Original Article

Evaluating the Impact of Educational Interventions on Medication Adherence Among Glaucoma Patients in Kazakhstan: A Public Health Perspective

Maiya Taushanova[1], * Lyudmila Yermukhanova[2], Saule Tazhbenova[3], Perizat Aitmaganbet[4], Yesset Muratov[5], Ruslan Irmekbayev [6], Issenova Balday [7], Dana Abilkassym[8]

ABSTRACT

Objective

Glaucoma, a prevalent eye condition stemming from optic neuropathy, can cause irreversible blindness if not treated. Lack of adherence to medical treatments for glaucoma often results in severe outcomes, including ongoing vision loss and eventual blindness. The aim of this study was to assess treatment adherence among glaucoma patients who attended the Glaucoma School at urban clinics in Aktobe, Kazakhstan.

Material and Methods

A cross-sectional study was conducted involving 183 glaucoma patients who sequentially underwent training at Glaucoma Schools in Aktobe, Republic of Kazakhstan. Data on adherence to glaucoma treatment were collected using the standardized Morisky Medication Adherence Scale-8 (MMAS-8) through a questionnaire. Analysis was performed using the statistical software SPSS (version 27.0.0.0, IBM Corporation, USA) and GraphPad Prism 9.5.1.733. A p-value of <0.05 was considered statistically significant. The study proposal was approved by the local bioethics committee of the West Kazakhstan Marat Ospanov Medical University.

Results

The study has identified a significant improvement in medication adherence among glaucoma patients, with reductions in the frequency of forgetting to administer eye drops—from daily forgetfulness ($p < 0.001$) to specific situations like travel ($p = 0.001$). There was a notable increase in the proportion of patients properly administering their eye drops the day before, with a significant rise from 63.9% to 72.1% ($p < 0.001$). Overall, the median adherence score improved significantly from 4,75 to 5,5 ($p < 0.001$) and there was a minor, non-significant shift towards higher adherence categories after the educational intervention ($p = 0.166$). Socioeconomic factors such as education and income levels significantly influenced adherence before the intervention, with higher levels associated with better adherence ($p < 0.001$ for education, $p = 0.020$ for income).

Conclusions

The study underscores that while educational interventions at the glaucoma school have shown improvements, adherence levels continue to be low, underscoring the necessity for sustained endeavors to bolster treatment adherence. Initiatives such as lectures, workshops, and seminars have proven successful in heightening awareness and garnering community support, thus positively affecting adherence. Socioeconomic factors exert a notable influence on adherence, indicating the importance of integrating social support into medical programs to assist economically disadvantaged groups. Limitations of the study include its brief duration and narrow geographical scope, potentially limiting the generalizability of the findings.Nonetheless, it provides valuable insights into managing glaucoma and underscores the necessity for continued research to refine educational and support strategies for glaucoma patients.

Keywords

compliance; glaucoma; questionnaires; adherence to treatment; MMAS-8; glaucoma school; eye drops;public health

INTRODUCTION

Glaucoma is a group of eye diseases characterized by damage to the optic nerve, which ultimately leads to irreversible blindness if left untreated. However, with early detection and treatment, significant vision loss can be prevented[1,2]. Current global statistics on the prevalence of glaucoma indicate that in 2020, nearly 4.14 million people suffered from visual impairment due to glaucoma, with 3.61 million of those being blind due to the condition. The overall age-standardized prevalence of blindness

1. Maiya Taushanova, Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
2. Lyudmila Yermukhanova, Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
3. Saule Tazhbenova, Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
4. Perizat Aitmaganbet, Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
5. Yesset Muratov, Department of Ophthalmology, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
6. Ruslan Irmekbayev, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan
7. Issenova Balday, Public Health Care Department, Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
8. Dana Abilkassym, Public Health Care Department, Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan

Correspondence

Maiya Taushanova, Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, Kazakhstan. Public Health and Health Care Department, West Kazakhstan Marat Ospanov Medical University, Aktobe, 03000, Kazakhstan; E-mail: taushanova.maiya@mail.ru

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and visual loss due to glaucoma was 81.5 per 100,000 in 1990 and 75.6 per 100,000 in 2017, with higher prevalence observed in regions with a low socio-demographic index[3]. Moreover, the overall prevalence of primary open-angle glaucoma worldwide over the last 20 years has been estimated at 2.4%, with variations depending on age, sex, and geographic location[4]. Early detection of glaucoma remains one of the most relevant topics in modern ophthalmology due to its correlation with adverse disability outcomes: glaucoma continues to be a leading cause of irreversible blindness both in Kazakhstan and globally. Annually, an average of 1 in 1,000 people over the age of 40 develops glaucoma, and these statistics indicate a steady increase in the prevalence of glaucoma among the population, associated with an increase in the number of elderly individuals in the overall population structure[5].

