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Survey of Refractive Errors in Secondary School and Refractive Errors Based- School Screening in Vietnam

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Abstract

BACKGROUND: School-based visual acuity screening activities calculate the rates of students with possible refractive errors (REs). School staff informs the results of the children's parents and the need for an in-depth examination to assist students with RE.

AIM: The study aimed to identify the prevalence of REs among secondary students and REs based school screening in some provinces in Vietnam.

METHODS: There are 4838 secondary students participating in the survey. All of them were screened for visual acuity by trained school staff including teachers and nurses. Then, a sub-sample of 1404 students was randomly selected for examination by ophthalmologists. There is a set of criteria to identify cases of low vision. We compared the school staff's visual acuity screening results with ophthalmologists' results to identify the difference in visual screening methods.

RESULTS: The proportion of students with untreated eye problems and that of students with an uncorrected refractive error are currently quite high (at, respectively, 18.5% and 24.6%), especially in urban areas in Da Nang and Hai Duong provinces. Two of three children with RE have not received the appropriate correction. The results of visual acuity screenings were conducted by school staff in the target area have a sensitivity of 60.9% and a specificity of 93.8%.

CONCLUSIONS: This indicates that efforts toward detecting students with RE need investments to mitigate the current issues in secondary school. The results suggest that school staffs including teachers and nurses need to be trained with better knowledge and skills in performing screening to improve their screening performance.

Introduction

Vietnam's National Prevention of Blindness Strategic Plan (2015–2020) identified refractive errors (RE) and childhood visual disorder as among the key areas to be addressed to cut back on the burden of avoidable blindness throughout the country. However, eye health has not been yet officially enclosed in the school health curriculum. Besides, there is a lack of guidelines for school staffs regarding implementing vision screening for students. In addition, eye care and appropriate referrals were not yet common in schools due to a number of shortcomings in eye health awareness among students and school staff, as well as a lack of eye health infrastructure and human resources for all schools [1].

Many international non-governmental organizations invested in eye health infrastructure and human resources in three provinces Hai Duong, Da Nang, and Tien Giang. Therefore, the study is implemented in these provinces. School-based visual acuity screening programs can determine students with potential visual impairments and inform their parents of their status and the need for any eye in-depth examination and other conditions to assist students with visual impairments [2], [3]. Several developing countries have undertaken such studies on RE screening to identify the level of suitability of the programs in the school system as different countries have different infrastructure, systems, and methods [4], [5]. Therefore, it is critical that Vietnam has a similar study on school RE screening, which should focus on both primary and lower-secondary schoolchildren. This part aims to review RE screening practices of other programs in the world, especially in the developing countries and key issues to be noted in carrying out such programs.

First, the cutoff points or a threshold for RE screening adopted may affect the cost and effectiveness of RE screening activities. Murthy (2000) suggests that it is possible to use the <6/12 (equivalent to 5/10) in the better eye threshold to increase cost-effectiveness of the school program [6]. Gianni *et al*. argue that decreasing the cutoff point would lead to a higher number of false negatives, which are the main cases to be avoided, and increasing the cutoff might lead to a larger number of false-positive cases, which may affect the cost of the program [7]. Second, the level

of accuracy of the screenings conducted by school staff varies sharply in the previous studies in the literature. In studies in Asian countries, that adopted the 5/10 (or equivalent) cutoff point, the level of sensitivity, which demonstrates the proportion of correctly identified positive cases among actual positive cases, could be as high as 93.5% in China [8] and as low as 59.0% [9] in Thailand. However, it can be noticed that there are few studies that examined the accuracy of RE screenings conducted on students, and the studies involving these subjects tend to feature lower rates of accuracy, such as those done by Teerawattananon *et al*. and Moghaddam *et al*. [9], [10] A study in Vietnam in Vung Tau presents a relatively high level of accuracy, however without the participation of primary school students [11]. Finally, external factors such as parents' cooperation and training of school staff can have impact on the implementation and effectiveness of such RE screening activities in school. In the study in Thailand, only 470 out of 624 students who were referred to ophthalmologists at provincial hospitals actually went there because of not obtaining consent from their parents or they did not show up [9].

