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Logistic Regression Model to Investigate the Risk Factors for Glaucoma

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ABSTRACT

Many studies have found that age, race, gender, past family history, and intraocular pressure (IOP) of the eyes are key risk factors for glaucoma disease. The current study aims to evaluate the relationship between glaucoma and various glaucoma risk factors in the Arabian ethnicity using a cohort cross-sectional observational design. Therefore, the current study is targeted at building a regression model to estimate the probability of injury to glaucoma disease, which is one of the serious diseases that affect the eyes. It uses the logistic regression model, which is one of the modern non parametric methods, and a cohort cross-sectional observational design. The study included a total of 136 glaucoma patients. The findings show that there is no link between gender and glaucoma ($p = 0.202$), while there is a link between age and glaucoma ($p = 0.004$). Furthermore, the findings demonstrate that there is no association between diabetic mellitus (DM) and glaucoma ($p = 0.273$), although there is a relationship between hypertension and healing degree ($p = 0.035$) and diabetes and healing degree ($p = 0.001$). The findings also show that the factors affecting injury are: age, gender, pressure, and geographical location, and that diabetes and climatic factors are not influential. Current findings may aid in the development of intervention strategies that will raise glaucoma awareness in the future.

1. INTRODUCTION

The major cause of global blindness is glaucoma, followed by cataracts. It is a main community health problem, being the leading cause of irretrievable visual impairment worldwide [1].

Normally, glaucoma is categorized into open angle glaucoma and closed angle one, also both types can further be classified as either primary or secondary. The primary open angle glaucoma (POAG) is the utmost common type of glaucoma contributing for about 74% of all glaucoma cases, the estimated number of POAG cases in 2020 is 53 million due to population ageing. In 2040, the estimated universal number of individuals with glaucoma will growth to 111.8 m [2].

The POAG is the common kind of glaucoma, it is characterized by the advanced deterioration of retinal ganglion cells (RGCs) and the axons in the optic nerve, causing structural changes in the head of the optic nerve which lead to visual field defects [3]. The sieve-like structure, lamina cribrosa, in the sclera which allows flow of the RGC and central retinal vessels, appears to be the main site of axonal injury in glaucoma [4]. The elevated intraocular pressure (IOP) is regarded the most important changeable risk factor of glaucomatous optic neuropathy (GON). Though, in a noteworthy that some patients characterized of normal tension glaucoma (NTG) in spite of normal IOP. So the other risk factors might also be included in the optical neuropathy of POAG [5].

Many epidemiological studies proposed that the chief risk factors for glaucoma are intraocular pressure (IOP), family history of the disease, age, race and gender [6-11]. One of the exceptional factors found in studies is the effect of race on the type of glaucoma, some researchers reports that African Americans are more prone to be hit by open angle glaucoma than whites [2].

POAG appears earlier in black people than in other ethnic groups and is closely connected to age. All of the patients are 85 years old, and the prevalence is substantially higher in those over 90. The largest prevalence is among older Hispanic or Latino adults (18%), followed by black people (15%), white people (7%), and Asian people (5%) [12].

The second kind of glaucoma is Primary angle closure glaucoma (PACG), which accounts for approximately 25% of all glaucoma cases and is a leading cause of blindness [13, 14]. POAG is growing more popular since studies suggest that one in every two glaucoma patients is ignorant of their condition [15, 16]. Therefore, determining the disease's spread is a time-consuming and labor-intensive process that necessitates numerous surveys.

Few studies have been undertaken in the Middle East region, and they have revealed a significant frequency of cataract, glaucoma, diabetic retinopathy, and dry eye disease [17-19]. Therefore, the goal of the current investigation is to address a knowledge gap by assessing the awareness of glaucoma and its risk factors among the Iraqi population using a logistic regression model.

2. METHODS

2.1 Design and area

This is a cohort cross-sectional observational study that was carried out on participants who visited the eye clinic at Ibn Al-Haitham Hospital in Iraq between June 2019 and May 2020. The Institutional Review Board (IRB) granted us ethical approval, and all patients agreed to participate in this study and consented. This research was carried out in accordance with the latest Helsinki Declaration (2013). Figure 1 shows the schematic diagram of current study.

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2.2 Criteria for inclusion and exclusion

The study samples were random and exceeded 300 samples. The sample was filtered for the reasons that will be discussed in this section so that the final number becomes 136 patients. The stage of exclusion or inclusion of participants in this study included two stages. In the first examination stage, all non-Iraqi participants were excluded, and Iraqi patients were included exclusively. This stage also includes the inclusion of patients with POAG or PACG in at least 1 eye.

