Project Hawkeye: A cross-sectional study on the prevalence of undetected refractive errors in school-age children

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Abstract

Introduction In the Philippines, essential eye care services are not easily accessible especially for those in lower income groups, putting public elementary school students at risk for under-diagnosis of problems in visual acuity. The objective of this investigation was to determine prevalence of undetected refractive errors among public elementary students using the Welch Allyn Spot™ Vision Screener.

Methods A cross-sectional design was used in this investigation to estimate the prevalence of uncorrected refractive errors in the first grade students in San Perfecto Elementary School using Welch Allyn Spot™ Vision Screener (Photoscreener). Eligible students who gave informed consent and assent answered a questionnaire and underwent an eye examination. The prevalence of undetected errors of refraction were computed for the sample population and for selected demographic variables.

Results Approximately one out of four students (24.53%) had errors of refraction, with the most common type being astigmatism (22.64%), followed by myopia (3.77%) and hyperopia (2.83%).

Conclusion This study revealed a high prevalence of undetected refractive errors among school-age children, higher than current published data (5%) in the Philippines.

Key words: Undetected refractive errors, Welch Allyn Spot™ Vision Screener, school-age children

The World Health Organization defined refraction error as "a very common eye disorder that could occur when the eye would not clearly focus the images from the outside world."[1] The most common refractive errors are myopia, hyperopia, astigmatism, and presbyopia. These vision problems can be easily addressed with the use of eyeglasses.[2] In addition, the WHO also emphasized that "school-age children constituted a particularly vulnerable group, where uncorrected refractive error might have a dramatic impact on learning capability and educational potential."[2] It also mentioned that uncorrected

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refractive error "could have a potential negative impact on career choice, ocular health, and sometimes, even self-esteem."[3]

In the Philippines, however, essential eye care services (e.g., vision testing and screening) have not been easily accessible, especially to those in the lower income group, including public elementary school students, making them at risk for under-diagnosis of these vision problems. While there is a legislative bill in the Philippine senate establishing a national vision screening program for kindergarten pupils, this would cater only to children entering the public school system. Students past the kindergarten level might have undetected eye problems, as well.[4] Thus, from a public health perspective, addressing this concern is relevant and requires urgent attention.

The general objective of this investigation was to determine prevalence of undetected refractive errors among first grade students in a public elementary school. Through this vision screening, the students who needed comprehensive examination by a pediatric ophthalmologist were identified. In addition, it also identified among those who tested positive what specific type of refractive errors the students suffered from.

Methods

A cross-sectional design was used in this investigation to estimate the prevalence of uncorrected refractive errors in the first grade students in San Perfecto Elementary School using the Welch Allyn Spot™ Vision Screener (Photoscreener). Eligible students who gave informed consent and assent answered a questionnaire and underwent an eye examination. The prevalence of undetected errors of refraction were computed for the sample population and for selected demographic variables. This study was approved by the Ethics Review Committee of UERMMMCI Research Institute for Health Sciences and coordinated with school authorities.

Subjects were chosen from the list of Grade 1 students enrolled in San Perfecto Elementary School. Sample size was estimated using an online application Open Epi to achieve a 95% level of confidence, precision of 5%, given an estimated prevalence of refractive errors of 5.04%.[5] The sample size obtained was adjusted for the anticipated non-participation rate; the final sample size was 82 subjects.

San Perfecto Elementary School was randomly selected based on the list of public elementary schools of the Department of Education in San Juan City. A list of first grade students was obtained, and those aged 6 years or older were recruited, as per 2014 recommendations of the Philippine Eye Research Institute (PERI) to perform vision screening in children every 1 to 2 years, after attaining 5 years old.[4] The study was explained to the students and their parents. Written informed consent was obtained from their parents and assent, from the children. Students who did not sign the assent were eventually excluded from the study.

