Glaucoma Profile at the Tertiary Ophthalmic Centers in Ankara, Turkey

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Abstract

Purpose: This study aimed to investigate the demographic and clinical characteristics of the patients with glaucoma, who presented at the tertiary ophthalmology clinics in Ankara, Turkey.

Patients and Methods: This cross-sectional study included all of the consecutive glaucoma patients or glaucoma suspects who presented at ten different tertiary ophthalmology clinics in Ankara between March 2015 and May 2015. The demographic characteristics and clinical findings of the patients were evaluated. Glaucoma was diagnosed according to the International Society for Geographical and Epidemiological Ophthalmology Classification. In the patients with binocular glaucoma, only the data of the worse eye was included for statistical analyses.

Results: A total of 4604 eyes of 2541 patients fulfilled the inclusion criteria and were classified as having glaucoma. Binocular involvement was present in 2063 (81.2%) patients. Primary open angle glaucoma (POAG) was the most common glaucoma type (38.8%), followed by exfoliative glaucoma (XFG; 26.2%), and primary angle-closure glaucoma (PACG; 7.7%). The distribution of the sexes was significantly different among the diagnosis groups ($P < 0.001$). The cup/disk ratio was the highest among the patients with secondary angle-closure glaucoma (SACG; $P < 0.001$). The visual field MD parameter was significantly higher in the patients with SACG and XFG ($P < 0.001$). Monocular and binocular blindness ratios were 21% and 2.8%, respectively.

Conclusions: The predominant type of glaucoma in Turkish clinic patients was found to be POAG, followed by XFG and PACG.

Introduction

Glaucoma of all types is the second leading cause of blindness worldwide as reported in approximately 8.4 million primary glaucoma-associated bilateral blindness in 2010, and this number is expected to reach 11.1 million by 2020 [1]. The global burden of glaucoma is predicted to increase due to the exponential rise in aging populations. The prevalence of glaucoma among the over 40 age group is calculated to increase from 2.65% in the year 2010 to 2.86% by the year 2020 [1]. The risk and types of glaucoma vary among specific ethnic groups [2–4]. Primary open-angle glaucoma (POAG) has been the most prevalent type of the disease. However, the prevalence of glaucoma types may differ from one population to other. For instance, primary angle-closure glaucoma (PACG) has been more frequent in Mongolia and normal tension glaucoma (NTG) has been reported to be more common than POAG in Japan, while the burden of congenital and childhood glaucoma is quite high in the Middle East and developing countries [5–7]. These differences may provide clues to the pathogenesis of glaucoma [8, 9]. Understanding the pattern and the associated characteristics of glaucoma is an essential and crucial step in developing strategic plans and corresponding intervention programs. In order to improve our understanding of the patient characteristics and the possible differences with reported research findings, there is a need for more sources of information on the profiles of glaucoma patients in a variety of populations.

There are no population-based studies addressing the prevalence of glaucoma in Turkey. Assuming a large number of glaucoma patients in the country, we conducted this study to determine the profile of glaucoma in central Turkey by investigating the pattern of different glaucoma types and associated patient characteristics among cases presenting to tertiary ophthalmology centers in Ankara. In this study, we describe the demographic features of patients, duration of the disease, type and severity of glaucoma, and the management methods.

It is likely that this study reflect the pattern of glaucoma in Ankara, thus providing useful background information to plan epidemiological studies in this region.

Methods

This study is conducted as a cross-sectional prospective study. All patients who presented and/or referred to the glaucoma units of 10 tertiary ophthalmology centers in Ankara during 2 months (from March 15th to May 16th 2015) and were diagnosed with glaucoma in either 1 eye or both eyes were included in the study. Ethical approval was obtained from the Institutional Research and Ethics Board of the Gülhane Military Medical Academy (2015-27). The ten tertiary ophthalmology centers recruited to this study were Ophthalmology Departments of Ankara University Medical School, Başkent University Medical School, Gazi University Medical School, Gülhane Military Medical School, Ankara Training and Research Hospital, Atatürk Training and Research Hospital, three satellite ophthalmology clinics of Numune Training and Research Hospital, and Ulucanlar Training and Research Hospital.

In all cases, demographic data, medical history, ophthalmologic history, glaucoma related history, and family history information were obtained before a thorough examination. All participants underwent a standardized ocular examination of both eyes with assessment of the best corrected visual acuity (BCVA), anterior chamber examination using slit lamp, applanation tonometry, gonioscopy, and dilated fundus examination. Intraocular pressure (IOP) was measured by Tonopen or Perkins applanation tonometer in cases with pediatric glaucoma. All these procedures were performed by a glaucoma specialist. Visual field evaluation with the Humphrey Visual Field Analyzer (Carl Zeiss Meditec, Inc) was performed except category 3 patients (see below), and pediatric patients. When considering those with pseudoexfoliation (PSX), only eyes where the diagnosis was absolutely certain were accepted, namely where a central granular deposit is observed on the anterior lens capsule, often with a clear zone where the iris has rubbed some of the deposited material off the lens.

