Original Article

Prevalence and Distribution of Refractive Errors among Ophthalmic Patients in Madang Province, Papua New Guinea

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Abstract

Purpose: To assess the prevalence and distribution of refractive errors in Madang Province, Papua New Guinea (PNG).

Methods: A retrospective hospital-based study was conducted at Madang Provincial Hospital Eye Clinic. It is a free eye clinic and spectacle costs are further subsidized by a nongovernmental organization. Nonprobability purposive sampling was used to retrieve patients' records at the eye clinic from January to December 2016. Only demographic and clinic data on the patients' first visit to the eye clinic were recorded and these included their age, gender, location, presenting visual acuity (VA), and refractive correction.

Results: One thousand and one hundred eighty-four patients' records were retrieved, of which 622 (52.53%) had refractive error. The mean age of refractive error presentation was 49.68 ± 16.29 years with a range of 9–86 years. There were more males (55%) than females. About a quarter of the patients (21.2%) presented with moderate visual impairment. There was a statistically significant relationship between visual impairment and age group ($P < 0.001$). Myopia (53.1%) was the most common type of refractive error followed by hyperopia (32.5%) and astigmatism (14.4%). The uptake of spectacle correction was very high (95.3%) among the patients. More than one-tenth of the patients (12.5%) reported from other provinces. Almost one-third of the patients (31.4%) could not obtain a VA of 6/6 after refraction. About one-fifth (17.0%) of the patients were suspected of functional amblyopia.

Conclusions: Uncorrected refractive error (URE) is a significant cause of visual impairment in PNG. There is a need for the integration of eye care services into primary health care for early detection, treatment, and prevention of visual impairment caused by UREs.

Keywords: Astigmatism, Myopia, Hyperopia, Refractive error, Visual impairment

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Introduction

Uncorrected refractive error (URE) is a leading cause of visual impairment globally.[1-4] Papua New Guinea (PNG) has one of the highest reported prevalence of blindness in the world, with URE as the main cause of blindness and visual impairment.[1] Vision loss as a result of URE has a significant impact on an individual's wellbeing including academic performance, employability, and productivity at work.[5-8] Visual impairment is classified based on the presenting visual acuity (VA) in the better eye under no visual impairment, mild, moderate, and severe visual impairment, and blindness.[9]

Vision loss caused by URE is easily avoidable. The mainstay of URE treatment is the dispensing of spectacles, contact lenses, and refractive surgeries.[10,11] A high proportion (72.7%) of natives in PNG do not have an appropriate correction for distance refractive error, and 80% do not have near correction.[1] Significant barriers to refractive correction are the inadequate distribution of refractive error services and limited numbers

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of eye care professionals across PNG. At present, the few ophthalmic clinicians trained at Divine Word University in Madang are the backbone of refractive error services in the country[12] since there are no institutions training optometrists. The majority of the natives in PNG reside in rural areas, whereas most eye care facilities are in urban centers or provincial capitals.[1]

There is a paucity of population-based data on refractive error and vision impairment across all age groups in PNG. To date, only two population-based surveys have estimated the prevalence and causes of visual impairment and blindness in PNG. A Rapid Assessment of Cataract Surgical Services (RACSS) was conducted in areas within and surrounding the capital, Port Moresby, in 2005.[13] More recently, an updated and modified version of the RACSS, a Rapid Assessment of Avoidable Blindness was conducted in the National Capital District, Highlands, Coastal and Islands regions in 2017.[1] However, both studies only assessed the prevalence and causes of visual impairment and blindness among people aged 50 years and above. Thus, the data from these studies cannot be generalized to those under 50 years. This study set out to determine the prevalence and causes of refractive error in Madang Province.

Methods

Purposive sampling was used to retrieve the records of patients who received refractive error services at Madang Provincial Hospital Eye Clinic from January to December 2016 for this retrospective study. The eye clinic offers free refractive error services and spectacles are further partially funded by the Fred Hollows Foundation NZ. It is the only facility that provides refractive error services in the entire province.

In this study, refractive error was based on unaided VA worse than 6/6 in the absence of other ocular diseases which improved with spectacle correction. It was further assessed by subjective refraction results and categorized based on other similar studies.[14,15] Functional amblyopia was suspected if the subjective refraction did not improve the VA up to 6/12 in one or both eyes in the absence of anatomical problems[16] such as cataract, corneal opacities, and retinopathies.