The notable prevalence of glaucoma is attributed to the subtle progression of this disease, often undetectable to patients in its initial stages, posing challenges in diagnosis and early detection. It's essential to recognize that glaucoma is a chronic, incurable condition. Diagnosing glaucoma requires lifelong, dynamic observation of patients, as only consistent medical monitoring enables the selection of the best treatment approach and timely adjustments.

Adherence to treatment among patients with glaucoma is a critical issue, and research indicates a high frequency of non-compliance for various reasons. Studies show that up to 80% of patients with glaucoma do not adhere to their treatment regimen, with forgetfulness being the primary reason for non-compliance[6,7]. Research has demonstrated that poor adherence to antiglaucoma medications is a significant barrier to the effective treatment of glaucoma, with non-compliance rates ranging from 22% to 39.7%[8,9]. Patient education plays a crucial role in enhancing treatment adherence as it increases awareness about the treatment and promotes better medication compliance[10]. Addressing barriers such as forgetfulness, costliness, and side effects is crucial for improving the effectiveness of glaucoma therapy and preventing disease progression.

Despite the abundance of available hypotensive medications, as well as the presence of cutting-edge laser and surgical technologies, glaucoma continues to hold a leading position among causes of disability.[11,12]. The reasons behind this include insufficient literacy among the population, as well as among medical personnel, regarding the etiology, pathogenesis, and treatment of this insidious pathology. Doctors often lack time to explain to patients what glaucoma is, how to treat it, and how to instill eye drops. The majority of glaucoma patients have insufficient compliance, manifested in non-compliance with the physician's recommendations for both the treatment of the primary disease and its ophthalmological complications. According to literature data, more than half of glaucoma patients are unaware of their ophthalmic pathology and do not seek consultation with an ophthalmologist. Insufficiently informed about their condition and lacking skills in its control, such patients often require medical assistance more frequently, cannot work effectively, therefore, only education in the "Glaucoma Patient School" can ensure an improvement in their quality of life[13]. The process of educating patients with the aim of fostering motivation for treatment plays a crucial role in glaucoma prevention.

Currently, there are several tools available for assessing medication adherence in chronic diseases. The Morisky Adapted Scale is one of the most validated questionnaires used to assess medication adherence, not only in ophthalmology, primarily in glaucoma, but also in other chronic conditions such as diabetes, osteoporosis, hypertension, epilepsy, organ transplantation requiring immunosuppressants, and other chronic diseases involving medication intake [14] . The rationale for this study was the lack of previous research in Kazakhstan assessing adherence to ocular drop therapy using the Morisky Scale adapted into Kazakh and Russian languages.

Purpose: Assessing the effectiveness of the "Glaucoma School" at urban polyclinics № 1 and 4 in Aktobe city by studying treatment adherence before and after the implementation of the glaucoma school.

MATERIALS AND METHODS

The study design involved a cross-sectional study. All participants attending the glaucoma school were included, totaling 183 individuals. Patient observation spanned six months. The research was conducted at urban polyclinics № 1 and № 4 in Aktobe city.

Inclusion criteria encompassed patients aged 18 and older diagnosed with glaucoma who also attended the glaucoma school. Exclusion criteria included individuals under 18 years old, pregnant women, patients unable to read the MMAS-8 questionnaire due

to poor vision or other reasons, and those experiencing difficulties understanding the research objectives.

Variables

Dependent variable: Adherence to glaucoma treatment. Independent variables in the study included socio-demographic data such as age, gender, level of education, marital status, social status, and income level, as well as variables related to health status: dynamic observation status, availability of free medication, history of surgeries, type of glaucoma, and presence of comorbidities. Patient data were collected using a questionnaire divided into two parts: the first part contained questions about the patient's socio-demographic data, while the second part presented the Morisky Scale consisting of 8 questions.