A data collection sheet was developed to collect patient information including the necessary demographic and clinical indices. Collected data included birth date, sex, date of first diagnosis, family history of glaucoma, glaucoma type, BCVA, IOP, vertical cup/disk (C/D) ratio, visual field mean deviation (MD) and pattern standard deviation (PSD) values. As expected, visual field data could be recorded in only Category 1 patients (see below). BCVA was measured with a decimal visual acuity chart and converted into logMAR units for analysis. Number of current glaucoma medications and previous glaucoma surgeries (including laser treatments) were recorded. Cases with a clear and confirmed diagnosis of glaucoma were included.

Glaucoma Classification

Glaucoma is defined according to the International Society for Geographical and Epidemiological Ophthalmology (ISGEO) Classification as follows [10,11]:

- *Category 1 diagnosis (structural and functional evidence).* Eyes with an ophthalmoscopic vertical C/D ratio or C/D ratio asymmetry >97.5th percentile for the normal population, or a neuroretinal rim width reduced to <0.1 C/D ratio (between 11 to 1 o'clock or 5 to 7 o'clock) that also showed a definite visual field defect consistent with glaucoma.
- *Category 2 diagnosis (advanced structural damage with unproven field loss).* If the subject could not satisfactorily complete visual field testing but had an ophthalmoscopic vertical C/D ratio or C/D ratio asymmetry > 99.5th percentile for the normal population, glaucoma was diagnosed solely on the structural evidence. In diagnosing category 1 or 2 glaucoma, there should be no alternative explanation for C/D ratio findings (dysplastic disc or marked anisometropia) or the visual field defect (retinal vascular disease, macular degeneration, or cerebrovascular disease).
- *Category 3 diagnosis (optic disc not seen, field test impossible).* When it is not possible to examine the optic disc, glaucoma is diagnosed if: (A) The visual acuity <3/60 and the IOP >97.5th percentile, or (B) The visual acuity <3/60 and the eye shows evidence of glaucoma filtering surgery, or medical records were available confirming glaucomatous visual morbidity.

Cut-off points for 97.5^{th} and 99.5^{th} percentile for ophthalmoscopic C/D ratio were accepted as 0.7 and 0.9, respectively. Cutoff point for 97.5^{th} and 99.5^{th} percentile of ophthalmoscopic C/D ratio asymmetry were accepted as 0.2 and 0.3. Cut-off point for 97.5^{th} percentile of IOP was accepted as 22mmHg [11,12].

Types of Glaucoma

1. POAG is defined as; optic nerve damage meeting any of the three categories of evidence above, in an eye which does not have evidence of angle closure on gonioscopy, and where there is no identifiable secondary cause.
2. PACG is defined as follows;

a. Primary angle-closure suspect (PACS): an eye in which appositional contact between the peripheral iris and posterior trabecular meshwork is considered possible.
b. Primary angle-closure (PAC): an eye with an occludable anterior chamber angle and features indicating that trabecular obstruction by the peripheral iris has occurred, such as peripheral anterior synechiae, elevated intraocular pressure, iris whorling (distortion of the radially orientated iris fibers), "glaucomflecken" lens opacities, or excessive pigment deposition on the trabecular surface. The optic disk does not have glaucomatous damage.
c. PACG: PAC together with evidence of glaucoma, as defined above.

In our study, cases with PACS and PAC were lumped under one category, "PAC".

3. NTG was defined as typical clinical findings of POAG and abnormal test findings at the levels of IOP below 22 mmHg.
4. Juvenile open-angle glaucoma (JOAG) as diagnosed in patients between the age of 3 and 30 years having the criteria of POAG.
5. Secondary glaucoma is based on the presence of glaucomatous optic neuropathy in the presence of a second ocular pathological process. This diagnosis group included secondary open-angle glaucoma (SOAG) cases such as pseudoexfoliative glaucoma (PSXG), pigmentary glaucoma, uveitic open-angle glaucoma, traumatic angle recession glaucoma, and steroid glaucoma or secondary angle-closure glaucoma (SACG) cases such as neovascular glaucoma, uveitic angle-closure glaucoma, glaucoma related to retina and vitreous diseases, lens related glaucoma, iridocorneal endothelial (ICE) syndrome, and malignant glaucoma.
6. Childhood glaucoma (CG) included patients with raised IOP due to trabeculodysgenesis with or without developmental anomalies of the eye present at birth or early childhood period and patients with glaucoma after congenital cataract surgery. The diagnosis was made in the presence of elevated IOP (measured under sedation in new-born and young children and confirmed by examination under general anesthesia) in association with at least one of the following findings: corneal haze with or without Haab's striae, enlarged corneal diameter (more than 12 mm), and increased C/D ratio of more than 0.4 or presence of significant C/D ratio asymmetry between two eyes.