Prior to the vision screening, a simple questionnaire was administered to the students. The questionnaire was constructed by the researchers, based on previous studies that described the population of interest, and was duly pilot-tested. This data ollection tool was used to describe the characteristics of the participants. It was administered to the students, with selected members of the research team assisting them. All students who agreed to participate in the research and answered the questionnaire were then examined using Welch Allyn Spot™ Vision Screener, which had been reported to have an 87.7% sensitivity and 75.9% specificity in detecting amblyopia.[6] Those found to have refractive errors were subsequently referred to the Department of Ophthalmology of the UERM Memorial Hospital PO Domingo Out-Patient Services for further evaluation and definitive management.

To ensure data integrity and minimize observer bias, only one person operated the equipment to screen all study participants. A Philippine board-certified pediatric ophthalmologist was also present during the study to supervise the examination procedure. In addition, there were only two assigned persons for data management (i.e., data coding, entry, cleaning, and statistical analysis). Frequencies were first encoded in Microsoft Office Excel 2013 and were then analyzed using Epi Info 7. The prevalence of undetected refractive errors was computed for the whole study population and according to age, sex, occupational status of parents, awareness of having errors of refraction, and access to ophthalmological health care.

Results

There were 125 students who met the inclusion criteria, all of whom were invited and eventually recruited for the study. A total of 106 pupils participated in the study and their sociodemographic

profile is summarized in Tables 1 and 2. Majority of them (64.15%) were six years old, with equal proportions of male and female subjects. None of the study participants were wearing corrective eyeglasses during the data collection.

Table 1. Characteristics of respondents according to age, sex, and responses to survey (N=106)

Characteristic	Frequency	Percentage (%)
Age (yr)		
5	15	14.15
6	68	64.15
7	16	15.09
8 to 10	7	6.60
Mean ± SD = 6.17 ± 0.834		
Sex		
Male	53	50.00
Female	53	50.00
Primary caregiver at home		
Both parents	24	22.64
One parent	61	57.55
Others	21	19.81
Employment of parents		
Both parents not employed	6	5.66
Mother only employed	22	20.75
Father only employed	52	49.06
Both parents employed	26	24.53

Table 2. Summary of responses to questionaire

	n=106	%
Answer to *"Malabo ba ang mata mo?"*		
Yes	12	11.32
No	94	88.68
Did a doctor check respondent's eyes in the past year?		
Yes	20	18.87
No	86	81.13
"Does anyone in the family wear eyeglasses?"		
Yes	52	49.06
No	54	50.94
"Do you inform parents/teachers when you feel pain/itching in your eyes?"		
Yes	53	50.00
No	53	50.00
"Do you do homework at home before coming to school?"		
Yes	84	79.25
No	22	20.75
"Do you read books, aside from those assigned in school?"		
Yes	54	50.94
No	52	49.06
"Do you watch television?"		
Every day	69	65.09
A few times a week	31	29.25
Not at all	6	5.66
"Do you play video games?"		
Every day	44	41.51
A few times a week	29	27.36
Not at all	33	31.13
"Do you use the computer aside from playing video games?"		
Every day	23	21.7
A few times a week	16	15.09
Not at all	67	63.21
"Do you play outdoors or play sports?"		
Every day	57	53.77
A few times a week	19	17.92
Not at all	30	28.3

The Welch Allyn Spot™ Vision Screener detected cases of refractive errors in 26 subjects, for an overall prevalence of 24.53%. As seen in Table 3, astigmatism was the most common bilateral (14.15%) or unilateral (8.49%) eye pathology. A few students had myopia (3.75%), hyperopia (2.83%), and anisometropia (2.83%), but there was no documentation of presbyopia.

The prevalence of refractive errors was also noted to be more common among the following subject profile: those who were five-year olds (26.67%), followed by six-year and seven-year olds, females (26.42%) versus males (Table 4); those whose primary caregiver was only one parent or someone else aside from their parents (2.00%), those whose parents were both unemployed (33.33%), those who admitted having poor vision (25.00%), those who consulted any physician to have their eyes examined in the previous year (35.00%), those who did not have any relatives with corrective eyeglasses (25.93%), those who did not report to their teachers whenever their eyes were painful or felt itchy (26.42%), those who did their homework at home before going to school

(26.19%), those who did not read books aside from those assigned by the school (25.00%), those who never watched television (33.33%), those who played video games a few times per week (27.59%), those who never used the computer aside from playing video games, and those who never played sports or did outdoor activities (30.00%) (Please refer to Table 5).