- Myopia: Spherical error of ≥−0.50 diopter (D) was considered as myopia. Furthermore, it was classified as low myopia when the spherical power was ≥−0.50 D to −3.00 D, moderate myopia (>−3.0 D to −6.0 D), and high myopia (>−6.0 D)
- Hyperopia: Spherical error of ≥+0.50 D was considered hyperopia. This was further classified as low hyperopia when the sphere was ≥+0.50 D to ≤+3.0 D, moderate hyperopia (>+3.0 D to ≤+6.0 D), and high hyperopia (>+6.0 D)
- Astigmatism: Any cylindrical error ≥±0.5. Astigmatism was sub-classified as simple myopic astigmatism, simple hyperopic astigmatism, compound hyperopic astigmatism, compound myopic astigmatism, and mixed astigmatism.

Distance visual impairment was categorized in terms of presenting (uncorrected) VA as follows:[9]

- No vision impairment: VA ≥6/12 in the better eye
- Mild visual impairment: VA <6/12 to 6/18 in the better eye
- Moderate visual impairment: VA <6/18 to 6/60 in the better eye
- Severe visual impairment: VA <6/60 to 3/60 in the better eye
- Blindness: VA <3/60 in the better eye.

The study included all records of patients who visited the eye clinic for refractive error services in 2016 but excluded the following categories of records:

- Incomplete records
- Patients with other ocular morbidities other than refractive errors (such as cataract, corneal opacities, and retinopathies)
- Patients with spherical refractive errors <±0.5 diopter sphere or cylindrical refractive error <±0.5 diopter cylinder.

Ethical clearance was obtained from the Faculty of Medicine and Health Sciences Research Committee (FMHSRC) of Divine Word University (approval number FRC/MHS/37-20). The eye clinic is a teaching facility, and patients are aware and consent that their data could be used for research studies. Written permission was further granted by the management of the eye clinic before accessing the patients' records. The study was conducted per the provisions of the Declaration of Helsinki.

All patient records for the study period were retrieved, and only data on the first visit to the clinic were extracted for the study. Data were entered into a spreadsheet on a password-protected computer, and only the researchers had access to it. The data included the patients' demographics, presenting VA, and final distance refractive corrections but excluded patients' identifiable data such as names, hospital numbers, phone numbers, and address. Data were manually cleaned and prepared for analysis. All analyses were completed using IBM SPSS Statistics for Windows, version 21 (IBM Corp., Armonk, N.Y., USA). Descriptive statistics were computed for all variables, and categorical data were expressed as frequencies and percentages. Mean ± standard deviation was used as the measure of central tendency. The Chi-square test was performed to determine the association between the patient demographic data and distribution of visual impairment as well as the type of refractive error. $P < 0.05$ was considered statistically significant.

Results

A total of 1184 patient records were retrieved. Among them, 622 (52.53%) met the inclusion criteria. Five hundred and sixty-two patient records were excluded from the study, and these were the patients with less than ±0.50 D refractive errors (341), cataract and pseudophakia (101),

incomplete records (97), corneal opacities (11), diabetic retinopathy (4), maculopathy (3), optic neuropathy (3), retinal vein occlusion (1), and posterior vitreous detachment (1).

The average age of eligible patients (mean ± standard deviation) was 49.68 ± 16.29 years with a range of 9–86 years. Only five younger children (≤10 years) visited the eye clinic for refractive error services during the period of the study, and two of them were excluded from the analysis because their records were incomplete. Of the 622 patients, 342 (55.0%) were males, and 280 (45.0%) were females, as shown in Table 1. The majority of the patients (87.5%) were from Madang Province, and the remaining (12.5%) were from 13 other provinces of PNG.

The majority (65.0%) of patients had no vision impairment, followed by moderate (21.2%), mild (10.6%), severe (1.6%) visual impairment, and blindness (1.6%) in the better eye. The distribution of visual impairment and gender is shown in Table 2. There was a statistically significant relationship between visual impairment and age groups ($P < 0.001$) as shown in Table 3.

Out of the 622 participants, 330 (53.1%) were myopes, 202 (32.5%) were hyperopes, and 90 (14.4%) had astigmatism as illustrated in Table 4. Furthermore, 593 (95.3%) of the patients took up spectacle correction.