Glaucoma Suspect

Cases not fulfilling the criteria for a definite glaucoma diagnosis but having diagnosis of glaucoma suspect including cases with ocular hypertension were excluded. Criteria for classification as glaucoma suspect were as follows [10]:

1. Disc suspects. Those who met category 1 (but not category 2) disk criteria, but were not proved to have definite field defects.
2. Field suspects. Those with definite field defects, but not meeting category 1 disk criteria.
3. Those with optic disk margin hemorrhages.
4. Those with an IOP >97.5th percentile.
5. Those with an occludable anterior chamber angle, but normal optic disk, visual field, intraocular pressure, and no peripheral anterior synechiae.

Criteria for blindness was BCVA less than 3/60 in the worse eye for monocular blindness and less than 3/60 in the better eye for binocular blindness [13,14].

Statistical analysis was conducted using the Statistical Package for Social Science (SPSS) by IBM, version 21 (IBM Corp. Release 2012, Armonk, NY) and Microsoft-Excel 2007. Continuous variables were expressed as the mean ± standard deviation. The Kruskal-Wallis non-parametric variance analysis test was used to investigate differences in continuous values for clinical characteristics between the groups. When there is a significant difference, Bonferroni approach was used. Pearson chi-square test was used to

analyze categorical values. A 2-tailed “p” value of <0.05 was considered statistically significant in all analyses.

Results

During the study period, 7500 eyes of 3750 glaucoma patients or glaucoma suspects underwent clinical examination. Among these, 4604 eyes of 2541 patients fulfilled the inclusion criteria of glaucoma depending on the ISGEO criteria. Figure 1 shows the flowchart of recruited patients. One hundred and twenty two eyes of 61 patients were excluded because of missing or insufficient data. Four hundred and fifty-nine eyes were healthy fellow eyes and 44 eyes were excluded because they were either phthisical or eviscerated. Of the remainder, 2271 eyes were excluded for being glaucoma suspects according to the ISGEO criteria.

The mean age of our patients was 62.84 ± 16.56 years ranging from 2 months to 97 years old. There were 1265 (49.8%) male and 1276 (50.2%) female patients ($p > 0.05$). Of the 2541 patients, 478 (18.8%) had monocular disease while the remaining 2063 (81.2%) had binocular disease. Since the two eyes of a person are not independent regarding clinical features including IOP and C/D ratio and for statistical purposes, only the worse eye was included in patients with binocular disease. Worse eye was selected depending on the amount of visual field damage and C/D ratio. Demographics and clinical characteristics of glaucoma patients are shown in Table 1.

Table 1
Characteristics of glaucoma patients.

Clinical characteristics	
Mean age (SD)	62.84 (16.56)
Sex (male/female)	1265/1276
Glaucoma duration	
Less than 1 year (%)	216 (8.5)
1–5 years (%)	902 (35.5)
More than 5 years (%)	1423 (56)
Mean Logmar BCVA (SD)	0.44 (0.57)
Mean IOP (SD)	16.83 (6.20)
Mean cup/disk ratio (SD)	0.71 (0.25)
Mean MD (SD)	-11.01 (8.71)
Mean PSD (SD)	6.18 (3.45)
Mean number of glaucoma medications (SD)	1.62(1.16)
Mean number of previous glaucoma surgery (SD)	0.51 (0.82)

BCVA = best corrected visual acuity; IOP = intraocular pressure; MD = mean deviation; PSD = pattern standard deviation; SD = standard deviation.

Among the glaucoma types, POAG comprised the largest group (38.8%), followed by PSXG (26.2 %) and PACG (7.7%). NTG (4.1%), CG (3.5%) and JOAG (2.2%) were other common diagnoses (Fig. 2). CG group comprised of primary congenital glaucoma (2.2%), glaucoma after congenital cataract surgery (1%), and other kinds of pediatric glaucoma (0.3%) types. Most common secondary glaucoma was uveitic open-angle glaucoma (3.8%) and neovascular glaucoma (2.8%), followed by traumatic glaucoma (2.4%) and pigmentary glaucoma (1.7%). Other glaucoma types seen less frequently were glaucoma related to retina and vitreous disorders (1.6%), steroid glaucoma (0.7%) and lens related glaucoma (0.4%). Distribution of diagnoses in CG and secondary glaucoma groups is shown in Table 2. There are arguments for and against classifying patients with glaucoma and PSX as secondary glaucoma. Since we had high number of PSXG patients, we have included them as a separate glaucoma type rather than classifying as secondary glaucoma, though this view remains to be elucidated [10]. Nine patients out of 666 with PSXG had angle-closure. More detailed information about laterality, age, sex distribution, BCVA, IOP, C/D ratio, and visual field parameters of major glaucoma groups is shown in Table 3.

Table 2
Distribution of diagnoses in childhood glaucoma and secondary glaucoma groups.

