Uncorrected Refractive Error and Presbyopia among Junior High School Teachers in Jakarta, Indonesia

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ABSTRACT

Purpose: To report on the frequency of observed refractive and accommodative errors among junior high school teachers in Jakarta, Indonesia, who participated in a Helen Keller International screening, refraction and spectacle distribution program.

Methods: A total of 965 teachers from 19 schools were eligible for screening; those with uncorrected distance visual acuity (VA) ≤6/12-3 and teachers ≥35 years old with uncorrected end-point print size >Jaeger (J) 6 were referred. Autorefraction and subjective refraction were performed for teachers with confirmed decreased VA. Refractive error was considered present if sphere ≤−0.75 diopters (D), sphere ≥+0.25D or cylinder ≤−0.50D resulted in ≥2 lines of improvement in VA. Presbyopia was considered present if an end-point print size >J6 improved by ≥1 optotype with the use of a lens ≥+1.00D.

Results: Overall, 866 teachers were screened (89.7% of those eligible) with complete screening data available for 858 (99.0%), among whom 762 failed screening. Distance refraction data were available for 666 of 762 (87.4%) and near refraction data for 520 of 686 (75.8%) teachers who failed screening. Of those screened, 76.2% of teachers had refractive and/or accommodative error and 57.1% had uncorrected refractive and/or accommodative error. Overall and uncorrected distance refractive error affected 44.2% and 36.0%, respectively; overall and uncorrected presbyopia affected 66.4% and 41.0%, respectively.

Conclusion: As defined in this program, refractive and accommodative errors were common among teachers in Jakarta.

Keywords: Indonesia, presbyopia, school teachers, vision screening, visual acuity

INTRODUCTION

Uncorrected refractive error (URE) is defined as a decrease in visual acuity (VA) that can be improved by refraction or pinhole.1 URE is a significant cause of visual impairment worldwide. In 2004, the World Health Organization (WHO) estimated that approximately 153 million people worldwide had URE1 and that the global productivity loss associated with URE was between $121 and 427 billion.2

Presbyopia is an age-related loss of accommodation of the eye’s crystalline lens that results in an inability to focus on objects at near distances. After about 50 years of age, nearly all individuals will experience some degree of presbyopia.3 The WHO has recognized that uncorrected presbyopia is likely to impact quality of life and economic productivity adversely, but that additional investigations are needed to understand better the unmet need for correction of presbyopia globally.1,2 Recently, a number of studies have examined rates of presbyopia in low and middle income countries and each has found a high rate of uncorrected presbyopia.4–10 Additionally, lower quality of life measures were significantly association with uncorrected presbyopia.9,11
Helen Keller International’s (HKI) ChildSight Eye Health Vision Screening Program in Jakarta, Indonesia, conducts vision screenings and spectacle distribution for junior high school teachers as part of a program to provide spectacles to students. Spectacles were distributed free of charge to teachers who met predetermined criteria. Teachers represent a unique population whose ability to see effectively is important for both their own quality of life and the education of their students.

The frequencies of refractive and accommodative errors reported herein are not intended to represent prevalence estimates; instead they are a quantitative reporting of our observations in screening, examining and distributing spectacles to school teachers in Jakarta, Indonesia.

**MATERIALS AND METHODS**

HKI’s Eye Health program in Jakarta, Indonesia, consists of a school-based program that includes VA screening, refraction when indicated, and provision of free eyeglasses to students and teachers who require them. The current program is functioning under a 3-year grant from the Standard Chartered Bank and the present study used data collected from July 2009–May 2010, the first year of the grant period. This retrospective assessment of HKI programmatic activity was approved by the Johns Hopkins University Institutional Review Board without the need for informed consent and the study adhered fully to the guidelines of the Declaration of Helsinki.

