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RESEARCH ARTICLE

Factors affecting childhood blindness and visual impairment in Baguio General Hospital and Medical Center

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ABSTRACT

Background and Objectives: The study determined the prevalence and causes of childhood blindness and visual impairment (VI) in the hospital and determined the association between risk factors and dimensions affecting eye care utilization and VI severity.

Methodology: This is a retrospective cross-sectional study which included 318 records of pediatric patients who consulted at the Baguio General Hospital and Medical Center (BGHMC) in 2018.

Results: The prevalences of bilateral childhood blindness and VI were 12/318 (3.8%) and 77/318 (24%), respectively. Cataract was the top cause for bilateral blindness while refractive error was for VI. More than 75% of the causes of bilateral childhood blindness and VI at BGHMC in 2018 were treatable. Forty-seven (15%) children had unilateral blindness. The top cause of unilateral VI was refractive error while ocular trauma was the top cause of unilateral blindness. Ninety-four percent of the causes of unilateral blindness and VI at the BGHMC in 2018 were preventable or treatable. Age of onset of disease (p<0.001), availability (mild-p<0.03), and affordability (mild-p<0.019, moderate-p<0.004, and blind-p<0.047) of eye care were significantly associated with VI severity.

Discussion: Childhood blindness and VI at BGHMC were high compared to the national adult prevalence and in other Asian and African countries. The top causes of childhood blindness and VI in this study were similar to the top causes reported in national and global studies. Age of onset, availability, and affordability of eye care were associated with the severity of VI.

Conclusion: Childhood blindness and VI were high in patients of the BGHMC in 2018 and were affected by age of onset of the eye disease and availability and affordability of eye care.

Keywords: *childhood, visual impairment, blindness, Northern Luzon, cataract, refractive error, ocular trauma*

Introduction

It is estimated that children constitute 3% of global blindness [1]. Since blindness and visual impairment (VI) start at an early age, the summative number of years these children were blind is almost equal to that of the number of total years of blindness in adults with cataract [2]. They also have significant personal and socio-economic impact amounting to USD 60-270 billion [3-5]. Because of these, the World Health Organization (WHO) included childhood blindness and VI in the priorities of VISION 2020 [6]. Corneal opacification from vitamin A deficiency and measles used to be the top causes of blindness in children [7]. However, due to VISION 2020's comprehensive programs on measles vaccination and vitamin A supplementation, recent global data shifted to congenital cataract as the top cause of childhood blindness [8]. This shift presented new challenges of ensuring that affected children get appropriate eye care.

WHO recognizes the need for additional eye care facilities and training of personnel since limited access to eye care in the past resulted in decreased coverage in Vitamin A supplementation and measles vaccines [9]. It also led to a

significant delay in consultation which affected visual prognosis in children [10,11]. However, ensuring eye care utilization does not only entail the availability of eye care facilities and personnel since other dimensions also affect utilization [12,13].

Aside from these dimensions, risk factors also predispose children to more severe VI. An earlier onset of eye disease, compounded by a delay in consult, can equate to poorer visual prognosis since the insult is introduced during the child's visual system development [14]. Women had 40% higher chances of becoming blind in India [15]. Although some hereditary retinal diseases and cataract were chromosomal in nature and affect women mostly, gender played a significant role [15-17]. Since some diseases are hereditary, the presence of the disease in the family is another risk factor [16,18].

Local data on childhood blindness and VI are limited despite areas in Northern Luzon having higher prevalences of adult blindness and VI than the national average [19]. The only available local data were from Gilbert and Foster in 1993 and Del Mundo and Chua in 2015 who listed common causes of childhood blindness and visual impairment in Manila, Baguio, and Davao [20,21]. This study was conducted to determine the prevalence and common causes of blindness and VI in children who consulted at the Baguio General Hospital and Medical Center (BGHMC), a tertiary government hospital serving Northern Luzon, Philippines in 2018. The study also determined the association between risk factors such as age at onset, sex, and family history, and dimensions affecting eye care utilization, such as availability and affordability.

