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Screening for Diabetic Retinopathy in Patients with Diabetes Mellitus in Urban and Rural Areas

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Abstract Diabetic retinopathy is one of the most common complications of diabetes. In the early stages of the disease, it can be asymptomatic, especially in the initial phases of diabetes. Screening examinations allow for the detection of diabetic retinopathy at early stages. The prevalence of diabetic retinopathy varies between urban and rural populations. Therefore, we conducted a screening examination for diabetic retinopathy among 860 patients (1714 eyes) with newly diagnosed type 1 and type 2 diabetes in the Andijan region. The aim of the examination was to determine the extent of hidden diabetic retinopathy among urban and rural populations and to compare its levels. As a result of the examination, diabetic retinopathy was detected in 13% of urban residents with type 1 and type 2 diabetes and in 30% of rural residents with type 2 diabetes, and necessary treatment measures were prescribed. The likelihood of developing diabetic retinopathy in rural residents with diabetes is 2.5 times higher than in urban residents with diabetes.

Keywords Diabetic retinopathy, Type 1 diabetes, Type 2 diabetes, Visual acuity, Screening examination, Rural population, Urban population

1. Introduction

DR is one of the most prevalent complications of DM and can lead to significant vision loss. The subclinical course of DR poses a particular challenge, as patients may not experience symptoms in the early stages of the disease, thereby complicating timely diagnosis and treatment [11]. DR is one of the most prevalent complications of diabetes, potentially leading to significant vision loss and blindness [7]. DR (DR) develops in 75% of patients with DM within 10 years of disease onset. In some cases, the living conditions and lifestyle of patients can influence the development, course of diseases, and the occurrence of complications. There are differences in the development of diabetic retinopathy among urban and rural populations in patients suffering from diabetes. Elevated blood glucose levels induce destructive changes in the walls of small blood vessels, including the destruction of pericytes and endothelial cells, thickening of the basement membrane, and aggregation of platelets and erythrocytes, which accelerates blood clotting and reduces blood flow. This leads to increased filtration of blood elements into tissues and irreversible organic changes [15]. DR can develop without any clinical symptoms until the diagnosis of DM [6]. In such cases, the diagnosis and treatment of DR are delayed. Consequently, it becomes challenging to prevent significant vision loss. Complications of DM lead to patients transitioning from an active to a passive state, limiting their work capacity and causing disability, while the applied treatment methods often fail to yield positive outcomes. In some cases, patients in the early stages of the disease relate to their health indifferently and neglect examinations of endocrinologists and ophthalmologists. The absence of physiological and psychological awareness of the complications of diabetes in patients, as well as an indifferent attitude to the early symptoms of DR can lead to the development of severe and incurable stages of complications [4]. Untimely intake of medications that lower blood sugar levels, excessive physical exertion, or negligence can contribute to the early development of diabetic retinopathy. Conversely, mental work and adherence to prescribed diets can slow down the progression of diabetic retinopathy [3]. In patients, DR may develop in one eye, leading to reduced visual acuity (VA) in that eye, while the other eye remains asymptomatic. Consequently, patients may not notice any clinical symptoms related to vision. This results in the loss of valuable time for implementing prescribed treatment methods for DR. Currently, the following methods are employed for the treatment of DR: laser photocoagulation, intravitreal injections of anti-VEGF agents, and vitreoretinal surgery, which play a crucial role in treating DR and limiting its pathological zones [2]. However, these methods do not always demonstrate their