There were 321 government-run junior high schools (grade 7–9) in Jakarta at the time of our study. Schools were selected for participation from each of Jakarta’s five administrative districts using the following criteria: (1) qualification as one of Jakarta’s poorest school districts based on the Badan Pusat Statistik (Central Agency on Statistics) Poverty Map,12 (2) not a recipient of a similar program by another local or international organization; (3) Department of Education approval to work in the selected schools; and (4) willingness of the school to participate and commit teacher and student time to training and screening. Since all of the 19 schools initially identified for participation received approval from the Department of Education and had a willingness to participate, we do not have data on the number of non-participating schools that would have met selection criteria. All classroom teachers and all health unit teachers were trained by HKI staff in VA screening procedures and were given Snellen charts to screen distance VA and continuous reading cards for near VA testing. A trained teacher at each school screened fellow teachers. Using a Snellen chart, distance VA at 6 m was screened with room lights on and not wearing any spectacles even if subjects habitually did so. Near vision was tested for teachers 35 years and older using a near chart held at 30 cm. Failing criteria were distance VA ≤6/12-3 in one eye and an end-point print size larger than Jaeger (J) 6 for near VA. Vision was screened without correction for all teachers so that those with spectacles and decreased VA would have the condition of their frames and lenses examined by a refractionist and would be eligible for a replacement pair.

A team of refractionists visited each school between 2 and 6 weeks after screening was completed. Teachers were instructed to bring their spectacles on the day of examination if they owned a pair. If a teacher presented with spectacles, the prescription was checked and distance and near acuities were examined with subjects wearing their habitual correction. Distance VA was examined without correction for all other referred subjects. Distance VA was measured in all cases using Snellen charts located at 6 m with room lights on. Subjects were eligible for new reading glasses (or a bifocal add) if they read an end point print size larger than J6 with correction or if the condition of their glasses was unacceptable; near vision was examined without correction for all other referred subjects.

Subjects with VA in the failing range underwent autorefraction using the Nidek ARK-30 2005 autorefractor (Nidek Co, Birmingham, UK) that was fitted with a chin and forehead rest and was mounted on a table-top for stability. Autorefraction was repeated until a reliability score of at least 7 was attained in both eyes. The autorefraction result was given to the refractionist who refined the prescription by subjective refraction using trial frames and lenses and measured the subject’s interpupillary distance. Near correction strength was determined using a table of suggested lens powers by age and was then refined subjectively.

Refractive error was defined as VA ≤6/12-3 that improved by at least two lines after subjective refraction; presbyopia was defined for teachers 35 years or older as an end-point print size larger than J6 at 30 cm in whom a plus lens resulted in at least one line of improvement of near vision when distance correction was worn as indicated. Subjects were classified as having URE if they had habitual VA ≤6/12-3 that improved by at least two lines after subjective refraction. Uncorrected presbyopia was defined as at least one line of improvement in habitual near VA using a reading lens for subjects with an end-point print size larger than J6. To estimate the upper frequency limit we assumed that all screen-positive subjects with missing examination data would require spectacles; the lower limit was calculated assuming that none of these individuals would benefit from correction. Accordingly, the frequencies of overall and uncorrected errors are presented as a point estimate ± margin of error.
TABLE 1. Demographics of teachers in Jakarta with missing and complete data.

<table>
<thead>
<tr>
<th>Refractive error data</th>
<th>Complete data (n = 666)</th>
<th>Missing data (n = 96)</th>
<th>p Value</th>
<th>Presbyopia data$^a$</th>
<th>Complete data (n = 520)</th>
<th>Missing data (n = 166)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD, years</td>
<td>45.8 ± 8.1</td>
<td>44.1 ± 8.8</td>
<td>0.06</td>
<td></td>
<td>47.9 ± 6.2</td>
<td>45.8 ± 6.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female, %</td>
<td>57.8</td>
<td>61.5</td>
<td>0.46</td>
<td></td>
<td>53.9</td>
<td>64.5</td>
<td>0.02</td>
</tr>
<tr>
<td>Spectacles at screening, %</td>
<td>62.1</td>
<td>49.0</td>
<td>0.01</td>
<td></td>
<td>65.0</td>
<td>56.4</td>
<td>0.05</td>
</tr>
<tr>
<td>Screening VA right eye$^b$</td>
<td>6/18</td>
<td>6/18</td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening VA left eye$^b$</td>
<td>6/18</td>
<td>6/15</td>
<td>0.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screening near acuity$^b$</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
<td>N12</td>
<td>N10</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

SD, standard deviation; VA, visual acuity.
$^a$Includes only teachers ≥35 years old
$^b$Median value

