, but associations vary across settings. A scoping review found heterogeneous adherence patterns, and a Saudi Arabian study linked medication adherence with perceived personal control, treatment effectiveness, and understanding of diabetes. Educational attainment is also an incomplete proxy for the skills needed to manage treatment: a recent systematic review found weak and inconsistent evidence linking health literacy with medication adherence in ethnic minority adults. [11-13]

The objective was to evaluate the association between lifestyle category and medication adherence, and describe adherence by educational level, age group, and gender, in adults with type 2 diabetes at a hospital in Trujillo, Peru. The findings can inform locally appropriate diabetes education and follow-up.

Materials and methods

Study design and setting

An observational, analytical cross-sectional study was conducted in the diabetes program of a hospital in Trujillo, Peru. Data were collected in 2026. Lifestyle and medication adherence were assessed at a single encounter, without an intervention or longitudinal follow-up. Reporting was guided by the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional studies. [14]

Participants and recruitment

The study included 208 adults with type 2 diabetes. Eligible patients were older than 18 years, had received their diabetes diagnosis between January and December 2023, and had been receiving treatment for more than six months. Patients were excluded if another illness interfered with assessment of the study variables, if mental health impairment prevented an adequate questionnaire response, or if they were not receiving diabetes treatment. Participants were recruited through the hospital diabetes program on the basis of the eligibility criteria. Enrollment required written informed consent before questionnaire administration.

Lifestyle assessment

Lifestyle was measured using the Instrumento para Medir el Estilo de Vida en Diabéticos (IMEVID), a 25-item questionnaire developed for adults with type 2 diabetes. Its seven domains address nutrition, physical activity, tobacco use, alcohol use, information about diabetes, emotions, and therapeutic adherence. The

original validation study reported a Cronbach's alpha of 0.81 and a test–retest correlation of 0.84. These estimates describe the published validation sample. [15]

The total IMEVID score ranges from 0 to 100, with higher scores reflecting more favorable behaviors. For this study, scores of 0–74 were classified as inadequate lifestyle and scores of 75–100 as adequate lifestyle. These operational categories were used consistently in the descriptive analysis and the comparison with medication adherence.

Medication adherence and sociodemographic variables

Medication adherence was evaluated using the four-item Morisky–Green questionnaire, a brief self-report measure of medication-taking behavior. The original instrument established concurrent and predictive validity in patients treated for hypertension. In the scoring system used in this study, scores ranged from 0 to 4: 0 indicated high adherence, 1–2 moderate adherence, and 3–4 low adherence. These three categories were retained for analysis. The questionnaire assesses medication behavior and was not used as a measure of glycemic control. [16]

Educational level was categorized as primary, secondary, technical, university, or postgraduate education. Age was analyzed in the recorded groups of ≤29, 30–44, 45–59, and >60 years. All included participants met the adult eligibility criterion. Gender was recorded as female, male, or other. Categories without participants were excluded from association testing.

Data collection

Institutional permission was obtained before the study, and questionnaire administration was coordinated with the hospital diabetes program. Participants received an explanation of the study purpose, procedures, and voluntary nature of participation before signing the consent form. IMEVID and Morisky–Green responses were obtained during the same assessment, and questionnaire scores and sociodemographic data were entered into Microsoft Excel for analysis.

Statistical Analysis

Categorical variables were summarized as frequencies and percentages. Overall lifestyle and adherence percentages used 208 participants as the denominator; adherence distributions within educational, age, and gender categories used the corresponding subgroup total. Percentages were rounded to one decimal place. Pearson's chi-square test was used to evaluate associations between lifestyle and adherence categories and between sociodemographic characteristics and adherence.

Because several sociodemographic categories had small expected cell frequencies, Fisher–Freeman–Halton conditional tests were also estimated using Monte Carlo sampling with fixed margins, 1,000,000 resamples, and a reproducible random seed of 20261021. These supplementary calculations used Python with SciPy 1.17.0. Cramér's V quantified the magnitude of each sociodemographic association. The significance threshold was $p < 0.05$. Analyses were interpreted as unadjusted associations; statistical significance did not establish causality.

Ethical considerations

The study protocol was approved by the responsible institutional research ethics committee. The study followed the principles of the Declaration of Helsinki, and authorization was obtained from the participating hospital before recruitment. All participants provided written informed consent after receiving information about the study purpose and procedures, confidentiality, voluntary participation, and their right to withdraw. Personal information was handled confidentially, access to the research records was restricted, and results are presented in aggregate form to protect participants' identities.