Spectacle correction improved their vision to an appreciable extent. The majority of the patients (83.0%) had VA better than or equal to 6/12 after refraction, and the remaining 106 (17.0%) patients were suspected of functional amblyopia. Almost one-third of the patients (31.4%) could not obtain a VA of 6/6 after refraction. There was a significant association between age group and the best-corrected visual acuity (BCVA) as shown in Table 5 ($P < 0.001$). Children were more likely to obtain an optimal VA of 6/6 after refraction compared to the elderly.

Discussion

To the best of our knowledge, this is the first study to provide insight on refractive error distribution, visual impairment, and blindness across all age groups in a hospital setting in PNG. A priority of the United Nations is to ensure good vision for persons living with preventable sight loss by 2030, of which the major cause is an URE.[17] In this study, the uptake of refractive error correction was 95.3%, which may be attributed to the high (94.1%) employment rate of the patients as the employed are more likely to afford associated costs such as transport and spectacles when seeking eye care services. The high spectacle acceptance rate may also be due to the fact that the facility offers free services, the partial funding of spectacle cost by the Fred Hollows Foundation NZ and the availability

Table 1: Distribution of demographics according to gender

Demographics	Gender of patients		Total (%)	*P*†
	Male	Female		
Age group				
Children (0-17)	12	14	26 (4.2)	<0.001
Youth (18-35)	33	67	100 (16.1)	
Adults (36-59)	154	138	292 (46.9)	
Elderly (>59)	143	61	204 (32.8)	
Employment				
Employed	95	43	138 (22.2)	0.001
Unemployed	2	2	4 (0.6)	
Pensioner	1	7	8 (1.3)	
Self employed	232	215	447 (71.9)	
Student	12	13	25 (4.0)	
Total	342	280	622 (100)	

†The relationship between the patients' demographics and the gender of patients was established with Chi-square test. $P \leq 0.05$ was considered statistically significant

Table 2: Distribution of visual impairment according to gender

Category of visual impairment	Gender of patients		Total (%)	*P*†
	Male	Female		
No vision impairment	205	199	404 (65)	0.020
Mild visual impairment	41	25	66 (10.6)	
Moderate visual impairment	87	45	132 (21.2)	
Severe visual impairment	5	5	10 (1.6)	
Blindness	4	6	10 (1.6)	
Total	342	280	622 (100)	

†The relationship between the category of visual impairment and the gender of patients was established with Chi-square test. $P \leq 0.05$ was considered statistically significant

Table 3: Association between category of visual impairment and age groups

Category of visual impairment	Age group of patients				Total	*P*†
	<18	18-35	36-59	60+		
No vision impairment	17	75	210	102	404	<0.001
Mild visual impairment	1	7	24	34	66	
Moderate visual impairment	8	13	52	59	132	
Severe visual impairment	0	2	3	5	10	
Blindness	0	3	3	4	10	
Total	26	100	292	204	622	

†The relationship between the category of visual impairment and the age group of patients was established with Chi-square test. $P \leq 0.05$ was considered statistically significant

of ready-made spectacles.[18,19] This report is in tune with the strong association between poverty and poor eye health and vice versa.[20]

The prevalence of visual impairment among patients who received care at the Madang Provincial Hospital Eye Clinic was high (35%). The prevalence in this study is consistent with similar studies in a hospital or clinic setting in developing countries. A study by Malu and Ojabo reported 36.8% of visual impairment in a private hospital in Nigeria.[21] Furthermore, this study identified that more than a tenth of patients (12.5%) travelled from other provinces to seek refractive error services in Madang. Due to the inadequate and unequal distribution of the eye care workforce in PNG, many people have no choice but to travel long distances to access refractive error services.

Table 4: Types of refractive error according to gender

Refractive error*	Gender of patients				Total (%)	*P*†
	Male	Total	Female	Total		
Myopia						
LM	163	193	125	137	330 (53.1)	0.134
MM	25		12			
HM	5		0			
Hyperopia						
LH	100	101	100	101	202 (32.5)	0.134
MH	0		0			
HH	1		1			
Astigmatism						
SMA	2	48	1	42	90 (14.4)	0.134
SHA	6		1			
CMA	26		21			
CHA	9		14			
MA	5		5			
Total		342		280	622 (100)	

†The relationship between the type of refractive error and the gender of patients was established with Chi-square test. *There was no statistically significant difference between the type of refractive error and gender of the patients. CHA: Compound hyperopic astigmatism, CMA: Compound myopic astigmatism, HH: High hyperopia, HM: High myopia, LH: Low hyperopia, LM: Low myopia, MA: Mixed astigmatism, MH: Moderate hyperopia, MM: Moderate myopia, SHA: Simple hyperopic astigmatism, SMA: Simple myopic astigmatism

There are 16 ophthalmologists, five optometrists, seven refractionists, and 67 ophthalmic nurses serving a population of over 8 million.[1] To be able to reduce the high prevalence of vision impairment and blindness in PNG, an equitable distribution of a dedicated eye care workforce is essential. Greater investment in the training of eye care professionals is thus needed to strengthen the eye care sector in PNG.

