

Association between health literacy and glycemic control in urban Vs. rural diabetic patients

Muhammad Naveed Iqbal, Muhammad Hassan, Syed Ali Rukh Pirzada, Muhammad Aamir, Fahad Qaisar, Umar Hayat

Bahawal Victoria Hospital/ Quaid-e-Azam Medical College, Bahawalpur Pakistan

ABSTRACT

Objective: To assess the association between health literacy and glycemic control among diabetic patients residing in urban and rural areas and to evaluate the relationship between socio-demographic factors, health literacy and glycemic outcomes.

Material and Methods: A comparative cross-sectional study was conducted at the Medicine OPD of Bahawal Victoria Hospital Bahawalpur from June to December 2024. Total of 126 patients with type 2 diabetes (63 urban and 63 rural) were enrolled using non-probability consecutive sampling. Health literacy was assessed using the HLS-EU-Q-16 tool and glycemic control was determined via HbA1c levels ($<7\%$ =controlled). Multivariate logistic regression was used to assess associations while adjusting for confounders.

Results: Urban participants had significantly higher health literacy scores than rural participants (35.2 ± 5.3 vs. 29.6 ± 6.2 ; $p<0.001$). Controlled glycemia was more common in urban patients (46% vs. 21% , $p=0.003$). After adjustment, each one-point increase in health literacy score was associated with 4% increased odds of controlled glycemia (aOR: 1.04, 95% CI: 1.01–1.07, $p=0.014$). **Conclusion:** Higher health literacy is significantly linked to better glycemic control, especially in urban settings. Rural patients face dual challenges of lower health literacy and reduced access to care. Targeted interventions are needed to improve health literacy and address systemic inequities in diabetes management.

Keywords: Diabetes mellitus, Glycemic control, Health literacy, HbA1c, Rural health, Urban health

This article can be cited as: Iqbal MN, Hassan M, Pirzada SAR, Aamir M, Qaisar F, Hayat U. Association between health literacy and glycemic control in urban Vs. rural diabetic patients. Pak J Pathol. 2025; 36(4): 300-304. DOI: <https://doi.org/10.55629/pakipathol.v36i4.959>

INTRODUCTION

Type 2 Diabetes Mellitus has emerged as a pressing global public health issue. The International Diabetes Federation (IDF) reported that in 2021, around 537 million adults worldwide were living with diabetes, a number expected to rise to 643 million by 2030 [1]. This growing burden is especially pronounced in low- and middle-income countries, where shifts in lifestyle, rapid urbanization, and aging populations have contributed significantly to the rising prevalence of the disease [2].

Successful management of diabetes depends largely on the patient's ability to engage in self-care practices, such as adhering to prescribed medications, maintaining a balanced diet, being physically active, and regularly monitoring blood glucose levels [3]. These behaviors demand not only personal motivation but also a solid understanding of

health-related information highlighting the essential role of health literacy in chronic disease management [4].

Health literacy refers to an individual's capacity to access, interpret, and apply basic health information and services to make informed health decisions [5]. It empowers patients to interact effectively with the healthcare system, follow medical advice, and adopt preventive health behaviors [6]. Research shows that limited health literacy is linked to worse blood sugar control, more frequent hospital admissions, and higher healthcare expenditures among people with diabetes [7].

Access to healthcare, education, and health resources often differs markedly between urban and rural communities. Urban residents generally enjoy greater access to medical facilities, specialized care, and public health initiatives [8]. In contrast, those in rural areas frequently contend with shortages of healthcare professionals, long distances to clinics, and lower levels of formal education, factors that can hinder health literacy and, in turn, compromise diabetes self-management [9].

These geographic disparities may ultimately influence clinical outcomes, particularly glycemic control. However, there is limited evidence directly comparing how health literacy affects blood sugar management in urban versus rural settings. While the importance of health literacy in chronic disease care is

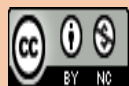
Correspondence: Dr. Muhammad Naveed Iqbal, Senior Registrar, Department of Medicine, Bahawal Victoria Hospital/ Quaid-e-Azam Medical College, Bahawalpur Pakistan

Email: naveediqbal9843@gmail.com

Receiving Date: 14 Oct 2024

Acceptance Date: 20 Dec 2025

Revision Date: 11 Dec 2025



Copyright © 2025. Muhammad Naveed Iqbal, et al. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, which permits unrestricted use, distribution & reproduction in any medium provided that original work is cited properly.