Methodology

This retrospective cross-sectional study was approved by the BGHMC Research Ethics Committee (BGHMC-REC-2019-43). Records of individuals aged 0-18 years based on the definition of a child under the Convention on the Rights of the Child who consulted in the Outpatient Department of the BGHMC Department of Ophthalmology in 2018 were reviewed and included in the study. The following data were retrieved from the patients' records and encoded: age at consult in years, sex, town and province of origin, age at onset of eye disease in years, family history of disease, visual acuity, and diagnosis. Assuming that the prevalence of childhood blindness in Filipino was 4% when this study was conducted, the study examined a minimum number of 244 records of children who consulted in the BGHMC related to visual impairment in 2018 to detect the prevalence of blindness as low as 1% at 80% statistical power and 5% level of significance. Random sampling was done.

All children whose records were reviewed and included in the study underwent history-taking and ophthalmological examination including visual acuity testing (presenting and best corrected) using a Snellen chart or a LEA chart as needed, gross examination, ocular motility testing, digital tonometry, direct fundoscopy, slit lamp examination, and, if needed and possible, direct dilated fundoscopy and full cycloplegic refraction. If possible, ocular ultrasound was done on children with significant media opacity.

Data were summarized using tables and charts. Presenting (not best corrected) visual acuities from the ophthalmological examination were used to classify patients' VI based on the 11th International Classification of Disease in Table 1 [22].

Table 1. *The World Health Organization 11th International Classification of Diseases for Visual Impairment (WHO, 2020)*

Classification	Vision, per eye, presenting
Mild	visual acuity of worse than 20/40
Moderate	visual acuity of worse than 20/60
Severe	visual acuity of worse than 20/200
Blindness	visual acuity of worse than 20/400

This was done by the WHO since using the best-corrected visual acuity would underestimate the real burden of refractive errors. The ICD classification was based on the visual acuity of the better eye of an individual. A patient with visual acuities of no light perception in the right eye (blind) and 20/20 on the left eye (normal) was still considered with no VI. However, since monocular VI and blindness affect stereopsis and limit peripheral vision, which present significant disability as well, this study also analyzed patients with monocular VI and blindness. The prevalence of childhood bilateral and unilateral blindness and VI in pediatric patients who consulted at the BGHMC in 2018 was computed as follows:

$$\text{(\%) Childhood Blindness} = \frac{\text{No. of blind child from medical records examined} \times 100}{\text{Total number of medical records of child examined}}$$

$$\text{(\%) Childhood VI} = \frac{\text{No. of child with VI from medical records examined} \times 100}{\text{Total number of medical records of child examined}}$$

The causes of childhood blindness and VI in pediatric patients who consulted at the BGHMC in 2018 were enumerated and ranked. They were classified as preventable or treatable. Preventable causes included eye trauma which could had been avoided with proper education of parents on not allowing children to play with sharp objects. Treatable causes were those that could not be prevented but with known management options, such as prescription glasses for refractive errors.

Risk factors such as age of onset (in years), sex, and family history were tested for association with VI using logistic regression. For dimensions affecting pediatric eye care utilization at the BGHMC, the type of community of the patient's hometown (urban or rural) was used as proxy for the availability of eye care. Those living in urban communities were assumed to have an ophthalmologist available in their area [23]. Urban classification was based on the definition used by the European Commission of having a population of at least 50,000 inhabitants and a minimum of 1,500 people per square kilometer population density [24]. The type of community was tested for association with VI severity using logistic regression. The delay in consult was used as a proxy to determine the patient's economic status and, in turn, affordability. The longer the delay meant the lower the economic status of the patient. A delay of < 1 week meant upper economic status, < 1 month meant middle economic status, 1-6 months meant lower economic status, and less than 6 months meant lowest economic status. Economic status was tested for association with the severity of VI. Stata version 14 (StataCorp LP. 2015. College Station, TX) was used for sample size calculation and statistical analyses.

Results

Demographics

A total of 318 medical records of children were included in the study. The distribution of age group is shown in Figure 1. The mean age at consult was 11±5 years while the mean age at onset of eye disease was 10±5 years. Half of those included were females. The patients came from the Cordillera Administrative Region (72%), Ilocos Region (20%), Central Luzon (6%), and Cagayan Valley (2%).