There were only a few studies on the prevalence of RE in Vietnam, which mostly focus on adults and students in secondary schools in specific areas. In Ho Chi Minh City in 2009, Xuyen *et al*. reported a very high rate of RE of 39.4%, mostly consisting of myopia, among students in lower and upper secondary schools [12]. The authors also noticed a significantly higher prevalence of RE in urban areas compared with urban ones. In Ha Noi, in the same year, the rate of myopia was 33.7% [13]. Significantly, this rate raised to as high as 40.0% the urban area. In Paudel *et al*. observed that the rate of RE was 21.5% on average and 27.5% in urban areas [11]. There is also a rapid increase in the prevalence of REs in different areas of the world, particularly in East Asians [14]. In addition, myopia prevalence increased with age [15]. However, there was a lack of studies that measure the prevalence of RE among younger schoolchildren, including those in primary schools. Therefore, it is important to have local data in Vietnam.

From the above literature review, it has pointed out that there is currently a lack of studies in Vietnam on the feasibility of school-based screenings for RE. There is an urgent need to address these gaps in the literature, especially in the context of Hai Duong, Da Nang, and Tien Giang, given the fact that VNCEC and BEBE are being implemented in these provinces. The results of the study will serve as an input for the design of school eye health activities. This study would ultimately provide the rationale to inform the development of programmatic approaches and advocacy efforts. This baseline study's objectives were to identify the prevalence of RE among students as well as describe the accuracy of visual acuity screening practices of school staff in selected provinces.

Materials and Methods

Study design

The baseline study includes two components

1. Visual acuity (VA) screening performed by school staff (including teachers and school nurses). Using a visual chart (alphabetical), hard tape for measuring distance, template to record VA screening results.
2. VA screening performed by ophthalmologists. Using visual chart (alphabetical), pinhole glasses and lens kit with trial lens set, auto-refractometer, ophthalmoscope, retinoscope, Jackson Crossed Cylinder, auto lensmeter, dilating eye drops, and template to record RE screening result.

Study setting

Mekong Development Research Institute (MDRI) sampling experts chose 26 schools in the target area of the projects and nine schools in the non-target area for the study.

As the ratio of the number of students in primary schools and lower secondary schools participating in the project's area was around 1.2, school selection was done using the probability proportional to size (PPS) approach, with the target of maintaining this ratio of students. Under this sampling approach, the schools with a larger number of students were more likely to be chosen in the sample. The final number of schools chosen in the target area was nine schools in Da Nang (comprising five primary schools), nine schools in Tien Giang (comprising six primary schools), and eight schools in Hai Duong (comprising four primary schools). In the non-target area in Da Nang, nine schools were chosen, among which five were at the primary level.

Participants and recruitment

With regard to VA screening by school staff and ophthalmologists, initially, students in all grades were selected to participate in this activity; however, during the 1st day of the fieldwork, MDRI realized that VA screening using alphabetical visual charts was not suitable for Grade 1 students. Therefore, officially, only those from Grade 2 to Grade 9 took part in this part of the study.

Recruitment approach

To ensure the representativeness of the survey, multistage stratified sampling, probability proportional to sample size and random sampling techniques were used to select the sample. At first, the PPS approach was used to select 26 target schools and nine non-target

schools, as discussed above in the study setting section. After the list of all classes and all students in the selected school was available, the random sampling technique was used to identify one class per grade in each school, and all students from the selected class were chosen to participate in VA assessment. Among the students screened by school staff, 25% of them were randomly chosen to take part in a follow-up RE screening performed by ophthalmologists.

