Article • Estimation of the Prevalence of Refractive Error in Kenya: A Systematic Review and Meta-Analysis

Shadrack Muma, B. Optom, MPH • University of KwaZulu-Natal • Durban South Africa
Kovin Naidoo, PhD • University of KwaZulu-Natal • Durban, South Africa
Rekha Hansraj, PhD • University of KwaZulu-Natal • Durban, South Africa

Shadrack Muma, B. Optom, MPH
Durban, South Africa

B.Optom, University of KwaZulu-Natal

MPH, University of KwaZulu-Natal

PhD candidate, (Optometry with Bias to Telemedicine and Social Entrepreneurship), University of KwaZulu-Natal

ABSTRACT

Purpose: To conduct a systematic review and meta-analysis on the prevalence of uncorrected refractive error in Kenya.

Methods: This was a systematic review and meta-analysis of published papers extracted from PubMed and Google Scholar published between the years 2000-2022. A Boolean operator of "AND" and "OR" was used. A meta-analysis was carried out to estimate the prevalence of uncorrected refractive error in Kenya. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was applied in reporting systematic review and meta-analysis.

Results: Out of the 20 identified articles, only eight were eligible for data extraction. The sample sizes varied from 326 to 10,579 in the eight articles. The prevalence of refractive error in Kenya reported from the meta-analysis was 6.39% (95% CI 2.3-7.2). The meta-analysis, using the random effect model, showed that sample size was statistically associated with the mean prevalence of refractive error per article (p=0.004).

Conclusion: The prevalence of uncorrected refractive error continues to pose a major challenge with the growing population in Kenya. As a result, there is a dire need for up-to-date information from population-based studies on refractive error across all age groups.

Keywords: Kenya, refractive error, visual impairment, visual loss

Introduction

According to the International Statistical Classification of Diseases (ICD), blindness is defined as having best-corrected visual acuity less than 3/60 or a central visual field no greater than 10 degrees in the better eye. Low vision (visual impairment less severe than blindness) is best-corrected visual acuity less than 6/18 to 3/60.[1] Refractive error, a leading cause of visual impairment, has a direct correlation between race and geographical location, with a high proportion of the affected populations living in developing countries.[2,3] Therefore, there is a dire need to estimate the prevalence of uncorrected refractive error in Kenya so as to provide information for policy development.

The magnitude of visual impairment globally as a result of uncorrected refractive error continues to pose a challenge in developing countries. The challenges could be attributed to the long life expectancy in different parts of the world.[4] However, with a lack of population-based studies concerning refractive error in Kenya, the estimated prevalence provided by various cross-sectional studies could be outdated and non-reflective of the actual prevalence. Hence, this study intended to provide an updated prevalence of refractive error in Kenya to better aid in the allocation of resources.

Methods

PubMed and Google Scholar were the main search engines used to extract information regarding refractive error prevalence in Kenya. Additional articles were retrieved manually from the references of the papers found. A Boolean operator of "AND" and "OR" was used. The keywords used were as follows: refractive error OR visual impairment OR visual loss OR avoidable blindness OR prevalence of refractive error AND Kenya.

The key considerations for the articles were based on the context, population, and the condition of the target population. Therefore, to be included in the systematic analysis, the article had to meet the following criteria:

1. Studies that adopted a probability sampling (This is intended to allow for generalizability);
2. Studies published between 2000 and 2022 and meeting other inclusion criteria;
3. Papers in which refractive error was tested using any type of optotype with consideration of best-corrected visual acuity or presenting visual acuity;
4. Studies conducted in Kenya with the native population; and
5. Studies with refractive error requiring a prescription of ±0.50 D.

The article search was done systematically, with abstracts explored to determine whether any met the inclusion criteria for the current review. The articles that met the inclusion criteria were read fully, and relevant data was exported to a spreadsheet. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was applied in reporting systematic review and meta-analysis to present the study inclusion, exclusion, and the reason for exclusion of the information in the diagram. The concepts extracted were the author name, the publication year, the region in the country where the study was conducted, the study design, the sample size, and the frequency of participants with refractive error.

The concepts of the articles were extracted using Microsoft Excel. A meta-analysis was conducted using SPSS version 27 to extract article concepts. The standard error of the prevalence of refractive error for each original article using the formula $\sqrt{}$ (P (100-P)/N) (where P is the prevalence of refractive error for each original article, N is the sample size of that specific study, and $\sqrt{}$ = the square root). Cases of heterogeneity of ≥75% were considered high, 25%-75% were moderate, and 25% or less were low.[5] A moderate degree of heterogeneity was noted on the articles retrieved (I2=34.5%, p=0.002); hence, to estimate the prevalence of visual impairment due to refractive error, a random-model approach was applied. To ensure that publication bias was addressed, Begg's regression intercept was adopted, with significance kept at 5%. There was no publication bias on the papers retrieved for the meta-analysis (p=0.013).