The MMAS-8 questionnaire

The non-specialized medication adherence assessment questionnaire (Morisky-Green 8-item scale) comprised 8 questions regarding patients' forgetfulness regarding medication intake, their carelessness in taking medications, discontinuation of medication intake in case of subjective improvement or worsening of symptoms, as well as issues with remembering the medication regimen. [15]. The original version of the MMAS-8 was translated from English into Russian and Kazakh by a bilingual translator proficient in English. Then, the translated questionnaire was translated back into English by another bilingual translator. The back-translated questionnaire was subsequently compared with the original English version, and finally, a finalized questionnaire was prepared with the consent of both translators to create a version that was semantically as close as possible to the original questionnaire. The translation process was conducted by a linguistic organization and then reviewed by a terminological committee at the West Kazakhstan Marat Ospanov Medical University, protocol № 27, dated November 30, 2021.

For items 1 through 7, the possible response options are "yes" or "no". Item 8 is rated on a 5-point Likert scale. For each "no" response, 1 point is awarded, while for "yes" responses, 0 points are assigned, except for item 5, where each "yes" response is awarded 1 point, and no points are assigned for "no" responses. When assessing item 8 (scores ranging from 0 to 4), if a patient selects the "0" response, 1 point is assigned, while if they select the "4" response, 0 points are awarded. Responses "1", "2", and "3" are rated as 0.25, 0.5, and 0.75 points, respectively. The total score on the MMAS-8 can range from 0 to 8, where higher scores indicate greater adherence. Based on the score obtained from the sum of all responses, the level of adherence to treatment is determined: low (<6 points), moderate (6–7 points), and high (8 points).

Ethical considerations: The study was approved by the Bioethics Committee of West Kazakhstan Marat Ospanov Medical University on November 19, 2021, Protocol № 9. Prior to participation in the project, each potential research participant was informed about the purpose and objectives of the study. They were also informed of their right to refuse participation in the research. In case of consent, potential participants signed an informed consent form.

Statistical analysis

In the study, data were presented as the mean value with standard deviation (Mean±SD) for quantitative variables and as a percentage for categorical variables using SPSS (version 27.0.0.0, IBM Corporation, USA). The McNemar test was applied to analyze categorical variables, allowing for the assessment of statistically significant differences in two dependent samples before and after the intervention. In cases where the data were more complex, the **McNemar-Bowker** test, adapted for more complex data structures, was used. The Wilcoxon signed-rank test was used to compare two dependent samples for quantitative measures, taking into account the non-normal distribution of data. The Mann-Whitney U test was used when comparing two independent samples. The Kruskal-Wallis test was applied for analyzing data from more than two groups, also suitable for data with non-normal distribution. A p-value <0.05 was considered statistically significant.

RESULTS

The socio-demographic characteristics of the participants are presented in Table 1. A total of 183 glaucoma patients with a mean age of 62.1±11.1 years underwent the Kazakh and Russian versions of the MMAS-8. Of all surveyed patients, 73 were male (39.9%) and 110 were female (60.1%).

Table 1. Socio-demographic status of patients

Variables		Frequency (n) (%)
Sex	Male	73 (39,9%)
	Female	110 (60,1%)
Age (Mean±SD), years		62,1±11,1
Educational level	Incomplete secondary education	11 (6%)
	Secondary education	39 (21,3%)
	Specialized secondary education	76 (41,5%)
	Higher education	57 (31,1%)
Marital status	Married	129 (70,5%)
	Widowed	32 (17,5%)
	Divorced	6 (3,3%)
	Never married	16 (8,7%)
Social status	Worker	44 (24%)
	Employee	23 (12,6%)
	Student	1 (0,5%)
	Entrepreneur	3 (1,6%)
	Retiree	90 (49,2%)
	Homemaker	6 (3,3%)
	Unemployed	16 (8,7%)
Income	Less than 50,000 tenge	20 (10,9%)
	50,000 - 100,000 tenge	92 (50,3%)
	100,000 - 150,000 tenge	47 (25,7%)
	150,000 - 200,000 tenge	21 (11,5%)
	More than 200,000 tenge	3 (1,6%)

The majority of the participants had been under dispensary observation for more than a year (168, 91.8%), and the same proportion received free eye drops (168, 91.8%). Among the participants, a smaller number, 44 (24%), had undergone eye surgery. Most were diagnosed with primary open-angle glaucoma (165, 90.2%), with a smaller number having primary angle-closure glaucoma (18, 9.8%). (Table 2)

