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Epidemiology of ocular disorders and visual impairment among school pupils in the Cape Coast Metropolis, Ghana

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Abstract

The purpose of the study was to determine the epidemiology of ocular disorders and visual impairment among junior high school children in the Cape Coast Metropolis, Ghana.

A cross-sectional study was conducted among junior high school children from both public and private schools. Participants underwent ophthalmic examination that included visual acuity testing, external eye examination, fundus examination, cover testing, and objective and subjective refraction. Socioeconomic statuses of the children were also determined. A principal cause of visual impairment was determined for participants with uncorrected visual acuities of 6/12 or worse in the better eyes. A total of 1252 were enumerated and 1029 children examined. Overall, ocular disorders were found among 104 (10.1%) pupils: refractive errors (37), conjunctival disorders (33), eyelid disorders (5), corneal disorders (4), retinal disorders (4), heterophoria (14), heterotropia (3), and amblyopia (4). Prevalence of visual impairment of 6/12 or worse in the better eye was 47 (4.6%), with refractive error being the major cause accounting for 37 (78.7%). Other causes were amblyopia, 4 (8.5%); retinal disorders, 4 (8.5%); and corneal disorders, 2 (4.3%). By the International Classification of Diseases (ICD) criteria, mild and moderate visual impairment using the better eye was 7.3% and 1.1%, respectively. Visual impairment was not significantly associated with age, gender, or socioeconomic status. Only 209 (20.3%) school pupils had had a previous eye examination, among whom 7 were wearing glasses. Majority (754 [73.3%]) of pupils were within low socioeconomic status ($p < .001$). The prevalence of eye disorders among junior high school pupils in the Cape Coast Metropolis was high compared to the global estimates. The cause of visual impairment was largely preventable, refractive error being the major cause. Uptake of eye care services among the school pupils was poor as majority of them had never had a previous eye examination. Incorporation of school eye screening programs into the school curriculum is recommended.

Keywords

Cape Coast, epidemiology, Ghana, ocular disorders, refractive error, visual impairment

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Introduction

The need for eye screening among school-age children has been emphasized worldwide. An estimated 25% of vision problems that school-age children suffer could be eliminated upon entry into school if appropriate eye screening programs are in place (Walker, 2009). It is recommended that children receive a comprehensive eye examination in order to assess and offer remedy in respect of deficiencies in ocular health, visual acuity (VA), refractive status, ocular motility, and binocular vision status (Walker, 2009). The interrelationships between vision problems and learning difficulties and the cost of undetected vision problems to the individual, family, and society are of concern (World Health Organization [WHO], 1999). In relation to disability-adjusted life years (DALY), childhood blindness is estimated as the second leading cause of burden due to blindness (Scheiman et al., 2002). The American Optometric Association estimates that 80% of a child's learning relies on his VA (Scheiman et al., 2002), and for this reason, early detection and treatment of eye and vision-related problems are needed. Early detection and preventive care are essential to maintain full functional ability and to avoid or minimize the consequences of disorders such as amblyopia and strabismus or even blindness (Casser, Carmiencke, Goss, Kneib, & Morrow, 2005; WHO, 1999). Although some children do show signs of visual difficulties before school-going age, many eye and visual problems become apparent when the child begins to attend school. Visual impairments (VIs) in children may be caused by a variety of disorders, and while some are untreatable, others may be remedied medically, surgically, or with the use of corrective lenses. To sufficiently deliver eye care services to children, data on the epidemiology of eye diseases and VI in children are needed in terms of resource allocation and policy initiatives. At the moment, there are no eye screening programs within the basic school system in Ghana. An earlier related study in this metropolis concentrated only on refractive error and its impact on visual disability among school pupils (Ovenseri-Ogbomo & Omuemu, 2010). The purpose of this study was therefore to provide a wider scope of assessment of ocular disorders and vision-related problems and their contribution to impaired vision among junior high school pupils in the Cape Coast Metropolis of Ghana. This information will be useful in advocacy for an eye screening program to be incorporated into the existing basic school system.