Results

The article search was conducted from 1st March to 15th April 2022. There were 20 articles retrieved from the search engines, with 12 from Google Search and 8 from PubMed. After careful evaluation of the tittles and the abstracts, 12 articles were found to be inappropriate and not relevant in regard to the study objective. Only eight articles were considered eligible and remained for the meta-analysis. Out of the 12 excluded articles, four articles focused on uptake of refractive error services, with the other six focusing on human resource and visual impairment.[6,7] To ensure that bias was eliminated, two articles in which participants were selected on a non-probability sampling approach were excluded.

The studies included for meta-analysis were conducted between 2000 and 2022 for cross-sectional studies (Table 1). The articles had varied sample sizes, with the least being n=326[8] and the highest being n=10579.[9] The total number of participants derived from the articles was 23,118, which was used to estimate the prevalence of refractive error in Kenya. The studies used were conducted from different parts of the country and were published in peer-reviewed journals. Studies were conducted in the following locations: nationwide,[10] Tranzoia County, Nairobi county,[11,12] Nakuru,[13] Voi, South Kenya, and Makueni.[14,15] The meta-analysis, using the random-effect model, showed that sample size was statistically associated with the mean prevalence of refractive error per article (p=0.004). The prevalence of refractive error was found to be 6.39% (95% CI 2.3-7.2).

Table 1. Studies Included in the Study of the Prevalence of Refractive Error in Kenya

Author(s) Name(s)	Year of publication	Publication status	Sample size	Prevalence (95% CI)	Response rate
Rono et al.[9]	2018	Published	10,579	(95% CI 3.49-15.47)	NR
Ndegwa et al.[12]	2006	Published	1438	(95% CI 4.95-7.15)	NR
Soler et al.[8]	2012	Published	326	(95% CI 3.69-10.47)	NR
Muma & Obonyo[10]	2020	Published	3400	(95% CI 4.59-13.97)	95.3%
Nyamai & Kenyata[11]	2019	Published	1376	(95% CI 6.12-9.34)	84.8%
Muma et al.[15]	2009	Published	1439	(95% CI 1.89-7.34)	94.5%
Wanyama et al.[17]	2013	Published	776	(95% CI 2.7-5.9)	NR
Mathenge et al.[13]	2007	Published	3784	(95% CI 4.8-6.8)	92.6%

NR: Not reported

Discussion

Developing countries have not embraced population-based studies. This could be attributed to inadequate personnel, funds, and time. As a result, refractive error studies are crucial to allow for planning and uptake of refractive error services. To ensure that policy makers obtain up-to-date information on refractive error, systematic analysis of published papers is desirable.

In this study, it is evident that most studies conducted in Kenya on refractive error are cross-sectional, with only one study conducted country-wide on the prevalence of refractive error among children aged 5-16 years. As a result, more population-based studies on refractive error in Kenya are desirable to allow for planning. The majority of the studies have been conducted in Nairobi, with others in Nakuru and Kitale region.[16] This could be attributed to population distribution in these regions, with insufficient human resources to address refractive error in other parts of the country. Hence, there is a dire need for up-to-date information on the prevalence of refractive error from each and every county in Kenya. However, the prevalence of 6.39% implies that the current avenues used in addressing refractive error in Kenya should be reformed to ensure that refractive error is sufficiently addressed. A study by Muma[15] reported a prevalence of 5.2% (75/1439), with hyperopia accounting for 3.2%, myopia 1.7%, and astigmatism 0.3% of refractive errors. Myopia was more likely to be present in children aged 14 to 15 years than those aged 12 to 13 years, with OR 2.9 (0.1 – 9.2). Therefore, population-based studies are desirable to ensure that each condition is managed comprehensively.

A study by Nyamai[7] reported the prevalence of myopia as 14.4% (194/1348), followed by astigmatism at 7.6% (103/1348) and hyperopia at 0.7% (10/1348). This shows that myopia continues to pose a challenge globally, with Kenya not being an exception. The visual acuity was tested using a LogMAR chart, and those who had visual acuity of 6/12 or less in the better eye were included for objective and subjective refraction. This is similar to a study by Muma,[10] which reported a mean prevalence of visual impairment based on pinhole value as 1.7 ± 0.3% using the World Health Organization definition. Using a Snellen chart in which presenting visual acuity of 6/60 was considered severe and worse than 6/18 was considered moderate, the prevalence of visual impairment based on presenting visual acuity was 2.4 ± 0.7%. Although the studies did not classify refractive error based on corrective power, effort should be directed towards developing a universal approach in the delivery of refractive error services so as to ensure that future studies on refractive error from population-based studies are accurate.