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effectiveness in preventing the decline in VA among patients, and in some cases, VA may continue to deteriorate compared to the initial state. Therefore, current research is ongoing to explore new treatment methods for DR and to refine existing treatment approaches. The primary objective of ongoing research in ophthalmology is the prevention of DR development and the arrest of identified pathological processes [8]. Data obtained from screening examinations allow for the identification of risk factors contributing to the early development of diabetic retinopathy, as well as factors that can slow its progression or contribute to the regression of diabetic retinopathy [10]. Ophthalmologists should detect DR at its early stages using contemporary diagnostic methods and integrate visualization techniques for these changes into clinical practice [12]. To achieve this objective, it is essential to conduct and implement SE for DR among patients with recently diagnosed DM [9]. Screening examinations allow for the organization of diabetes management processes among urban and rural populations by analyzing their daily lifestyle and work activities. This enables the analysis of the pathogenesis of diabetic retinopathy and the development of necessary recommendations for the active life of other patients [13]. SEs are a crucial preventive measure for preserving VA in patients and preventing blindness. They enable the timely detection of DR and facilitate the prompt implementation of prescribed treatment methods [3]. The implementation and conduct of SE are highly effective in preventing future vision problems. SE for DR in patients with DM play a crucial role in detecting early signs of DR and facilitating the timely application of prescribed treatment methods [2]. Conducting SE for DR in remote areas among populations affected by DM is crucial for preventing the decline in VA and blindness. Such screenings can potentially contribute to the preservation of patients' active work capacity in the future [10]. The detection of early-stage DR, specifically non-proliferative DR, and the subsequent limitation of degenerative fields and regression of the pathological process play a crucial role in preserving VA in patients. This also confers economic and social benefits to the patients [1]. We conducted SE for DR among patients with recently diagnosed DM and identified the benefits of this method. The goal and objectives of the study are to conduct screening examinations for diabetic retinopathy among patients with newly diagnosed type 1 and type 2 diabetes living in urban and rural areas, in order to determine the prevalence of diabetic retinopathy and identify differences between these groups.

2. Materials and Methods

For our study, we selected 860 patients (1714 eyes) with newly diagnosed diabetes from the urban and rural populations of the Andijan region and conducted a screening examination for diabetic retinopathy on a voluntary basis. Of these, 566 individuals (66%) were rural residents, and 294 individuals (34%) were urban residents. The examination was carried out at the Andijan branch of the Republican Specialized Scientific-Practical Medical Center of Endocrinology the majority of patients were examined in both outpatient and inpatient settings. The duration of DM ranged from 0.1 to 2 years. The age of the patients varied from 12 to 78 years. Among them, female accounted for 375 individuals (44%), and male accounted for 485 individuals (56%) (***Table 1***). Type 2 DM was diagnosed in 828 (96%) patients, while type 1 DM was diagnosed in 32 (4%) patients. Additional chronic eye diseases were detected in 76 patients (9%) (142 eyes). Among the patients, 42 individuals (5%) (82 eyes) had myopia, and 24 individuals (3%) (48 eyes) had hyperopia. These patients utilized prescribed eyeglasses and contact lenses. In 6 patients (0.7%) (6 eyes), VA was 0 (zero) due to injuries sustained during their lifetime. In 4 patients (0.5%) (6 eyes), glaucoma was diagnosed, and appropriate eye drop medications were prescribed. Among them, 294 individuals (34%) (564 eyes) are urban residents. This includes 12 individuals (1.3%) with type 1 diabetes and 282 individuals (33%) with type 2 diabetes. Children account for 3 individuals (0.4%), including 1 boy (0.1%) and 2 girls (0.2%). There is 1 adolescent (0.1%), a girl. Young adults account for 9 individuals (1%), including 4 men (0.5%) nd 5 women (0.6%). Middle-aged individuals account for 208 people (24%), including 120 men (14%) and 88 women (10.2%). Elderly individuals account for 73 people (8.4%), including 46 men (5.3%) and 27 women (3.1%). Rural residents account for 566 individuals (66%) (1150 eyes). This includes 20 individuals (2.3%) with type 1 diabetes and 546 individuals (63%) with type 2 diabetes. Children account for 4 individuals (0.5%), including 2 boys (0.2%) and 2 girls (0.2%). Adolescents account for 4 individuals (0.5%), including 2 boys (0.2%) and 2 girls (0.2%). Young adults account for 14 individuals (1.6%), including 6 men (0.7%) and 8 women (0.8%). Middle -aged individuals account for 404 people (47%), including 204 men (24%) and 200 women (23%). Elderly individuals account for 140 people (16.2%), including 100 men (12%) and 40 women (4.6%).