Sample size

The sample size was estimated separately for the two groups: Target and non-target. VA assessments were conducted by trained teachers and nurses at all schools participating in the survey, covering a sample size of 4838 students. Around 30% of these students were then randomly selected for a close-up examination by ophthalmologists, making up a sub-sample of 1404 students.

Data collection

The consent form was sent to the parents of all students in the sample before field implementation. School nurses help to distribute the consent form to parents and collect the signed consent form well in advance of the field survey. Regarding those who refused to participate, the enumerators asked the schools to enumerate the number of refusals and accordingly, handed out consent forms to participants in the reserve list.

With regard to the screening procedure, school staff measured students' visual acuity of each eye when not wearing glasses, and visual acuity of each eye when wearing glasses (if students are already wearing glasses). In the training, ophthalmologists trained teachers and nurses to refer all those students who have a visual acuity of <7/10 in one or both eyes and those who have abnormalities in either eye to doctors for further assessment. The results of VA screening performed by school staff were recorded using a standard form. Teachers and nurses noted their referrals by ticking a box in their forms.

On the completion of VA screening by school staff, on a separate day, ophthalmologists carried out a follow-up VA screening on 25% (randomly chosen) of the school staff's VA screening sample. In the original design of the study, among the students examined by ophthalmologists, if any of them showed signs of low vision, they would be further checked to identify the causes. However, during the fieldwork, the ophthalmologists just followed a similar procedure to that of the teachers due to the parents not agreeing with the use of dilating eye drops on their children. Ophthalmologists measured students' visual acuity when not wearing glasses, when wearing the glasses that students already had, and when wearing pinhole glasses. In addition, they examined students' eyes for other eye diseases and abnormalities. Ophthalmologists recorded the results using a standard form. Then, for each student, ophthalmologists concluded whether the student had RE and/or eye diseases, and in which eye after testing.

Data synthesis and analysis

Analysis of the prevalence of RE and visual issues

Based on ophthalmologists' results, the research team calculated the number of cases of low vision based on a set of criteria. Sampling weights were used to reflect the representativeness of the sample.

Some indicators for analysis as untreated vision problems (VA with current glasses of one or both eyes <7/10 or presenting eye diseases in one or both eyes), refractive error (concluded as having RE in one or both eyes by ophthalmologists), uncorrected refractive error (concluded as having RE in one or both eyes by ophthalmologists and VA with current glasses of one or both eyes <7/10), corrected the refractive error (concluded as having RE in one or both eyes by ophthalmologists and VA with current glasses of both eyes ≥7/10), and mild cases of refractive error (that do not require correction) (concluded as having RE in one or both eyes by ophthalmologists and VA without glasses of both eyes ≥7/10).

Untreated vision problems were defined as VA with current glasses of one or both eyes <7/10 or presenting eye diseases in one or both eyes.

Analysis of school staff's performance

The research team assessed the accuracy of VA screening activities by comparing school staff and ophthalmologists' results. From ophthalmologists' results, the students who were concluded by ophthalmologists as having a vision of lower than 7/10 in either eye (with current pair of glasses, if they already had one), or having abnormalities in either eye, were marked as those with "positive" results. From the school staff's results, the research team based solely on their final column in the result forms (about whether the student was referred for further examination) to identify those with "positive" results. This was because the study is more interested in the accuracy of the referrals that school staff made than their detailed VA results.

The school staff's results were then compared to those of ophthalmologists by a set of indicators, consisting of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Sensitivity was calculated as the ability of school staff to identify low VA (the proportion of actual cases of low VA

that is correctly identified by school staff). Meanwhile, specificity was analyzed as the ability of school staff to identify normal VA (the proportion of actual cases of normal VA that is correctly by school staff).

The data were managed and analyzed with STATA 14.0 software. Descriptive statistics were used to identify the prevalence of untreated vision problems and RE by province and project area, as well as sensitivity, specificity, PPV, and NPV of participants. We used p-values of t-test at 95% confidence interval to show statistically significant differences between prevalence values of different groups.