Diagnosis	Patients No. (%)
Childhood glaucoma	89 (3.5)
Primary congenital glaucoma	56 (2.2)
Glaucoma after congenital cataract surgery	25 (1)
Other childhood glaucomas	8 (0.3)
Secondary open angle glaucoma	219 (8.6)
Uveitic open-angle glaucoma	98 (3.8)
Traumatic glaucoma	60 (2.4)
Pigmentary glaucoma	43 (1.7)
Steroid glaucoma	18 (0.7)
Secondary angle-closure glaucoma	137 (5.4)
Neovascular glaucoma	71 (2.8)
Retina and vitreous diseases	41 (1.6)
Lens related glaucoma	10 (0.4)
Uveitic angle-closure glaucoma	9 (0.4)
ICE syndrome	5 (0.2)
Malignant glaucoma	1 (0)

Table 3
Clinical characteristics of major glaucoma types.

	POAG (n = 986)	XFG (n = 666)	PACG (n = 196)	NTG (n = 105)	JOAG (n = 56)	SOAG (n = 219)	SACG (n = 137)	CG (n = 89)	PAC (n = 87)	Total (n = 2541)
Laterality										
Unilateral	109	152	20	11	5	93	78	5	5	478
Bilateral	877	514	176	94	51	126	59	84	82	2063
Age (y)										
<20	-	-	-	-	8	11	5	54	-	78
20–29	-	-		-	17	12	5	12	-	46
30–39	20	2	7	-	14	36	5	8	-	92
40–49	52	5	6	6	11	59	15	10	4	168
50–59	210	45	52	22	5	51	33	2	32	452
60–69	327	184	71	42	1	37	32	3	34	731
70–79	280	259	45	27	-	10	31	-	14	666
≥80	97	171	15	8	-	3	11	-	3	308
Mean Age (SD)	65.4 (11.2)	72.7 (9.0)	64.1 (11.5)	64.7 (10.8)	32.5 (12.9)	47.6 (15.4)	59.0 (17.2)	19.5 (16.6)	62.0 (9.1)	62.8 (16.6)
Sex										
Male	468	402	63	38	27	131	83	36	17	1265
Female	518	264	133	67	29	88	54	53	70	1276
LogMAR BCVA (SD)	0.31 (0.46)	0.49 (0.58)	0.39 (0.52)	0.19 (0.36)	0.53 (0.66)	0.52 (0.63)	1.28 (0.69)	1.06 (0.61)	0.20 (0.30)	0.44 (0.57)
IOP (SD)	16.5 (4.7)	16.7 (6.5)	16.2 (5.6)	13.9 (2.9)	17.1 (6.4)	17.2 (6.8)	21.9 (11.9)	19.0 (5.8)	17.9 (4.9)	16.8 (6.2)
C/D ratio (SD)	0.69 (0.21)	0.75 (0.21)	0.67 (0.24	0.70 (0.16)	0.76 (0.25	0.68 (0.24)	0.87 (0.20)	0.75 (0.23)	0.32 (0.12)	0.71 (0.25)

BCVA = best corrected visual acuity; C/D = cup/disk; CG = childhood glaucoma; IOP = intraocular pressure; JOAG = juvenile open-angle glaucoma; MD = mean deviation; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PSD = pattern standard deviation; XFG = exfoliative glaucoma; SACG = secondary angle-closure glaucoma; SD = standard deviation; SOAG = secondary open-angle glaucoma; Y = years.

	POAG (n = 986)	XFG (n = 666)	PACG (n = 196)	NTG (n = 105)	JOAG (n = 56)	SOAG (n = 219)	SACG (n = 137)	CG (n = 89)	PAC (n = 87)	Total (n = 2541)
MD	-10.4	-13.4	-11.9	-8.3	-11.3	-11.0	-15.8	-9.5	-2.7	-11.0
(SD)	(8.1)	(9.2)	(8.3)	(7.1)	(9.9)	(9.0)	(9.3)	(4.8)	(2.8)	(8.7)
PSD	6.2	6.6	6.7	6.0	5.8	5.6	6.4	5.0	2.7	6.2
(SD)	(3.4)	(3.4)	(3.2)	(3.7)	(3.8)	(3.4)	(3.6)	(2.9)	(1.9)	(3.4)

BCVA = best corrected visual acuity; C/D = cup/disk; CG = childhood glaucoma; IOP = intraocular pressure; JOAG = juvenile open-angle glaucoma; MD = mean deviation; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PSD = pattern standard deviation; XFG = exfoliative glaucoma; SACG = secondary angle-closure glaucoma; SD = standard deviation; SOAG = secondary open-angle glaucoma; Y = years.

Most of the patients (56%) had the disease for more than 5 years. After exclusion of the patients with JOAG and CG, age distribution of patients was significantly different between the diagnosis groups (χ^2 = 525.066; $p < 0.001$). In pairwise comparisons, patients with PSXG were relatively older and patients with SOAG were relatively younger than patients with other types of glaucoma ($p < 0.001$) (Table 4). Mean age of patients with JOAG and CG were 32.5 ± 12.9 years and 19.5 ± 16.6 years, respectively.