Methods

Sample selection

We conducted a descriptive cross-sectional study. Based on data from the Ghana education service (Ghana Statistical Service [GSS], 2000), there were 57 junior high schools in Cape Coast Metropolis of the Central Region of Ghana. The Central Region, situated at the southern part of the country along the Atlantic Ocean, is one of the 10 administrative regions of Ghana. The 57 junior high schools were clustered under six educational circuits in the metropolis. From each circuit, one private and one public school were randomly selected. Hence, 12 schools were randomly selected from the metropolis. All pupils from the selected schools were enumerated. Sample size calculation was based on the expression $N = Z^2 (1 - p) (p)/b^2$, where N is the minimum sample size, p is the anticipated prevalence of VI (taken as 20%), b is the desired error bound taken as 5%, and Z is the standard score at 95% confidence interval (1.96). To account for 10% attrition rate and 100% sample effect associated with cluster samples, the minimum calculated sample size was 542. The student population of all the 57 junior high schools in the metropolis was 9153, and all the students from the 12 selected schools were 1252 (13.7%). Thus, 1252 pupils were enumerated out of which 1029 were examined, giving a participation rate of 82.2%. Pupils who were absent from school on the day of examination and those whose consent forms were not signed as well as those who voluntarily declined to participate constituted the non-participation rate.

Ethical consideration

The protocol was presented to and approved by the Department of Optometry Ethical Board, University of Cape Coast. Again, permission was sought from the Regional Education Directorate and heads of the selected schools. The Regional Education Directorate and school authorities at each of the selected schools were contacted through a prescheduled personal discussion for explanation of the project objectives and procedures. Written consent forms were given to parents/guardians through their wards to be signed and returned to the schools. Pupils who had attained age 18 years signed the forms themselves. The procedure of the examination was explained to the school children before they were examined. The children were assured of safety and confidentiality. They were also informed they could refuse participation in the study at any time if they so wished.

Clinical examination

The research team consisted of five optometry practitioners (Doctors of Optometry [ODs]) and some sixth year optometry students. The ODs had undertaken studies of similar nature, and so they knew their roles. The clinical students recorded demographic data and VA testing. The ODs carried out the remaining examination procedures. Diagnosis of ocular diseases was confirmed by the resident ophthalmologist at the Department of Optometry training clinic on a subsample basis. Demographic data including, age, sex, parent's occupation, parents' level of education, residence of pupil, and previous eye examination were recorded for each participant. Socioeconomic statuses of pupils were determined as has previously been done elsewhere (El-Bayoumy, Saad, & Choudhury, 2007; Ovenseri-Ogbomo & Assien, 2010) by using parents' education, occupation, and employment status. All the pupils underwent an ophthalmic examination including VA testing, external and internal eye examination, and cover testing. VA was measured using the Snellen chart. External eye and anterior segment eye examination was performed with a penlight. Streak retinoscopy and subjective refraction (non-cycloplegic) were performed on pupils whose presenting VA was 6/9 or worse in either eye. Internal eye examination was performed by indirect ophthalmoscopy (in a dark room) after instilling two drops of 2.5% phenylephrine ophthalmic preparation (cycloplegic was not used because school terminal examinations were so close). All pupils whose presenting VAs were 6/12 or worse were assigned a cause for the VI (Pik-Pin, Yahya, Pokharel, & Ellwein, 2005; Salomão et al., 2008; Wedner et al., 2002). In the case of multiple causes in the same eye or where the causes in the right and left eyes differed, the principal cause for the person was selected as the one that was more amenable to treatment/prevention. Refractive error was assigned as the cause of the VI if in the absence of any obvious pathology, vision improved to 6/6 or better with refraction. Amblyopia was assigned the cause if, in the absence of any noticeable pathology or abnormality, there was no improvement in vision with refraction. Presenting VA was measured with habitual optical correction in place, if any, and for the non-wearer, the VA was determined without any correction. Uncorrected VA was measured without any correction on. All other definitions and diagnostic criteria were based on the International Classification of Diseases (ICD) (WHO, 2005). Pupils who were diagnosed of various eye diseases were referred to the Department of Optometry eye clinic.

