Assessing the performance of vision screening performed by trained teachers in school children

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Received- 02 November 2018 Initial Review - 19 November 2018 Accepted - 07 December 2018

ABSTRACT

Background: The World Health Organization report states that visually impaired individuals around the world are as high as 285 million. **Aim:** This study aims to assess the validity of teacher-based vision screening in primary schoolchildren (aged 6–7 years), implemented post-training. **Methods:** The study was conducted between November 2014 and February 2015 in Aydin province of Turkey and it was planned in different phases; invitation of teachers for participation in the study, implementation of teacher training program for the screening of refractive error, strabismus and color blindness, and testing the teachers' performance. To evaluate the validity of the proposed teacher-based visual screening, the assessment results of the teachers were compared with the ophthalmologist's diagnosis which was regarded as the gold standard. Results were expressed in terms of sensitivity, specificity, and positive and negative predictive values. **Results:** Eight teachers who successfully completed the training and participated in the student's screening process, had teaching experience ranging from 5 to 15 years. The false positive error and false negative error rates were about 3% and 7%, respectively. Further, quantification yielded sensitivity of 84%, specificity of 94%, positive predictive value of 91%, and negative predictive value of 88%. **Conclusions:** Teachers with adequate training can accurately and reliably detect the refractive error, strabismus, and color blindness in schoolchildren.

Key words: *Eye problems, Schoolchildren, Teachers, Vision screening*

According to the World Health Organization (WHO), people with visual impairment around the world are in excess, i.e., 285 million and about 39 million are blind. About 19 million children are classified as visually impaired, of which >90% live in developing countries, the vast majority of them in rural areas of the least-developed countries [1].

To address the issue, a global coalition of non-governmental organizations and the WHO has launched an initiative program Vision 2020: The right to sight [2]. It was strategized for the elimination of avoidable visual impairment and blindness and one of its core focus areas is the correction of visual impairment at an early age. Success of this program, in general, necessitates gathering reliable information concerning the visual impairment screening and its treatment. However, access to this information is limited in developing countries such as in Turkey. Screening is used widely for identifying children with reduced vision. Regular screening for correctable visual problems has been mandated for many years as a part of several federal programs in many developed countries and is typically the responsibility of the school nurses [3]. However, Turkey has not yet implemented such program at a national scale.

In Turkey, about 18 million students are presently in the kinder gardens, primary schools, and high schools. In 2015–2016, nearly 5 million students attended primary schools operated under the Ministry of National Education [4]. According to a variety of region-specific pilot studies in Turkey, the prevalence of refractive error was found in the range of 5.3%–37% and strabismus from 2.5% to 12%, amidst elementary school students [5-8]. This indicates significant prevalence of eye disorders in the schoolchildren of Turkey, where the students are supposed to be regularly screened in "public community health centers" in coordination with their family physicians or health technicians as directed by the health rules and regulations [4]. However, many students miss this crucial screening due to a number of reasons including the implementation difficulties of the public policies and follow through. Nurses can play an important role in screening [9], but given the lack of nurses and nursing services in the schools, it is the teachers who may potentially overtake the function of nurses and participate in vision screening after being properly trained, thus leading to early diagnosis of children. Such potential has been investigated by several studies conducted in different countries with a focus on detecting refractive errors only [10-13]. It has also been suggested that in addition to eye screening programs amidst elementary school students to detect refractive error, other disorders such as strabismus and color vision

deficiency, which can also be accessed screened and evaluated, should be integrated into routine screening programs [14-18].

This research was, therefore, initiated, with an intent to determine exact role that the trained teachers could play in visual screening process for children with visual impairment in public schools. We aimed to assess the performance and validity of the teacher vision screening in primary schoolchildren.

MATERIALS AND METHODS

The quasi-experimental study was conducted between November 2014 and February 2015. The research adhered to the tenets of the Declaration of Helsinki and ethical clearance was approved by the institutional ethics committee. Initially, 10 teachers were enrolled into the training program after obtaining their written consent. The written consents from those parents interested in the study were then obtained to include their children in the study. Students (6–11 years) were selected from 1st to 4th grade from primary school section.

Previously, the regional office of National Education Ministry in the city of Soke in Aydin province was contacted for the approving and assigning two schools; one for recruiting the teachers and the other for recruiting the students. The specific criteria were (1) the schools had to be from rural areas or no earlier record of visual screening, (2) the teachers were required to have at least 5 years of professional education experience, and (3) the students were to have no history of diagnosed eye disease and be enrolled in either 1st, 2nd, 3rd, or 4th grade (6–11 years old). The study was planned in different phases; inviting teachers to participate in the study and selecting teachers, implementing eye screening training program to the teachers in vision screening of schoolchildren, and testing the teachers' performance in detecting the eye health problems by comparing to those of ophthalmologist.