Table 2. Clinical history of patients

Indicator		n (%)
Dispensary registration status	Less than a year on dispensary registration	15 (8.2%)
	More than a year on dispensary registration	168 (91.8%)
Do you get free drops?	Yes	168 (91.8%)
	No	15 (8.2%)
Have you ever had eye surgery?	Yes	44 (24%)
	No	139 (76%)
Diagnosis	Primary open-angle glaucoma	165 (90.2%)
	Primary angle-closure glaucoma	18 (9.8%)

Total of 105 cases of chronic diseases were registered among the patients. The most commonly encountered disease was arterial hypertension (AH), reported in 89 cases (486%). Diabetes mellitus (DM) was mentioned in 20 cases (109%), angina pectoris in 18 (98%), ischemic heart disease in 7 cases (38%), and other diseases in 26 cases (142%). (Table 3).

Table 3

Comorbidities	n (%)
Arterial hypertension	89 (48,6%)
Diabetes mellitus	20 (10,9%)
Angina pectoris	18 (9,8%)
Ischemic heart disease	7 (3,8%)
Other disease	26 (14,2%)
Coexisting conditions	105 (57,4%)

It is noteworthy that the proportion of participants who occasionally forgot to administer their eye drops decreased from 42.1% to 33.3% ($p < 0.0001$) as shown in Figure 1a. Similarly, the frequency of forgetting to administer eye drops over the last two weeks also declined from 39.9% to 31.1% ($p < 0.0001$) as depicted in Figure 1b. Furthermore, the number of participants who discontinued eye drops without consulting their physician decreased from 41% to 32.2% ($p < 0.0001$) as illustrated in Figure 1c. During travel or while away from home, the incidence of forgetting eye drop administration reduced from 35.5% to 29.5% ($p = 0.0001$) as demonstrated in Figure 1d. Additionally, the proportion of participants who successfully administered their eye drops the day before increased significantly from 63.9% to 72.1% ($p < 0.0001$) as presented in Figure 1e. The tendency to avoid using eye drops when feeling that their eye condition was under control decreased from 42.6% to 37.2% ($p = 0.0002$) as shown in Figure 1f. There was also a reduction in the concern about forgetting to take a dose from 44.3% to 35.5% ($p < 0.0001$) as illustrated in Figure 1g. The study also categorized the frequency of forgetting eye drop administration, noting various frequencies, though not all were statistically significant as depicted in Figure 1h. Importantly, the overall median adherence score significantly improved from 4,75 to 5,5 and the interquartile range narrowed from 35-60 to 40-68 ($p < 0.0001$), indicating an overall enhancement in adherence to the eye drop regimen post-intervention as shown in Figure 1i.