Among urban residents with diabetes, additional chronic eye diseases were detected in 38 individuals (4.4%) (72 eyes): 17 individuals (2%) (32 eyes) had myopia, including 1 boy (0.1%), 5 young adults (0.6%) (2 men (0.2%) and 3 women (0.4%)), all of whom are patients with type 1 diabetes. The remaining 11 individuals (1.2%) are middle-aged (5 men (0.6%) and 6 women (0.7%)), all of whom are patients with type 2 diabetes. Hypermetropia was detected in 18 individuals (2%) (36 eyes). Of these, 12 individuals (1.3%) are middle-aged (7 men (0.8%) and 5 women (0.6%)). 6 individuals (0.7%) are elderly (2 men (0.2%) and 4 women (0.5%)). Glaucoma was detected in 2 middle-aged individuals (0.2%) (1 man (0.1%) and 1 woman (0.1%)) (4 eyes). Corneal degeneration was detected in 1 elderly individual (1 man) (1 eye). All of them are patients with type 2 diabetes.

Among rural residents with diabetes, additional chronic eye diseases were detected in 38 individuals (4.4%) (70 eyes): 25 individuals (3%) (50 eyes) had myopia, including 2

adolescents (0.2%) (2 girls), 8 young adults (0.9%) (5 men (0.6%) and 3 women (0.4%)), all of whom are patients with type 1 diabetes. The remaining 15 individuals (2%) (30 eyes) are middle-aged (7 men (0.8%) and 8 women (0.9%)), all of whom are patients with type 2 diabetes. Hypermetropia was detected in 6 individuals (7%) (12 eyes). Of these, 2 men (0.2%) and 4 women (0.5%) are middle-aged. Glaucoma was detected in 2 elderly individuals (1 man (0.1%) and 1 woman (0.1%)) (2 eyes). Corneal degeneration was detected in 5 middle-aged individuals (4 men (0.5%) and 1 woman (0.1%)) (5 eyes). All of them are patients with type 2 diabetes.

Patients with recently diagnosed DM who were receiving outpatient treatment visited the ophthalmologist 1 or 2 times, while inpatient patients underwent treatment for the first time. None of them had previously undergone an examination by an ophthalmologist. Their VA, intraocular pressure, and visual field were measured, and ophthalmoscopic and biomicroscopic examinations were conducted with pupil dilation using mydriatics. Additionally, endocrinological parameters, particularly blood glucose levels, were taken into account. Moreover, the daily lifestyle of the patients, their mental and physical activities and capabilities, as well as the measures for controlling diabetes, were organized in a comprehensive manner.

3. Results and Their Discussions

We conducted SE for DR in 860 patients (1714 eyes) and obtained the following results: signs of DR were detected in 102 patients (12%) (177 eyes) (***Diagram 1***). The following types of DR were identified in accordance with the contemporary classification:

1. Early nonproliferative diabetic retinopathy (Ear NPDR).
2. Moderate nonproliferative diabetic retinopathy (Mod NPDR).
3. Severe nonproliferative diabetic retinopathy (Sev NPDR).