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (version 16; SPSS Inc., Chicago, IL, USA). Chi-square test was used to determine associations between categorical variables. A value of $p \leq .05$ was considered statistically significant. Where applicable, logistic regression analysis was used to predict the association between dependent and independent variables.

Table 1. Relationship between gender and some measured variables.

Variable	Male, *n* (%)	Female, *n* (%)	*p*-value	OR	95% CI
Refractive error			.06		
Yes	11 (29.7)	26 (70.3)			
No	452 (45.6)	540 (54.4)			
Type of school			<.001	1.602	1.25–2.51
Public	295 (49.9)	296 (50.1)			
Private	168 (38.4)	270 (61.6)			
Previous eye examination			<.001	1.78	1.30–2.45
Yes	71 (34.0)	138 (66.0)			
No	392 (47.8)	428 (52.2)			
Socioeconomic status			.33		
High	34 (44.2)	43 (55.8)			
Medium	80 (40.4)	118 (59.6)			
Low	349 (46.3)	405 (53.7)			
Visual impairment			.1		
Yes	16 (34.1)	31 (65.9)			
No	447 (45.5)	535 (54.5)			
Wearing glasses			.1		
Yes	1 (14.3)	6 (85.7)			
No	462 (45.2)	560 (54.8)			
Cause of visual impairment			.1		
Refractive error	12 (32.4)	25 (67.6)			
Amblyopia	1 (25.0)	3 (75.0)			
Corneal disorders	1 (50.0)	1 (50.0)			
Retinal disorders	3 (75)	1 (25)			

OR = odds ratio; CI: confidence interval.

Results

Out of 1252 pupils enumerated, 1029 were examined. Their ages ranged from 9 to 22 years with a mean age of 14.78 ± 0.54 years. Of them, 591 (295 [49.9%] males, 296 [50.1%] females) were selected from public schools, while 438 (168 [38.4%] males, 270 [61.6%] females) were from private schools. A total of 463 (44.99%) were males and 566 (55.01%) were females (Table 1 shows the relationship between gender and measured variables). Majority of the pupils (754 [73.3%]) were in the low socioeconomic status, followed by medium socioeconomic status (198 [19.2%]) and high socioeconomic status (77 [7.5%]). Pupils attending public schools were more likely to belong to low socioeconomic status than their counterparts attending private schools (odds ratio [OR] = 2.56, 95% confidence interval [CI] = [1.59 - 4.15], $p < .001$). Mild VI (VI category 0: VA of 6/9 to 6/18) (WHO, 2005) in the better seeing eye was found among 72 (7.0%) participants. Moderate VI (VI category 1: VA worse than 6/18 to 6/60) in the better eye was present among 11 (1.1%) pupils (Table 2 represents VA of participants using the better eye). Monocularly, however, two pupils recorded perception of light (PL) in their left eyes (i.e. two pupils had monocular blindness of their left eyes). Uncorrected and presenting VIs of 6/12 or worse in the better eye were 47 (4.6%) and 40 (3.9%), respectively. Refractive error was the major cause of VI (37 [78.7%]), followed by amblyopia (4 [8.5%]), retinal disorders (4 [8.5%]), and corneal disorders (2 [4.3%]) (Table 1). Association between VI and socioeconomic status was statistically not

Table 2. Uncorrected visual acuity (VA) using the better seeing eye.