The HKI liaison at each participating school was asked to identify two or three teachers to complete our knowledge, attitudes and perceptions (KAP) questionnaire. There was no systematic sampling employed in the selection of the teachers that were surveyed. The results of this questionnaire were compiled in order to begin to understand potential barriers to care. Subjects were excluded from analysis if they were found to have missing or discrepant data for relevant variables. Contingency tables were used to examine frequencies and crude associations. The $\chi^2$ or Fisher exact test were used for categorical data and the t-test or the Mann-Whitney U test were used to compare continuous data, as indicated. A non-parametric test for trend was used to compare the proportion of teachers affected across groups of increasing age. Logistic modeling was used to determine factors associated with spectacle possession. Logistic models were used to predict the odds of spectacle possession for teachers with different diagnoses. Odds ratios were calculated by comparing the odds of spectacle possession among teachers with a given diagnosis against all other diagnoses necessitating spectacles. All statistical tests were performed using Stata version 11/IC (Stata Corp, College Station, TX, USA) and were 2-sided with a 0.05 level of significance.

RESULTS

A total of 965 teachers from 19 junior high schools were invited to our screenings and 866 participated (89.7%); of these, complete screening data was available for 858 (99.0%) subjects. Most teachers (762, 88.8%) failed screening and those who passed were significantly younger than those who failed (33.9 ± 6.6 vs 45.6 ± 8.2 years, $p < 0.001$). Of those who failed screening, 275 (36.1%) had both distance and near VA in the failing range while 239 (31.4%) failed only distance and 248 (32.5%) failed only near VA screening. Slightly more than half of the teachers (54.3%) had spectacles at the time of screening and they were significantly more likely to fail screening than those not wearing spectacles ($p < 0.001$).

Data from distance refraction was available for 666 of 762 (87.4%) teachers and data for near correction was available for 520 of the 686 (75.8%) teachers at least 35 years of age who failed screening. Data was missing because 75 screen-positive teachers were lost to follow-up (absent or chose not to undergo examination). The remaining teachers were excluded because examiners did not record one or more pieces of data needed to complete the analysis. Of note, there were no significant differences in age, sex distribution or screening VA between those who had complete and missing follow-up data for distance correction (Table 1). However, we did find that teachers were more likely to have complete data if they had spectacles at the time of screening ($p = 0.01$).

A number of variables including age ($p < 0.001$), sex ($p = 0.02$), possession of spectacles at screening ($p = 0.05$) and screening VA ($p < 0.001$) differed significantly between individuals with and without complete follow-up data for near correction.

The median uncorrected and habitual distance VA for teachers who failed the screening and for whom examination data were available were 6/18 and 6/12 (there was no difference between right and left eyes) and the median uncorrected and habitual end-point print sizes were J10 and J8.

Some refractive and/or accommodative error was found among 76.2 ± 9.0% of screened teachers and an uncorrected refractive and/or accommodative error was found among 57.1 ± 7.6% of screened teachers. Of these, 11.1 ± 3.6% had uncorrected low vision (better seeing eye ≤ 6/18) at the time of examination. The mean and median spherical equivalent refraction prescribed were respectively, −1.1 ± 2.1 D and −0.8 D in the right eye and −1.0 ± 2.0 D and −0.8 D in the left eye (range: −11.75 to +4.75 D; Figure 1). The mean and median reading power prescribed were +1.9 ± 0.5 D and +1.75 D, respectively (range: +1.0 to +3.0D).

Following refraction, subjects experienced a median 2-line improvement in distance VA in both eyes and the median end-point print size improved to J4. After
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FIGURE 1. Distribution of magnitude of refractive error in school teachers in Jakarta. The histogram depicts the number of teachers requiring different levels of spherical equivalent refraction (data shown are for right eyes). The left-skewed distribution is indicative of the relatively higher frequency of myopia in this study.


<table>
<thead>
<tr>
<th>Overall prevalence, %</th>
<th>Uncorrected prevalence, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>All refractive errors&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.2</td>
</tr>
<tr>
<td>Hyperopia (≥0.25 D)</td>
<td>16.6</td>
</tr>
<tr>
<td>Myopia (≥0.75 D)</td>
<td>25.1</td>
</tr>
<tr>
<td>Astigmatism (≥0.50 D)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.3</td>
</tr>
<tr>
<td>Presbyopia (≥1.00D)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>66.4</td>
</tr>
</tbody>
</table>

D, dioptr.
<sup>a</sup>Margin of error is ±3.7% for overall prevalence and ±3.6% for uncorrected prevalence.
<sup>b</sup>More than one condition was possible for each individual.
<sup>c</sup>Margin of error is ±8.1% for overall prevalence and ±6.6% for uncorrected prevalence.

refraction, 0.1% of screened teachers had a corrected VA in the better seeing eye that would still be classified as low vision (VA between 6/18 and 6/60) and none could be classified as legally blind (VA worse than 6/60 in the better seeing eye).

