



Medical Direct Cost of Glaucoma in Morocco

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Abstract

Objective: To estimate the direct medical cost of glaucoma in Morocco and identify the factors associated with it. **Methods:** A cost-of-illness study was carried out to determine the direct medical cost of glaucoma in Morocco between November 2021 and February 2022. Patients with glaucoma who had received treatment for at least 12 months were recruited from Hassan II University Hospital, and were investigated from a societal perspective. The bottom-up costing method was used to estimate annual direct costs. **Result:** Overall, 151 patients were included while the mean age was 59.1 ± 8.9 years with a female predominant (57.6%). The direct medical cost of glaucoma was estimated to be 406.61 USD with 95% CI: 318.36 - 494.86 annually per patient, with medical treatment being the most expensive healthcare service. Advanced age, duration of illness, and severity of glaucoma were found to be associated with higher direct medical costs. **Conclusion:** The economic burden of managing glaucoma is expected to continue rising, which highlights the importance of early detection and effective policies based on cost-of-illness analyses to optimize spending and reduce the burden on the healthcare system.

Subject Areas

Ophthalmology

Keywords

Glaucoma, Cost of Illness, Direct Medical Cost

1. Introduction

Glaucoma is a chronic eye disease that can cause permanent vision loss if not properly managed [1]. In Morocco, glaucoma is the second leading cause of

blindness, accounting for 14.3% of cases [2].

Chronic diseases are long-term health conditions that often require ongoing medical care and can significantly impact a person's quality of life. These diseases can also have a significant financial impact on individuals and healthcare systems [3]. The annual direct medical cost per patient with glaucoma in the United States ranged from 623 USD to 2511 USD depending on the severity of the disease [4].

The direct medical costs of glaucoma can include several factors, such as diagnosis and testing, medications, surgery, and follow-up visits. The diagnosis and testing may involve a comprehensive eye exam, visual field test, and imaging tests like optical coherence tomography (OCT). Depending on the severity of the disease, glaucoma patients may require prescription eye drops that can be expensive. If medication is not sufficient to control glaucoma, surgery may be necessary, including laser surgery or traditional surgery such as trabeculectomy. Additionally, patients with glaucoma require regular follow-up visits with their ophthalmologist or optometrist to monitor their disease progression and adjust treatment plans as necessary [5] [6] [7] [8].

The medical cost analysis of chronic diseases can play a significant role in policy management by providing valuable insights into the economic burden of chronic diseases on individuals, families, and society as a whole. Medical cost analysis can help policymakers understand the financial burden of chronic diseases on healthcare systems and the economy. By analyzing medical costs associated with chronic diseases, policymakers can identify the most significant cost drivers and develop strategies to reduce costs. Moreover, a medical cost analysis can also inform policy decisions related to health insurance coverage and reimbursement policies [9] [10] [11].

However, to the best of our knowledge, no research has been conducted on this topic in Morocco. Therefore, the objective of this study is to estimate the direct medical cost of glaucoma in Morocco.

2. Methods

2.1. Study Design and Population

A cost-of-illness (COI) study was carried out at the department of ophthalmology in Omar Drissi Hospital, Hassan II University Hospital, Fez, Morocco, between November 2021 and February 2022, and based on the prevalence. The study included adult patients with a confirmed diagnosis of glaucoma, who were followed for a minimum of 12 months and did not have any other ophthalmologic illness. The costs were measured for the one-year period of 2020.

2.2. Data Collection

Data were collected by a team of trained investigators using a questionnaire designed in conjunction with experts in the area of study. The questionnaire covers a range of information including sociodemographic factors, glaucoma-related

information, and data about healthcare services. Sociodemographic data includes age, gender, marital status, level of education, monthly income, and health insurance. The glaucoma-related information involves the type, duration, and severity of the disease based on initial visual field [12]. The survey also includes details about various healthcare services, such as the number of ophthalmology appointments, length of hospital stays, supplementary tests, medical procedures, laser treatments, and surgical interventions.