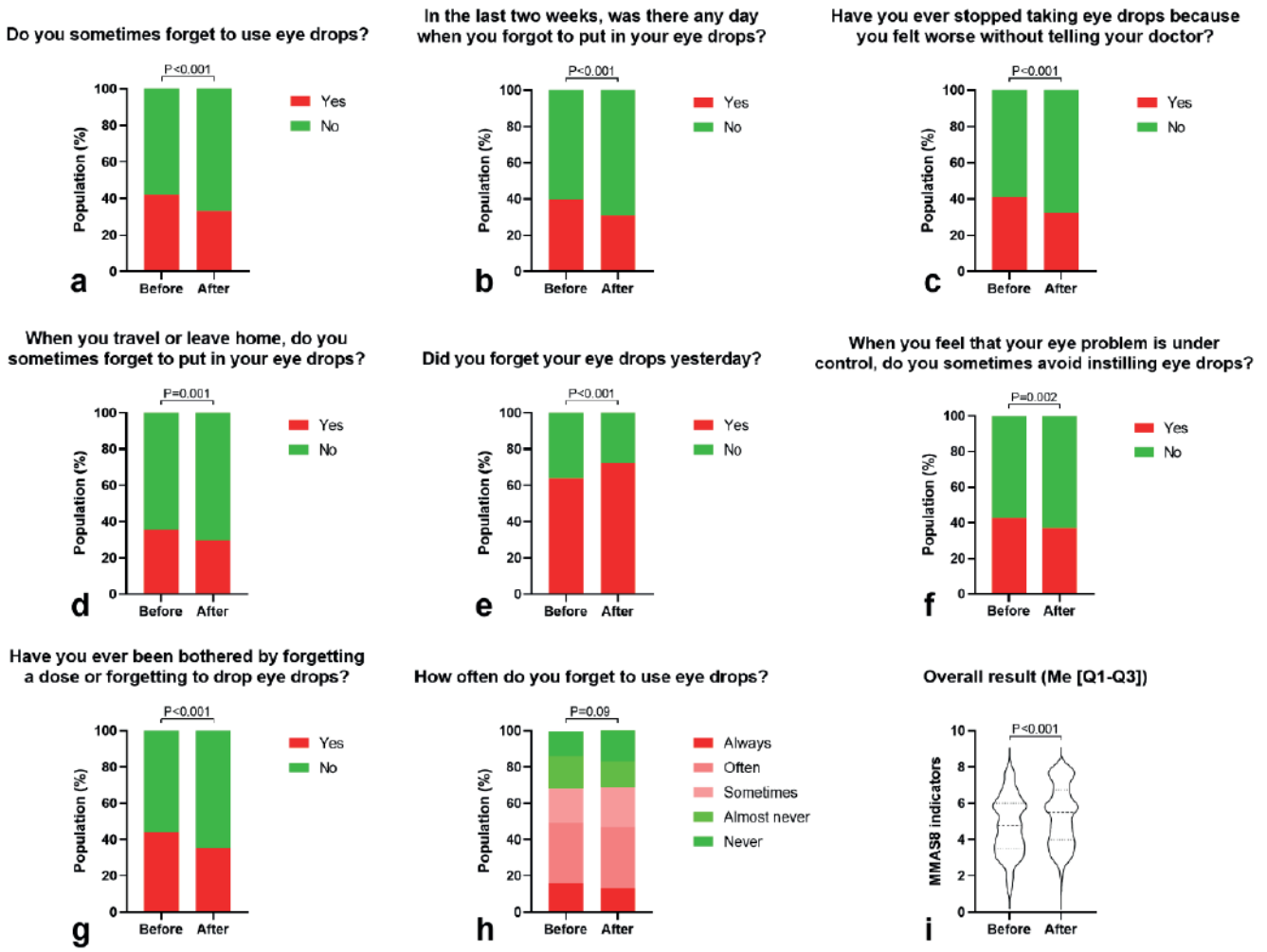

Figure 1. Indicators of adherence to treatment before and after the implementation of a glaucoma school for patients

Only 11% of participants had high adherence, which increased to 38% post-intervention, though this change was not statistically significant (p = 0.166). Medium adherence slightly decreased from 19.7% to 18%, and low adherence also decreased slightly from 79.2% to 78.1%. This suggests a small shift from lower to higher adherence categories following the intervention (Table 4).

Table 4. Comparison of therapy adherence levels in patients before and after attending glaucoma school

Adherence to therapy	Before	and After	p*
High	2 (1,1%)	7 (3,8%)	0,166
Average	36 (19,7%)	33 (18%)	
Low	145 (79,2%)	143 (78,1%)	

*** McNemar-Bowker** test

Before the educational intervention, the results revealed that medication adherence, as measured by the Medication Adherence Scale (MMAS-8), was significantly influenced by various factors. Specifically, the level of education and income had a statistically significant impact on adherence, with higher levels of education and income associated with better adherence ($p < 0.0001$ for education and $p = 0.0020$ for income). Additionally, patients with diabetes and angina showed significant variations in adherence scores, indicating that the complexity of these conditions might affect patients' medication-taking behavior ($p = 0.0031$ for diabetes and $p = 0.0017$ for angina). The analysis used non-parametric tests suitable for the data's distribution, with the Mann-Whitney U test applied to two-group comparisons and the Kruskal-Wallis test for comparisons across multiple groups (Table 5). After the implementation of the educational intervention, the Medication Adherence Scale (MMAS-8) scores exhibited changes across different demographic and clinical factors, yet these changes did not reach statistical significance. Gender, education level, marital status, social status, and income level all showed varied MMAS-8 scores post-intervention; however, none of these factors showed a statistically significant difference (with p-values ranging from 0.067 to 0.287). Similarly, receiving free eye drops, undergoing eye surgery, and having conditions such as diabetes or angina did not result in statistically significant differences in adherence scores. These results suggest that the educational

Table 5. MMAS-8 results before attending glaucoma school.