The overall proportion affected by refractive error was 44.2 ± 3.7%, and by presbyopia was 66.4 ± 8.1% in this study. The proportions affected by URE and uncorrected presbyopia were 36.0 ± 3.6% and 41.0 ± 6.6%, respectively (Table 2). Refractive and accommodative errors were also examined by age, and the older cohorts of teachers were more likely to be presbyopic (p = 0.004), while we found no association between age and refractive error (Table 3).

Spectacle coverage was 53.9% among teachers who were found to have a refractive error, and 36.9% of those with glasses were found to be adequately corrected. Among presbyopic teachers, 47.1% already had reading glasses and 68.5% of these had an adequate prescription. Among teachers with a significant refractive or accommodative error, those with hyperopia (odds ratio, OR, 5.4, 95% confidence interval, CI, 3.0–9.6, p < 0.001) or myopia (OR 2.0, 95% CI 1.2–3.5, p = 0.01) had significantly greater odds of possessing adequate spectacles than those with astigmatism. Concomitantly, teachers with astigmatism had a decreased odds of possession of adequate spectacles compared to those without astigmatism (OR 0.6, 95% CI 0.4–0.9, p = 0.03), and the odds of adequate spectacle possession were unchanged for teachers with presbyopia compared to those without presbyopia (OR 1.0, 95% CI 0.5–2.1, p = 0.9).

Among teachers who completed our KAP questionnaire (n = 41), two teachers (4.9%) reported having insurance that would cover spectacle purchase. The most common (22.5%) perceived lowest price that respondents thought one could pay to purchase glasses locally was 200,000–500,000 Indonesian Rupiah (US$22–55); however, 87.8% of teachers answered that eyeglasses were affordable and 31.7% answered that spectacles make a person look less attractive, 34.1% felt that spectacles were not comfortable, and 9.8% reported that spectacles can make one’s vision worse.

**DISCUSSION**

In our experience, refractive error and presbyopia were common among urban Indonesian school teachers and were frequently untreated. Teachers undergoing examination had a median habitual distance VA of 6/12 and a median end-point print size of J8; with correction we observed improvement to 6/7.5 and J4, respectively. The impact of URE and uncorrected presbyopia in this population may be substantial, especially if they affect teacher performance. Refractive error programs aimed at school children ought to consider also examining teachers, both to provide care to teachers and to provide motivation for them to assist students. Further research is needed to

**TABLE 3. Prevalence of refractive and accommodative error by age, in teachers in Jakarta.**

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Refractive error prevalence&lt;sup&gt;a&lt;/sup&gt; % ±SD</th>
<th>Presbyopia prevalence&lt;sup&gt;b&lt;/sup&gt; % ±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤35 (n = 142)</td>
<td>41.1 ± 4.6</td>
<td>–</td>
</tr>
<tr>
<td>36–40 (n = 137)</td>
<td>37.6 ± 4.7</td>
<td>40.5 ± 9.9</td>
</tr>
<tr>
<td>41–45 (n = 175)</td>
<td>39.2 ± 3.2</td>
<td>72.5 ± 7.4</td>
</tr>
<tr>
<td>46–50 (n = 180)</td>
<td>42.5 ± 3.1</td>
<td>70.8 ± 7.5</td>
</tr>
<tr>
<td>51–55 (n = 140)</td>
<td>55.0 ± 4.3</td>
<td>73.9 ± 7.5</td>
</tr>
<tr>
<td>≥56 (n = 84)</td>
<td>55.9 ± 2.4</td>
<td>78.0 ± 7.7</td>
</tr>
</tbody>
</table>

SD, standard deviation.
<sup>a</sup>Test for trend, p = 0.64.
<sup>b</sup>Test for trend, p = 0.004.
determine whether these findings apply to other settings and developing countries.