VA	*n* (%)
6/4	6 (0.6)
6/5	686 (66.7)
6/6	251 (24.4)
6/9	39 (3.8)
6/12	25 (2.4)
6/18	11 (1.1)
6/24	5 (0.5)
6/36	5 (0.5)
6/60	1 (0.1)
Total	1029 (100.0)

significant ($p = .22$) (Table 3). Although majority of pupils without VI (796 [81.1%]) have not had any history of previous eye examination, as much as almost half of the pupils with VI (23 [48.9%]) have not had a previous eye examination (OR = 3.90, 95% CI = [2.14 - 7.11], p-value < .001) (Table 3). A total of 209 participants responded to have had a previous eye examination of which 71 (34%) were males and 138 (66%) were females. Females were more likely to have undertaken a previous eye examination than males (OR = 1.78, 95% CI = [1.30 - 2.45], $p < .001$) (Table 1). There was no significant association between previous eye examination and socioeconomic status ($p = .41$). Seven pupils were found wearing their corrective glasses of which four pupils had their uncorrected VA worse than 6/12 while three had a VA of 6/9. Various ocular disorders were found among 104 (10.1%) pupils (Table 4 shows various eye disorders among the children) – refractive error, 37 (35.6%); consisted of myopia, 15 (40.5%); hyperopia, 13 (35.1%); and astigmatism, 9 (24.4%). Majority of pupils with refractive error (19 [51.4%]) had never had any previous eye examination, while 18 (48.6%) pupils with refractive error had had a previous eye examination. A total of 30 (81.1%) pupils with refractive errors were not wearing glasses (Table 5). Corneal disorders (4 [3.8%]) consisted of two cases of binocular corneal opacities and one monocular corneal opacity and a limbal dermoid. Retinal disorders (4 [3.8%]) were mainly toxoplasmic retinochoroiditis and optic neuritis. Heterophoria was found in 14 (13.5%) pupils, while 3 (2.9%) pupils had heterotropia (at both near and distance). Amblyopia was found in 4 (3.8%) pupils.

Discussion

The findings of 4.6% uncorrected VI of 6/12 or worse and 7.0% mild VI (of the better eye) in this study are similar to an earlier RESC (Refractive Error Study in Children) study conducted in this same metropolis (Ovenseri-Ogbomo & Omuemu, 2010). With a study population of 961 and a mean age of 10.5 ± 3.4 years, the previous study found that mild VI was 6.9% and 6.6% in the right and left eyes, respectively. That study did not, however, represent VI using the better seeing eye. Another RESC study in Agona Swedru, also in this region, with a study size of 604 (mean age of 14.52 ± 1.50 years), found uncorrected VI of 6/12 or worse in the better eye as 4.5% (Ovenseri-Ogbomo & Assien, 2010). The occurrence of 4.6% VI in this study is high compared to the global rates of 0.2% for the age group 0–14 years and 1.2% for the age group 15–39 years (Pascolini & Mariotti, 2012). Consistent findings have shown that uptake of eye care services among school children in this region is poor and that the cause of visual disability is largely preventable. This study found that just 20.3% of the study population had a previous eye examination. Again, among

Table 3. Visual impairment versus previous eye examination, socioeconomic status, and refractive error.

	Previous eye examination		*p*-value	OR	95% CI	Socioeconomic status			*p*-value	Refractive error		*p*-value
	Yes, *n* (%)	No, *n* (%)				High	Med.	Low		Yes, *n* (%)	No, *n* (%)	
Visual impairment			<.001	3.90	2.14–7.11				.22			<.001
Yes	23 (48.9)	24 (51.1)				5 (10.6)	12 (25.5)	30 (63.9)		37 (78.7)	10 (21.3)	
No	186 (18.9)	796 (81.1)				72 (7.3)	186 (18.9)	724 (73.7)		0 (0.0)	982 (100)	

OR = odds ratio; CI: confidence interval.

Table 4. Ocular disorders among the pupils.

Disorder	*n* (%)
Refractive error	37 (35.6)
Conjunctival disorders	33 (31.7)
Lid disorders	5 (4.8)
Corneal disorders	4 (3.8)
Retinal disorders	4 (3.8)
Amblyopia	4 (3.8)
Heterophoria	14 (13.5)
Heterotropia	3 (2.9)
Total	104 (100)

Table 5. Socioeconomic status and refractive error versus type of school, previous examination, and wearing of glasses.

