The prevalence of blindness and low vision in older onset diabetes mellitus and associated factors: A community-based study

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PURPOSE. *This community-based study was conducted to assess the prevalence and related factors of low vision and legal blindness in older onset diabetic patients (diagnosed at age 30 and older).*

METHODS. *All known diabetic patients who live in the four primary health care center region Abidinpaşa Ankara, Turkey (total population: 96,348) were included in this cross-sectional study. The prevalence of known diabetes mellitus is 2.2%, of which 96.6% are older onset and 3.4% are younger onset.*

RESULTS. *In the older onset diabetes group (1289 cases), 10.8% of the population had low vision and only 2.7% had legal blindness. Diabetic retinopathy (DR) was observed in 23.6% of the patients with low vision (42% proliferative DR) and in 62.9% of the patients with legal blindness (90.1% proliferative DR).*

CONCLUSIONS. *In older onset diabetic patients with low vision, nonproliferative retinopathy was a more frequent cause of impaired vision than proliferative retinopathy. Low vision and legal blindness caused by retinopathy were significantly associated with sex, age at examination, age at diagnosis, duration of diabetes, type of diabetes treatment, and hypertension in univariate analysis. However, in logistic regression analysis, low vision and legal blindness caused by retinopathy were found to be associated with longer duration of diabetes (≥15 years), use of insulin, and hypertension.(Eur J Ophthalmol 2004; 14: 298-305)*

KEY WORDS. *Diabetes mellitus, Diabetic retinopathy, Legal blindness, Older onset, Low vision*

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INTRODUCTION

Diabetic retinopathy (DR) is the most important eye complication of diabetes mellitus (DM) and causes blindness in adults (1). DR is the second leading cause of legal blindness in developed countries and the primary cause of blindness in people between 25 and 64 years old (2-5). The risk of blindness in diabetic patients is 25 times higher than in non-diabetics (6, 7). Furthermore, the risk of blindness is 50 to 80 times higher in the insulin-dependent population of younger onset diabetic patients (8).

Accurate and comprehensive data on the prevalence of diabetes-related blindness and low vision are not readily available. As existing data have come from blindness registration systems and large multipurpose national health surveys and are not standard or objective, they cannot be used in comparative purposes. For this reason, a population-based survey was conducted to estimate the size of the problem. This study, which includes prevalence, incidence, progression, and risk factors of DR, and its stages, is the first pop-

ulation-based study related to DR in Turkey. Blindness and low vision in older onset DM, its causes, and related associations are also evaluated.

METHODS

This study was conducted within the population of the four primary health care centers (total population: 96,348) located in the research and training area of the Public Health Department of Ankara University. The screening team of this study included residents of the Public Health Department, Ankara University School of Medicine intern doctors, and staff of the related health care centers. A total of 2136 (686 male, 1450 female) known diabetics were detected by home visits. The patients were provided with the necessary information about this study and consent forms. They were invited to the Preventive Ophthalmology Unit for examination and treatment and 1334 of them accepted ophthalmic examination. There was no statistically significant difference between participants (62.5%) and nonparticipants in age or sex (p>0.05).

Forty-five of 1334 patients were younger onset diabetics (3.4%) who were diagnosed before the age of 30 and the remaining 1289 patients were older onset diabetics (96.6%). Because of the small size of the young onset diabetics group, this research was conducted only in the older onset diabetics group.

A detailed questionnaire form, including sociodemographic properties, DM and other illness histories, weight, height, and the results of eye examination and blood pressure, was given to all 1334 patients. A written protocol with the department of Endocrinology and Metabolic Diseases, Ankara University School of Medicine, enabled all the patients to undergo consultation and necessary laboratory testing without any charge.

Routine ophthalmologic examination included fundus evaluation by Goldmann three time mirror lens and fundus photography and fundus fluorescein angiography if needed.

A DR evaluation protocol was developed using the guidebook prepared by WHO Regional Office for Europe (9). In cases of different retinopathy levels for each eye, the higher level was taken as the retinopathy level of the patient.