In a study by Mathenge,[13] visual acuity was tested using a Snellen chart at 6 meters in which a pinhole was used to test visual acuity of participants with 6/18 or worse in either eye. Blindness was defined as visual acuity of 3/60 in the better eye with best correction. Severe visual impairment was 3/60 to 6/60, and visual impairment was 6/60 to 6/18, both with best available correction. The prevalence of bilateral blindness (presenting visual acuity 3/60 or worse) was 2.0%, and the prevalence of bilateral visual impairment (visual acuity of 6/18–6/60) was 5.8% in the sample. Avoidable causes of blindness (i.e., cataract, refractive error, trachoma, and corneal scarring) were responsible for 69.6% of bilateral blindness and 74.9% of bilateral visual impairment. Although population-based studies are desirable, causes of blindness should be ruled out for an accurate prevalence of refractive error.

A study by Rono[9] among children in primary schools defined visual impairment as vision less than 6/12 in either eye with a correction of ±0.25 D. The proportion of children identified as having visual impairment who attended their hospital referral was significantly higher in the group who had used the Peek Visual Acuity mobile application (285/531, 54%) than in the standard group (82/366, 22%) ($p<0{\cdot}0001$). Therefore, technology advancement will not only promote the uptake of refractive error but will address issues around cost-effectiveness in delivery. According to Wanyama,[17] the prevalence of visual impairment was 4.77%, with blindness being 0.13%. Girls contributed 35.14% of cases of visual impairment, while boys contributed 64.86%. The age group most affected was 11-15 years (59.46%). There were higher chances of developing visual impairment with increasing age. The leading cause of visual impairment was refractive error (81.08%). Other causes included albinism, corneal disease, disease of the whole globe, and strabismus. Hence, there is a dire need for population-based studies to ensure that the aging population is assisted before they become less productive to society as a result of refractive error.

As the population continues to grow in Kenya, it is evident that the prevalence of refractive error continues to increase. For instance, in a

study conducted in Nairobi in 2019, the reported prevalence was 15.5%, while in 2006, it was 6.2%.[17] This significant increase should be addressed to ensure that an increase in population does not affect vision and quality of life. While the study tested visual acuity using a pinhole for all participants with a presenting acuity of worse than 6/12 in one or both eyes, the prevalence of refractive error ranged between 4.7%-80%, with wide geographic variability and low coverage of screening services being issues of concern. As a result, stringent measures should be undertaken to ensure that vision screening activities are conducted frequently for early detection of refractive error. Although the leading cause of visual impairment was presbyopia, which affected 25.11% of participants, it was denoted that cataracts contributed (32.58%) to the overall prevalence correction. Therefore, for effective management of refractive error, other ocular conditions such as cataract should also be addressed.

According to a paper included in this meta-analysis by Ndegwa,[12] in which visual impairment was defined as presenting visual acuity of less than 6/18 but equal to or better than 3/60 in the better-seeing eye, the prevalence of blindness and visual impairment was 0.6% and 6.2% in males and females, respectively. This implies that more females are at a higher risk of developing refractive error. The study also acknowledged that cataracts were significantly higher among females (25%) compared to males (12.5%). As a result, gender equity should be prioritized to ensure that everyone can benefit from refractive error services. Refractive errors accounted for 25.0% of blindness, which is significant and warrants action. Of those with visual impairment, 58.1% had refractive errors, while 35.5% had cataracts. This paper denotes that the prevalence of blindness in slum areas was slightly lower in comparison to the national average (0.7%). However, visual impairment was almost three times higher. Hence, population-based studies will ensure equitable distribution of refractive error services and planning for human resources.

Conclusion

This meta-analysis shows that the prevalence of uncorrected refractive error continues to pose a challenge in Kenya. As a result, there is a dire need for up-to-date information on the prevalence of refractive error in Kenya. It is evident that as the population continues to grow, the incidence of refractive error continues to grow. This shows that there is a gap when it comes to estimating the real prevalence, as elderly individuals are rarely included in the studies. Hence, more inclusive studies of all ages are desirable for accurate information.

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Correspondence regarding this article should be emailed to Shadrack Muma, B. Optom, MPH at mumashadrack275@gmail.com.
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