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Availability, Prices and Affordability of Glaucoma Medicines among Private Pharmacies of Nampula City in Mozambique

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Abstract

Introduction: Glaucoma is a group of chronically progressive disorders of the optic nerve and a worldwide leading cause of irreversible vision loss. Eye chronic diseases including glaucoma are major public health problems around the world, rapidly increasing with a growing and aging population. The treatment of chronic diseases lasts a lifetime. The purpose of this study is to assess the availability, prices and affordability of the medicines for glaucoma management in private pharmacies of Nampula City in Mozambique. **Material and Methods:** The standardized methodology designed by the World Health Organization and Health Action International was employed to conduct the study about the availability, price and affordability of glaucoma medicines in Nampula City from October to November 2021. Data were collected in 39 private pharmacies using a survey with fifteen glaucoma Medicines. **Results:** The Average of medicines availability was 46.6% (0.0% - 71.8%) with a mean of 8.86. The availability level demonstrated that 14 (93.3%) of all surveyed glaucoma medicines were very low and 1 (6.67%) was fairly high. Timolol was the most available medicine, found in 28 (71.8%) while apraclonidine, carteolol, levobunolol, carbachol, brinzolamide, bimatoprost, travoprost and unoprostone were not available. The medicine with the lowest price was latanoprost (2.84 USD) and the higher was acetazolamide (23.58 USD). None of the surveyed medicines were considered affordable. **Conclusion:** The majority of surveyed glaucoma medicines were not available and they were totally unaffordable against the defined thresholds. Policy strategy and technical options should be driven and implemented by the government to ensure the availability and affordability of glaucoma medicines at various levels of the Mozambican healthcare system.

Keywords

Availability, Prices, Affordability, Medicines, Glaucoma

1. Introduction

While contagious or communicable diseases have been the focus of treatment efforts for many years in many low- and middle-income countries (LMICs), recently, the rising burden of non-communicable diseases (NCDs), such as glaucoma, has created substantial attention [1].

Glaucoma is the leading cause of irreversible blindness worldwide. The global prevalence of glaucoma in people aged 40 to 80 years is estimated to be 3.5%. With the growing number and proportion of older persons in the population, it is projected that 111.8 million people will have glaucoma in 2040 [2].

Glaucoma affects more than 70 million people worldwide with approximately 10% being bilaterally blind. Glaucoma can remain asymptomatic until it is severe, resulting in a high likelihood that the number of affected individuals is much higher than the number of diagnosed patients [3].

Glaucoma causes irreversible blindness in 4.6 to 6.7 million people worldwide and accounts for 8% of blindness among the 39 million people who are blind worldwide. In 2010, glaucoma was responsible for 4.4% of blindness in Africa. The prevalence of glaucoma blindness is higher in Africa than in other regions of the world, accounting for about 15% of blindness [4].

In the early stages, glaucoma is mainly asymptomatic and thus, many patients are not aware of their disease. In high-income countries, about half of the patients do not know that they suffer from glaucoma [5]. Progressive neurodegeneration of the optic nerve and the loss of retinal ganglion cells is a hallmark of glaucoma [6].

Treatment purposes are to lower intraocular pressure (IOP), and to get a good patient compliance with good tolerance and good ratio cost/effectiveness. Glaucoma treatment should stop optic nerve fiber layer loss and stabilize visual field defects. Medical topic treatment is the first line of treatment, with possible association of drops and absence of benzalkonium chloride for some of them. Five therapeutic classes are available: Prostaglandin Analogues, Beta-Blockers, Carbonic Anhydrase Inhibitors, Alpha-Adrenergic Receptor Agonists and Cholinergic Agonists [7] [8] [9].

Price variations among glaucoma medicines may affect health professional's decisions and cause a high impact on the public health budget. Because glaucoma patients often use medicines for a long time, price estimations of different IOP-lowering eye drops are important and meaningful [10].

The epidemic of non-communicable chronic diseases results in devastating consequences for individuals, families and communities, in addition to overloading health systems. The socioeconomic costs associated with non-communicable

chronic diseases have an impact on the economies of countries, being estimated at US $7 trillion during 2011-2025 in LMICs [11].

In the United States, the cumulative cost of medicines used for chronic diseases is high, and the therapeutic management cost is estimated at $2.5 billion per year, with direct costs at $1.9 billion and indirect costs at $0.6 billion [12].

Most glaucoma patients do not take their medicines as prescribed. Estimates of the cost and affordability of prescribed glaucoma medicines are vital to implementing potentially effective interventions [13].