Childhood VI and Blindness

Seventy-seven (24%) children had bilateral visual impairment while 12 (3.8%) were bilaterally blind. The mean age of children with bilateral VI was 10±4 years while the mean age of bilaterally blind children was 8±7 years. Forty-five (58%) children with bilateral VI and eight (67%) bilaterally blind children were females. A detailed distribution of the children according to the severity of visual impairment is shown in Figure 2.

Of the 77 bilaterally visually impaired children, 54 had refractive errors (RE) (Table 2). Refraction data were only available in 36 children (Table 3). Myopia was the most common error of refraction among these children at 54%. Six percent of the causes were preventable while 91% were treatable.

Of the 12 blind children, five (36%) had bilateral congenital cataract while seven were found with optic nerve atrophy from a central etiology, cortical blindness, keratoconus, optic nerve hypoplasia, pathologic myopia, retinoblastoma, and panuveitis. Anatomically, five (36%) had pathology with the lens, 2 with optic nerve, 1 with retina, 1 with cornea, and 2 with normal-appearing globe. Etiologically, 9 were from unknown etiology while 3 were from childhood factors. Seventy-six percent of the causes were treatable.

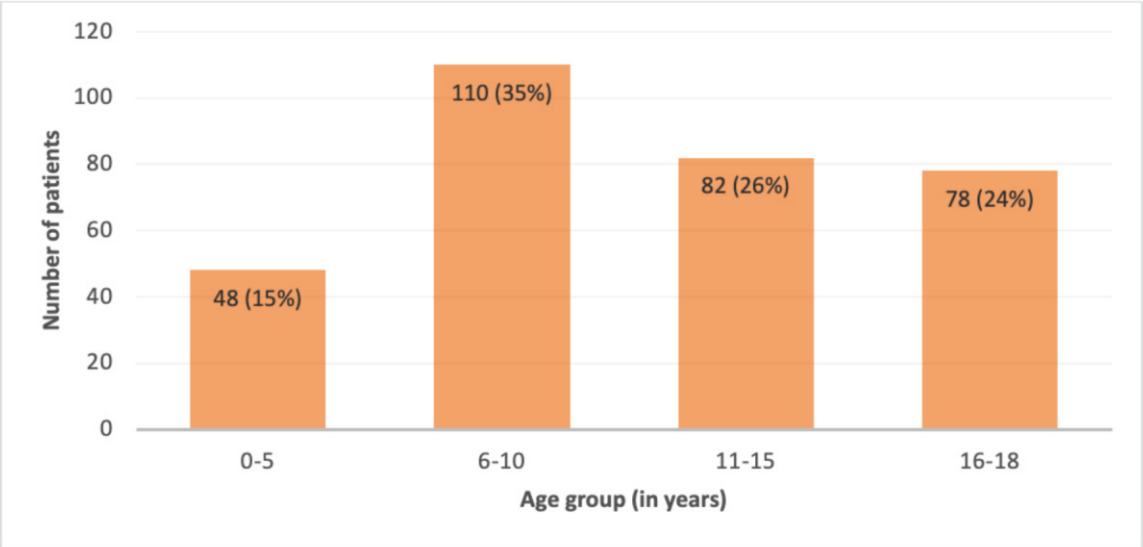

Figure 1. *Age distribution of pediatric patients who consulted at the BGHMC in 2018.*