Table 4
Significant differences in age, IOP, VA, VCD, MD and PSD values in major glaucoma types.

Variable	Diagnosis I	Diagnosis II							
Age		POAG	XFG	PACG	NTG	JOAG	SOAG	SACG	CG
	POAG		+			NA	+	+	NA
	XFG	+		+	+	NA	+	+	NA
	PACG		+			NA	+		NA
	SOAG				+	NA			NA
IOP	POAG				+			+	+
	XFG				+			+	+
	PACG				+			+	+
	NTG								
	SOAG				+			+	+
LogMAR BCVA	PAAG		+		+			+	+
	XFG				+			+	+
	PACG		+		+				+
	NTG					+		+	+
	SOAG				+			+	+
	SACG					+			
C/D ratio	POAG		+					+	
	XFG						+	+	
	PACG		+					+	
	NTG							+	
	SOAG							+	
	CG							+	
MD	POAG		+						
	XFG						+		

BCVA = best corrected visual acuity; C/D = cup/disk; CG = childhood glaucoma; IOP = intraocular pressure; JOAG = juvenile open-angle glaucoma; MD = mean deviation; NA = not applicable; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PSD = pattern standard deviation; XFG = exfoliative glaucoma; SACG = secondary angle-closure glaucoma; SD = standard deviation; SOAG = secondary open-angle glaucoma.

Variable	Diagnosis I	Diagnosis II		
	PACG		+	
	NTG			+
PSD	PSXG		+	

BCVA = best corrected visual acuity; C/D = cup/disk; CG = childhood glaucoma; IOP = intraocular pressure; JOAG = juvenile open-angle glaucoma; MD = mean deviation; NA = not applicable; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PSD = pattern standard deviation; XFG = exfoliative glaucoma; SACG = secondary angle-closure glaucoma; SD = standard deviation; SOAG = secondary open-angle glaucoma.

Sex distribution was significantly different between the diagnosis groups ($\chi^2 = 115.169$; $p < 0.001$). Female ratio was higher in patients with PAC, PACG, and NTG, while male ratio was higher in PSXG and SOAG groups.

BCVA highly varied between different types of glaucoma ($\chi^2 = 282.073$; $p < 0.001$). The worst BCVA was noted in patients with SACG ($p < 0.001$). Eyes having PAC and NTG were least effected in regards of BCVA ($p < 0.001$).

Mean IOP level was significantly different between the diagnosis groups ($\chi^2 = 106.664$; $p < 0.001$). Mean IOP was highest in patients with SACG, followed by CG.

Mean C/D ratio was 0.711 ± 0.24 and amount of disk damage significantly varied between the diagnosis groups, ($\chi^2 = 287.972$; $p < 0.001$) as C/D ratio being highest in patients with SACG followed by JOAG, CG, and PSXG ($p < 0.001$).

Mean MD and mean PSD values were − 11.01 ± 8.71dB and 6.18 ± 3.45dB, respectively. MD value significantly varied between the diagnosis groups ($\chi^2 = 287.972$; $p < 0.001$), and was significantly higher in patients with PSXG, and SACG.

On the basis of ISGEO criteria, 1730 (64.2%) of our patients were category 1, 584 (22.5%) were category 2, and 140 (4.0%) were category 3. Monocular blindness was present in 535 (21%) patients, while binocular blindness was present in 72 (2.8%) patients. Monocular blindness was most common in patients with SACG (64.2%), and binocular blindness was most common in patients with CG (21.3%) (Table 5).

Table 5
Categories and blindness in major glaucoma types.

	Diagnosis Categories Based on ISGEO No. (%)			Monocular Blindness, No. (%)	Binocular Blindness, No. (%)
	1	2	3		
POAG	820 (83.1)	151 (15.3)	15 (1.6)	157 (15.9)	10 (1)
XFG	431 (64.8)	208 (31.2)	27 (4.0)	168 (25.2)	17 (2.6)
PACG	151 (77.0)	41 (20.8)	4 (2.2)	31 (15.8)	4 (2)
NTG	97 (91.9)	8 (8.1)	0 (0.0)	7 (6.7)	0 (0.0)
JOAG	35 (61.8)	20(36.4)	1 (1.8)	14 (25.0)	5 (0.9)
SOAG	143 (65.3)	57 (26.1)	19 (8.5)	49 (22.3)	6 (2.7)
SACG	29 (21.0)	71 (52.1)	37 (26.9)	88 (64.2)	11 (8)
CG	24 (26.4)	28 (31.9)	37 (41.7)	21 (23.6)	19 (21.3)
Total	1730 (64.2)	584 (22.5)	140 (4.9)	535 (21.0)	72 (2.8)

CG = childhood glaucoma; ISGEO = International Society for Geographical and Epidemiological Ophthalmology; JOAG = juvenile open-angle glaucoma; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; XFG = exfoliative glaucoma; SACG = secondary angle-closure glaucoma; SOAG = secondary open-angle glaucoma.