When the best-corrected visual acuity (BCVA) in the better eye was equal to or less than 0.1, it was accepted as legal blindness. If the BCVA was 0.2 to 0.4, it was accepted as low vision. When the BCVA in the better eye was equal to or higher than 0.5 and the fellow eye was equal to or lower than 0.1, it was grouped as unilateral blindness, and if the BCVA was 0.2 to 0.4 in the fellow eye, it was grouped as unilateral low vision.

Chi-square, t-test, F test, and logistic regression analyses were applied to data and they were evaluated with SPSS program.

RESULTS

The characteristics of the 1289 older onset DM patients according to the type of treatment are given in Table I. The female:male ratio was in 2.2 for the whole group and 75.8% of the patients (977 patients) have used oral antidiabetic drugs for DM treatment. There is no statistically significant difference between the groups in treatment type (insulin, oral antidiabetics,

TABLE I - SOME CHARACTERISTICS OF OLDER ONSET PATIENTS WITH DIABETES MELLITUS ACCORDING TO THE TYPE OF TREATMENT

| Characteristic | Type of treatment | | | | |
	Insulin	Oral antidiabetics	Diet	Total	p value
Female to male ratio	2.1 (81/38)	2.3 (678/299)	1.8 (123/70)	2.2 (882/407)	> 0.05
Age at examination, yr*	59.0 ±10.4	58.6 ± 9.8	55.5 ± 10.7	58.2 ± 10.0	<0.001
Age at diagnosis, yr*	45.9 ±10.9	51.1 ± 9.9	50.7 ± 10.3	50.6 ± 10.15	<0.001
Duration of diabetes, yr *	13.8 ± 8.2	7.5 ± 5.9	4.8 ± 4.3	7.7 ± 6.3	> 0.01

* Mean±standard deviation.

or diet group) for either sex (p>0.05). While the average age at DM diagnosis for the whole group was 50.6±10.2 years, it was significantly lower for the insulin group (45.9±10.9 years) than oral antidiabetic users (51.1±9.9 years) and diet group (50.7±10.3 years) (p<0.001). Although the average patient age at examination in the whole group was 58.2±10.0 years, the average age was found to be significantly lower in the dieting diabetics group (p<0.001). The average time since diagnosis was 7.7±6.3 years for all patients; however, it was shorter in dieting patients and two to three times longer in insulin users than the others (p<0.001).

Distribution of BCVA in relation to sex is given in Table II and 69.3% of our patients had BCVA higher than 0.5 in both eyes. This ratio was significantly higher for males (74.9%) than females (66.7%) (p<0.05).

Sixty-four patients (12.2%) had unilateral low vision and 35 (5%) had unilateral blindness. Unilateral low vision and blindness were found to be higher in females. Two patients out of 64 who had unilateral blindness had no perception in one eye and two patients had enucleation in one eye. When we evaluated the visual acuities, 10.8% of the patients (140 patients) had low vision. The prevalence of legal blindness in the whole group was 2.7% (35 patients). This value was 1.7% for males and 3.2% for females and the difference was statistically significant (p<0.05).

The distribution of low vision and blindness due to DR levels is given in Table III and 84.2% of the patients (938/1114) who had legally normal vision did not have DR. DR was detected in 15.8% of patients and 81.8% of them had nonproliferative, 18.2% pro-

TABLE II - THE DISTRIBUTION OF CORRECTED VISUAL ACUITY ACCORDING TO SEX

Characteristic	Normal				Low vision			Blindness		
Visual acuity										
One eye	≥0.5	≥0.5	≥0.5	≥0.5	0.2-0.4	0.2-0.4	0.2-0.4	≤0.1>0.05	≤0.1>0.05	≤0.05
Fellow eye	≥0.5	0.2-0.4	≤0.1>0.05	≤0.05	0.2-0.4	≤0.1>0.05	≤0.05	≤0.1>0.05	≤0.05	≤0.05
Sex										
Male	74.9	11.5	0.7	3.7	4.4	1.5	1.5	0.2	1.0	0.5
Female	66.7	12.5	1.2	4.0	9.9	0.8	1.8	0.8	0.9	1.5
Total	883	157	14	50	105	13	22	8	12	15
%	69.3	12.2	1.1	3.9	8.1	1.0	1.7	0.6	0.9	1.2

p<0.05

TABLE III - THE DISTRIBUTION OF LOW VISION AND BLINDNESS DUE TO LEVELS OF DIABETIC RETINOPATHY (DR)