Indicator		Result of MMAS-8 before training	p*
Gender	Male	4,3 [3,5-5,8]	0,231
	Female	4,8 [3,5-6]	
Level of education	Incomplete secondary education	4,5 [3-6,3]	<0,001
	Secondary education	4,3 [3,3-5,8]	
	Specialized secondary education	4 [3,3-5,1]	
	Higher education	5,8 [4,8-6]	
Marital status	Married	4,5 [3,5-5,8]	0,185
	Widowed	5,8 [3,9-6,3]	
	Divorced	4,5 [3,5-6,5]	
	Never married	4,8 [3,4-5,8]	
Social status	Worker	3,8 [3,3-5]	0,101
	Employee	4,5 [3-5,8]	
	Student	5,8 [5,8-5,8]	
	Entrepreneur	5,3 [4,3-5,8]	
	Retiree	5,4 [3,8-6,3]	
	Homemaker	4,8 [3,3-6,3]	
	Unemployed	4,6 [3,5-5,3]	
Income	Less than 50,000 tenge	5 [3,6-5,8]	0,020
	50,000 - 100,000 tenge	5 [3,8-6,1]	
	100,000 - 150,000 tenge	3,8 [3-5]	
	150,000 - 200,000 tenge	4,8 [4-5,8]	
	More than 200,000 tenge	5,8 [5,3-6,5]	
8. Dynamic observation status	Less than one year under dynamic observation	5 [3,3-5,8]	0,899
	More than one year under dynamic observation	4,8 [3,5-6]	
9. Do you get free drops?	Yes	4,8 [3,5-6]	0,899
	No	5 [3,3-5,8]	
10. Have you ever had eye surgery?	Yes	4,8 [3,5-6,3]	0,719
	No	4,8 [3,5-5,8]	

Indicator		Result of MMAS-8 before training	p*
11.Diagnosis	Primary open-angle glaucoma	4,8 [3,5-6]	0,714
	Primary angle-closure glaucoma	4,9 [4-5,3]	
Arterial hypertension	Yes	5 [3,8-5,8]	0,073
	No	4,3 [3,3-6]	
Diabetes mellitus	Yes	4,8 [3,5-5,8]	0,031
	No	6,1 [3,6-7]	
Angina pectoris	Yes	4,8 [3,5-6]	0,017
	No	3,8 [2.8-4.5]	
Coronary heart disease	Yes	4,8 [3,5-5,9]	0,108
	No	5,8 [4,3-6,8]	
Other diseases	Yes	4,8 [3,5-6]	0,660
	No	4,6 [3,5-6]	
Comorbidities	Yes	5 [3,5-5,8]	0,455
	No	4,5 [3,3-6]	

*If category 2 – U-Mann-Whitney criterion, if more than 2-Kruskal-Wallis criterion

program, while perhaps beneficial in some respects, did not lead to a measurable improvement in overall medication adherence as captured by the MMAS-8 across the studied variables. Non-parametric tests, such as the Mann-Whitney U test for two categories and the Kruskal-Wallis test for more than two, were used to determine these outcomes, indicating that the data did not follow a normal distribution (Table 6).

Table 6. MMAS-8 results after attending glaucoma school.

Indicators		Results of MMAS-8 after training	p
Gender	Male	5 [3,5-6,3]	0,067
	Female	5,8 [4,3-6,8]	
Level of education	Incomplete secondary education	4,5 [3-7]	0,104
	Secondary education	5,3 [3,8-6,5]	
	Specialized secondary education	4,8 [3,8-6,5]	
	Higher education	5,8 [5-6,8]	
Marital status	Married	5 [3,8-6,5]	0,293
	Widowed	5,9 [4,4-7,5]	
	Divorced	5,4 [3,5-6,8]	
	Never married	5,4 [4,1-6,8]	
Social status	Worker	4,6 [3,5-5,9]	0,163
	Employee	5,8 [4-7]	
	Student	5,8 [5,8-5,8]	
	Entrepreneur	5,3 [4,3-5,8]	
	Retiree	5,8 [4,3-7]	
	Homemaker	4,8 [3,3-6,3]	
	Unemployed	5 [3,6-5,8]	
Income	Less than 50,000 tenge	5,3 [4,1-6]	0,287
	50,000 - 100,000 tenge	5,8 [4-7]	
	100,000 - 150,000 tenge	4,8 [3,5-6,5]	
	150,000 - 200,000 tenge	5,5 [4-6]	
	More than 200,000 tenge	7,5 [5,3-7,8]	
8. Dynamic observation status	Less than one year under dynamic observation	5,8 [5-7,5]	0,178
	More than one year under dynamic observation	5,3 [3,8-6,6]	
9. Do you get free drops?	Yes	5,3 [3,8-6,6]	0,178
	No	5,8 [5-7,5]	
10. Have you ever had eye surgery?	Yes	5,1 [3,6-6,8]	0,584
	No	5,5 [4-6,5]	
11.Diagnosis	Primary open-angle glaucoma	5,5 [3,8-6,8]	0,692
	Primary angle-closure glaucoma	5 [4,3-5,8]	
Arterial hypertension	Yes	5,5 [4-6,5]	0,865
	No	5,5 [3,8-6,8]	
Diabetes mellitus	Yes	5,3 [4-6,5]	0,071
	No	6,6 [3,9-7,8]	
Angina pectoris	Yes	5,5 [4-6,5]	0,414
	No	4,4 [3.8-6.8]	
Coronary heart disease	Yes	5,4 [3,8-6,6]	0,582
	No	5,8 [4,3-6,8]	
Other diseases	Yes	5,5 [3,8-6,5]	0,221
	No	5,8 [4-7]	
Comorbidities	Yes	5,1 [4-6]	0,357
	No	5,8 [4-6,8]	