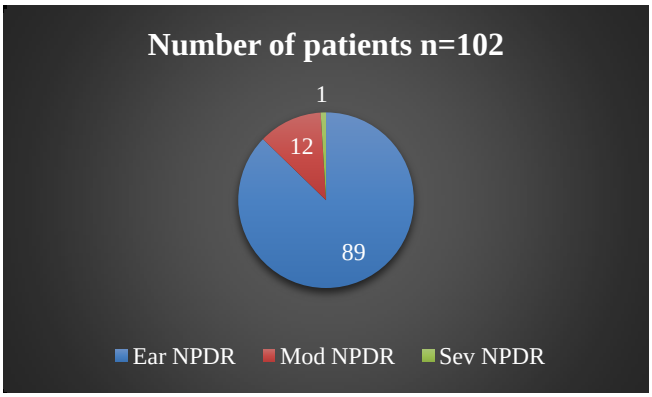

Diagram 1. Distribution of Identified DR by Classifications

Table 1. Distribution of Examined Patients

№	Age	♂;♀	Urban			Rural			General (Urban and Rural)
			Type of Diabetes Mellitus			Type of Diabetes Mellitus			
			1 - Type	2 - Type	Total	1 - Type	2 - Type	Total	
1	0 - 14	♂	1		1	2		2	3
		♀	2		2	2		2	4
2	15 - 17	♂			0	2		2	2
		♀	1		1	2		2	3
3	18 - 29	♂	3	1	4	5	1	6	10
		♀	5		5	7	1	8	13
4	30 - 54	♂		120	120		204	204	324
		♀		88	88		200	200	288
5	55 - 78	♂		46	46		100	100	146
		♀		27	27		40	40	67
	Total		12	282	294	20	546	566	860
	Other ophthalmic diseases								
1	Myopia	♂	4	2	6	10	4	14	20
		♀	9	2	11	6	5	11	22
2	Hyperopia	♂	1	9	10		3	3	13
		♀		8	8		3	3	11
3	Glaucoma	♂		1	1			0	1
		♀		1	1		2	2	3
4	Corneal degeneration	♂		1	1		4	4	5
		♀			0	1		1	1
	Total		14	24	38	17	21	38	76

Among them, 3 patients (0.3%) had type 1 DM, and 99 patients (11.5%) had type 2 DM. The age categories were distributed as follows: 1 patient (0.1%) was a child (male), 2 patients (0.2%) were adolescents (both males), 74 patients (9%) were of middle age ((male — 31 (4%), female — 43 (5%)), and 25 patients (3%) were elderly (male — 12 (1.4%), female — 13 (1.5%)). Additionally, 4 patients (0.5%) (male — 3 (0.3%), female — 1 (0.1%)) had myopia, and 5 patients (0.6%) (male — 3 (0.3%), female — 2 (0.2%)) had hyperopia (***Table 2***). The distribution among patients living in the city is as follows: in total, diabetic retinopathy was detected in 31 patients (4%). Diabetic retinopathy was not detected in patients with type 1 diabetes. Early non-proliferative diabetic retinopathy was detected in 24 middle-aged patients (12 men (1.3%) and 12 women (1.3%)) and in 3 elderly patients (2 men (0.2%) and 1 woman (0.1%)), all of whom are patients with type 2 diabetes. Moderate non-proliferative diabetic retinopathy was detected in 2 middle-aged women and in 2 elderly patients (1 man (0.1%) and 1 woman (0.1%)). All of them are patients with type 2 diabetes.

The distribution among patients living in rural areas is as follows: non-proliferative diabetic retinopathy was detected in 1 adolescent (0.1%) and 2 young men (0.2%), all of whom are patients with type 1 diabetes. Early non-proliferative diabetic retinopathy was detected in 50 middle-aged patients (23 men (3%) and 27 women (3%)) and in 9 elderly patients (3 men (0.4%) and 6 women (0.7%)), all of whom are patients with type 2 diabetes. Moderate non-proliferative diabetic retinopathy was detected in 7 patients (0.8%). All of them are middle-aged, including 2 men (0.2%) and 5 women (0.6%). All of them are patients with type 2 diabetes. Severe non-proliferative diabetic retinopathy was detected in 1 middle-aged woman (0.1%) with type 2 diabetes.