Discussion

The prevalence of refractive errors among Grade 1 students in San Perfecto Elementary School (24.53%) in San Juan City was higher than those shown in most literature in other countries. For instance, a study in Ethiopia found the prevalence of refractive

Table 3. Prevalence of type of refractive errors detected in the respondents based on visual screening

Type of refractive error	Frequency	Prevalence (%)
Astigmatism		
Right eye only	9	8.49
Left eye only	0	0
Both	15	14.15
Myopia		
Right eye only	2	1.89
Left eye only	0	0
Both	2	1.89
Hyperopia		
Right eye only	0	0
Left eye only	1	0.94
Both	2	1.89
Anisometropia	3	2.83

Table 4. Prevalence of refractive errors according to respondents' age and sex

	Prevalence (%)
Age (yr)	
5	26.67
6	25.00
7	25.00
8	20.00
Sex	
Male	22.65
Female	26.42

Table 5. Prevalence of refractive errors according to the respondents' answers to questionnaire

	Prevalence (%)
Primary caregiver at home	
Both parents	21.43
One parent	25.00
Others	25.00
Employment of parents	
Both unemployed	33.33
Mother only employed	18.18
Father only employed	26.92
Both employed	23.08
"Malabo ba ang iyong mga mata?"	
Yes	25.00
No	24.47
Had their eyes checked by the physician in the last one year.	
Yes	35.00
No	22.09
Does another family member use eyeglasses?	
Yes	23.08
No	25.93
Report to their teachers whenever their eyes are painful or itchy	
Yes	22.64
No	26.42
Accomplishes their homework at home before going to school	
Yes	26.19
No	18.18
Reads books aside from those required by school	
Yes	24.07
No	25.00
Television use	
Daily	26.09
A few times a week	19.35
Not at all	33.33
Video game use	
Daily	25.00
A few times a week	27.59
Not at all	21.21
Computer use	
Daily	26.09
A few times a week	18.75
Not at all	25.37
Playing outdoors/playing sports	
Daily	21.05
A few times a week	26.32
Not at all	30.00

errors among schoolchildren aged 7 to 15 to be 6.3%.[7] Another study in India reported that the prevalence of refractive error among schoolchildren of the same age bracket was 7.03%.[8] However, compared to the present study, these foreign studies used eye charts (e.g., Snellen and Jaeger) instead of the photo screener. Furthermore, refractive errors among the participants were more prevalent in the five-year olds than the older schoolchildren - a finding consistent with previous investigations that suggested the hyperopic shift might have taken place (i.e., myopia had been documented to be more prevalent in younger population and eventually diminishing with advanced age).[9] Thus, the prevalence of errors of refraction had been reported to be actually less among children more than 5 to 10 years of age.

More female schoolchildren had refractive errors than males. Some experts theorized that the eye of a female appeared to have a shorter axial length and shallower anterior chamber depth than that of a male; hence, the higher probability of being hyperopic among females.[10] However, this observation had been challenged by other investigations, and another viewpoint suggested that the prevalence of refractive errors among school-children did not significantly differ between biological sexes.[11] Nonetheless, more studies supported the female preponderance of refractive errors.

The prevalence of refractive errors was higher among those who admitted having poor vision and those who consulted the physician in the last one year with complaints of abnormal eyesight (i.e., painless blurring of vision). For schoolchildren with refractive errors who did not tell their teachers whenever their eyes felt painful or itchy, they could have resorted to excessive tearing, covering, blinking, closing, or rubbing their eyes instead to relieve their symptoms and to address the issue of blurring of vision.