Results

The analysis included 208 participants. Of these, 116 (55.8%) were older than 60 years and 131 (63.0%) were female. Primary or secondary education was recorded in 162 participants (77.9%).

Inadequate lifestyle was identified in 167 participants (80.3%), while 41 (19.7%) were classified as having an adequate lifestyle. Low medication adherence was the most frequent category, affecting 104 participants (50.0%); high adherence was observed in 30 (14.4%). Lifestyle category was associated with medication adherence category (Pearson's chi-square test, $p < 0.001$). (Table 1).

Table 1. Distribution of lifestyle and medication adherence among adults with type 2 diabetes (n = 208).

Measure and category	Score	n	%
Lifestyle (IMEVID)			
Inadequate	0–74	167	80.3
Adequate	75–100	41	19.7
Total		208	100.0
Medication adherence (Morisky–Green)			
High	0	30	14.4
Moderate	1–2	74	35.6
Low	3–4	104	50.0
Total		208	100.0

IMEVID, Instrumento para Medir el Estilo de Vida en Diabéticos. Each participant contributes one classification within each measure. Percentages use 208 as the denominator. Higher IMEVID scores indicate more favorable lifestyle behaviors; higher Morisky–Green scores indicate poorer medication adherence.

Table 2. Medication adherence by educational level, age group, and gender (n = 208).

Characteristic	High n (%)	Moderate n (%)	Low n (%)	Total n
Educational level				
Primary	7 (9.5)	28 (37.8)	39 (52.7)	74
Secondary	16 (18.2)	33 (37.5)	39 (44.3)	88
Technical	7 (20.0)	8 (22.9)	20 (57.1)	35
University	0 (0.0)	2 (33.3)	4 (66.7)	6
Postgraduate	0 (0.0)	3 (60.0)	2 (40.0)	5
Age group (years)				
≤29	0 (0.0)	1 (33.3)	2 (66.7)	3
30–44	2 (9.5)	8 (38.1)	11 (52.4)	21
45–59	8 (11.8)	21 (30.9)	39 (57.4)	68
>60	20 (17.2)	44 (37.9)	52 (44.8)	116
Gender				
Female	17 (13.0)	48 (36.6)	66 (50.4)	131
Male	13 (17.1)	26 (34.2)	37 (48.7)	76
Other	0 (0.0)	0 (0.0)	1 (100.0)	1
Total	30 (14.4)	74 (35.6)	104 (50.0)	208

Values are n (row %), except the subgroup total, which is n. Percentages describe adherence within each educational, age, or gender category; the final row uses the full sample. Totals may differ from 100.0% by 0.1 percentage point because of rounding. All participants were older than 18 years.

Table 3. Unadjusted associations of sociodemographic characteristics with medication adherence.

Characteristic	Pearson χ^2	df	Pearson p-value	Monte Carlo p-value	Cramér's V
Educational level	8.570	8	0.380	0.420	0.144
Age group	3.944	6	0.684	0.735	0.097
Gender	1.681	4	0.794	0.869	0.064

df, degrees of freedom. Pearson p-values are based on the chi-square statistic. Monte Carlo p-values estimate the two-sided Fisher–Freeman–Halton conditional test with fixed margins and 1,000,000 resamples (seed 20261021). Cramér's V summarizes association magnitude on a 0–1 scale. Each analysis includes 208 participants and all three adherence categories.

Low adherence occurred in 39 of 74 participants with primary education (52.7%) and 39 of 88 with secondary education (44.3%). Among participants older than 60 years, 52 of 116 (44.8%) had low adherence and 20 (17.2%) had high adherence. The corresponding proportions with low adherence were 50.4% among female participants and 48.7% among male participants (Table 2).

Educational level, age group, and gender were not significantly associated with medication adherence in the Pearson analyses ($p = 0.380$, 0.684, and 0.794, respectively). Conditional Monte Carlo tests gave the same inferential conclusion ($p = 0.420$, 0.735, and 0.869). Cramér's V ranged from 0.064 to 0.144 (Table 3).

Discussion

This hospital-based study identified frequent inadequate lifestyle classifications and low medication adherence among adults with type 2 diabetes. Lifestyle category was associated with adherence category, whereas educational level, age group, and gender did not show statistically significant associations with the three adherence levels. The latter conclusion was unchanged when conditional analyses were used for sparse categories. These results support assessing adherence directly during follow-up rather than relying on demographic characteristics to identify patients who may need assistance.