The identified DR in patients was classified as follows (***Diagram 2***):

1. Early nonproliferative diabetic retinopathy was identified in 89 patients (10.3%). Of these, 86 patients (10%) had type 2 DM, and 3 patients (0.3%) had type 1 DM. The duration of diabetes ranged from 0.5 to 1.5 years. Prior to the examination, 4 patients had myopia, and 5 patients had hyperopia. Female accounted for 46 individuals (5.3%), and male accounted for 43 individuals (5%). Vascular angiopathy and microaneurysms were detected in the fundus. The VA of these patients after correction was V=0.7±2.43. Pathological conditions of intraocular pressure and visual field were not identified.
2. Moderate nonproliferative diabetic retinopathy was identified in 12 patients (1.4%). All of them had type 2 DM. The duration of diabetes ranged from 0.8 to 2 years. Female accounted for 9 individuals (1%), and male accounted for 3 individuals (0.3%). Significant vascular angiopathies, microaneurysms, and severe exudates were detected in the fundus. The VA of these patients after correction was V=0.4±3.58. Pathological conditions of intraocular pressure were not identified. The visual field was 405.1°±152.3°.

Table 2. Distribution of DR by Age and Types of DM in Patients

Type of diabetes	Age	♂;♀	Urban			Tot.	Rural			Tot.	General
			Degree of DR				Degree of DR				
			Ear NPDR	Mod NPDR	Sev NPDR		Ear NPDR	Mod NPDR	Sev NPDR		
1 - Type	Children	♂				**0**				**0**	**0**
		♀				**0**				**0**	**0**
	Teenagers	♂				**0**	1			**1**	**1**
		♀				**0**				**0**	**0**
	Young	♂				**0**	2			**2**	**2**
		♀				**0**				**0**	**0**
2 - Type	Adults	♂	12			**12**	23	2		**25**	**37**
		♀	12	2		**14**	27	5	1	**33**	**47**
	Elderly	♂	2	1		**3**	3			**3**	**6**
		♀	1	1		**2**	6	1		**7**	**9**
Tot			**27**	**4**	**0**	**31**	**62**	**8**	**1**	**71**	**102**
Other ophthalmic diseases											
Myopia		♂	3			**3**				**0**	**3**
		♀				**0**	1			**1**	**1**
Hyperopia		♂				**0**	3			**3**	**3**
		♀	1			**1**	1			**1**	**2**
Tot			**4**	**0**	**0**	**4**	**5**	**0**	**0**	**5**	**9**

3. Severe nonproliferative diabetic retinopathy was identified in one patient (0.1%), a female, in one eye. The patient had type 2 DM. The duration of diabetes was 2 years. Significant vascular angiopathies, vascular anomalies, microaneurysms, and severe and soft exudates were detected in the fundus. The VA of this patient was V=0.09. Pathological conditions of intraocular pressure were not identified. The visual field was 420°.