It was striking that refractive errors were more common among those who did not have any known relatives wearing eyeglasses. Refractive errors, like most medical conditions, had been shown to have some form of genetic bases; they might have probable heritable traits. This finding suggests that the interaction of genetic and environmental factors could better predict the occurrence of refractive errors among children.

However, asking the schoolchildren for any relatives with eyeglasses entailed possible risk of missing those who regularly used contact lenses, which the schoolchildren might be unaware of. In fact, in a study regarding awareness and attitude towards refractive error correction methods, 80.3% were unaware of contact lens usage, and a significant correlation between educational level and knowledge of contact lens usage was established. Some individuals, although suffering from visual impairment, might prefer not to wear eyeglasses at all, since some might argue that eyeglasses could have limiting effects on their activities of daily living, or they simply lacked access to affordable refractive services and corrective lenses.[12]

Nonetheless, disease of the eye might be undetected or under-diagnosed. For instance, in a study among Latin patients, 53% had various eye diseases, of which 63% were previously undetected.[13] Thus, further probe on the eye diseases of the schoolchildren's family and their corresponding knowledge might possibly reveal the current burden of refractive errors among the general population. However, this was beyond the scope of this study.

Majority of schoolchildren who never or minimally spent time doing outdoor and sports activites also had refractive errors. Recent pertinent studies had established among children who engaged more time doing outdoor activities had less chances of becoming myopic.[14] Some experts theorized that children might develop refractive errors from spending too much time indoors, or from reading or playing video games excessively, thereby exhausting their eyes, especially if they did so in poorly illuminated rooms, which could precipitate eyestrain.

On the other hand, refractive errors might cause these schoolchildren not to enjoy doing outdoor activities due to difficulty in seeing their surroundings, especially at a distance. Since the children were very much familiar with their homes, other experts suggested that children with undetected refractive errors might prefer to stay indoors because they found it more difficult to adapt outdoors, where more variable visual stimuli demanded more physiologic compensatory mechanisms in the eyes. These schoolchildren might also be discouraged to stay outdoors, perhaps because they were not at par with the play performance of their peers. Indeed, even before reaching schoolage, some children with visual impairments already exhibited some forms of clincial developmental delays, including inability to

appropriately participate in pretend play.[13] Morever, others who had difficulty in symbolic play might also suffer deficits in language and social-emotional development.[15]

Another study linked unemployment of biological parents to uncorrected refractive errors among children and adult relatives.[13] Intuitively, these pictured a cycle of poverty, with possible concomitant malnutrition, leading to the public health burden of undetected refractive errors not only in pediatric populations, but also in adults and older age groups, across generations.

Using the Welch Allyn Spot™ Vision Screener, the prevalence of undetected refractive errors among school-age children in the first grade was 24.53% - a finding much higher as documented by other previous studies done in the Philippines. Refractive errors were more common in schoolchildren who were females, who belonged to the lower socioeconomic stratum, who did not regularly engange in outdoors activities, and peculiarly had no known relatives wearing corrective eyeglasses. The findings of this investigation suggested a more complex interplay of genetic and environmental factors, possibly affecting the prevalence of refractive errors in young pediatric populations.

This cross-sectional study described the burden of undetected refractive errors in a small pediatric population in San Juan City, using a novel screening tool - the Welch Allyn Spot™ Vision Screener. The said tool appeared to be a convenient method in screening for visual impairment in a resource-limited locality. However, there was no attempt to determine the accuracy of the said tool, nor was there any intention to establish causal factors for refractive errors in school-age children.

Future studies might explore the usefulness of the Welch Allyn Spot™ Vision Screener in generating a wider or even a national database on visual acuity disorders, in monitoring the progression of refractive errors in a cohort of study subjects, both pediatric and adult age groups, as well as in formulating health policies and future programs on eye and vision care. Probing for risk factors for eye diseases and visual impairment in children and their families, as well as their corresponding knowledge levels on proper eye care, might produce a more accurate picture of the true burden of errors of refraction among Filipino families and communities.

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