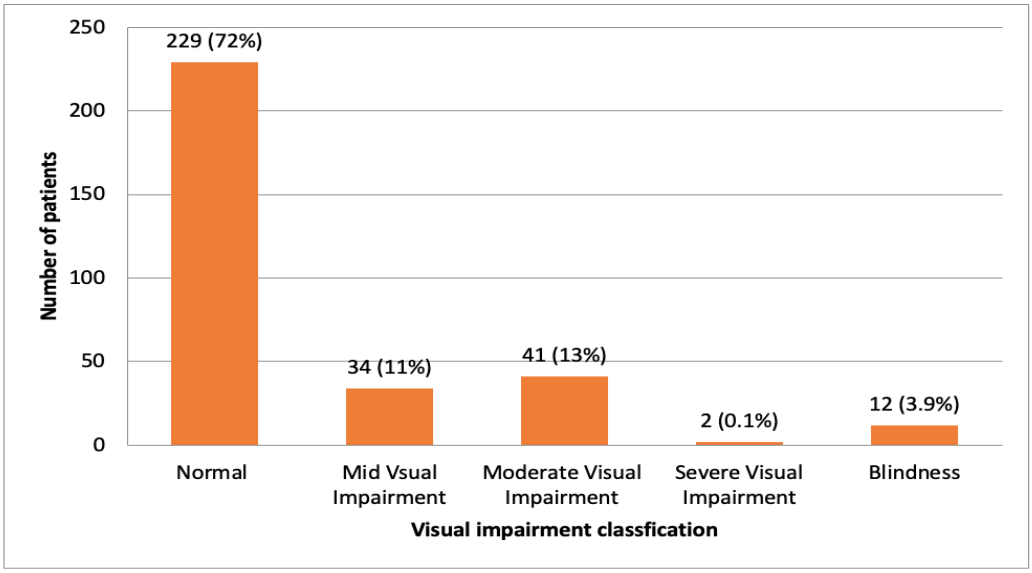

Figure 2. *Distribution of pediatric patients who consulted at the BGHMC in 2018 based on the ICD-11 Visual Impairment classification.*

Table 2. *Causes of bilateral Visual Impairment among pediatric patients who consulted at the BGHMC in 2018.*

Causes	Number of Children	Percentage (%)	Type
Refractive errors	54	70	Treatable
Congenital cataract	14	17	Treatable
Trauma	2	3	Preventable
Infection	2	3	Preventable
Retinal detachment	2	3	Treatable
Optic nerve atrophy	2	3	NP, NT*
Ptosis	1	1	Treatable
Total	**N**	**100**	

* NP- non-preventable; NT- non-treatable

Table 3. *Distribution of errors of refraction in pediatric patients who consulted in BGHMC Ophthalmology OPD in 2018.*

Error of Refraction	Number of Children	Percentage (%)
Myopia alone	19	54
Mixed		
Myopia + Astigmatism	6	17
Hyperopia + astigmatism	4	10
Hyperopia alone	4	10
Astigmatism alone	3	9
Total	**36**	**100**

Unilateral Involvement

Of the 636 eyes analyzed, 186 eyes (29%) had mild to severe VI while 71 eyes (11%) were blind. The distribution of the severity of VI per eye based on the ICD-11 is shown in Figure 3. Forty-two (13%) children who were initially classified as normal using the visual acuity of the better eye as a basis were found to have unilateral VI. Thirty-seven (12%) children who were similarly classified initially as normal using the visual acuity of the better eye as a basis, were unilaterally blind. Ten (3%) more children initially classified as visually impaired using the visual acuity of the better eye as a basis, were unilaterally blind.

Overall, there were 47 (15%) children examined with unilateral blindness. The mean age of children with unilateral VI was 11±5 years while the mean age for children with unilaterally blindness was 11±4 years. Twenty-three (58%) children with unilateral VI and 21 (46%) with unilateral blindness were females. The top cause of unilateral VI was