	Type of school		*p*-value	OR	95% CI	Previous eye examination		*p*-value	Wearing glasses		*p*-value
	Public, *n* (%)	Private, *n* (%)				Yes, *n* (%)	No, *n* (%)		Yes, *n* (%)	No, *n* (%)	
Socioeconomic status			<.001	2.56	1.59–4.15			.41			.498
High	30 (39.0)	47 (61.0)				19 (24.7)	58 (75.3)		0	77 (100)	
Medium	93 (47.0)	105 (53.0)				44 (22.2)	154 (77.8)		0	198 (100)	
Low	468 (62.1)	286 (37.9)				146 (19.4)	608 (80.6)		7 (0.9)	747 (99.1)	
Refractive error			.08					<.001			<.001
Yes	16 (43.2)	21 (56.8)				18 (48.6)	19 (51.4)		7 (18.9)	30 (81.1)	
No	575 (58.0)	417 (42.0)				191 (19.3)	801 (80.7)		0	992 (100)	

OR = odds ratio; CI: confidence interval.

the 47 children with VI in this study, 24 (51.1%) had never had their eyes examined previously, while 37 (78.7%) were as a result of refractive error. The study at Agona Swedru found only 13.3% to have had a previous eye examination and worst still, the earlier study in this metropolis found just a meager 0.6% having had previous eye examination. This study also revealed that among the

37 children who needed glasses, only 7 (18.9%) children were found wearing them. In the other two studies, spectacle use was found in 3 (out of 79 who needed correction) and 6 (against 245 who needed correction), respectively (Ovenseri-Ogbomo & Assien, 2010; Ovenseri-Ogbomo & Omuemu, 2010). This study like the earlier one in the metropolis found that majority of the school children were in the lower socioeconomic status. None of these studies, however, found any association between socioeconomic status and uptake of eye care services (undergoing eye examination and obtaining glasses when indicated). The lack of association between socioeconomic status and uptake of eye care services suggests that factors other than socioeconomic status may be the barriers to uptake of eye care services in the study population. This trend of insignificant association between socioeconomic status and uptake of eye care services has also been reported in Egypt among 5839 pupils (El-Bayoumy et al., 2007). A study in Nigeria among school children, however, found an inverse relationship between ocular diseases and socioeconomic statuses of the participants (Ajaiyeoba, Isawumi, Adeoye, & Oluleye, 2007). Unlike this study, an appreciable rate of spectacle use has been reported in Egypt (El-Bayoumy et al., 2007) and Tanzania (Wedner et al., 2002) with 42.3% and 30% among 1292 and 154 pupils who, respectively, needed glasses. Different studies have also reported varying rates of spectacle usage among school children, ranging from 18.4% among 4364 school children in China (He et al., 2004), 5.9% among 2441 pupils in Brazil (Salomão et al., 2008), 3.3% among 1144 pupils in Nigeria (Ajaiyeoba et al., 2007) to a situation in South Africa where among 388 pupils (hyperopia alone accounting for 73%), no pupil was wearing spectacles (Mabaso, Oduntan & Mpolokeng, 2006). In this study, VI had a significant association with previous eye examination, meaning that pupils with VI were more likely to seek eye care services. The implication is that more pupils particularly those with visually impairing conditions are likely to patronize the provision of eye screening programs within the basic school system. This calls for the provision of eye care services into the school health program. The Vision 2020's strategy of prevention of VI recommends the full range of comprehensive eye care services to be integrated into health-care systems and delivered to the population in a stepwise manner (WHO, 2006). This is particularly true as our findings suggest that availability of eye care services will improve patronage by the pupils. In India, school eye screening is a highly cost-effective method of correcting VI in school-age children (Lester, 2007). Similar to this study, the study in Brazil found no association between VI and age or sex (Salomão et al., 2008). With the various ocular disorders reported in this study, refractive error was the major cause of uncorrected VI accounting for 78.7%. Similar findings have been reported in many studies around the world where refractive error has been identified as the single most significant cause of avoidable visual disability, accounting for up to 94% (Ajaiyeoba et al., 2007; El-Bayoumy et al., 2007; He et al., 2004; Mabaso et al., 2006; Naidoo et al., 2003; Ovenseri-Ogbomo & Assien, 2010; Pik-Pin et al., 2005; Pokharel, Negrel, Munoz, & Ellwein, 2000; Salomão et al., 2008; Wedner et al., 2002). The study in Nigeria on 1144 pupils reported ocular disorders in 15.5% in the order of conjunctival disorders, refractive errors, lid disorders, corneal disorders, and cataract. Although refractive error was the second most common ocular disorder, it was the major cause of VI (Ajaiyeoba et al., 2007). In Tanzania, refractive error accounted for 88.5% of VI of 6.9%, while non-refractive causes were strabismus (0.2%) and amblyopia (0.4%) (Wedner et al., 2002). The study in China recorded uncorrected and presenting VA of 6/12 or worse of 22.3% and 10.3%, respectively, where refractive error was the cause in 94.9% of VI. Other ocular findings were amblyopia (1.9%), media and fundus disorders (0.73%), and myopia (73.1%) (He et al., 2004). The study in Brazil among 2441 pupils recorded uncorrected and presenting VA of 6/12 or worse of 4.82% and 2.67%, respectively, with refractive error causing 76.8% of VI (Salomão et al., 2008). In highly industrialized countries of Europe, the pattern of ocular diseases is mainly retinal disorders, optic atrophy, and lesions of the higher visual pathways and retinopathy of prematurity (Kocur & Resnikoff, 2002). Differences in ethnic background,