increasingly acknowledged, most existing studies have either focused on urban populations or combined urban and rural participants without distinguishing between them. Consequently, it remains unclear whether the relationship between health literacy and glycemic control varies meaningfully by location.¹⁰ Furthermore, the influence of health literacy on diabetes outcomes may be shaped by socio-demographic variables such as age, education, income, and duration of illness yet these modifying effects are poorly understood, especially in rural contexts [11]. Filling this knowledge gap is crucial for designing targeted, context-sensitive strategies that address the unique challenges faced by different populations.

This study therefore aimed to examine the link between health literacy and glycemic control assessed via HbA1c levels among individuals with Type 2 diabetes in both urban and rural areas. It also seeks to explore how socio-demographic factors interact with health literacy to influence diabetes outcomes.

MATERIAL AND METHODS

This was comparative cross-sectional study to assess the association between health literacy and glycemic control among diabetic patients residing in urban and rural areas. The study was conducted at the Medicine Outpatient Department (OPD) of Bahawal Victoria Hospital/ Quaid-e-Azam Medical College, Bahawalpur from June to December 2024. The target population included adults aged 18 years or older diagnosed with type 2 diabetes mellitus. Participants were recruited using non-probability consecutive sampling during their routine outpatient visits. Sample size of 126 diabetic patients was calculated by using WHO sample size calculator based on detecting a mean difference of 0.5% in HbA1c levels between urban and rural groups,¹³ assuming 80% power and a 95% confidence level i.e. 63 participants were from urban areas and 63 from rural areas.

Participants fulfilling the inclusion criteria were enrolled after obtaining informed consent. Those with cognitive impairment, acute illness or inability to communicate effectively were excluded. Data was collected through structured in person interviews using a pretested questionnaire. The data collection tool included three main components: a demographic and clinical information sheet, the HLS-EU-Q-16 (Health Literacy Survey–European Questionnaire) to assess health literacy and glycemic control measurement via HbA1c levels. The HLS-EU-Q-16 is a validated, multi-dimensional instrument that evaluates perceived difficulties in accessing,

understanding, appraising and applying health related information across 16 items, each rated on a 5-point Likert scale [14].

Venous blood samples were collected under standardized conditions by trained phlebotomists, and HbA1c levels were measured. Glycemic control was operationalized as a binary variable: "controlled" if HbA1c < 7.0% and "uncontrolled" if HbA1c ≥ 7.0% following ADA guidelines [15].

The independent variable was health literacy score, while the dependent variable was glycemic control status (HbA1c ≤7.0% vs >7.0%). Potential confounding variables included age, gender, monthly income, educational level, duration of diabetes and presence of comorbidities which were recorded during the interview.

All statistical analyses were performed using SPSS version 26.0. Descriptive statistics were used to summarize baseline characteristics of the study population. Continuous variables like age, duration of diabetes mellitus, HbA1C level and health literacy score were expressed as means and standard deviations while categorical variables like gender, education, income, comorbidities and glycemic control were presented as frequencies and percentages. Normality of the data was checked by using Shapiro Wilk test. Differences in demographic and clinical characteristics between urban and rural participants were analyzed using independent samples t-test for continuous variables and chi-square test for categorical variables.

To evaluate the association between health literacy and glycemic control, multivariate logistic regression models were constructed adjusting for relevant covariates. An interaction term (health literacy × place of residence) was included to test whether the effect of health literacy on glycemic control differed significantly between urban and rural settings.

Ethical approval was obtained from the Ethical Review Committee and informed consent was obtained from all participants before data collection. Confidentiality was maintained and personal identifiers were removed from datasets used for analysis.

RESULTS

Total 126 participants (63 urban and 63 rural) were included in the study. The mean age of the participants was 52.7 ± 8.9 years with slightly more females 67 (54.0%) than males. Most participants with type 2 diabetes mellitus had mean duration of illness of 7.3±4.1 years. Approximately 62% of urban participants had at least a secondary level of education compared to only 32% of rural participants ($p<0.001$). Monthly income was significantly higher

among urban patients with 41% earning more than PKR 50,000 per month versus 16% of rural participants ($p=0.002$) (Table-I).