DR level	Normal	Low vision	Blindness	Total
Not evaluated	–	–	2	2
No DR	938	107	11	1056
Nonproliferative	144	19	2	165
Macular involvement				
Yes	(31)	(4)	(1)	(36)
No	(113)	(15)	(1)	(129)
Proliferative	13	3	2	18
Photocoagulated	17	9	12	38
Focal	(12)	(6)	(6)	(24)
Panretinal	(5)	(3)	(6)	(14)
Advanced diabetic eye disease	2	2	6	10
Total	1114	140	35	1289

liferative DR. Among the 140 patients with low vision, DR was diagnosed in 33 patients (23.6% nonproliferative and 42% proliferative). In the 22 legally blind patients out of 35 (62.9%), the main reason for loss of vision was DR (90.1% proliferative DR). Because two patients out of these groups had bilateral cataract, evaluation of fundus could not be done at the first medical examination and after cataract operations DR was not detected. A relationship could not be established between DR and legal blindness. In 13 patients, the distribution of the etiology of blindness was glaucoma (3 cases), macular degeneration (3 cases), degenerative myopia (3 cases), cataract (2 cases), and cornea dystrophy-optic atrophy-retinitis pigmentosa (1 case).

The relationship between low vision/legal blindness and DR was examined by using independent variables (Tab. IV). Levels of low vision due to DR were the same for both males and females but the level of blindness in females (1.8%) was higher than in males (1.2%) (p<0.05). Low vision/legal blindness due to reasons other than DR was also higher in females than males (p<0.05). When legal blindness due to DR was classified according to age, it was found to increase with age and had a peak between 60 and 69 years (3.2%). Also, low vision due to DR was found to be increased with increasing age. It was found that legal blindness and low vision due to reasons other than DR were two and seven times higher, respectively, in the 70 years and over age group than the younger than 45 years group. Legal blindness due to DR was found to be significantly higher in patients whose age at diagnosis of diabetes fell in between the 30 to 39 and 40 to 49 years groups. Low vision due to DR was the highest (42%) for patients diagnosed in the 30 to 39 years group. There was a significant relationship between duration of DM and legal blindness due to DR and low vision prevalence. For example, low vision due to DR was 0.8%, 2.4%, and 8% of patients whose duration of diabetes is less than 5 years, between 6 and 14 years, and more than 15 years, respectively. These values were 1%, 0.6%, and 5.7% for legal blindness due to DR.

According to type of treatment, 90.9% of the legal blindness was due to DR in insulin users, 42.1% for oral antidiabetic users, and 60.0% diet-controlled diabetics. Low vision due to DR was 38.1% and 23.2% for insulin users and oral antidiabetic users, respec-

tively. When the type of treatment is considered, blindness due to DR was 8.4% for insulin users, 0.8% for oral antidiabetic users, and 1.6% for diets. Legal blindness due to DR was significantly higher for insulin users than for the other two groups. The frequency of blindness due to other reasons than DR was 0.8% for insulin users, 1.1% for oral antidiabetic users, and 1% for diets and there was no significant difference. Low vision due to DR was significantly higher for insulin users (6.7%) than oral antidiabetic users (2.6%). Patients with hypertension displayed very similar characteristics to the patients without hypertension. The only significant difference was the higher prevalence of low vision in patients with hypertension (4.8% vs 1.6%) (p<0.05). Blindness due to DR was slightly higher in smokers (1.9%) than nonsmokers (0.8%), but a significant relationship could not be established (p<0.05).

A logistic regression analysis was done between independent variables (sex, age, age at diagnosis, known DM duration, current DM treatment, hypertension, smoking status) and blindness and low vision due to DR. The results are given in Table V. Sex, current age, age at diagnosis, blindness, and low vision due to DR lost significance after logistic regression despite these items having significant relationships beforehand. A relationship was detected between blindness and low vision due to DR and hypertension, diabetes duration (higher than 15 years), and insulin treatment. Possible risk values in terms of blindness and low vision due to DR were 6 times higher for patients who had diabetes more than 15 years, 4.5 times higher for insulin users, and 2 times higher for patients with hypertension.