2.3. Costing Analysis

The study adopted a societal perspective using a cost-of-illness approach, which examines the disease's impact on the economy by evaluating its effect on all economic entities. This approach provides an assessment from the perspective of each organization and is highly recommended for such studies [9]. The time horizon for estimating the cost of illness was one year, regardless of when the disease first appeared. Only direct medical cost was considered, while intangible and indirect costs were disregarded. To estimate the direct medical costs, the study utilized the bottom-up costing approach, which covers the total value of healthcare services.

The costs for the medical services data were calculated individually for each service, including the cost of consultation, hospitalization, complementary tests, medication (eye drops), laser treatment, and surgical intervention, if applicable, by multiplying the unit price by the number of medical acts/eye drops. The unit price was obtained by consulting specialists, reviewing the National Health Insurance Agency (ANAM) [13] repository and the price of different pharmaceutical products on the medicament.ma website. The direct medical costs were initially calculated in Moroccan Dirham (MAD) and then converted to USD using the exchange rate as of December 31, 2020 [14].

2.4. Statistical Analysis

Initially, a descriptive study was conducted, and various variables were expressed as mean, standard deviation, number, and percentage. Then, analysis of variance (ANOVA) or simple linear regression was performed to determine the factors associated with direct medical costs. The statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS) software version 26, and the significance level was set at $p < 0.05$.

2.5. Ethical Consideration

The approval of the Ethics Committee of the Faculty of Medicine and Pharmacy of Fez has been obtained.

Participants were provided with information about the study and asked to give consent to participate before data collection. They were informed that their participation was voluntary and would not affect their medical care. In addition, they were assured that their data would remain confidential and would only be accessible to the research team.

3. Result

3.1. Sociodemographic and Clinical Characteristics

A total of 151 patients were included in the study, with a mean age of 59.1 ± 8.9 years. The majority of participants were female (57.6%). Most participants were married (76.2%) and had low educational attainment (60.9%). The professional status and monthly income data showed that a large proportion of the participants were unemployed (80.1%) and had a low monthly income (89.4%). The majority of participants had insurance coverage through the government-sponsored RAMEd program (78.8%).

Forty-two percent of the participants had a prior medical or surgical history. The most common type of glaucoma was primary open-angle glaucoma (POAG) (68.2%), followed by primary angle-closure glaucoma (PACG) and other types (19.9% and 11.9%, respectively). Duration of less than 5 years of psoriasis was slightly predominant (57.6%) and severe glaucoma was the most frequent (43.2%). **Table 1** summarizes the sociodemographic and clinical characteristics of participants.

3.2. Direct Medical Cost per Patient

As shown in **Table 2**, the annual direct medical cost mean of glaucoma was 406.61 USD (95% CI: 318.36 - 494.86). Medical treatment was the most expensive healthcare service with a mean cost of 205.74 USD (95% CI: 177.54 - 233.93) and accounting for 50.59% of the overall DMC. Hospitalization was the second most expensive service, with a mean cost of 58.82 USD (95% CI: 5.46 - 112.18) and a DMC percentage of 14.46%. Ophthalmologic consultation has the lowest mean cost of 31.60 USD (95% CI: 29.38 - 33.82) and the lowest DMC percentage of 7.77%. Optical Coherence Tomography (OCT) has a mean cost of 15.24 USD (95% CI: 7.72 - 22.76) and a DMC percentage of 3.74%. Laser treatment and surgical treatment have similar mean costs of 50.57 USD (95% CI: 32.45 - 68.68) and 44.62 USD (95% CI: 9.51 - 79.72), respectively. Laser treatment has a DMC percentage of 12.43% and surgical treatment has a DMC percentage of 10.97%.