geographical locations, and age group of pupils in the studies may account for the differences among these studies. It should be recognized, however, that the immediate public health problem pertains not to patterns and prevalence of VI per se but to the impact of VI on academic performances, quality of life and career preparation of school children, and the extent to which VI remains uncorrected although highly avoidable. Because of the relative ease of obtaining refractive error services, low uptake of refractive error services is a reflection of the poor state of eye care services. The general uptake of eye care services was found to be low in this study. The revelation that only 20.3% of the children had previously undertaken eye examination is alarming considering the fact that these students had at least 6 years of primary education without undergoing any eye examination either in the community or in school. This calls for incorporation of eye screening programs into the existing basic school system. Elsewhere in Australia, it is reported that about 20% of the population have their eyes examined each year (Taylor, Livingston, Stanislavsky & McCarty, 1997). There has been a recommendation from the American Academy of Pediatrics that children have their eyes checked throughout their first year in life and also to have a routine eye examination every year beginning at age 5 years (Swanson et al., 2002).

In this study, the prevalence of eye disorders among junior high school in the Cape Coast Metropolis was found to be high as compared to global estimates. VI among the school pupils was still a problem as earlier studies have found, and refractive error was the major cause of VI. Uptake of eye care services among the school pupils was poor as majority of them had never had previous eye examinations. We recommend incorporation of school eye screening programs into the school curriculum.

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References

Ajaiyeoba, A. I., Isawumi, M. A., Adeoye, A. O., & Oluleye, T. S. (2007). Pattern of eye diseases and visual impairment among students in southwestern Nigeria. *International Ophthalmology*, *27*, 287–292.

Casser, C., Carmiencke, K., Goss, D. A., Kneib, B. A., & Morrow, D. (2005). *Optometric clinical practice guideline: Comprehensive adult eye and vision examination* (2nd Edn). St. Louis, MO: American Optometric Association.

El-Bayoumy, B. M., Saad, A., & Choudhury, A. H. (2007). Prevalence of refractive error and low vision among school children in Cairo. *Eastern Mediterranean Health Journal*, *13*, 575–579.

Ghana Statistical Service [GSS]. (2000). *Population and housing census: Summary report of final results*. Accra.

He, M., Zeng, J., Liu, Y., Xu, J., Pokharel, G. P., & Ellwein, L. B. (2004). Refractive error and visual impairment in urban children in Southern China. *Investigative Ophthalmology & Visual Science*, *45*, 793–799.