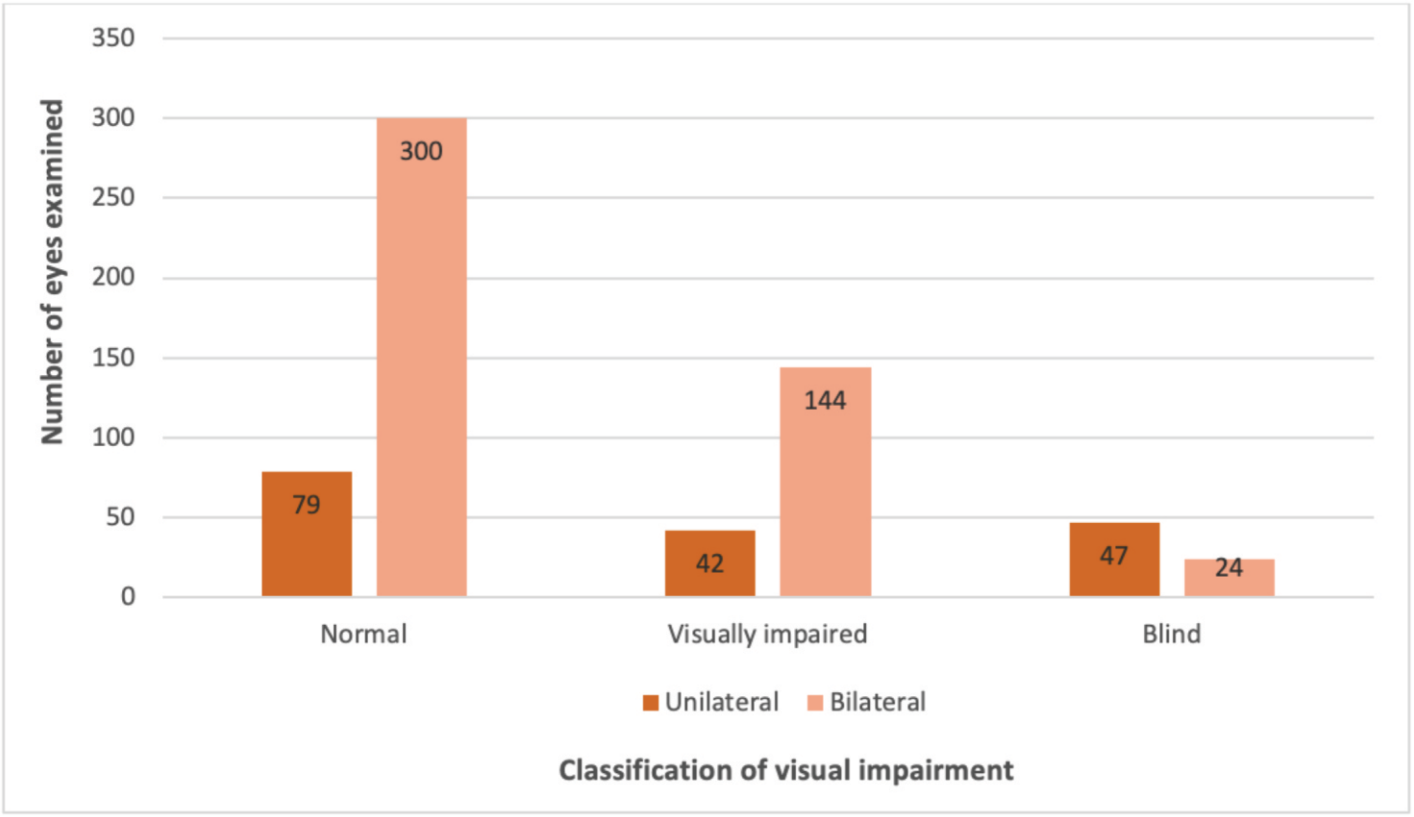

Figure 3. *Distribution of eyes of the pediatric patients who consulted in BGHMC Ophthalmology OPD in 2018 based on visual impairment.*

Table 4. *Causes of unilateral VI among pediatric patients who consulted at the BGHMC in 2018.*

Causes	Number of Children	Percentage (%)	Type
Refractive errors	22	53	Treatable
Trauma	10	25	Preventable
Infection	3	8	Preventable
Congenital cataract	1	2	Treatable
Strabismus	1	2	Treatable
Glaucoma	1	2	Treatable
Microphthalmia	1	2	NP, NT
Corneal edema	1	2	Treatable
Central Serous Retinopathy	1	2	Treatable**
Unspecified	1	2	-
Total	**42**	**100**	

* NP- non-preventable; NT- non-treatable
**treatable if not self-limiting

refractive error while ocular trauma commonly perforating injuries from sharp objects and ruptured globe from blunt trauma due to vehicular accidents were the top causes for unilateral blindness. Listed in Tables 4 and 5 are the causes of unilateral VI and blindness among pediatric patients who consulted at the BGHMC in 2018. Thirty-three percent of the causes for unilateral VI were preventable while 63% were treatable. Fifty-one percent of the causes for unilateral blindness were preventable while 43% were treatable.