Half of the participants were classified as having low adherence, and only 14.4% met the high-adherence category. International meta-analyses also describe substantial adherence difficulties, although their pooled estimates of adherence to oral agents and insulin cannot be directly compared with this study's three-level questionnaire classification. Differences in treatment regimen, instrument, scoring threshold, and recruitment setting affect prevalence estimates. Similarly, the 29.2% frequency of poor adherence among participants with diabetes in Peruvian national surveys does not establish that adherence is worse in Trujillo, because the population and measurement approach differ. [6,7,9]

The lifestyle finding is clinically relevant because routine diabetes care requires several behaviors to be sustained at the same time. In a Mexican primary care study, receipt of diabetes education and medical nutrition therapy was associated with better dietary habits and lower glycated hemoglobin. That study measured clinical outcomes, whereas the present study assessed questionnaire categories. The findings therefore support attention to behavioral needs without establishing that the lifestyle classification observed here predicts metabolic control or complications. [17]

The relationship between IMEVID and Morisky–Green classifications requires particular interpretive care. IMEVID includes a therapeutic adherence domain, so its total score and a separate medication adherence measure capture partly overlapping behaviors. Assessment of both questionnaires at the same encounter can also produce shared self-report effects. The association should consequently be understood as a relationship between these operational measures, not as evidence that diet or physical activity independently determines medication adherence. Domain-specific analyses and prospective measures would help distinguish these relationships. [15,16]

The absence of statistically significant demographic associations should not be interpreted as proof that education, age, or gender never matters for adherence. National Peruvian data identify sociodemographic and access-related differences, while the Puno study illustrates that associations also depend on the medication and comorbidity being examined. Within the present sample, several educational and age categories were small, and the "other" gender category contained one participant. The conditional analyses support the stability of the statistical conclusion, but these data do not justify subgroup-specific clinical claims. [9,10]

Educational attainment alone is unlikely to represent the full set of skills and beliefs involved in treatment management. The systematic review by Parmar et al. found inconsistent associations between health literacy and medication adherence, while research on illness perceptions emphasizes perceived treatment benefit and personal control. These factors may be appropriate targets for clinical conversations, although they were not measured in this study. Education should therefore be adapted to patients' understanding, priorities, and practical circumstances rather than allocated solely by completed schooling. [11-13]

The practical implication is to integrate medication review with individualized lifestyle support. Evidence from diabetes self-management education supports improvements in self-care, and a review of medication adherence interventions found promise in approaches that combine educational and behavioral components. Current recommendations likewise favor collaborative goal setting and continuing support. For this population,

a reasonable service response is to ask about difficulties with medication use, assess readiness for dietary and activity changes, and agree on feasible follow-up goals. These are implications for care design rather than intervention effects demonstrated by this study. [4,18,19]

Specific delivery strategies require their own evaluation. The DiabeText randomized trial improved self-reported medication adherence and quality of life but did not produce a significant between-group difference in glycated hemoglobin at 12 months. Exercise interventions delivered through family management or self-management have improved glycemic outcomes in a separate meta-analysis. Together, these findings support considering accessible follow-up and family involvement where appropriate, while measuring behavioral and clinical outcomes separately. They do not establish that any one strategy will be effective in this hospital population. [20,21]

Strengths include assessment of both lifestyle and medication adherence in the same clinical population, explicit questionnaire thresholds, and retention of all three adherence categories. The study also examined the sensitivity of demographic comparisons to sparse cell frequencies. Limitations arise from its cross-sectional design, recruitment from a single hospital program, and reliance on self-report, which is susceptible to recall and socially desirable responses.

The study population may not represent people who have disengaged from care. The analyses describe unadjusted associations and do not establish temporal order, causal effects, or independent clinical predictors. Future studies should use prospective follow-up, complementary adherence measures, and clinical endpoints to evaluate whether changes in specific behaviors accompany sustained improvements in diabetes management. [8]

Conclusions

Inadequate lifestyle and low medication adherence were frequent among adults with type 2 diabetes attending the study hospital in Trujillo. Lifestyle category was associated with adherence category, while educational level, age group, and gender did not show statistically significant associations with adherence. These findings support incorporating direct assessment of medication use and lifestyle into diabetes follow-up.

Author Contributions Statement (CrediT)

AER: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Validation, Visualization, Supervision, Project administration, Writing – original draft, and Writing – review & editing.

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Conflict of Interest

The author declares no financial or non-financial conflicts of interest relevant to this study.

Data Availability

The participant-level data are not publicly available because they contain confidential health information. Requests for access to de-identified data may be addressed to the corresponding author and will be considered on reasonable scientific grounds, subject to institutional authorization and applicable confidentiality requirements.

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