Ethical and other approvals obtained

An ethical approval application was lodged to the Ethical Review Board of the Hanoi Medical University Ref No. 57/HDDDDHYHN in early December 2016. The application was assessed through a full review procedure and was approved in late January 2017. The survey was also approved by the Project Management Board in the Department of Education of Training in each of the three provinces. The Department in each province also provided strong support to arrange logistics, to help the enumerators to approach the schools more easily. Consent forms were sent to parents of students participating in the examination. The study was only conducted with children's parent consent agreement.

Results

Prevalence of RE and visual issues

As demonstrated in Table 1 the overall prevalence of RE was 24.6% in the target area, of this, 17.9% were corrected, 11.5% were mild cases, and 70.5% were uncorrected cases. RE affected 32.7% of the student population in the non-target districts of Da Nang, 44.3% of those in Da Nang's targeted districts, 35.6% of those in Hai Duong, and only 6.4% of students in the project's target areas in Tien Giang, where the prevalence of RE was the lowest.

Breaking down these results by classification criteria also revealed some interesting trends. There was no proven difference between male and female students in terms of eye diseases and RE, however, there was a significant difference (at 99% of confidence) of 27.6% in the prevalence of RE (in one or both eyes) in rural (14.3%) compared to urban (41.9%) areas, proving once again a well-observed fact in the eye care community. In addition, lower secondary students were more likely to have untreated eye diseases and RE than their primary counterparts (at 99% of confidence).

While there were several notable differences in the prevalence of eye issues and RE between provinces, area types, and school levels, there was no striking difference in terms of corrected, mild, or uncorrected RE proportions across those classification criteria. The general trend was that only 15–20% of RE cases have been corrected, together with around 10% of mild cases requiring no treatment and leaving behind 60–70% of uncorrected cases.

It has also been shown from the results that the prevalence of untreated vision problems (including RE) in one or both eyes varies among areas. Specifically, Tien Giang had a significantly lower proportion of untreated cases of visual issues (around 4.5%) than other provinces. The non-target area in Da Nang also showed a lower level of prevalence compared to the targeted area in the same province (23.7% compared to 31.9%, verified by a t-test at 95% of confidence). Meanwhile, there was no statistically significant difference between the target areas in Da Nang and Hai Duong. The average prevalence of untreated eye issues was around 28 to 32% in these two areas.

Table 1: Prevalence of untreated vision problems and refractive error by province and project area

Targeted area	Untreated vision problems (including RE) (%)	RE in general (including corrected cases) (%)	Uncorrected RE (%)	Corrected RE (%)	Mild RE that do not require correction (%)
Da Nang province (nontarget)					
n	303	303	98	98	98
Percentage	23.7	32.7	72.5	15.2	12.3
95% CI	18.9–28.5	27.3–38.0		8.0–22.5	5.7–19.0
Total (target only)					
n	1039	1039	325	325	325
Percentage	18.5	24.6	70.5	17.9	11.5
95% CI	16.2–20.9	22.0–27.3	65.5–75.5	13.7–22.1	8.1–15.0
By location (target only)					
Da Nang province					
n	390	390	183	183	183
Percentage	31.9	44.3	70.6	14.9	14.5
95% CI	27.3–36.6	39.3–49.2	63.9–77.2	9.7–20.1	9.4–19.7
Hai Duong province					
n	297	297	122	122	122
Percentage	28.6	35.6	70.6	19.0	10.4
95% CI	23.4–33.7	30.1–41.1	62.5–78.8	11.9–26.1	4.9–15.8
Tien Giang province					
n	352	352	20	20	20
Percentage	4.5	6.4	70.0	26.4	3.6
95% CI	2.3–6.7	3.9–9.0	48.0–92.0	5.3–47.6	5.4–12.6

RE: Refractive errors, CI: Confidence interval.