DISCUSSION

The level of legal blindness in diabetics is significantly higher than in nondiabetics (6, 7, 10, 11). In this study, the prevalence of low vision and blindness in older onset diabetics were found to be 10.9% (2.6% DR, 8.3% other reasons) and 2.7% (1.7% DR, 1% other reasons) respectively. Other studies have detected higher or lower blindness prevalence (6, 12). The methods used in these studies were not standard, especially in detecting diabetics who were the domain of the study, diabetes type, and low vision/blindness

TABLE IV - THE RELATIONSHIP BETWEEN VISUAL ACUITY AND DIABETIC RETINOPATHY (DR) ACCORDING TO SOME INDEPENDENT VARIABLES

| Variables | Visual acuity in better eyes | | | | | Total | p value |
| | ≥0.6 | 0.5-0.2 (Low vision) | | ≤0.1 (Blindness) | | | |
	Normal %	Due to DR %	Due to other reason %	Due to DR %	Due to other reason %		
Sex							
Male	90.9	2.5	4.9	1.2	0.5	407	<0.05
Female	84.4	2.6	9.9	1.8	1.4	882	
Age, yr							
≤49	94.5	1.2	2.8	0.4	1.2	253	
50-59	90.8	1.9	5.3	1.0	1.0	415	
60-69	83.5	3.4	9.5	3.2	0.5	442	<0.001
≥70	72.1	3.9	20.1	1.1	2.8	179	
Age at diagnosis, yr							
30-39	88.0	4.2	4.7	2.1	1.0	191	
40-49	91.2	1.9	3.6	2.1	1.2	421	<0.001
50-59	86.4	3.1	8.7	1.0	0.7	413	
≥60	77.7	1.5	17.8	1.5	1.5	264	
Duration of DM, yr							
≤5	89.7	0.8	7.6	1.0	1.0	609	
6-14	87.4	2.4	9.0	0.6	0.6	468	<0.001
≥15	75.0	8.0	9.0	5.7	2.4	212	
Treatment of DM							
Insulin	73.1	6.7	10.9	8.4	0.8	119	
Oral	87.0	2.6	8.5	0.8	1.1	977	<0.001
Diet	91.7	-	5.7	1.6	1.0	193	
Hypertension							
No	87.7	1.6	8.1	1.6	1.1	893	<0.05
Yes	83.6	4.8	8.8	1.8	1.0	396	
Smoking							
Nonsmoker	84.6	2.9	9.3	1.9	1.3	792	
Past smoker	87.6	1.6	8.0	1.6	1.2	249	>0.05
Smoker	91.1	2.4	5.2	0.8	0.4	248	

criteria; therefore a direct comparison was not possible. The Wisconsin study, which was similar to our study in terms of method and description, had 10% low vision prevalence and 1.6% blindness prevalence for older onset diabetics (10).

In this study, the main reason for low vision was found to be DR (23.6%), 42% in the proliferative stage. In 62.9% of patients who fit the description of legal

TABLE V - THE RESULTS OF LOGISTIC REGRESSION ANALYSES: BLINDNESS AND LOW VISION DUE TO DIABETIC RETINOPATHY

Variable	B value	SE	p value	Odds ratio	95% Confidential range
Duration of diabetes mellitus (DM), yr					
≤5	0.4079	0.4132	0.3236	1.504	0.669-3.380
6-14	1.7905	0.3930	0.0000	5.992	2.774-12.946
≥15	—	—	—	—	—
Hypertension					
No	—	—	—	—	—
Yes	0.7221	0.2921	0.0134	2.059	1.161-3.650
Treatment type					
Diet	—	—	—	—	—
Insulin	1.5268	0.6758	0.0239	4.604	1.224-17.311
Oral	0.5035	0.6209	0.4174	1.655	0.490-5.587

In logistic regression analyses, the group with duration of DM >5 years, no hypertension, and dietary treatment of DM was taken as reference

blindness, the main reason for decreasing visual field was also DR, 90.1% in the proliferative stage. In most of the other studies related to this topic the most common reason for legal blindness in older onset diabetics was macular edema (10, 13, 14). However, there was no explanation about the relationship between them.