Discussion

This study aimed to explore the characteristics of glaucoma patients in the city of Ankara. To the best of our knowledge, no previous studies in Turkey included a large number of glaucoma patients such as our study, neither studied the proportion of the different types of glaucoma and their general characteristics. Ankara is the capital and the second largest city of Turkey after Istanbul and major urban center in Central Turkey. This urban area has a stable and homogenous population, with about 98% of the population identified as being Turkish ethnicity. We used an internationally recognized glaucoma classification system, and all the patients were examined by glaucoma specialists. The population of our study consisted of Caucasian origin, therefore the comparison of our results with those from other studies including Caucasian race would be appropriate.

We found POAG as the most common glaucoma type. In several other studies, POAG was also declared as the most common type of glaucoma in various populations [15–18]. In Caucasian races, POAG accounts for 75–95% of the primary glaucomas [18]. In our study, women were more likely to develop POAG (52.5%). Male/female ratio of POAG patients differed from one study to other. While men were more commonly affected from POAG in Thessaloniki Eye Study, Yazd Study and the Maccabi Glaucoma Study reported a higher prevalence of POAG in women [16, 17, 19]. Mean age of our POAG patients was similar to the

previous reports. There was a trend for increased number of POAG patients with increasing age. Approximately 89% of the patients with POAG had bilateral involvement.

A remarkably high number of PSXG cases were noted in this study and PSXG was the second most common diagnosis after POAG. As well known, prevalence of PSX highly varies between different ethnic groups. In a study from Japan, PSXG accounted for nearly 60% of POAG cases [6]. On the other hand, a low prevalence of PSXG has been reported amongst Eskimos [12]. PSXG was the most common glaucoma subtype in a clinic-based study from Ethiopia [14]. Reykjawik Eye Study revealed that 31% of open-angle glaucoma patients had PSX [12]. This ratio was similar in a study from Finland which reported that one third of newly diagnosed glaucoma cases had PSX [20]. On the other hand, PSXG was not so common in India, Saudi Arabia, and finally Iran which is an eastern neighbor to Turkey [16, 21, 22]. In Greece, another neighbor to the west of Turkey however, clinic-based study revealed that PSXG is probably responsible for the majority of severe cases of glaucoma [23]. In a recent population-based study, PSX syndrome has been shown to be common in Turkey [24]. In a study from Eastern Mediterranean area of Turkey, percentage of PSX syndrome in patients with open-angle glaucoma was 46.9% [25]. This ratio was quite high compared to our results in which 40.7% of open-angle glaucoma patients were PSXG. This ratio was around the highest ratios reported so far. PSXG patients comprised the oldest patients in the overall group and, similar to a previous study from Turkey, there was male preponderance [24]. Bilateral involvement in these patients was present in 77% of our series, similar to the previous reports [16, 23]. Visual field parameters MD and PSD showed that PSXG patients had the second most serious field defects. Monocular and binocular blindness was common in PSXG patients (Table 5).

PACG was the third most common diagnosis. The prevalence of PACG was 2 times that of PAC. This finding is similar to previous reports and may suggest that not all people with PAC progress to PACG. Bilateral involvement was present in 90% of our PACG patients. Similar to reports of other clinic-based studies, there was a significant female preponderance [21, 22]. Proportion of PACG has been reported to be 16.7% and 16.3% of POAG in Europe, and worldwide, respectively [18]. This ratio was slightly higher (19.4%) in our study population, but lower than the proportion of this glaucoma type in Asia and some neighboring countries [22]. Monocular and binocular blindness were not so high when compared with other diagnosis groups. Blindness ratio was less than POAG and PSXG, 15.8% and 4% of PACG cases had monocular and binocular blindness, respectively. We think that, compared with POAG and PSXG, PACG is more likely to be symptomatic, resulting in a greater probability of seeking medical services. Another probability is that the easy access to cataract surgery in Turkey may have prevented these cases to progress to advanced glaucomatous damage.

NTG was the fourth common diagnosis in our group. NTG is reported as a common diagnosis in many population-based studies, though the numbers vary in different studies and populations. The main reasons for the variation are the differences in normal IOP range in different populations and difficulty in making the diagnosis. Large epidemiological studies in North America, Europe, and Australia estimated the prevalence of NTG to be up to half that of POAG [26–28]. The prevalence is considerably higher in Japan [6, 29]. The ratio of NTG in all the patients was 4.1% in our study. Our finding is similar to the previous reports from the neighboring countries and other white populations. In Maccabi Glaucoma Study, authors

report that about 2.4% of the glaucoma patients were NTG [17]. This ratio was 6% in a clinic-based study from Riyadh and 1.6% in a population based study from Yazd [16, 22]. In our study, NTG patients had the highest BCVA value. Monocular blindness ratio was less than half of POAG and there was no case with binocular blindness.