There has been little previous research on refractive or accommodative errors specifically among teachers. In fact, no previously published data was available on the rate of refractive errors among teachers. However, one study examined overall and uncorrected rates of presbyopia among public high school teachers in Kumasi, Ghana. In that study, 68.1% of teachers aged 36 years and over were presbyopic and 29.6% of these did not have any form of near-vision correction at the time of the study. The overall proportion of teachers affected by presbyopia in our study and among Ghanaian teachers was similar. However, the Ghanaian study reports a much lower frequency of uncorrected presbyopia though this may have been due to differences in case definitions.

The frequencies of uncorrected refractive and accommodative errors in this study may appear high for several reasons. Barriers or perceived barriers to care may limit teachers’ access to spectacles. Accordingly, the KAP questionnaire was employed as a pilot to improve our basic understanding of some of the barriers to care among this group. It is important to note that our KAP questionnaire only surveyed 41 teachers and that they were not chosen systematically. Consequently, results of the KAP survey should be interpreted with caution. Among those surveyed, less than 5% reported having insurance that would cover eyeglasses. Additionally, more than 30% did not feel that glasses were comfortable or attractive. Results also suggest the existence of poor health literacy among teachers. For example, approximately 10% of teachers believed that glasses could make one’s eyes worse. Addressing misperceptions in future interventions may improve uptake of spectacles. Likewise, it is important to educate teachers about the need for re-examination of VA in the future even after obtaining a pair of spectacles.

Several recent studies have examined barriers to spectacle use in settings from China, Zanzibar and Alabama. Each study identified distinct barriers to spectacle use including poor quality of available glasses, perception that vision was normal, not knowing their condition was treatable, lack of transportation to a doctor, and cost of glasses. As barriers to spectacle use varied from study to study, it appears that they are contextual and likely driven by both cultural and economic factors. Accordingly, future studies should seek to better understand and address these context-specific obstacles to care.

There were several limitations of the present study that may have impacted our findings. First, refractionists visited each school on only one day, so there was no opportunity for teachers who forgot their spectacles to be reexamined with their corrective lenses and this may have biased our frequency calculations upward. Additionally, since this was not a prevalence survey, did not employ systematic sampling, and used a narrow sample frame, the frequencies presented may not be generalizable to those outside of this sector of the Indonesian population. Of note, the school population that we studied was biased toward poor urban neighborhoods.

Estimates of URE could also be biased downward since not all teachers underwent refraction; we do not know if the screening tests were 100% sensitive, and those who already wore spectacles were more likely to have complete data. Moreover, the rate of missing data in this study was high, resulting from both loss to follow-up and incomplete recording of data. The rate of missing data was greater for near compared to distance examination. Because our definition of presbyopia required that we observe an improvement in VA after correction, teachers with missing data could not be classified as presbyopes even though 67 of them received reading glasses. Notwithstanding, all screened teachers were included in the denominator of frequency calculations and a range was estimated with the lower limit assuming that no teachers with missing data would require correction and the upper limit assuming that all of these individuals would require spectacles. The relatively high rate of missing data for near refraction resulted in a wider margin of error around the proportion of teachers with accommodative compared to refractive errors.

The criteria used to determine refractive and accommodative error were not the same as in all previous studies. The WHO’s working definition of presbyopia includes inability to read J6 print at 40 cm. While the 30 cm distance used in our program may more closely approximate habitual reading distance, the frequency of presbyopia would be lower had we employed the further testing distance. The criteria used to define refractive errors in this study were also more lenient than in some past studies and this may have caused an overestimation of these frequencies. In fact, the median spherical equivalent prescribed was only −0.8 D, and this represents a relatively mild level of undercorrection. Consequently, due to differences of both study design and case definitions, caution should be exercised when comparing results across studies.

We acknowledge that some refractive errors treated in this study were mild and may have had only minimal effect on teacher performance, nonetheless the frequencies of overall and uncorrected refractive and accommodative errors were high. Nearly half the teachers had refractive error and over a third of all teachers did not have proper spectacles. Likewise, two-thirds of teachers at least 35 years old had presbyopia and almost half had uncorrected presbyopia. Additional work is needed to better understand population-based prevalence, willingness-to-pay,
quality of life and improvement in work-related tasks among teachers following correction of VA.

DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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REFERENCES