The prevalence of pure refractive error (52.53%) was similar to findings in developing countries. A study in Asia by Natung *et al*. reported a prevalence of 55.56% among patients who visited a hospital in North-East India.[22] Studies in Africa have also reported a prevalence of 50% and above for refractive error.[21,23,24] This high prevalence shows that vision impairment caused by URE is a major public health challenge; hence, adequate provisions are needed in developing countries such as PNG. In contrast, Kaiti *et al*. and Bhardwaj *et al*. reported a lower prevalence of refractive error in Nepal and India, respectively.[14,25] This difference can be attributed to the greater number and availability of eye care personnel in the catchment area of these facilities. Furthermore, Abraham and Megbelayin did not exclude other ocular comorbidities in their study.[24]

The distribution of refractive error was skewed toward myopia. This finding is similar to studies in hospitals in developing countries with reports that myopia is the leading type of refractive error followed by hyperopia and astigmatism.[21-26] In contrast, Kaiti *et al*. reported that astigmatism was the most prevalent type of refractive error followed by myopia and hyperopia among patients in Nepal.[14] The high prevalence of astigmatism instead of myopia can be attributed to the difference in geographical locations and ethnicity.[27] Nonetheless, globally, myopia is the most prevalent type of refractive error.[27]

There was a relationship between age and visual impairment ($P < 0.001$), indicating a high incidence of visual impairments in the older population in this study. The likelihood of the aged having a visual impairment is high compared to children, youth, and younger adults, as reported by previous studies.[28-31] Thus, there is a need for periodic eye examination among the aged to reduce the high prevalence of visual impairment.

Table 5: Age distribution of best-corrected visual acuity of patients

Best-corrected visual acuity	Age group of patients				Total (%)	*P*†
	<18	18-35	36-59	60+		
6/6	21	85	230	91	427 (68.6)	<0.001
6/9	1	6	24	25	56 (9.0)	
6/12	2	1	12	18	33 (5.3)	
6/15	0	2	14	26	42 (6.8)	
6/18	1	3	5	16	25 (4.0)	
6/24	0	2	7	14	23 (3.7)	
6/36	1	1	0	8	10 (1.6)	
6/60	0	0	0	6	6 (1.0)	
Total	26	100	292	204	622	

†The relationship between the best-corrected visual acuity and the age group of patients was established with Chi-square test. $P \leq 0.05$ was considered statistically significant

Almost one-third of the patients (31.4%) could not obtain an optimal VA of 6/6 after refraction which included 106 (17.0%) patients suspected of long-standing functional amblyopia. The most common cause of amblyopia is URE;[32] therefore, the significant association between the age group and the BCVA in this study ($P < 0.001$) suggests the likelihood that the older patients may have had long-standing refractive errors but reported quite late for intervention. Amblyopia treatment is more effective among younger children.[33,34] However, only a few younger children visited the eye clinic for refractive error services during the period of this study. Therefore, early detection and preventive measures such as vision screening programs for children should be given much attention in addressing refractive errors and amblyopia in Madang.

This is hospital-based research, and as such, the findings may not be fully generalized for the entire province and country. In addition, very few younger children patronized refractive error services during the period of this study; thus, the data does not give a true reflection of the pattern and distribution of refractive errors among younger children in Madang Province.

In conclusion, refractive error and visual impairment are high in PNG and can be easily treated through the availability of refractive error services and eye care personnel. Myopia is the most common type of refractive error among natives in Madang Province. National strategic plans for the integration of eye care services into all district hospitals for the early detection and correction of refractive errors need to be developed and implemented by the government of PNG and the National Department of Health. Management strategies and guidelines for myopia should also be employed in all district hospitals. In addition, health promotion and education can help to reduce the high burden of refractive error and visual impairment. Moreover, a population-based study is needed to accurately estimate the prevalence and distribution of refractive errors and amblyopia across all age groups in PNG.

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Conflicts of interest

There are no conflicts of interest.

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