Performance of school staff in conducting VA assessment

The performance of school staff plays a key role in the effectiveness of school eye health intervention because their initial stage of VA screening will help determine the students who need further examination by ophthalmologists. It is important to maximize correctly specified positive cases and avoid false-negative cases as these would be against both the students and the project's interests.

Table 2 shows some diagnostic statistics demonstrating the accuracy of VA screening performed by school staff. Target and non-target areas are separated and the "Total" value only considers target areas as some interventions have only been undertaken there.

Table 2: Performance of school staff by location

Targeted area	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Da Nang province (nontarget)				
Percentage	69.0	90.1	68.1	90.5
95% CI	58.0–80.0	86.2–94.0	57.0–79.1	86.7–94.3
Total (target only)				
Percentage	60.9	93.8	74.4	89.0
95% CI	54.7–67.2	92.1–95.4	68.2–80.5	86.9–91.1
By location (target only)				
Da Nang province				
Percentage	56.1	92.6	79.6	80.5
95% CI	47.5–64.6	89.4–95.8	71.2–87.9	75.9–85.0
Hai Duong province				
Percentage	65.6	89.7	74.4	85.1
95% CI	55.8–75.4	85.5–93.9	64.7–84.0	80.3–89.9
Tien Giang province				
Percentage	76.9	97.1	50.0	99.1
95% CI	50.4–103.4	95.2–98.9	26.0–74.0	98.1–100.1

PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence interval.

In the target area, the school staff's overall performance was reflected by a sensitivity measure of 60.9%. It means that only 60.9% of students with either eye abnormalities or whose vision was lower than 7/10 in one or both eyes were identified by school staff. The specificity level demonstrated that 93.8% of students with good vision were recognized by school staff, leaving a false-positive rate of approximately 6.2%. Among the students who were referred to ophthalmologists, 74.4% were actual cases of low vision (as shown in the PPV). This means that ophthalmologists would need to spend extra time and effort on the 25.6% of students who were incorrectly referred to them.

In the non-target area in Da Nang, the sensitivity, specificity, positive predictive, and NPVs were, respectively, 69.0%, 90.1%, 68.1%, and 90.5%. In comparison with those of the target area in the same province, these statistics demonstrated a better coverage of correct referrals, however, they also indicated a slightly higher level of false positive cases, as shown by a lower specificity measure.

Across the surveyed provinces in the target areas, Hai Duong performed significantly better than Da Nang in terms of sensitivity, with 9.5% more cases of low vision being identified. Between Tien Giang and two other provinces, although the sensitivity measure seems to be higher, statistical tests proved that they only featured a significantly higher level of specificity, lower level of PPV, and higher level of NPV, without any firm evidence backing the difference in sensitivity. These did not mean that school staff in Tien Giang performed better, but were most likely the results of the low prevalence of low vision and RE in Tien Giang.

Statistically significant differences have been revealed between urban and rural areas. Statistical test results had demonstrated that in rural areas, school staffs were better at identifying low vision, with a sensitivity measure of 74.0%, compared to 57.5% in urban areas. Their PPV was also significantly lower and they also demonstrated a higher NPV. This implied that rural school staff had fewer cases of false negative results.

Discussion

This part discusses the results of VA screenings, including figuring out the proportion of school children with untreated vision problems, uncorrected RE, and corrected RE in the surveyed areas and assessing the accuracy of VA screening at the school level. Regarding the prevalence of presenting low VA and RE among schoolchildren, the results of this study confirm previously investigated trends in surveys in other Vietnamese locations. The accuracy of school staff's screening activities, however, was lower than previously observed in other provinces, with some noticeable differences across location and area type.