The second examination stage included the inclusion of patients with both types of diseases under study exclusively and the exclusion of others. People who have had cataract surgery and those with systemic diseases that may cause a visual field (VF) are also excluded at this stage. In addition to those, the study exclusions are those who suffer from keratoconus and corneal dystrophy. Other patients excluded at this stage are those who use contact lenses.

2.3 Parameters measured

Glaucoma was diagnosed by an ophthalmologist based on IOP readings, optic nerve alterations, and visual field deficits. Furthermore, patients' demographic data, such as gender, age, and ethnicity, as well as past ocular and medical history, such as hypertension and diabetes, were collected.

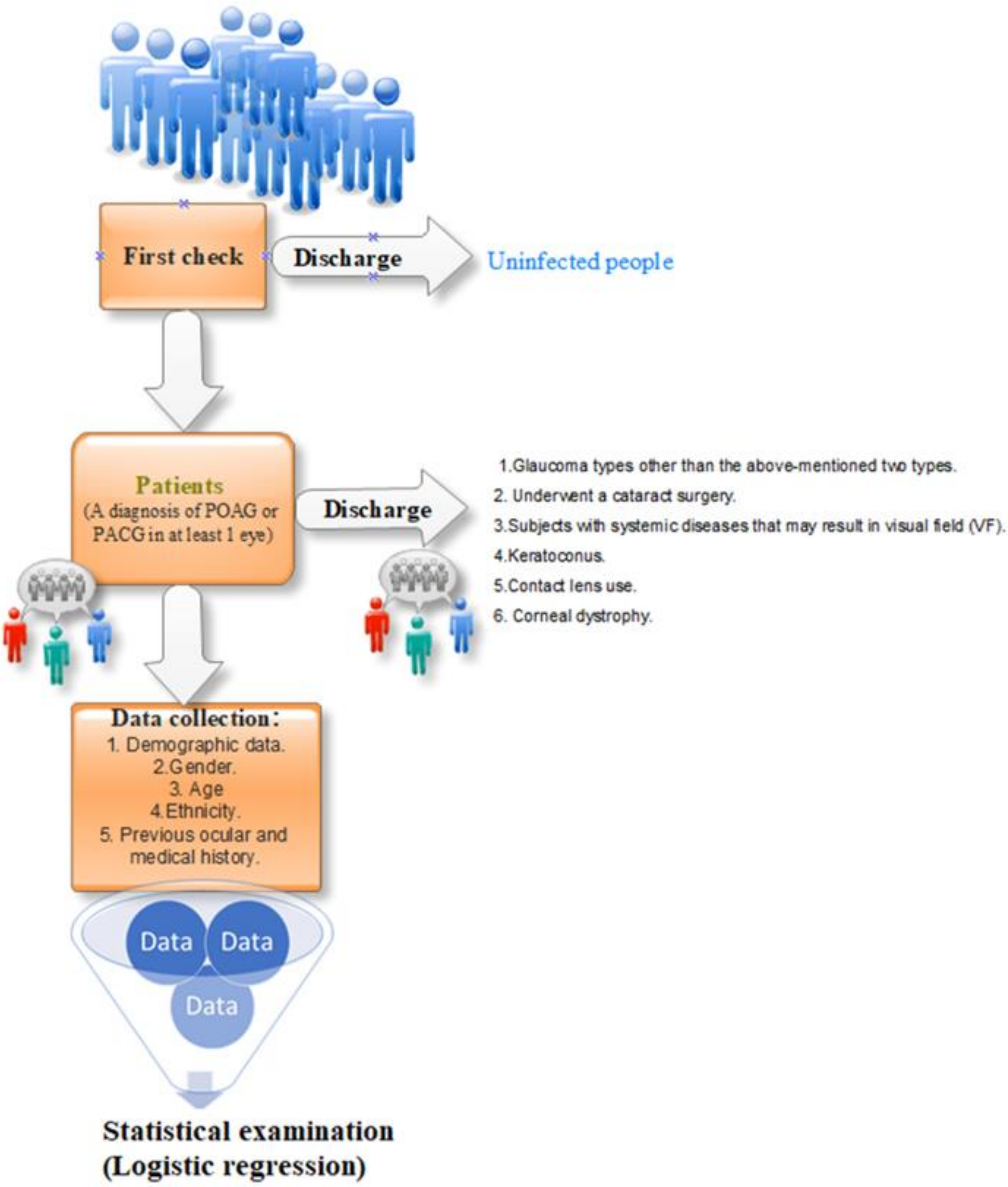

Figure 1. Schematic diagram of current study

2.4 Statistical analysis

SPSS ver. 24.0 (Chicago, USA) was used in the current study's statistical analysis. It first identified the sample population, then classified them according to gender, then recorded the data using numbers (percentages) and the mean (standard deviation). To consider the influence of gender on the development of glaucoma, a logistic regression with a generic estimating equation was used. Pearson's correlation was utilized to investigate the relationship between age and the other parameters. To specify statistical relationship or significance, we utilized p less than 0.05.

3. RESULTS

The study sample included 136 Iraqi patients, 75 (55.1%) of whom were males and 61 (44.9%) of whom were females, with a mean age of 58.3 years (SD = 2.4). Table 1 depicts the distribution of age ranges for all ages.

The largest number of the study sample was 45 patients, who were between 61-70 years old, followed by 27 patients, who were between 71-80 years old. Regarding the chronic diseases, 105 patients (77.2%) of the study suffered from hypertension, in addition to 51 patients (37.5%) from the study sample suffer from diabetes.

A simple linear regression test was performed to examine the relationship between gender disparity and the development of glaucoma. Table 2 displays that the value of adjusted R square = 0.005, indicating that the equation is predictive but weak because it is less than 1.

Table 3 displays the outcomes of the ANOVA analysis as well as if there is a statistically significant difference between groups under consideration. Table 4 shows the findings of an investigation into the relationship between glaucoma and gender using the chi-squared test.