The overall mean health literacy score (HLS-EU-Q-16) was 32.4 ± 6.7 , with a possible range of 16–80. Urban participants had significantly higher health literacy scores than rural participants (35.2 ± 5.3 vs. 29.6 ± 6.2 , $p<0.001$) (Figure-I).

The mean HbA1c level was $7.8 \pm 1.3\%$, with 42 participants (33.3%) having controlled glycemia (HbA1c $<7.0\%$). A significantly higher proportion of urban participants had controlled glycemic levels

compared to rural participants (46% vs. 21%, $p=0.003$) (Table-II).

Unadjusted logistic regression showed that each one-point increase in health literacy score was associated with 5% increased odds of having controlled glycemia (OR: 1.05, 95% CI: 1.02–1.08, $p=0.002$). After adjusting for age, gender, income, education, duration of diabetes and comorbidities, the association remained significant (aOR:1.04, 95% CI: 1.01–1.07, $p=0.014$) (Table-III).

Table-I: Baseline demographic and clinical characteristics by place of residence.

Variable	Urban (n=63)	Rural (n=63)	p-value
Age (years), Mean $\pm$ SD	51.9 $\pm$ 8.5	53.5 $\pm$ 9.3	0.34
Female gender, n (%)	35 (55.6%)	32 (50.8%)	0.58
Education: $\geq$ Secondary, n (%)	39 (61.9%)	20 (31.7%)	<0.001
Income >PKR 50,000/month, n (%)	26 (41.3%)	10 (15.9%)	0.002
Duration of diabetes (years)	7.1 $\pm$ 4.2	7.5 $\pm$ 4.0	0.59
Comorbidities, n (%)	38 (60.3%)	41 (65.1%)	0.56

Table-II: Comparison of glycemic control between urban and rural patients.

Outcome	Urban (n=63)	Rural (n=63)	p-value
Mean HbA1c (%)	7.4 $\pm$ 1.1	8.2 $\pm$ 1.3	<0.001
Controlled glycemia (HbA1c $<7\%$)	29 (46.0%)	13 (20.6%)	0.003

Table-III: Multivariate logistic regression model showing predictors of glycemic control (HbA1c $<7\%$).

Variable	Adjusted OR	95% CI	p-value
Health literacy score	1.04	1.01 – 1.07	0.014
Age	0.99	0.95 – 1.03	0.61
Female gender	1.22	0.58 – 2.58	0.6
Education $\geq$ Secondary	2.08	0.95 – 4.57	0.067
Income >PKR 50,000/month	1.85	0.82 – 4.17	0.14
Duration of diabetes	1.03	0.94 – 1.12	0.56
Comorbidities	0.89	0.41 – 1.94	0.77

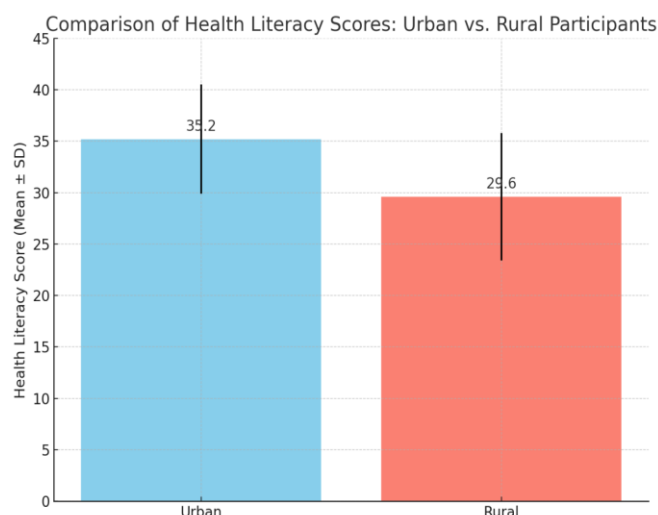


Figure 1: Mean health literacy scores by residence ($p < 0.001$)

DISCUSSION

Study findings revealed that urban diabetic patients had significantly higher health literacy scores and better glycemic control compared to their rural

counterparts. The mean health literacy score among the overall population was 32.4 ± 6.7 on the HLS-EU-Q-16 scale, with urban participants scoring significantly higher than rural participants (35.2 ± 5.3 vs. 29.6 ± 6.2 ; $p<0.001$). These findings align with global evidence showing that individuals living in urban areas tend to have greater access to education, healthcare services and digital resources which collectively enhance health literacy [11,12].