3.3. Factors Influencing Direct Medical Cost

Table 3 presents factors that influence the direct medical cost (DMC) of glaucoma, with corresponding estimated costs (in USD) and statistical values. Increasing age was associated with a decrease in DMC ($\beta = -7.5$; 95% CI: $-13.1 - -2.01$). The type of glaucoma was also associated with DMC, with primary angle-closure glaucoma (PACG) having the highest estimated cost at 668.9 USD, followed by other types at 492.5 USD and primary open-angle glaucoma (POAG) at 315.1 USD. The duration of glaucoma was significantly associated with DMC, with the estimated cost for 5 years or more being higher at 551.8 USD than for less than 5 years at 299.7 USD. Increased glaucoma severity was significantly associated with increased direct medical costs, and the estimated cost for severe glaucoma was the highest at 557.7 USD followed by moderate

Table 1. Sociodemographic and clinical characteristics of participants (n = 151).

Variable	Mean ± SD or N (%)
Age, y	59.1 ± 18.9
Gender	
Male	64 (42.4)
Female	87 (57.6)
Familial status	
Unmarried	36 (23.8)
Married	115 (76.2)
Study level	
Illiterate	92 (60.9)
Primary	41 (27.2)
Secondary/University	18 (11.9)
Professional status	
Unemployment	121 (80.1)
Employment	30 (19.9)
Monthly income, USD\$	
<224.7	135 (89.4)
224.7 - 561.7	13 (8.6)
>561.7	3 (2.0)
Medical insurance	
Not insured	9 (6.0)
RAMED	119 (78.8)
Insured	23 (15.2)
Medical and surgical antecedents	
No antecedent	52 (34.4)
1 antecedent	64 (42.4)
2 antecedents or more	35 (23.2)
Type of glaucoma	
POAG	103 (68.2)
PACG	30 (19.9)
Other types	18 (11.9)
Duration of glaucoma	
<5	87 (57.6)
≥5	64 (42.4)
Severity of glaucoma (n = 146)	
Mild	30 (20.5)
Moderate	53 (36.3)
Severe	63 (43.2)

POAG: Primary Open-Angle Glaucoma; PACG: Primary Angle-Closure Glaucoma; SD: Standard Deviation.

Table 2. Healthcare services direct medical cost of patients with glaucoma in 2020.

Healthcare services	Number of observations	Mean cost US\$ (95% CI)	Overall DMC percentage
Ophthalmologic consultation	151	31.60 (29.38 - 33.82)	7.77
Hospitalization	11	58.82 (5.46 - 112.18)	14.46
Optical Coherence Tomography (OCT)	18	15.24 (7.72 - 22.76)	3.74
Medical treatment	137	205.74 (177.54 - 233.93)	50.59
Laser treatment	29	50.57 (32.45 - 68.68)	12.43
Surgical treatment	6	44.62 (9.51 - 79.72)	10.97
Overall Direct Medical Cost	151	406.61 (318.36 - 494.86)	100.0

CI: Confidence Interval; DMC: Direct Medical Cost.

Table 3. Factors influencing direct medical cost of glaucoma.

Factors	Direct medical cost (USD\$) β (95% CI) or mean (95% CI)	<i>p</i> -value
Age, y	-7.5 (-13.1 - -2.01)	0.008
Gender		0.886
Male	399.0 (332.2 - 465.8)	
Female	412.1 (310.6 - 513.7)	
Type of glaucoma		0.006
POAG	315.1 (266.7 - 363.6)	
PACG	668.9 (514.9 - 822.8)	
Other types	492.5 (394.4 - 590.7)	
Duration of glaucoma, y		0.005
<5	299.7 (259.3 - 340.1)	
\geq 5	551.8 (427.9 - 675.8)	
Severity of glaucoma		0.015
Mild	232.2 (207.2 - 257.3)	
Moderate	336.9 (289.8 - 383.9)	
Severe	557.7 (432.9 - 682.4)	
Treatment		<0.001
Medical treatment only	301.2 (262.6 - 339.9)	
Laser or surgical treatment	839.5 (683.1 - 996.0)	

POAG: Primary Open-Angle Glaucoma; PACG: Primary Angle-Closure Glaucoma; CI: Confidence Interval.

then mild glaucoma at 336.9 USD and 232.2 USD. Finally, treatment was also significantly associated with glaucoma DMC, the estimated cost for laser or surgical treatment was much higher at 839.5 USD than for medical treatment only at 301.2 USD.