The significance value is 0.202 (p = 0.202), which is more than 0.05. As a result, it entails accepting the alternative hypothesis and rejecting the null hypothesis, which states that there is no relationship between gender and glaucoma. In addition, the value of the constant A = 1.053 and the value of the coefficient B = - 0.027 are taken from Table 4. Therefore, the prediction equation in Eq. (1) is as follows:

$$Y = 1.053 + (-0.027)X \qquad (1)$$

Furthermore, the correlation between age and glaucoma was examined using a simple linear regression test, which yielded a result of adjusted R square = 0.054, indicating that the equation is predictive but weak because it is less than 1. The findings are shown in Table 5.

Table 1. The distribution of ranges of all ages included in the study

Age	Frequency	Percent
Less than 11 years	18	13.2
11-20 years	3	2.2
21-30 years	7	5.1
31-40 years	5	3.7
41-50 years	4	2.9
51-60 years	22	16.2
61-70 years	45	33.1
71-80 years	27	19.9
81-90 years	5	3.7
Total	136	100.0

Table 2. Simple liner regression (a. Predicators: (constant), Gender)

Model Summary				
Model	R	R square	Adjusted R Square	Std. Error of the Estimate
1	o.110[a]	0.012	0.0005	

Table 3. ANOVA analysis for glaucoma and gender

	Model	Sum of Square	df	Mean Square	F	Sig.
1	Regression	0.024	1	0.024	1.647	0.202[b]
	Residual	1.947	134	0.15		
	Total	1.971	135			

a: dependent variable (glaucoma)
b: Predicators, constant (Gender)

Table 4. Chi-squared test of glaucoma and gender

Model		Unstandardized Coefficients		Mean Square	t	Sig.
		B	Std. Error	Beta		
1	Constant	1.053	0.032		33.0096	0.000
	Gender	-0.027	0.021	-0.110	-1.283	0.202

Table 5. Simple linear regression of age

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.247[a]	0.061	0.054	0.11752

Table 6. ANOVA analysis for glaucoma and age

	Model	Sum of Square	df	Mean Square	F	Sig.
1	Regression	0.120	1	0.120	8.675	0.004[b]
	Residual	1.851	134	0.120		
	Total	1.971	135			

a: dependent variable (glaucoma)
b: Predicators, constant (Age)

Table 7. Chi-squared test of glaucoma and age

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	1.087	0.027		40.960	0.000
	Age	-0.012	0.004	-0.247	-2.945	0.004

Table 6 displays the results of the ANOVA analysis as well as if there is a statistically significant difference between the groups under consideration. Table 7 shows the findings of an investigation into the relationship between glaucoma and gender using the chi-squared test.