Study results also showed that only 33.3% of all participants had controlled glycemia (HbA1c $<7\%$) with a marked disparity between urban and rural groups (46% vs. 21%, $p=0.003$). This supports previous research indicating that poor glycemic control disproportionately affects rural populations due to limited access to diabetes care, lower socioeconomic status and reduced awareness about disease management [13,14,15]. These results are consistent with a recent Pakistani study by Khan *et al.*, which reported suboptimal glycemic control among rural diabetic patients in Punjab province [16].

Importantly, multivariate logistic regression analysis demonstrated that higher health literacy was independently associated with improved glycemic outcomes. Each one-point increase in health literacy score was linked to 4% higher odds of having controlled glycemia after adjusting for key confounders (*aOR*: 1.04, 95% CI: 1.01–1.07, *p*=0.014). This finding reinforces the critical role of health literacy in chronic disease self-management and supports interventions aimed at improving patient understanding of diabetes care [7,17].

The effect of health literacy on glycemic control appeared to be stronger among urban participants, suggesting that even when rural patients have adequate health literacy structural barriers such as lack of access to regular care or medicines may still hinder effective diabetes management [18,19]. This highlights the need for context-specific strategies to address both health literacy and systemic inequities in rural settings.

This study stands out as one of the first from Pakistan to directly compare health literacy and glycemic outcomes among urban and rural populations living with diabetes. It employed the validated HLS-EU-Q-16 instrument to measure health literacy, enhancing the reliability of the findings and allowing meaningful comparisons with international research. By accounting for a range of demographic and clinical factors in the analysis, the study strengthens the robustness and validity of the observed associations.

The study design limits causal inference regarding relationship between health literacy and glycemic control. The sample size was relatively small and study was limited to a single center, potentially affecting generalizability. Some unmeasured confounding variables such as dietary habits or medication adherence were not included in the analysis.

CONCLUSION

Higher health literacy is significantly associated with better glycemic control among diabetic patients, particularly in urban areas. Rural populations face compounded challenges related to both health literacy and access to care. Targeted health education programs and policy-level interventions are needed to bridge these disparities and improve diabetes outcomes across geographic divides.

CONFLICT OF INTEREST

Authors declare no conflict of interest

GRANT SUPPORT & FINANCIAL DISCLOSURE

Declared none

AUTHORS CONTRIBUTION

Muhammad Naveed Iqbal: Substantial contributions to study design, acquisition of data, manuscript drafting or reviewing it critical for important intellectual content, final approval, accountable for all aspects of publication

Muhammad Hassan: Substantial contributions to acquisition of data, Manuscript drafting or reviewing it critical for important intellectual content, final approval, accountable for all aspects of publication

Syed Ali Rukh Pirzada, Muhammad Aamir, Fahad Qaisar, Umar Hayat: Substantial contributions to analysis and interpretation of data, critical review, final approval, accountable for all aspects of publication

REFERENCES

1. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition scientific committee. IDF DIABETES ATLAS [Internet]. 10th edition. Brussels: International Diabetes Federation; 2021. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK581934/>
2. Shrestha DB, Budhathoki P, Sedhai YR, Marahatta A, Lamichhane S, Nepal S, *et al.* Type 2 diabetes mellitus in Nepal from 2000 to 2020: A systematic review and meta-analysis. *F1000Research*. 2021; 10: 543. DOI: <https://doi.org/10.12688/f1000research.53970.2>
3. Whittemore R, Vilar-Compte M, De La Cerda S, Marron D, Conover R, Delvy R, *et al.* Challenges to diabetes self-management for adults with type 2 diabetes in low-resource settings in Mexico City: a qualitative descriptive study. *Int J Equity Health*. 2019; 18(1): 133. DOI: <https://doi.org/10.1186/s12939-019-1035-x>
4. Shahid R, Shoker M, Chu LM, Frehlick R, Ward H, Pahwa P. Impact of low health literacy on patients' health outcomes: a multicenter cohort study. *BMC Health Serv Res*. 2022; 22(1): 1148. DOI: <https://doi.org/10.1186/s12913-022-08527-9>
5. U.S. Department of Health and Human Services. Quick Guide to Health Literacy. Washington, DC: National Institutes of Health; 2020. Available at: <https://www.nih.gov/sites/default/files/about-us/publications/quick-guide-health-literacy.pdf>
6. Ruegg R, Abel T. The relationship between health literacy and health outcomes among male young adults: exploring confounding effects using decomposition analysis. *Int J Pub Health*. 2019; 64(4): 535-45. DOI: <https://doi.org/10.1007/s00038-019-01236-x>
7. Misra R, Adelman MM, Kirk B, Sambamoorthi U. Relationship among diabetes distress, health literacy, diabetes education, patient-provider communication and diabetes self-care. *Am J Health Behavior*. 2022; 46(5): 528-40. DOI: <https://doi.org/10.5993/AJHB.46.5.4>
8. Parmar J, El Masri A, MacMillan F, McCaffery K, Arora A. Health literacy and medication adherence in adults from ethnic minority backgrounds with type 2 diabetes mellitus: A systematic review. *BMC Public Health*. 2025;