Risk factors in the development of eye diseases in pediatric patients who consulted at BGHMC in 2018

There was a statistically significant association (P<0.001) between the age of onset of eye disease (in years) and blindness. VI was more severe when the onset of the eye disease was earlier among pediatric patients who consulted at the BGHMC in 2018 (Table 6). The association between sex and severity of VI was not statistically significant (Table

Table 5. *Causes of unilateral blindness among pediatric patients who consulted at the BGHMC in 2018.*

Causes	Number of Children	Percentage (%)	Type
Ocular trauma	18	38	Preventable
Corneal Perforating Injury	9		
Ruptured Globe	5		
Traumatic cataract	3		
Macular scar	1		
Congenital cataract, unoperated	7	15	Treatable
Infection (e.g. ruptured keratitis)	6	13	Preventable
Uveitis	5	12	Treatable
Unknown etiology (retinal detachment and vitreous hemorrhage)	3	6	NP, Treatable
Phthisis bulbi	2	4	NP, NT
Glaucoma	2	4	Treatable
Retinoblastoma	1	2	Treatable
Optic atrophy	1	2	NP, NT
Keratoconus	1	2	Treatable
Error of refraction	1	2	Treatable
Total	**47**	**100**	

* NP- non-preventable; NT- non-treatable

Table 6. *Association of age of onset of eye disease to severity of VI among pediatric patients who consulted at the BGHMC in 2018.*

VI	Odds Ratio	*P*-value
Mild	1.00	-
Moderate	0.71	0.76
Severe	1.00	-
Blind	0.05	<0.001*

* statistically significant

Table 7. *Association of sex to severity of VI among pediatric patients who consulted at the BGHMC in 2018.*

VI	Odds Ratio	*P*-value
Mild	1.87	0.10
Moderate	1.63	0.15
Severe	-	-
Blind	2.32	0.18

* statistically significant

Table 8. *Association of availability to severity of VI among pediatric patients who consulted at the BGHMC in 2018.*

VI	Odds Ratio	*P*-value
Mild	2.48	0.03*
Moderate	1.14	0.70
Severe	0.89	0.94
Blind	0.89	0.84

* statistically significant

Table 9. *Association of affordability to severity of VI among pediatric patients who consulted at the BGHMC in 2018.*

VI	Odds Ratio	*P*-value
Mild	2.83	0.019*
Moderate	3.57	0.004*
Severe	-	-
Blind	8.08	0.047*

* statistically significant

7). The association of the presence of a similar eye disease with VI severity cannot be tested since only two patients had a family history of eye disease.

Dimensions for eye care utilization among pediatric patients who consulted at the BGHMC in 2018

Availability of eye care

Based on data from the Philippine Statistics Authority, Baguio City and La Trinidad in Benguet, Dagupan City in Pangasinan, and Angeles City in Pampanga are urban centers (25). There were 176 (55%) children living in these places considered urban communities. Living in an urban community was significantly associated with having a mild VI (p<0.03). Those living in a rural community had higher chances of developing severe VI and blindness (OR<1). However, the associations were not statistically significant (Table 8).

Affordability of eye care

The distribution of economic status based on delay in consult is summarized in Figure 4. The economic status of the pediatric patient was found to be significantly associated with the severity of VI (p<0.05). Those from the lowest economic status who had the longest delay in consult resulted in more severe VI (Table 9).