JOAG constituted 2.3% of all glaucoma patients in our study group. This ratio was slightly lower than the ratio of Indian patients (3.38%) while it was higher than the ratio in Ethiopian patients (0.9%) [14, 21]. The mean age of patients was 32,5 ± 12.9 years, and sex distribution was equal. Similar to previous studies, there was mostly bilateral involvement (91%) [14, 22]. While there was quite high number of monocular blindness (25%), binocular blindness (0.9%) was less than the average ratio of the whole patients.

SOAG contributed to 8.6% of all types of glaucoma. This ratio was higher compared to similar clinic-based studies in which the ratios were 3.0% and 3.3% [14, 22]. In our study, uveitic open-angle comprised the 44.7% of all SOAG patients and 3.8% of all patients. This ratio was significantly higher than a previous study by Cumurcu et al, which reported a ratio of 0.8% for uveitic open-angle glaucoma [22, 24]. In a study of 100 patients with uveitis, all of whom had anterior uveal involvement, glaucoma was present in 23 cases [30]. McCluskey et al pointed out to glaucoma as one of the most insidious and, unfortunately, often overlooked complication of uveitis [31]. Other common types of SOAG were traumatic glaucoma (2.4%) and pigmentary glaucoma (1.7%). As expected, patients with traumatic glaucoma mostly had monocular disease and were young male cases. Unilateral ocular involvement was significantly higher in SOAG patients and SOAG patients were younger than POAG, PSXG, and PACG patients. Male/female ratio was also significantly higher in SOAG patients. Monocular and binocular blindness ratios were 22.3% and 2.7%, respectively.

SACG patients were 5.4% of all glaucoma patients. In other two clinic-based studies, this ratio was 3.0% and 9.3% [14, 22]. In our study, male/female ratio of SACG patients was significantly higher than the other diagnosis groups. BCVA was worst and IOP was highest in this diagnosis group. SACG patients had the most severe disc damage. This diagnosis group included patients with neovascular glaucoma (2.8%), glaucoma related to retina and vitreous diseases (1.6%), lens related glaucoma (0.4%), uveitic angle-closure glaucoma (0.4%), ICE syndrome (0.2%), and malignant glaucoma. Highest monocular blindness ratio was in SACG patients (64.2%). Binocular blindness ratio was lower (8%).

Childhood glaucomas were 3.5% of all glaucoma types. This ratio was slightly higher than the results of a study from Saudi Arabia which has reported a ratio of 2.6% for childhood glaucomas [22]. Primary congenital glaucoma (PCG) cases were 66% of CG cases, comprising 2.2% of the whole study population. As well-known, the incidence of PCG is geographically and ethnically variable, ranging from 1:22.000 in Northern Ireland to as high as 1:2.500 in Saudi Arabia and 1:1.250 among Gypsies in Romania [32, 33]. It is also common in certain regions of Turkey, but epidemiologic data regarding its incidence is lacking. Our ratio for PCG was very close to a previous study from Turkey while it was higher than the results of a clinic-based study from India in which, Das et al has reported the proportion of PCG as 0.79% [21, 34]. The sex ratio was significantly shifted towards the male side in our study population, as was reported in other studies. Glaucoma after congenital cataract surgery was the second most common type of glaucoma in

childhood group (1%). Other CG cases associated with aniridia, Sturge-Weber syndrome, Axenfeld-Rieger anomaly and Peters anomaly comprised 0.3% of all patients. Nearly all of the patients (98%) with CG in our study population had bilateral involvement. CG patients had the highest ratio of binocular blindness (21.3%).

Over 20% of our patients were blind in at least one eye and 2.8% were blind bilaterally. This ratio is better than the reports of some clinic-based studies but monocular blindness ratio was higher than the study of Pakravan et al. which reported a ratio of 10.8% [14, 16, 20]. Quigley et al estimated the global binocular blindness ratio in OAG and ACG patients as 8.4 billion/80 billion (10.5%) by year 2010 [1]. Bilateral blindness ratio in our study population is remarkably lower than this.

Our study has some limitations. The study is clinic-based rather than population-based which will have limited value in reflecting the true population when guiding service development. The sample is not representative of the whole population since only the patients who sought help were included. The strength of our study is that the study recruited a large number of patients from 10 different centers and used strict criteria in definition of glaucoma and glaucoma suspects. The ISGEO classification uses both structural and functional parameters for glaucoma diagnosis. There have been no previous studies investigating profile of glaucoma in Turkey and very little information is available glaucoma types, age distribution, burden of the disease and its management strategies. We think that our study may serve as a baseline for population based studies in the country.

Declarations

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Conflict of interest: The authors have no conflicts of interest to declare that are relevant to the content of this article.