An ophthalmologist was assigned for conducting a 3-week training session of the teachers in collaboration with the principal investigator (NK). They conducted a 10 h training session in a 3-week period. The sessions focused on filling the survey forms, checklists, and performing specific visual screening tests (Snellen card, cover/uncover test, and Ishihara test) for detecting visual impairments in the participating cohort of primary schoolchildren.

Visual acuity test for screening refractive errors was developed for screening refractive errors using a retroilluminated Snellen's visual acuity chart. The chart was positioned about 6 meters from the subject at the eye level. The subject was suspected as having refractive error if one eye has <80% vision or the difference between the eyes is >30%.

Cover/uncover tests for screening strabismus are a test where the child first focuses on an interesting object such as a small toy at about 3 meters away. The examiner covers one eye with a handheld occluder or cupped hand while watching the other eye for any movement of fixation. The examiner then removes the cover to see if the first eye has deviated. If no movement is elicited on the test, an alternate cover test is performed by adopting the same procedure, while the examiner looks for ocular deviation. If misalignment of either eye occurs during these provocative maneuvers, strabismus is indicated. With practice, the entire ocular alignment screening examination can be accomplished in about 60 s.

Color blindness was classified in three parts as normal, partially deficient, or total color vision deficiency as determined by Ishihara vision test. Subject is presented with a colored figure from a booklet which shows a mosaic pattern of a number painted with a specific color. The subject is then asked to recognize the embedded number in the pattern. The level of recognition is rated for the classification purpose.

After the theoretical and practical training sessions were over, each teacher conducted visual screening tests on the children from their schools. The ophthalmologist then tested the same students using the same tools followed by comparing the results of the teachers and the ophthalmologist. The performances of two teachers were found to be dissatisfying as they could not follow the procedures fully, and they were excluded from the study.

Since this tests measure visual angle, illumination in the room and alienation from the crowd are essential factors affecting the visual screening. Therefore, maximum care was exercised for attaining optimal performance and proper evaluation. This phase of the study was conducted with the remaining eight teachers in a room equipped for the tests. Before the teachers' performing the vision screening, the students were tested by the ophthalmologist who dedicated 2 weeks of time to examine approximately 30 students per day since each examination took around 10 min/student. These vision screening results of the ophthalmologist were kept blinded/undisclosed from the teachers. The teachers then repeated the same examination procedures one by one on the students independently, in the absence of the ophthalmologist, on the same day to conduct an unbiased assessment.

To evaluate the validity of visual screening by teachers, the assessment results were compared with the ophthalmologist diagnosis regarded as the gold standard. The sensitivity, specificity, and positive and negative predictive value with 95% confidence intervals were calculated, and the results were expressed as percentages or means.

RESULTS

A total of 300 primary school students from 1st to 4th grade were included in the study. The average age of the students was 9.1±1.3 (range: 6–11 years) where 60% of females and 40% were male (145 boys and 155 girls). The eight enrolled teachers had teaching experience of 5–15 years (median 10 years).

The visual assessment results of the students by ophthalmologist are presented in Table 1. Totally 55.3% of the students (166) were identified as having no eye problems and 134 students (44.7%) as suffering from at least one sort of visual impairment; 75 (56%) with refractive error, 41 (31%) with strabismus, or 18 (13%) with color blindness by the ophthalmologist.

The visual assessment results of the students by the trained teachers are presented in Table 2. Teachers' performance in

Table 1: Gender and grade distribution of children with visual impairment detected in 300 children by an ophthalmologist

Grades	Normal vision (n=166)	Visual impairment (n=134)		
		Refractive error (n: 75)	Strabismus (n: 41)	Color blindness (n: 18)
	n (%)	n (%)	n (%)	n (%)
Grade 1	23 (14)	14 (19)	10 (24)	6 (33)
Grade 2	39 (23)	13 (17)	11 (27)	3 (17)
Grade 3	48 (29)	19 (25)	7 (17)	5 (28)
Grade 4	56 (34)	29 (39)	13 (32)	4 (22)
Total	166 (100)	75 (100)	41 (100)	18 (100)

visual assessment exhibited variations. For example, teacher T1 correctly identified 100 of the 134 students who had visual deficiency but identified the remaining 34 as normal. Teacher T1 also made errors when evaluating the students with normal vision since 26 of these 166 normal students were identified as having the condition of impairment. The other 140 students were correctly identified as normal.