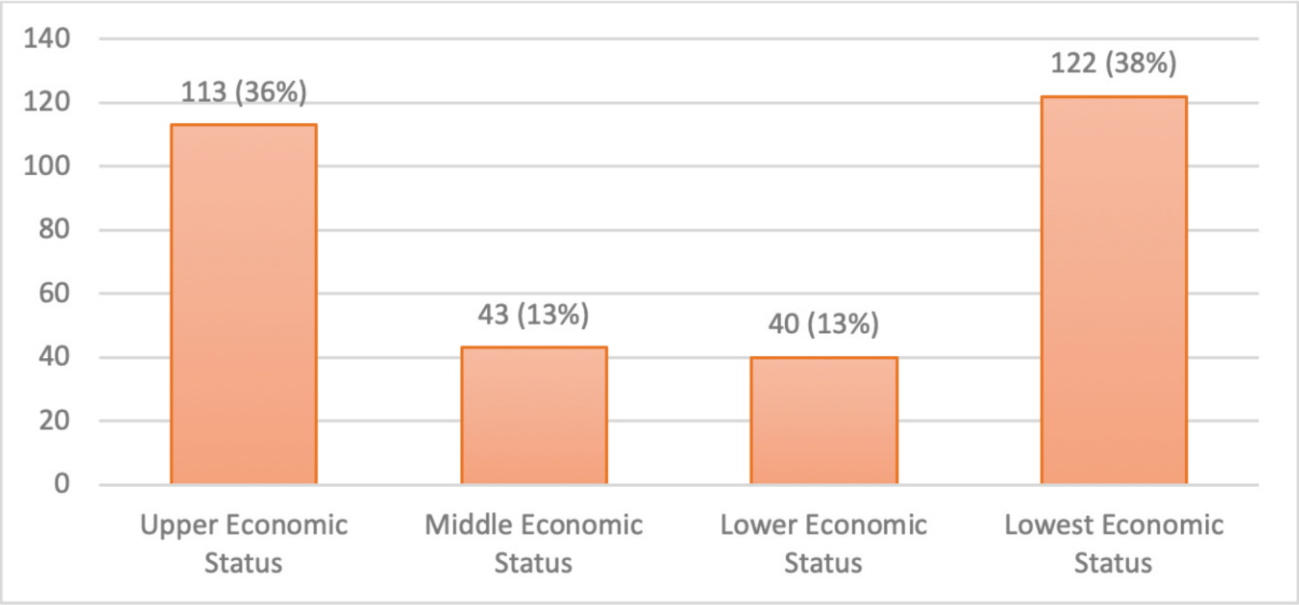

Figure 4. *Distribution of pediatric patients who consulted at the BGHMC in 2018 based on economic status.*

Discussion

This hospital-based study was able to determine the prevalence and causes of childhood blindness and visual impairment in Baguio General Hospital and Medical Center and the association between risk factors and dimensions affecting pediatric eye care utilization with VI severity. Local data are important for monitoring local eye health status and creating health policies. A hospital-based study may underrepresent the actual extent of the problem similar to school for the blind-based studies when compared to population-based studies [26]. However, this can be a safe alternative in the setting of the current pandemic. Similarly, this study has the greatest number of subjects on childhood blindness and VI in the Philippines.

Prevalence and Causes of Childhood Blindness and Visual Impairment among pediatric patients at the BGHMC in 2018

Bilateral childhood blindness (3.8%) at the BGHMC in 2018 was higher than the 0.6% national adult blindness and the 0.15% childhood blindness in low to middle-income countries [27,28]. However, these comparator studies were population-based. Childhood blindness at the BGHMC in 2018 was still higher though when compared to similar hospital-based studies done in Saudi Arabia (2%), but was lower than Cameroon (4.7%), and Mali (11.5%) [29-31]. The top cause of bilateral childhood blindness at the BGHMC in 2018 was cataract and this was reflective of the national adult and global data [27, 33]. This was different from the top causes of retinopathy of prematurity and retinoblastoma from Del Mundo and Chua's study due to their younger population (mean age of 1 year). More than 75% of the causes of bilateral childhood blindness and VI at the BGHMC in 2018 were treatable. As expected, the top cause of bilateral childhood blindness in Northern Luzon has shifted from Vitamin A deficiency in 1992 to congenital cataract in 2018 [20].

It was notable that by analyzing patients with unilateral VI and blindness, 86 more children were identified to be visually impaired at the BGHMC in 2018. Unilateral childhood blindness (15%) at the BGHMC in 2018 was higher than the national adult blindness (0.7%) and the unilateral adult blindness in Cameroon (1.7%), Ethiopia (7.3%), Yemen (7.7%), and Jordan (9.1%) [27,33-36]. Ocular trauma was the top cause of unilateral blindness at the BGHMC in 2018 similar to hospital-based studies in Cameroon, Mali, and Saudi Arabia [29-31]. Ninety-four percent of the causes of unilateral blindness and VI at the BGHMC in 2018 were preventable or treatable.

Unilateral (13%) and bilateral (24%) childhood VI at the BGHMC in 2018 were higher than the national adult VI of 5% and other Asian and African countries which ranged from 1.5% (Nigeria) to 12.2% (Vietnam) [27,37]. The top cause of unilateral and bilateral VI at the BGHMC in 2018 was uncorrected refractive error which was reflective of the national adult and global data [27,32]. Myopia remained the most common refractive error at the BGHMC in 2018 [38].