The price of medicine is considered one of the most important obstacles to accessing health care. The purchase of medicines contributes significantly to the health care budget of developing countries, and drug expenditures may amount to 50% to 90% of no personnel costs. In developing countries, studies and data on medicine prices are scanty. Measuring and understanding the reasons for the price of medicines is the first stage to develop medicine pricing policies that would ensure the affordability of medicines [14].

Reliable evidence is required in order to understand what the specific problems are for one to come up with the best way to improve the situation, as well as whether governmental controls are necessary to ensure that essential medicines are available at the least cost to the consumer [15].

Additionally, the interest in the private pharmacies is due to the often observed chronic shortages of medicines in public health facilities in low-middle income countries, forcing consumers to buy medicines in the private sector, despite the fact that because of the shortage budget conducted to health departments in most African countries, the health systems survive mostly supported in medical donations (including medicines). The construction concept of private sector demands the support of public sector services leading to more complete services provision (including pharmacies).

Several researchers from different countries have compared the prices of various glaucoma medicines, and yet, there is no registration of studies performed in Mozambique on this topic. In this study, we aimed to access the availability, price and Affordability of glaucoma medicines among private pharmacies in Nampula City in Mozambique.

2. Materials and Methods

A descriptive cross-sectional survey of availability, prices and affordability of glaucoma medicines was conducted. Study design and methods were adapted from a standardized methodology for systematic facility-based surveys developed by the World Health Organization (WHO) and Health Action International (HAI) [16].

The study was conducted in six administrative areas of Nampula City (the largest and most developed urban city in Nampula province). Data were collected on the availability and price of glaucoma medicines from October to November 2021 and prices of fifteen glaucoma medicines in 39 private pharmacies

were obtained (**See Appendix 1**).

Data collection was performed by ten fourth year optometry students, previously trained over a week in the knowledge and skills required to conduct the survey in accordance with the WHO/HAI method, by a pharmacy lecturer in the Faculty of Health Sciences at Lúrio University. The data collection and treatment were supervised by the principal investigator. The authors used a standardized data collection form to ensure data reliability and consistency.

The core list of glaucoma medicines was selected based on information available in the literature. Pharmacies were selected at random with the support of 2021 core list of registered and licensed pharmacies in Nampula City, provided by the provincial pharmacy department. The enrolment of the pharmacies in this study was based in the free will participation and availability of ophthalmic drugs. All the pharmacies where the responsible refused to participate were not included in the study.

Appointments were performed with responsible people to survey the pharmacies, before data collection to ensure survey efficiency; then, data collectors surveyed each pharmacy and met with the supervisor at the end of each day, to check completed data collection forms and ensure that the data were complete, consistent, and legible.

We used a Microsoft Excel workbook to entry the data collected and all data were entered twice by two research assistants; then we performed a software verification to identify any data entry errors as it is recommended by the WHO/HAI methodology.

Availability was defined as the proportion of pharmacies in which the medicines were available at the time of the survey. We determined the availability of glaucoma medicines in the private pharmacies. **Prices** were presented in United States dollar (USD) for international comparison and as defined by the WHO; **affordability** was estimated using the daily wage of the lowest-paid unskilled government worker in Mozambique by determining the number of days' wages required to purchase selected medicines [17].

Statistical analysis assessed availability as the percentage of pharmacies where the medicine was found at the time of the survey, and as mean the percentage availability across the basket of selected glaucoma medicines. Mean percentage of availability of all survey medicines was calculated. Following the approach of previous studies, four categories were established to classify availability: Very low (<30%), low (30 - <50%), fairly high (50 - <80%) and high (≥80%) [18].

The median prices were calculated in local currency (Mozambican Metical/MZN) then converted into USD and interquartile range (IQRs) were computed to estimate the extent of price variation across pharmacies and medicines as well as the days' wages required to purchase selected medicines for glaucoma treatment; those were 137.3 MZN (US dollars 2.15 at conversion rate of 1 USD = 63.83 MZN) per day at the time the survey was applied and a medicine was classified affordable if not exceeding a maximum of one day salary.

The MPR was the comparison of the local median package price of the medicine with the median package price in the Management Sciences for Health 2003 Price Indicator Guide.

Before starting data collection, the study protocol was submitted to the Faculty of Health Sciences scientific committee and the Lúrio University' Bioethics Committee for approval. Written informed consent was issued and obtained from all pharmacy representatives included in the study. Pharmacy managers and/or staff were provided all relevant information including study background, purpose and methods before consenting to data collection. The survey was applied in the official speaking language in Mozambique (Portuguese) and the information checked by a pharmacist. All information related to the pharmacies identification was codified and classified to ensure the fully accomplishment of Helsinki Declaration (2013) principles.