On the average, the teachers identified 112 students visually impaired correctly but identified 10 students as false positive. Thus, the false positive error rate in identifying the visual impairment among the children by the teachers was about 3%. Teachers identified no vision problem in 22 students who actually had impaired vision. Thus, the false negative error rate in identifying the visual impairment among the children by the teachers was about 7%. Sensitivity and specificity were 84% and 94%, respectively, in the screening done by teachers and positive predictive value was found to be 91%, negative predictive value was found to be 88%.

Table 2: Comparison of teacher's visual assessments (combination of all three impairment conditions) of the students against the diagnosis by an ophthalmologist

T	Ophthalmologist's assessment: Visual impairment (+) n: 134		Ophthalmologist's assessment: No visual impairment (Vi) (-) n: 166	
	True positive	False negative	False positive	True negative
T1	100	34	26	140
T2	97	37	11	155
T3	93	41	7	159
T4	107	27	4	162
T5	114	20	3	163
T6	126	8	18	148
T7	130	4	12	154
T8	128	6	1	165
Mean value	112	22	10	156

T: Teachers

DISCUSSION

In many countries, including Tanzania, Mexico, North America, New York, South Africa, Thailand, and Vietnam, health nurses are not employed in the schools. Therefore, the potential role of school teachers in vision screening has been investigated. [10-14,19-21]. The current systematic study further demonstrated this potential, as teachers reliably identified the students' visual impairment as the false positive error rate was about 3%. In the past, Wedner *et al*. [14] from Tanzania measured the prevalence of eye diseases in primary schoolchildren. Simple screening by teachers correctly identified 80% of the pupils who were found to have bilateral poor eyesight by the eye team, with 91% specificity and 70% sensitivity. To determine whether teachers' abilities to detect vision problems in their students could be enhanced, Krumholtz reported a statistically significant increase in the ability of teachers to correctly identify children with functional visual problems based on education [10]. It was recommended that an in-service lecture is given to school teachers to heighten their awareness of vision problems that may impact learning performance. In a study performed by Sharma *et al*., it was reported that vision screening performed by teachers can achieve accurate results after providing a brief training in this setting and there is support among teachers for screening [12].

Sudhan *et al*. assessed the effectiveness of teachers in a vision screening program for children in classes 5th–12th in India [22]. Teachers screened 68,833 of these 77,778 enrolled children achieving coverage of 88.50%. 1713 (57.97%) children were identified as false positives after the examination by the ophthalmic assistants. Ophthalmic assistants examined another 543 children who were identified as normal by the school teachers and identified 33 (6.08%) of these 543 children as false negatives. Our study results, in comparison to this study, provided less false negatives ratio. OstadiMoghaddam *et al*. determined the sensitivity and specificity of the screening tests performed by the teachers as 37.5% and 92.0%, respectively [11]. The positive and negative predictive values were 25.0% and 95.4%, respectively. Teerawattananon *et al*. assessed the accuracy and feasibility of screening by teachers and indicated that screening program conducted in schools by teachers was reasonable and feasible, but teachers would benefit from further education and that the vast majority of teachers are willing to conduct a school-based screening program [13]. Paudel *et al*. determined sensitivity and specificity of teachers' vision screening, the same were 86.7% and 95.7%, respectively [21].

Latorre-Arteaga *et al*. reported to analyze the utility of vision screening conducted by teachers and to contribute to a better estimation of the prevalence of childhood refractive errors [23]. The prevalence of refractive error was 6.2% (pre-schoolchildren) and 6.9% (elementary schoolchildren); specificity of teachers' vision screening was 95.8% and 93.0%, while positive predictive value was 59.1% and 47.8% for each group, respectively. In a

parallel study, Saxena *et al*. determined the sensitivity as 79.2% and specificity as 93.3% in visual screening by teachers [24].

The prevalence of eye disorder among the participating population of schoolchildren in our study was 45%, of which 56% was refractive errors, 31% was strabismus, and 13% was color blind. The corresponding values representing the subclassification of the overall population were, respectively, 25%, 14%, and 6%. These findings were within the ranges reported in the literature for Turkey for refractive errors (0.4–56.5%) and color blindness (2–7%), but slightly higher for strabismus (2.5–13.9%) [5-9].

On an average, the eight enrolled teachers for the study achieved sensitivity of 84%, specificity of 94%, positive predictive value of 91%, and negative predictive value of 88% in visual screen in of three important eye conditions.

CONCLUSIONS

Inadequate resources and personnel lead to lack of regular vision screening by nurse or other health professionals in primary school-aged children in many countries. However, when properly trained, teachers can reliably perform the basic visual screening task for detecting the impairments in schoolchildren.

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Funding: None; Conflict of Interest: None Stated.

How to cite this article: Kirag N, Bilgen M. Assessing the performance of vision screening performed by trained teachers in school children. Indian J Child Health. 2018; 5(12):709-712.

Doi: 10.32677/IJCH.2018.v05.i12.001