4. Discussion

The aim of this study is to evaluate the direct medical cost of glaucoma in Morocco and identify the factors associated with it.

According to the present study, the estimated annual direct medical cost (DMC) of glaucoma was 406.61 USD (95% CI: 318.36 - 494.86). The healthcare service with the highest direct medical cost was medical treatment (50.59%), and has a mean cost of 205.74 USD. followed by Hospitalization, which had the second-highest overall DMC percentage at 14.46% and a mean cost of 58.82 USD. Then, laser treatment and surgical treatment had an overall DMC percentage of 12.43% and 10.97% respectively and a mean cost of 50.57 USD and 44.62 USD. Meanwhile, Ophthalmologic consultation and Optical Coherence Tomography (OCT) were the lowest overall DMC percentage at 7.77% and 3.74% and a mean cost of 31.60 USD and 15.24 USD respectively.

The result of the overall DMC is in line with Fu *et al.* study and Rahman *et al.* study, which found a glaucoma mean direct cost of 405 EUR (428.2 USD) and 475 EUR (498.7 USD) [15] [16]. The finding that medical treatment represents the half overall DMC percentage is consistent with other studies that have investigated healthcare costs [8]. This can be explained by the Chronic nature of the illness, which requires ongoing treatment to manage and prevent vision loss.

Direct medical cost of glaucoma was associated with several factors. Advanced age and duration of the illness was associated with the DMC and can be attributed to the severity of the glaucoma since it increases with the age of the patient and the duration of the evolution of the disease. In the present study, the severity of glaucoma was also associated with an increase in the DMC. This finding is consistent with several studies that have evaluated this association [4] [8] [17] [18].

The annual direct cost of Primary Angle Closure Glaucoma (PACG) was significantly highest (668.9 USD) than direct cost of Primary Open Angle Glaucoma (POAG) and other glaucoma types. In the Wang *et al.* study, the direct cost of PACG was lowest at 261.7 USD [19]. This difference can be attributed to the different time periods of each study, especially the 2002 Singapore study by Wang *et al.* [19].

The treatment was obviously associated with the direct cost of this eye disease, the use of laser treatment or surgical treatment made the direct medical cost very high. This finding is consistent with the Rahman *et al.* study which found that non-drug and drug costs made up 66% and 34% respectively, of the lifetime costs [16].

Early detection of glaucoma is important for several reasons, including pre-

servicing vision, reducing the need for more invasive treatments, and potentially reducing medical expenses over time. However, if glaucoma is detected early, treatment can begin to slow or even stop the progression of the disease. It can also help identify risk factors for the disease, such as high eye pressure or a family history of glaucoma, which can inform preventive measures to reduce the risk of developing the disease [20]. While it's true that the initial cost of glaucoma screening and early detection may be a medical expense, it is likely to be much less expensive than the costs associated with treating advanced-stage glaucoma. Advanced-stage glaucoma often requires more invasive treatments, such as laser therapy or surgery, which can be costly. In addition, vision loss caused by glaucoma can also result in indirect costs, such as lost productivity and decreased quality of life.

In summary, medical cost analysis of chronic diseases plays a critical role in policy management by providing policymakers with essential information to make informed decisions about resource allocation, healthcare delivery, and health insurance policies. In Morocco, healthcare spending accounts for 5.5% of GDP [21], and non-communicable diseases make up 75.3% of the total burden of disease globally. The burden attributable to non-communicable diseases represents 75.3% of global burden diseases [22]. By understanding the economic burden of chronic diseases, policymakers can design effective policies that improve health outcomes while minimizing healthcare costs.

5. Conclusions

Glaucoma is a leading cause of blindness in Morocco, and the prevalence of the disease is expected to increase in the coming years due to the aging population and changes in lifestyle. The cost of managing glaucoma will therefore continue to rise, placing a significant burden on the healthcare system.

Early detection and effective policies based on rigorous cost-of-illness analyses could optimize spending and reduce the burden on the healthcare provider.

Conflicts of Interest

The authors declare no conflicts of interest.

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