3. Results

3.1. Availability of Glaucoma Medicines

The availability of glaucoma medicines varied in the private pharmacies. Average availability of medicines was 46.6% with the mean of 8.86% ranged (0.0% - 71.8%) respectively. The most available medicine group is beta-blockers represented by two medicines and found in 31 pharmacies followed by Carbonic Anhydrase Inhibitors found in 12 pharmacies, Alpha-Adrenergic Receptor Agonists found in 4 pharmacies, Prostaglandin Analogues found in 3 pharmacies and Cholinergic Agonists found in 2 pharmacies. Information regarding availability of glaucoma medicines is summarized in Table 1.

Timolol was the most available glaucoma medicine in the pharmacies with 71.8%, followed by acetazolamide, dorzolamide and brimonidine with 17.9%, 12.8% and 10.3% accordingly. Betaxolol and latanoprost scored 7.7% and pilocarpine 5.1%. The least available medicines were apraclonidine, carteolol, levobunolol, carbachol, brinzolamide, bimatoprost, travanoprost and unoprostone with 0.0%. The availability level showed that 14 (93.3%) of all surveyed glaucoma medicines were very low, 1 (6.67%) was fairly high and there were no medicine in Low and High Category.

3.2. Glaucoma Medicine Patients Prices

Information regarding the median unit prices of glaucoma medicines can be found in Table 2. There is a wide variation of prices among individual medicines. Acetazolamide had the higher variation of price with a median price and interquatile range (IQR) of 23.58 **USD** (2.27 - 25.85), followed by pilocarpine with 13.00 **USD** (1.57 - 14.57), dorzolamide with 5.59 **USD** (7.81 - 13.86), brimonidine with 4.79 **USD** (9.92 - 14.71), betaxolol with 3.76 **USD** (7.13 - 10.89) and timolol with 2.91 **USD** (1.22 - 4.14). In comparison with the international prices, pilocarpine is 4.39 times more expensive and acetazolamide is 3.71 times more expensive while timolol, dorzolamide and latanoprost are 0.77, 0.75 and 0.49 shipper.

Table 1. Availability of glaucoma medicine in the surveyed pharmacies in Nampula City [n (%)].

Glaucoma Medication Groups	Medicine	Formulation and strength	Availability n (%)	Target Size Pack
Alpha-Adrenergic Receptor Agonists	Apraclonidine	Eye drop, 0.5%	0 (0.0%)	5 mL
	Brimonidine	Eye drop, 0.2%	4 (10.3%)	5 mL
Beta-Blockers	Timolol	Eye drop, 0.5%	28 (71.8%)	5 mL
	Carteolol	Eye drop, 1%	0 (0.0%)	5 mL
	Levobunolol	Eye drop, 0.5%	0 (0.0%)	5 mL
	Betaxolol	Eye drop, 0.5%	3 (7.7%)	5 mL
Cholinergic Agonists	Pilocarpine	Eye drop, 1%	2 (5.1%)	10 mL
	Carbachol	Eye drop, 3%	0 (0.0%)	15 mL
Carbonic Anhydrase Inhibitors	Acetazolamide	Tablet, 250 mg	7 (17.9%)	30 Tablets
	Brinzolamide	Eye drop, 1%	0 (0.0%)	5 mL
	Dorzolamide	Eye drop, 2%	5 (12.8%)	5 mL
Prostaglandin Analogues	Bimatoprost	Eye drop, 0.03%	0 (0.0%)	3 mL
	Travoprost	Eye drop, 0.004%	0 (0.0%)	2.5 mL
	Unoprostone	Eye drop, 0.15%	0 (0.0%)	5 mL
	Latanoprost	Eye drop, 0.005%	3 (7.7%)	2.5 mL
Mean availability of glaucoma medicines in percentage			**8.89**	
Availability category Level n (%)	**Very low**	**Low**	**Fairly high**	**High**
	<30%	30 - <50%	50 - <80%	≥80%
	14 (93.3)	0 (0.0)	1 (6.67)	0 (0.0)

Table 2. Prices of Glaucoma medicines in the private pharmacies.