Ninety-six percent of the unilateral VI causes at the BGHMC in 2018 were preventable or treatable while 97% percent of the bilateral VI causes were preventable or treatable.

Risk Factors of Eye Diseases

Age of onset of eye disease was significantly associated with severity of VI because the visual system was still developing when the diseases set in among younger children, which lowered the child's visual potential [14]. Although this could be offset by timely and proper intervention, the delay in consult often made it challenging. Although there were more females with bilateral VI and blindness, sex was not a statistically significant risk factor in the severity of VI unlike in some Asian countries [15-17,29-31].

Dimensions of Eye Care Utilization

The shift in the top causes of bilateral childhood blindness and VI to treatable causes highlighted the need for increased pediatric eye care utilization. However, despite recommendations from the WHO, the availability of well-equipped facilities and trained personnel remained a significant dimension affecting both the severity of VI and the pediatric eye care utilization at the BGHMC [9]. Living in an urban area, where a General Ophthalmologist could see the patient right away is significantly associated with a milder VI (p<0.03) [23].

Affordability or economic status, based on the length of delay in consult was another significant dimension that affected VI severity (mild p<0.019, moderate p<0.004, and blind p<0.047) and pediatric eye care utilization at the BGHMC. Those with delays in consult of equal to or more than 6 months were assumed to be in the lowest economic status.

Recommendation

The results of this study were shared with the local policymakers to create and implement policies and programs to lower the prevalence of childhood blindness and VI among pediatric patients of the BGHMC. The identified causes shall be addressed especially the preventable (e.g. ocular trauma) and treatable (e.g. cataract and refractive errors) ones in accordance with the aims of the VISION 2020 program. Public health information drives are good ways to raise awareness among parents and caregivers on preventive measures, such as reminders not to let children play with sharp objects like scissors and sticks, and that childhood cataract and refractive errors need to be identified and treated early. Republic Act 11358 or the National Vision Screening Act can significantly help in achieving these [39]. Increasing awareness together with continued hospital financial assistance programs can help prevent delay in consultations which leads to more severe VI. The BGHMC will continue to monitor the prevalence of childhood blindness and VI in the hospital to assess the effect of these interventions. It will also maintain a local database with the hope that it will inspire the creation of a national database that will provide updated data from the country.

Programs that will incentivize ophthalmologists who choose to practice in rural areas by offering more competitive compensation, support for family, and opportunities to grow similar to what was done in India can also be introduced to increase ophthalmologists in rural areas [40]. Setting up a telemedicine system can also temporarily fill the gap [41]. Graduates of ophthalmology residency programs from the BGHMC and other tertiary DOH-retained hospitals in Northern Luzon shall be encouraged and supported to return and serve in their home provinces.

The limitations of this study included its retrospective nature and its being hospital-based which can expectedly increase the count of individuals with severe ophthalmological conditions leading to an increased prevalence. However, higher prevalences remained even when compared to similar hospital-based studies. Although community-based studies remain the best option to determine the prevalence, hospital-based studies are a safe alternative to update data in the current setting of the COVID-19 pandemic.

Conclusion

The prevalences of unilateral and bilateral VI and blindness among pediatric patients who consulted at the BGHMC in 2018 were high. The most common cause of unilateral blindness was ocular trauma while cataract was for bilateral blindness. The top cause of blindness has shifted from Vitamin A deficiency to congenital cataract in 2018. Meanwhile, the most common causes of unilateral and bilateral VI were refractive errors. Age of onset of eye disease was found to be significantly associated with the severity of VI (p<0.001) in this study, while availability (p<0.03) and affordability (mild p<0.019, moderate p<0.004, and blind p<0.047) of eye care were found to be significantly associated with the severity of VI and the pediatric eye care utilization at the BGHMC. Living in urban areas provided higher chances of being seen by an ophthalmologist and was significantly associated with a milder VI. Although most medical services were covered by PhilHealth at the BGHMC, delay in consult of more than 6 months was still high.

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