- 25(1): 222. DOI: <https://doi.org/10.1186/s12889-024-20734-z>
9. Wang W, Zhang Y, Lin B, Mei Y, Ping Z, Zhang Z. The urban-rural disparity in the status and risk factors of health literacy: A cross-sectional survey in central China. *Int J Environ Res Public Health*. 2020; 17(11): 3848. DOI: <https://doi.org/10.3390/ijerph17113848>
10. Butayeva J, Ratan ZA, Downie S, Hosseinzadeh H. The impact of health literacy interventions on glycemic control and self-management outcomes among type 2 diabetes mellitus: A systematic review. *J Diabetes*. 2023; 15(9): 724-35. DOI: <https://doi.org/10.1111/1753-0407.13436>
11. Marshall N, Butler M, Lambert V, Timon CM, Joyce D, Warters A. Health literacy interventions and health literacy-related outcomes for older adults: A systematic review. *BMC Health Serv Res*. 2025; 25(1): 1-3. DOI: <https://doi.org/10.1186/s12913-025-12457-7>
12. Asharani PV, Lau JH, Roystonn K, Devi F, Peizhi W, Shafie S, *et al*. Health literacy and diabetes knowledge: a nationwide survey in a multi-ethnic population. *Int J n Environ Res Public Health*. 2021; 18(17): 9316. DOI: <https://doi.org/10.3390/ijerph18179316>
13. Guo XM, Zhai X, Hou BR. Adequacy of health literacy and its effect on diabetes self-management: A meta-analysis. *Aust J Prim Health*. 2021; 26(6): 458-65. DOI: <https://doi.org/10.1071/py20079>
14. Kianmehr H, Zhang P, Luo J, Guo J, Pavkov ME, Bullard KM, *et al*. Potential gains in life expectancy associated with achieving treatment goals in US adults with type 2 diabetes. *JAMA Netw Open*. 2022; 5(4): e227705. DOI: <https://doi.org/10.1001/jamanetworkopen.2022.7705>
15. Siddique K, Malik RA, Usman A, Ishfaq K, Nadeem MS, Qadir M, *et al*. Self-care behaviors and glycemic control among older Type 2 diabetes mellitus patients in low-income families in Southern Punjab, Pakistan. *J Human Behavior Social Environ*. 2022; 32(1): 67-76. DOI: <https://doi.org/10.1080/10911359.2020.1851843>
16. Wei Y, Chen Y, Zhao Y, Rothman R, Ming J, Wang L, *et al*. Health literacy and exercise interventions on clinical outcomes in Chinese patients with diabetes: A propensity score-matched comparison. *BMJ Open Diabetes Res Care*. 2020; 8(1): e001179. DOI: <https://doi.org/10.1136/bmjdr-2020-001179>
17. Sørensen K, Pelikan JM, Rothlin F, Ganahl K, Slonska Z, Doyle G, *et al*. Health literacy in Europe: comparative results of the European health literacy survey (HLS-EU). *The Eur J Public Health*. 2015; 25(6): 1053-8. DOI: <https://doi.org/10.1093/eurpub/ckv043>
18. American Diabetes Association Professional Practice Committee, American Diabetes Association Professional Practice Committee: 6. Glycemic targets: Standards of Medical Care in Diabetes—2022. *Diabetes Care*. 2022; 45(Supplement 1): S83-96. DOI: <https://doi.org/10.2337/dc22-s006>