The value of Sig is 0.004, which is less than the value of 0.05. As a result, there is a link between age and glaucoma, and the null hypothesis should be rejected in favor of the alternative hypothesis. In addition, the value of the constant A = 1.087 and the value of the coefficient B = - 0.012 are taken from Table 7. As a result, Eq. (2) depicts the prediction equation:

$$Y = 1.087 + (-0.012)X \tag{2}$$

Similarly, linear regression, ANOVA and chi-squared tests were performed, to judge the relationship between glaucoma and hypertension, Tables 8-10. The findings uncover that the value of adjusted R square = 0.043 and, therefore, the equation is predictive and weak because it is less than 1. Besides, the value of Sig is 0.008, which is a value of less than 0.05. Therefore, the null hypothesis should be rejected and accept the alternative hypothesis, meaning that there is a relationship between hypertension and the glaucoma. Moving to Table 10, the value of the constant A = 0.935 and the value of the coefficient B = 0.065. Therefore, the prediction Eq. (3) is as follows:

$$Y = 0.935 + 0.065X \tag{3}$$

Table 8. Simple linear regression of Hypertension

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.225[a]	0.051	0.043	0.11816

a: Predicators, constant (Hypertension)

Table 9. ANOVA analysis for glaucoma and Hypertension (ANOVA[a])

	Model	Sum of Square	df	Mean Square	F	Sig.
1	Regression	0.100	1	0.100	7.135	0.008[b]
	Residual	1.871	134	0.014		
	Total	1.971	135			

a: dependent variable (glaucoma)
b: Predicators, constant (Hypertension)

Table 10. Chi-squared test of glaucoma and hypertension

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	0.935	0.031		29.848	0.000
	Age	0.065	0.024	0.225	2.671	0.008

a: dependent variable (glaucoma)

Table 11. Simple linear regression of diabetes

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.095[a]	0.009	0.002	0.12072

Table 12. ANOVA analysis for glaucoma and diabetes

	Model	Sum of Square	df	Mean Square	F	Sig.
1	Regression	0.018	1	0.018	1.211	0.273[b]
	Residual	1.953	134	0.015		
	Total	1.971	135			

a: dependent variable (glaucoma)
b: Predicators, constant (Diabetes)

Table 13. Chi-squared test of glaucoma and diabetes

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	0.976	0.036		29.932	0.000
	Diabetes	0.024	0.021	0.095	1.100	0.273

a: dependent variable (glaucoma)

Table 14. Simple linear regression relationship between hypertension and healing degree

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.181[a]	0.033	0.026	0.47347

a: Predicators, constant (Hypertension)

Table 15. ANOVA analysis for hypertension and healing degree (ANOVA[a])

Model		Sum of Square	df	Mean Square	F	Sig.
1	Regression	1.020	1	1.020	4.551	0.035[b]
	Residual	30.039	134	0.224		
	Total	31.059	135			

a: dependent variable (healing degree)
b: Predicators, constant (Hypertension)

Table 16. Chi-squared test of hypertension and healing degree

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	1.394	0.126		11.097	0.000
	Diabetes	0.206	0.097	0.181	2.133	0.035

a: dependent variable (healing degree)

Table 17. Simple liner regression relationship between diabetes and healing degree

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.286[a]	0.082	0.075	0.46132

Table 18. ANOVA analysis for diabetes and healing degree (ANOVA[a])

Model		Sum of Square	df	Mean Square	F	Sig.
1	Regression	2.541	1	2.541	11.941	0.001[b]
	Residual	28.518	134	0.213		
	Total	31.059	135			

a: dependent variable (healing degree)
b: Predicators, constant (Diabetes)

Table 19. Chi-squared test of diabetes and healing degree

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Constant	1.188	0.139		8.576	0.000
	Diabetes	0.282	0.082	0.286	3.456	0.001

a: dependent variable (healing degree)

In a similar manner, linear regression, ANOVA and chi-squared tests were performed, to judge the relationship between glaucoma and diabetes in Tables 11-13. The findings show that the value of adjusted R square = 0.002 and therefore the equation is predictive and weak because it is less than 1. Also, the value of Sig = 0.273, which is a value higher than 0.05. Therefore, the alternative hypothesis will be rejected and accepted the null hypothesis, meaning that there is no relationship between diabetes and the glaucoma. The value of the constant A in Table 13 is 0.976, and the value of the coefficient B is 0. 024. Therefore, the prediction equation is as follows in the Eq. (4):