Ethics Approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Research and Ethics Board of the Gülhane Military Medical Academy (2015-27).

Consent: Informed consent was obtained from all individual participants included in the study.

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Figures

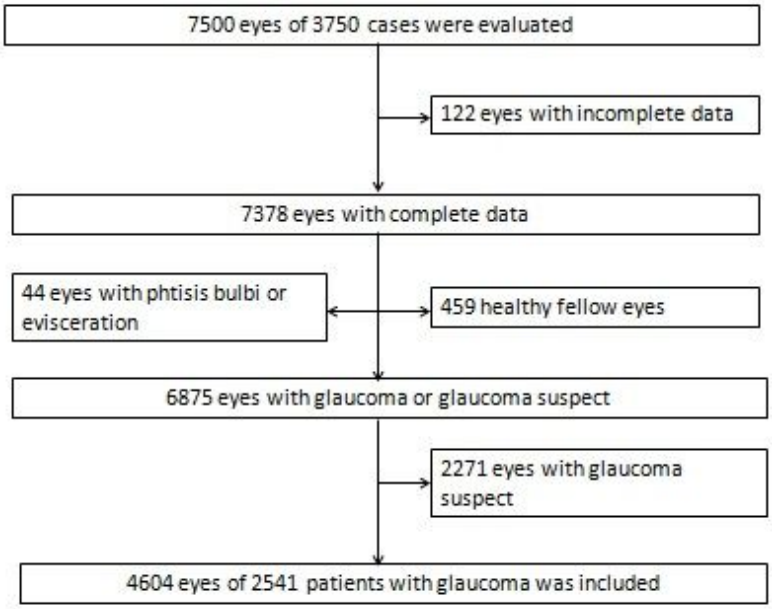

Figure 1

Participation flow chart

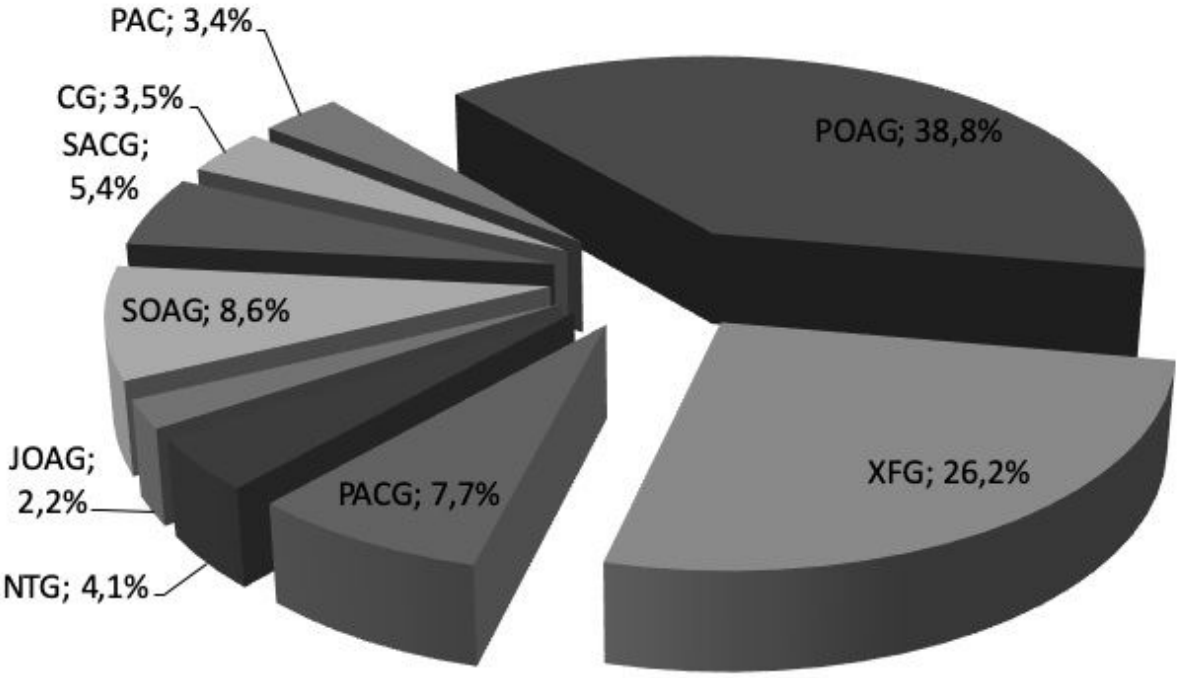

Figure 2

Distribution of different glaucoma types by ratios; CG = childhood glaucoma; JOAG = juvenile open-angle glaucoma; NTG = normal tension glaucoma; PAC = primary angle closure; PACG = primary angle-closure glaucoma; POAG = primary open-angle glaucoma; PSXG = pseudoexfoliative glaucoma; SACG = secondary angle-closure glaucoma; SOAG = secondary open-angle glaucoma