Glaucoma Medicines Group	Medicine Name	Formulation and strength	Median price ratio in USD	Local median Price (IQR) in USD
Alpha-Adrenergic Receptor Agonists	Apraclonidine	Eye drop, 0.5%	-	-
	Brimonidine	Eye drop, 0.2%	-	4.79 (9.92 - 14.71)
Beta-Blockers	Timolol	Eye drop, 0.5%	0.77	2.91 (1.22 - 4.14)
	Carteolol	Eye drop, 1%	-	-
	Levobunolol	Eye drop, 0.5%	-	-
	Betaxolol	Eye drop, 0.5%	-	3.76 (7.13 - 10.89)

Continued

Cholinergic Agonists	Pilocarpine	Eye drop, 1%	4.39	13.00 (1.57 - 14.57)
	Carbachol	Eye drop, 3%	-	-
Carbonic Anhydrase Inhibitors	Acetazolamide	Tablet, 250 mg	3.71	23.58 (2.27 - 25.85)
	Brinzolamide	Eye drop, 1%	-	-
	Dorzolamide	Eye drop, 2%	0.75	5.59 (7.81 - 13.86)
Prostaglandin Analogues	Bimatoprost	Eye drop, 0.03%	-	-
	Travoprost	Eye drop, 0.004%	-	-
	Unoprostone	Eye drop, 0.15%	-	-
	Latanoprost	Eye drop, 0.005%	0.49	2.84 (13.66 - 16.50)

3.3. Affordability of Glaucoma Medicines

If we consider the daily wage of the lowest-paid unskilled government worker to purchase selected Medicine for glaucoma treatment in Mozambique, the median cost was considered unaffordable for the entire spectrum of surveyed medicines, meaning that none of the surveyed glaucoma medicines cost less or equal than one day's wage.

The day's wages required to purchase the selected medications for glaucoma treatment range from (1.3 - 11). The medication that requires more days of work to purchase is acetazolamide with 11 days, followed by pilocarpine with 6 days, dorzolamide with 2.6 days, brimonidine with 2.2 days, betaxolol with 1.7 days, timolol with 1.4 days and latanoprost with 1.3 days. The information about the affordability of glaucoma medications is presented in Table 3.

4. Discussion

To the best of our knowledge, this is the first study that sought to investigate the availability, price and affordability of antiglaucoma medicines in Mozambique. This is important because it is estimated that glaucoma is the main causes of irreversible blindness in worldwide, particularly in Sub Saharan Africa, where the prevalence is estimated to be higher.

In this study we access the availability, prices and affordability of 15 glaucoma medicines in private pharmacies in Nampula City. The results of our study show that only 46.6% of the surveyed glaucoma medicines are available in private pharmacies and that most medicines (93.3%) have very low availability.

Timolol eye drop 0.5% (71.8%) was the most available medicine. Among beta-blockers, timolol is most used. It has few topical side effects, but some important systemic side effects on the cardiac and respiratory systems. The quality of patient's care needs a concerned efficacy and safety. The balance between

Table 3. Affordability of glaucoma medicines.

Glaucoma Medicine Group	Medicine Name	Formulation and strength	Median Price in USD	Days wages to pay for Medicine
Daily wage of the lowest-paid unskilled government worker			**2.15 USD**	
Alpha-Adrenergic Receptor Agonists	Apraclonidine	Eye drop, 0.5%	-	-
	Brimonidine	Eye drop, 0.2%	4.79	2.2
Beta-Blockers	Timolol	Eye drop, 0.5%	2.91	1.4
	Carteolol	Eye drop, 1%	-	-
	Levobunolol	Eye drop, 0.5%	-	-
	Betaxolol	Eye drop, 0.5%	3.76	1.7
Cholinergic Agonists	Pilocarpine	Eye drop, 1%	13.00	6.0
	Carbachol	Eye drop, 3%	-	-
Carbonic Anhydrase Inhibitors	Acetazolamide	Tablet, 250 mg	23.58	11
	Brinzolamide	Eye drop, 1%	-	-
	Dorzolamide	Eye drop, 2%	5.59	2.6
Prostaglandin Analogues	Bimatoprost	Eye drop, 0.03%	-	-
	Travoprost	Eye drop, 0.004%	-	-
	Unoprostone	Eye drop, 0.15%	-	-
	Latanoprost	Eye drop, 0.005%	2.84	1.3

efficacy and safety is always the main aspect to care patients. Using preservative-free timolol gel 0.1% for treatment, IOP was at the same level of the other beta-blockers at higher concentration, but it was better tolerated. Preservative-free treatment improved the quality of life reducing dry-eye like symptoms; furthermore, the presence of an artificial tear in the medication bottle could help adherence. The once daily dosing improves compliance [19].

Medicine is an important element in health systems and the guarantee of their availability, affordability and rational use, maintaining cost-effectiveness and sustainability is a challenge for most countries in the world, especially in view of the increase growing demand. This is why the median availability of medicines in low-income countries in 2016 was 60% [20].