The other reasons for blindness in older onset diabetics were cataract, glaucoma, and age-related macular degeneration and the frequency of these was higher for diabetics than nondiabetics (14). In this study it was found that 37.1% of legal blindness was caused by reasons other than DR (glaucoma, macular degeneration, degenerative myopia, cataract, cornea dystrophy, optic atrophy, and retinitis pigmentosa). This ratio in a similar study was found to be 49% (10).

When DR-related blindness was analyzed, it was seen that the level of legal blindness was higher for females regardless of the cause. Low vision and blindness was found to be higher in females both in the DR and other reasons group. These findings matched the related report, which noted that blindness and low vision prevalence of diabetics were higher in females (10, 12). In the Wisconsin study, it was stated that legal blindness prevalence of younger onset diabetics was at a similar level for males and females but it increased for females in older onset diabetics. A similar relationship was also observed for nondiabetics,

which was related to the selective survival of females. Nevertheless, the relationship between blindness and low vision related to DR and sex became insignificant in logistic regression analysis in this study.

Our results that visual acuity in older onset diabetics decreased with increasing age were in agreement with other studies (10). Generally it was known that blindness prevalence increases with increasing age (3). In diabetics, legal blindness and low vision due to reasons other than DR increased with increasing age.

Blindness and low vision due to DR were found to be increased with younger age at the time of diagnosis. It may be explained as an inverse relationship between age at diagnosis and diabetes duration. However, this relationship had no significance in logistic regression analysis.

Legal blindness was found to be increased significantly with diabetes duration of 15 years or more and a similar result was reported in the literature (10).

Our results indicate that blindness and low vision due to DR increases in insulin treatment group. In a study from Denmark, the prevalence of blindness in insulin users and the prevalence of low vision in oral anti-diabetic users were reported to be higher (12). Also, in Wisconsin, Barbados, and Blue Mountain Eye Studies for older onset diabetes patients, the sever-

ity of DR was significantly associated with the insulin use (15-17). In United Kingdom Diabetes Study, it was reported that intensive blood-glucose control by either sulfonylureas or insulin substantially decreases the risk of microvascular complications (18). The association between poor blood glucose level control and visual loss due to DR was shown in the Wisconsin study (19). The use of insulin is associated with poor blood glucose control and higher risk of severe diabetes. The prevention of DR through control of glycemia will have a beneficial effect on visual loss (19).

In spite of a significant relationship between smoking status and blindness and low vision due to DR, interestingly, prevalence of blindness in smokers was lower than nonsmokers and former smokers. The role of smoking in DR has not been clearly established. Some studies have shown a positive association whereas others have not. It seems that there is little or no association between smoking and incidence or progression of DR. It is possible, however, that the failure to establish a correlation between DR and smoking may result from the increased mortality among smokers (early death among smokers would obviously reduce their chances of developing an advanced stage of retinopathy) (20).

According to logistic regression analysis, older onset diabetics were 6 times more likely to get DR-related blindness or low vision if the duration of diabetes is 15 years or over, 4.5 times more likely if they are insulin users, and 2 times more likely if they have hypertension. These three factors are generally related to DR progression. Retinopathy is the main reason for blindness and low vision in diabetics. The prevalence of DR increases with increasing diabetes duration (21). It is also expected that blindness due to DR increases with increasing diabetes duration. In the same manner, insulin usage and hypertension in older onset diabetics significantly increase the risk of DR progression (21, 22). Mouton and Gill reported higher progression risk of DR in hypertensive cases and oral antidiabetic users than insulin users (23).

DR, which was the main cause of blindness in diabetics, cannot be avoided by primary prevention methods, but it was possible to avoid 2/3 of blindness due to DR in diabetics by regular control, early diagnosis, and treatment (24, 25). The benefits gained from DR screening were 6 or 10 times higher than the cost of screening (25-27).

This study continues to evaluate the factors related to DR, blindness, or low vision due to DR. Further studies about progression of DR and its stages, blindness and low vision incidence, early diagnoses, and treatments for prevention of blindness are in progress.

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