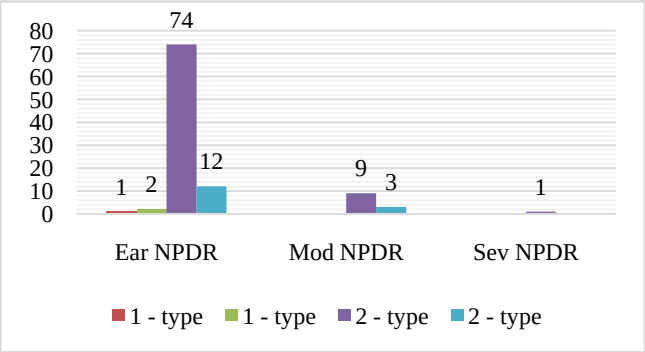

Diagram 2. Distribution of Patients with DR by Age and Types of DM

Patients diagnosed with DR were referred to the regional ophthalmology dispensary for comprehensive examinations and necessary treatment interventions. It was determined that 102 patients (12%) (177 eyes) had DR detected in the early stages of DM. The detected diabetic retinopathy among patients living in the city accounted for 10.5% of the total number of examined patients in the city. The detected diabetic retinopathy among patients living in rural areas accounted for 18% of the total number of examined patients in rural areas. Given that 75% of patients with DM develop DR within 10 years, the early stage of DM cannot guarantee the absence of DR development or the initiation of primary pathological processes. When diagnosing DM, it should not be considered the onset of the disease but rather the point at which the condition is identified in the examined patient. Almost all patients with diabetes living in the city take medications to maintain normal blood sugar levels in a timely manner and primarily engage in mental work. They regularly visit an endocrinologist. Physical activity is low, and they do not engage in heavy physical labor. Negligence is not observed. Patients with detected diabetic retinopathy mainly suffer from other cardiovascular diseases such as hypertension and atherosclerosis. These diseases contribute to the development of diabetic retinopathy. Among patients requiring insulin, no signs of diabetic retinopathy were detected in children, adolescents, and young adults. According to anamnestic data, 74 patients (8.6%) (35 males (4%) and 39 females (4.5%)) with diagnosed DR had a history of obesity, arterial hypertension, and atherosclerosis over an extended period. The identified comorbid conditions may serve as catalysts for the development of DR in patients with DM [14]. Patients living in rural areas mainly spend a lot of time engaged in heavy physical labor, adherence to dietary guidelines is low, and the regularity of taking medications to lower blood sugar levels is also low. In patients with detected diabetic retinopathy, the retinopathy mainly develops as a result of heavy physical labor, and patients do not seek timely consultations with necessary specialists. Signs of diabetic retinopathy were detected in patients with both types of diabetes. Additionally, 82 patients (9.5%) (40 males (4.6%) and 42 females (4.8%)) with diagnosed DR did not consult an endocrinologist at the appointed times, disregarded their DM, and did not adhere to the prescribed medication regimen for maintaining normal blood glucose levels. Prolonged elevation of blood glucose levels above normal accelerates the development of destructive changes in the walls of microvessels [5]. The conducted screening studies will serve as medical information for future medical examinations in the Andijan region and will require specific refinements. This is due to the fact that the conditions of each specific area may influence the emergence and development of certain diseases.

4. Conclusions

Based on the conducted research, the following conclusions can be drawn:

1. The SE method for DR constitutes a specialized diagnostic technique aimed at detecting DR in patients with DM. This method enables the identification of early pathological signs of DR in the initial stages of DM. The SE method for DR plays a pivotal role in preventing the progression of DR to severe stages. As a result, the likelihood of vision loss is reduced, and visual function is preserved.
2. Given that DR can develop asymptomatically in the early stages of the disease, timely screening for DR plays a crucial role in preventing disability caused by ocular complications. Screening for DR enables the timely identification of pathological processes and the prompt application of appropriate therapeutic interventions. This is pivotal in preventing the progression of DR to severe stages and in reducing future treatment costs.
3. Utilizing this method, general information can be obtained regarding micro- and macroangiopathies occurring in other parts of the body, based on early pathological processes in the retinal vessels. This facilitates multidisciplinary collaboration with specialists from other fields, thereby enabling the preservation of patients' active life activities and work capacity.
4. Among patients with diabetes living in urban areas, diabetic retinopathy is rarely encountered in the early stages of the disease. The main reasons for this include having sufficient information about diabetes, timely intake of medications to lower blood sugar levels according to the prescribed regimen, and greater focus on mental work compared to physical labor. Additionally, they lead an active lifestyle, avoid negligence, and adhere to safety guidelines.

5. Among patients living in rural areas, diabetic retinopathy develops earlier for the following reasons: their attention and daily lifestyle are focused on heavy physical labor, they do not take medications to lower blood sugar levels at the prescribed times and according to the regimen, they do not pay attention to the treatment of concomitant diseases, and they do not follow the rules for complete treatment. They rarely or never visit an endocrinologist and ophthalmologist. The presence of negligence among middle-aged and elderly patients also accelerates the development of diabetic retinopathy and other vascular diseases.

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