Compared to some studies in Vietnam, the rates of RE in this study were considerably consistent. Xuyen *et al*. reported that the rate of RE in Ho Chi Minh City was 39.4% [12], with a notable difference between rural and urban areas. Thanh *et al*. also concluded a myopia rate of 33.7% in Ha Noi, with the figures rising above 40.0% in central urban districts [13]. In Paudel *et al*. observed an overall rate of RE of 21.5%, more specifically 27.5% in the urban area, but just focusing on lower secondary schools. This study's results regarding the prevalence of RE in Da Nang (44.3%), Hai Duong (35.6%), and Tien Giang (6.4%) can be considered consistent, with an overall rate of 24.6% in all three provinces [11]. Discrepancies between these provinces can be due to the unbalanced proportion of rural and urban schools, as well as of primary and lower secondary schools among them. Specifically, all schools in Da Nang's target area are urban schools while most of the schools in Tien Giang are located in rural areas.

A limitation of this study is that due to parents' disapproval of the ophthalmologists' use of dilating eye drops when conducting eye examination at the schools, students' specific RE condition (myopia, hyperopia, or astigmatism) was not collected. Instead, the ophthalmologists examined the students' VA like

the school staff did to assess their accuracy. If any abnormalities were noticed, a result form has been sent to the parents to inform them so they can have their child further checked by an eye specialist. Therefore, without such information, comparison with existing studies in terms of each condition is not possible.

In terms of school staff's performance, the overall performance in the target area was much weaker than previously reported by Paudel *et al*. in Vung Tau, where the accuracy was observed at 86.7% sensitivity, 95.7% specificity, 86.7% PPV, and 95.7% NPV [11]. When compared to studies in other Asian countries (Table 3), the sensitivity and specificity measures in this study were only higher than those of Iran. Nevertheless, those studies mostly approached secondary school students. When it comes to screening primary schoolchildren's VA, most previous studies feature lower detection rates.

Table 3: Comparison of visual acuity screening results with other studies

Location	Author	Cut-off	School level	Results
China	Sharma *et al*. [8]	≤ 20/40 (5/10)	Secondary	Sensitivity 93.5% Specificity 91.2%
Iran	Khandekar *et al*. [16]	< 20/40 (6/12)	Children aged 3–6 years	Sensitivity 74.5% Specificity 97.2%
Nigeria	Tabansi *et al*. [17]	< 6/18 in either or both eyes	Children aged 6–11 years	Sensitivity 53.3% Specificity 98.4%
Nepal	Adhikari and Shrestha [18]	< 6/12	Children aged 3–7 years	Sensitivity 80.0% Specificity 99.0%
Iran	Ostadi Moghaddam *et al*. [10]	≤ 20/25 (8/10)	Both primary and secondary	Sensitivity 37.5% Specificity 92%
India	Rewri *et al*. [19]	≤ 6/12	Children aged 10–19 years	Sensitivity 96.2% Specificity 90.2%
Peru	Latorre-Arteaga *et al*. [20]	≤ 6/9 in one or both eyes	Children aged 3–11 years and	Sensitivity 93.0% Specificity 47.8%
Thailand	Teerawattananon *et al*. [9]	≤ 20/40 (5/10)	Primary	Sensitivity 59% Specificity 98%
Vung Tau – Vietnam	Paudel *et al*. [11]	≤ 20/40 (5/10)	Secondary	Sensitivity 86.7% Specificity 95.7%
India	Priya *et al*. [21]	< 20/30	Children aged 6–17 years	Sensitivity 79.2% Specificity 93.3%
India	Saxena *et al*. [22]	< 6/12	Children aged 6–15 years	Sensitivity 77.0% Specificity 97.1%
India	Kaur *et al*. [23]	< 6/9 in either eye	Children aged≤16 years	Sensitivity 98.0% Specificity 27.8%
This study		< 7/10	Both primary and secondary	Sensitivity 60.9% Specificity 93.8%

One factor affecting the screening performance of school staff which has not been frequently discussed is the quality of the training given to them. Paudel *et al*. only mentioned that they conducted a half-day training session with practice and provision of necessary equipment [11]. This is very similar to the training sessions that were held in the three provinces before the fieldwork of this study. However, it has been noticed during The Foundation and MDRI's supervision that the school staff (especially in Da Nang's target area) was initially not very confident when implementing VA screening at their schools and was not clear about how to record results on the VA form. This was improved by The Foundation and MDRI in the survey in the non-target area by providing school staff more time to practice before the fieldwork. That might explain why school staff in the non-target area performed significantly better than their colleagues in targeted schools.