Our results express an unfavourable situation, converging with the global average scenario. Mendes *et al.* (2014) studied the availability of medicines for chronic diseases in 40 developing countries, finding an average of availability of medicines of 41.6% for chronic diseases [21].

The availability of medicines for glaucoma treatment is low, but there is at least one medicine per each group is evident. When medication shortages occur, most prevalent behaviours described by doctors, are analysing the possibility of substituting the prescribed drug. However, replacing a drug of continuous use

can compromise disease control or adherence to therapy, impacting the treatment effectiveness [22].

The Cost of glaucoma medicines in this study varies in accordance with the individual medicine and pharmacy. None of the surveyed glaucoma medicine was affordable considering the daily wage of the lowest-paid unskilled government worker. The proposed measure of affordability in the WHO/HAI methods has been widely recognized as it clearly and unambiguously shows the financial burden for those having to purchase their medicines individually [23].

The cumulative cost of medications used for chronic diseases is high, and the price of glaucoma medicines has been cited as a medicine adherence barrier in most cases [12].

A study performed by Usifoh (2015) to access the availability and affordability of antiglaucoma drugs in Benin City, revealed that the most affordable product in private pharmacies was acetazolamide tablets (0.16 days) and timolol eye drop (0.59 days) [24].

This is a better result than ours; we didn't find any affordable medicine for glaucoma treatment, considering the number of days wage to purchase a medicine at the local median price.

5. Strength and Limitations of the Study

The implementation of a standardized methodology approved by the WHO produced reliable information for future research development. Furthermore, this is the first study performed in Mozambique to access availability, price and affordability of glaucoma medicines. Our results are the baseline information for future strategy planning and interventions about glaucoma programs in Mozambique. It will allow future researchers to focus in the glaucoma medications/treatment compliance and satisfaction among glaucoma patients and about other determinants playing a huge influence on the availability of glaucoma medications. Despite the efforts of the research team to guarantee the reliability of the information, it is also important to mention that the applied cross-sectional design did not capture stock fluctuations over the time.

6. Conclusions

This study provided evidence on availability, cost and affordability of glaucoma medicines in private pharmacies of Nampula City in Mozambique.

The results of this study demonstrated that the majority of surveyed glaucoma medicines were not available and that they were totally unaffordable against the defined thresholds.

These findings may serve as basic data to raise the attention of the policymakers and pharmacy owners, to improve the availability and affordability of glaucoma medicines in Mozambique.

Glaucoma patients need a reliable supply of affordable medicines as it is a chronic disease and demands a lifelong treatment to lag the speed of its damage.

The early detection and adequate treatment improve glaucoma patients' life quality, while the availability and affordability of medicines can drive to a situation of treatment compliance, leading that the patient may never experience blindness, depending on the patient's age at the diagnostic time.

The next steps will assess the exact causes of the results, and conduct similar surveys in other Mozambican capital cities, as well as in the national health system to enable conclusive statements about access to glaucoma medicines.

Also, a detailed investigation regarding the glaucoma medicines prescription practices should be performed to identify the challenges and barriers.

Finally, a policy strategy and technical options should be driven and implemented by the government to ensure the availability and affordability of glaucoma medicines at various levels of the Mozambican healthcare system.

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Conflicts of Interest

The authors declare they have no conflicts of interest to perform this research or publish a manuscript.

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Appendix 1. Questionnaire

Confidential For Research Purpose Only			
Availability, Prices and affordability of glaucoma medicines among private pharmacies of Nampula City in Mozambique.			
Medicine name (Formulation and strength), Target Size Pack	**Availability**		**Target Size Pack price In MZN**
	Yes	**No**	
Apraclonidine (Eye drop, 0.5%), 5 mL			
Brimonidine (Eye drop, 0.2%), 5 mL			
Timolol (Eye drop, 0.5%), 5 mL			
Carteolol (Eye drop, 1%), 5 mL			
Levobunolol (Eye drop, 0.5%), 5 mL			
Betaxolol (Eye drop, 0.5%), 5 mL			
Pilocarpine (Eye drop, 0.5%), 10 mL			
Carbachol (Eye drop, 3%), 15 mL			
Acetazolamide (Tablet, 250 mg), 30 Tablets			
Brinzolamide (Eye drop, 1%), 5 mL			
Dorzolamide (Eye drop, 2%), 5 mL			
Bimatoprost (Eye drop, 0.03%), 3 mL			
Travoprost (Eye drop, 0.004%), 2.5 mL			
Unoprostone (Eye drop, 0.15%), 5 mL			
Latanoprost (Eye drop, 0.005%), 2.5 mL			
Dispenser signature:			
Place and Date:			