$$Y = 0.976 + 0.024X \tag{4}$$

The relationship between hypertension and healing degree was tested using linear regression, ANOVA and chi-squared tests and the results are shown in Tables 14-16. According to the results, the value of adjusted R square = 0.026 and, therefore, the equation is predictive and weak because it is less than 1. Besides, the findings also show that the value of Sig is 0.035, which is a value of less than 0.05. Therefore, the null hypothesis should be rejected and accepted as the alternative hypothesis, meaning that there is a relationship between hypertension and healing. Moving to the last Table, the outcomes uncover that the value of the constant A = 1.394 and the value of the coefficient B = 0.206. Therefore, the prediction equation is as follows in Eq. (5):

$$Y = 1.394 + 0.206X \tag{5}$$

Similarly, the relationship between diabetes and healing degrees was tested using linear regression, ANOVA and chi-squared tests and the results are shown in Tables 17-19. The value of adjusted R square = 0.075. Accordingly, the equation is predictive and weak because it is less than 1. Also, the value of Sig = 0.001, which is a value of less than 0.05. Therefore, the null hypothesis should be rejected and accepted as the alternative hypothesis, meaning that there is a relationship between diabetes and healing degree. From Table 19, the value of the constant A = 1.188 and the value of the coefficient B = 0.282. Therefore, the prediction equation is as follows in Eq. (6):

$$Y = 1.188 + 0.282X \quad (6)$$

In terms of geographical location, we find that the highest percentage of casualties is in Baghdad. This is due to the greater population weight as the capital. The rest of the central provinces are similar in terms of infection ratio, except for Diyala and Karbala (5.882), also because of population density.

However, the further south we go, the higher the ratio of infections, with Maysan ranking second in injuries (13.97), Dhi Qar third (12.5), Basra fourth (10.29), and so on.

This is due to the fact that most of the professions in these provinces are characterized by hard physical effort, such as farming and raising animals and poultry, where physical and psychological stress factors are high.

As for the climatic factor, it was excluded after it was found that the temperatures and the rate of rainfall are very close. Table 20 shows the distribution of patients by geographical location of the country.

Table 20. Distribution of patients by geographical location of the country included in the study

Provinces Location	Provinces	No. Patients	Percent
Central Provinces	Baghdad	33	24.264
	Diyala	8	5.882
	Anbar	4	2.941
	Babyion	5	3.676
	Karbala	8	5.882
	Wasit	3	2.205
Southern Provinces	Basra	14	10.294
	Qadisiyah	7	5.147
	Najaf	12	8.823
	Maysan	19	13.97
	Dhi Qar	17	12.5
	Muthanna	6	4.411
Total		136	100.0

4. DISCUSSION

Using a cohort cross-sectional observational approach, this study was conducted on the Iraqi population to evaluate the most common risk factors. Gender differences in glaucoma type preferences were discovered to be consistent with prior research that indicated no obvious gender preference for open angle glaucoma (POAG) [20]. Furthermore, the findings indicate that women are at a higher risk of angle closure glaucoma [21, 22].

Chi-squared analysis revealed that there is a relationship between age and the glaucoma, the older the subject, the more susceptible he/she to accrue glaucoma, which is in accordance with the reported cases [17, 18].

Hypertension is a key risk factor for a variety of diseases; roughly 1.13 billion adults, or around 22% of the world's population, have hypertension [23]. Similar to previous studies [24, 25], the current investigation discovered a link between hypertension and glaucoma. Furthermore, the current investigation found a link between hypertension and healing degree [24]. Diabetes Mellitus (DM) prevalence in 2017 reached 425 million worldwide (9.0% among adults) [26]. Zhou et al. [27] conducted a meta-analysis of case-control and reported that individuals with DM have an increased risk of developing POAG. In the current study, no such relationship was found, probably due to the sample size of the current study (only 136). Nevertheless, data from the current study uncovered that there is a relationship between diabetes and healing degree [28].

5. CONCLUSION

Incident cases were drawn from glaucoma patients' cross-sectional data to explore gender disparities, age structure, and glaucoma risk factors. The current study finds there is a link between gender and glaucoma. It was also found that the geographical location is important in terms of increasing the number of injuries, as there was no effect or link between diabetes and glaucoma. On the other hand, current findings did not find a significantly greater incidence rate for females compared to males, nor did they find a link between diabetes and glaucoma. In addition, the current study uncovered that the incidence and prevalence of glaucoma increases with age and hypertension. As a result, the present findings may aid in the development of intervention strategies that will raise patient and physician awareness and, as a result, minimize the occurrence of glaucoma in the future.

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