*If category 2 – U-Mann-Whitney criterion, if more than 2-Kruskal-Wallis criterion

DISCUSSION

Glaucoma, being a chronic condition, necessitates sustained engagement from both patients and doctors. Adherence refers to how well individuals adhere to their doctor's instructions regarding medication intake. For their well-being, it's imperative that glaucoma patients adhere to the medications prescribed by their doctors. Previous global studies have indicated unsatisfactory levels of adherence to glaucoma treatment. Traditionally, management decisions have been primarily made by doctors, but there's an anticipation of a shift in this approach. Doctors should strive to involve patients more actively in the collaborative management of chronic conditions. The glaucoma school organized various classes aimed at enhancing disease management and patient education. Lectures covering glaucoma offered comprehensive insights into its types, causes, and repercussions. Practical sessions focusing on the correct usage of eye drops aided patients in mastering instillation techniques and avoiding common errors.

In addition, seminars on stress management and maintaining a healthy lifestyle were organized, which included stress reduction methods and information on safe physical exercises that do not increase intraocular pressure. The program also included nutrition consultations, where nutrients and diets beneficial for eye health were discussed. Sessions on managing medication treatment helped patients learn to adhere to their medication schedules. Group discussions and support meetings provided a platform for exchanging experiences and advice among patients, strengthening the community and support among participants. An important addition to the program was lectures from specialists such as ophthalmologists and endocrinologists, who shared the latest research and advancements in the treatment of glaucoma. Additionally, consultations with a psychologist and social worker were included, providing support in adapting to life with glaucoma and helping to address social and emotional issues related to the condition.

This study showed that patients with higher levels of education often adhered to glaucoma treatment compared to patients with insufficient knowledge ($p < 0.001$). This finding was corroborated by studies conducted in Egypt and Nigeria[16,17]. Glaucoma patients who adhere to therapy with a treatment adherence level of more than 80% are less likely to become blind[18].

Income plays a significant role in patients' adherence to glaucoma treatment[19]. A lower income level is associated with reduced adherence to glaucoma medication, leading to potential treatment interruptions and decreased therapy effectiveness[20]. Socioeconomic factors such as income may hinder access to regular ophthalmic care, which is crucial for early detection and treatment of glaucoma[21]. Patients with lower incomes may face difficulties in acquiring medications, scheduling doctor visits, and overcoming financial barriers. In our study, indicating statistically significant differences in the overall MMAS-8 score based on income levels before attending glaucoma school underscores that prior to educational programs, treatment adherence among patients varied depending on their economic status. This suggests that before educational sessions, economic conditions influenced patients' ability to follow medical recommendations, manifested in varying degrees of treatment adherence. Individuals with higher incomes may have had more opportunities to purchase necessary medications and access medical services, thereby increasing their adherence to treatment. Conversely, patients with lower incomes may have experienced financial difficulties limiting their ability to regularly take medications and visit doctors, thus reducing their adherence. These data indicate the need for integrating socioeconomic support into treatment and education programs to improve outcomes for patients with limited resources and underscore the importance of considering economic factors when planning measures to enhance treatment adherence[22]. Therefore, eliminating income-related barriers through patient education, support programs, and improving access to affordable medical services can help increase treatment adherence and overall management of glaucoma patients in economically disadvantaged populations.