Kocur, I., & Resnikoff, S. (2002). Visual impairment and blindness in Europe and their prevention. *British Journal of Ophthalmology*, *86*, 716–722.

Lester, B. A. (2007). Comparing the cost-effectiveness of school eye screening versus a primary eye care model to provide refractive error services for children in India. *Community Eye Health*, *20*, 15.

Mabaso, R. G., Oduntan, A. O., & Mpolokeng, M. B. L. (2006). Refractive status of primary school children in Mopani district, Limpopo Province, South Africa. *South African Optometrist*, *65*, 125–133.

Naidoo, K. S., Raghunandan, A., Mashige, K. P., Govender, P., Holden, B. A., Pokharel, G. P., & Ellwein, L. B. (2003). Refractive error and visual impairment in African children in South Africa. *Investigative Ophthalmology & Visual Science*, *44*, 3764–3770.

Ovenseri-Ogbomo, G. O., & Assien, R. (2010). Refractive error in school children in Agona Swedru, Ghana. *South African Optometrist*, *69*, 86–92.

Ovenseri-Ogbomo, G. O., & Omuemu, V. O. (2010). Prevalence of refractive error among school children in the Cape Coast Municipality, Ghana. *Clinical Optometry*, *2*, 59–66.

Pascolini, D., & Mariotti, S. P. (2012). Global estimates of visual impairment: 2010. *British Journal of Ophthalmology*, *96*, 614–618.

Pik-Pin, G., Yahya, A., Pokharel, G. P., & Ellwein, L. B. (2005). Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *Ophthalmology*, *112*, 678–685.

Pokharel, G. P., Negrel, A. D., Munoz, S. R., & Ellwein, L. B. (2000). Refractive error in children: Result from Mechi Zone, Nepal. *American Journal of Ophthalmology*, *129*, 436–444.

Salomão, S. R., Cinoto, W., Berezovsky, A., Mendieta, L., Nakanami, C. R., Lipener, C., . . . Ellwein, L. B. (2008). Prevalence and causes of visual impairment in low-middle income school children in São Paulo, Brazil. *Investigative Ophthalmology & Visual Science*, *49*, 4308–4313.

Scheiman, M. M., Amos, C. S., Ciner, E. B., Marsh-Tootle, W., Moore, D. B., & Rouse, M. W. (2002). *Optometric clinical practice guidelines: Paediatric eye and vision examination* (2nd Edn). St. Louis, MO: American Optometric Association.

Swanson, J. T., France, L. F., Grimm, K. C. T., Harbaugh, N., Herr, T., Jakubec, J., . . . Yasuda, K. (2002). Use of photoscreening for children's vision screening. *Pediatrics*, *109*, 524–525.

Taylor, H. R., Livingston, P. M., Stanislavsky, Y. L., & McCarty, C. A. (1997). Visual impairment in Australia: Distance visual acuity, near vision, and visual field findings of the Melbourne visual impairment project. *American Journal of Ophthalmology*, *123*, 328–337.

Walker, D. K. (2009). *Building a comprehensive child vision care system: A report of the National Commission on Vision and Health*. Cambridge, MA: ABT Associates, Inc. (The Commission, Alexandria, VA).

Wedner, S. H., Ross, D. A., Todd, J., Anemona, A., Balira, R., & Foster, A. (2002). Myopia in secondary school students in Mwanza City, Tanzania: The need for a national screening program. *British Journal of Ophthalmology*, *86*, 1200–1206.

World Health Organization. (1999). Report of WHO/IAPB scientific meeting, Hyderabad, India, 13–17 April. Childhood Blindness Prevention (WHO/PBL/87). Retrieved from http://whqlibdoc.who.int/hq/2000/WHO_PBL_00.77.pdf

World Health Organization. (2005). *International statistical classification of diseases and related health problems* (10th Revision, 2nd Edn). Geneva: Author.

World Health Organization. (2006). *VISION 2020 action plan for 2006–2011*. Geneva: Author.