The fact that school staff in rural areas performed significantly better than those in urban schools might be attributed to two factors. First, in rural areas, eye issues are less prevalent, and thus school staff had more time to examine the students who showed signs of low vision. In urban areas, with a high rate of untreated visual issues at around 30%, school staff's attention was more diverted. In addition, teachers could only conduct VA screening during a fixed amount of time allocated for this activity in the timetable and very few schools allowed extra time. This fixed amount of time and the large proportion of students with low vision might have affected the quality of their screening activities.

A small number of unidentified cases of eye problems (8/118 – in the whole target and non-target sample) such as conjunctivitis, blepharitis, conjunctiva stones, and retinal detachment were encountered by school staff. They were often overlooked as school staff has not been trained to identify such abnormalities. Although the proportion of students with these diseases is small, the project may consider training school staff on identifying these abnormalities and how to correctly refer these students for treatment.

Limitations

This baseline study has some limitations. First is the disagreement of the parents with the use of dilating eye drops in visual acuity assessment. Second is the waiting time between the teacher's assessment and the doctor's follow-up examination. Specifically, ophthalmologists are unable to conduct the eye examinations thoroughly as permission has not been granted by parents for the use of dilating eye drops on the children, although the research team has tried to convince them. However, as the safety of the children and the cooperation of the parents are highly valued by the research team, the research's design has been modified to remove this component. The children identified as having visual issues by teachers and confirmed by ophthalmologists have, therefore, been referred to local hospitals for further examination. This has, in turn, made this study unable to analyze more detailed indicators for various forms of RE. In addition, visual acuity screenings performed by school staff and doctors take place on separate days for most schools. This may lead to inconsistencies in the evaluation of students' visual acuity between 2 days of screening, especially when the eyes of children possess great adjustment capacity during school age.

Conclusions

The proportion of students with untreated eye problems and that of students with an uncorrected

refractive error are currently quite high (at, respectively, 18.5% and 24.6%), especially in urban areas in Da Nang and Hai Duong provinces. The accuracy of the visual acuity screenings performed by teachers and school nurses in the project's target area is demonstrated by a sensitivity of 60.9% and a specificity of 93.8%. This indicates that efforts toward detecting school students with poor vision at school need further investments to mitigate the current problems. This outcome suggests that teachers and school nurses need to be trained and equipped further with better skills and knowledge in conducting screening to improve their screening performance.

Declarations

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Ethics approval

Subjects were adequately informed about the purpose of the study and participated voluntarily. Information on the study subjects is confidential and data collected in this study were only used for research purposes. The study did not affect the rights, health, and economy of the study subjects.

Consent to participate

A consent form was sent to the parents of all students in the sample before the study.

Availability of data and materials

Data are available from the corresponding author on reasonable request.

Authors' contributions

Conceptualization, A.V.T, F.D, V.P.T, and N.T.H.T.; data curation, X.T.T.L., A.V.T, F.D, V.P.T, and N.T.H.T; formal analysis, X.T.T.L., A.V.T, and V.P.T.; investigation, A.V.T, V.P.T, N.T.H.T., and X.T.T.L.; methodology, X.T.T.L., A.V.T, F.D, V.P.T, and N.T.H.T.; project administration and supervision, A.V.T and N.T.H.T.; visualization, X.T.T.L. and A.V.T,; writing – original draft, A.V.T and X.T.T.L.; and writing, reviewing, and editing, A.V.T, F.D, X.T.T.L., V.P.T, and N.T.H.T. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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