Patients with diabetes may have a higher likelihood of developing glaucoma due to shared risk factors and pathophysiological similarities between these two conditions[23]. Statistically significant differences in the overall MMAS-8 score based on diabetes and angina indicators before attending glaucoma school indicate that the level of treatment adherence among patients with

these comorbidities varied. Patients with diabetes often face unique challenges such as the need to coordinate multi-aspect treatment and manage stress from multiple chronic conditions, which can complicate treatment adherence. Similarly, patients with angina experience additional issues related to the need for multiple medications and worsening overall physical condition, which can also negatively affect their ability to follow medical recommendations. These data underscore the importance of an integrated approach to managing patients with multiple chronic conditions and the need to consider these factors when developing educational and supportive programs to improve treatment adherence.

Previous studies have shown that improving disease knowledge was associated with better self-management in chronic obstructive pulmonary disease and chronic kidney disease[24,25]. Therefore, with improved knowledge about glaucoma, we believe that glaucoma patients may be more motivated to manage their own condition. Improving treatment adherence enhances disease outcomes and reduces medication wastage[26,27].

The absence of statistically significant differences in the overall MMAS-8 score across various indicators after attending glaucoma school indicates that the educational program had a universal impact on treatment adherence levels among all participants, regardless of their initial individual characteristics such as education level, income, diabetes, or angina. Such an outcome may also suggest the effectiveness of the glaucoma school educational program, highlighting its significance as a tool for enhancing overall treatment adherence levels among glaucoma patients, including those with comorbidities.

Analysis showed that regular attendance at glaucoma schools significantly improved adherence to therapeutic regimens among participants. Interestingly, the improvement in therapy adherence was observed not only in terms of regular use of prescribed drops but also in the increase in patients' overall awareness of their condition and methods of its control.

The study confirms the importance of educational programs for patients with chronic diseases such as glaucoma. Glaucoma schools, by providing systematic education and support, can play a key role in improving clinical outcomes and enhancing the quality of life for patients. It is important to continue developing and expanding such programs to achieve the best possible outcomes in glaucoma management.

Our study faces several limitations. Firstly, for participants to effectively read and understand the materials provided in glaucoma school and questionnaires, it is necessary for them to have sufficiently good vision and satisfactory cognitive status. Glaucoma school may not be suitable for people with severely impaired vision, which is often associated with late stages of glaucoma, as well as for individuals with limited cognitive abilities.Thirdly, the six-month duration of observation did not allow assessing how education affects the cessation of glaucomatous optic neuropathy progression.Fourthly, the severity of the disease, baseline intraocular pressure, medication side effects, and patient preferences could influence their treatment adherence and treatment method selection; however, in this study, we could not account for all these factors. Additionally, the study only included patients from two urban clinics in Aktobe, Kazakhstan, which may not fully reflect the demographic and clinical characteristics of the population as a whole.

CONCLUSIONS

The study underscores that the level of adherence to glaucoma treatment in the investigated institutions remains comparatively low, indicating the need for intensified efforts to improve it. The implementation of an educational program in the glaucoma school led to a significant improvement in the level of treatment adherence. The effectiveness of the program was manifested through a series of activities, including lectures on glaucoma, workshops on the proper use of eye drops, as well as seminars on stress management and nutrition. These activities not only increased participants' awareness but also facilitated the formation of a supportive community among them. The results also confirm the influence of socio-economic factors, including income level and education, on treatment adherence. This underscores the importance of integrating social support measures into medical programs to improve treatment outcomes, especially among economically vulnerable populations. However, the limited observation period and geographic specificity of the sample may affect the generalizability

of the data. Nevertheless, this study makes a significant contribution to understanding key aspects of glaucoma management and developing strategies to improve treatment adherence. Continued research in this area will contribute to the development of more targeted and effective educational and supportive programs for patients with glaucoma.

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Authors's contribution:

Data gathering and idea owner of this study: Maiya Taushanova and Lyudmila Yermukhanova

Study design: Saule Tazhbenova and Perizat Aitmaganbet

Data gathering: Yesset Muratov, Ruslan Irmekbayev

Writing and submitting manuscript: Maiya Taushanova

Editing and approval of final draft: Issenova Balday, Dana Abilkassym, Maiya Taushanova

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