Prevalence and associated factors of uncorrected refractive errors among school children in suburban areas in Bandung, Indonesia

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Abstract: Refractive errors lead to visual impairment if they are uncorrected. The prevalence of uncorrected refractive errors in children is considerably high, even though they can be easily corrected with spectacles. To estimate the prevalence of uncorrected refractive errors and investigate their associated factors among school children in suburban areas in Indonesia. This cross-sectional study was conducted among school children aged 11–15 years in randomly selected schools. All students in the selected schools underwent uncorrected, presenting, and best-corrected visual acuity testing. Structured interviews were administered to the parents of children with refractive errors. All associated factors were analysed by multivariate logistics regression. A total of 3035 school children, 1193 boys and 1842 girls, were examined. The prevalence of refractive errors was 15.9% (95% CI: 14.7–17.3), while that of uncorrected refractive errors was 12.1% (95% CI: 11.0–13.4). Lower father’s income was associated with a higher prevalence of uncorrected refractive errors (OR: 1.69; 95% CI: 1.6–2.69; p = 0.26). Worse visual performance (OR: 0.38; 95% CI: 0.27–0.55; p = 0.1) and longer distance to primary healthcare services (OR: 0.50; 95% CI: 0.37–0.69; P = 0.1) were associated with a lower prevalence of uncorrected refractive errors. Uncorrected refractive errors are the most common cause of visual impairment in children. Visual impairment due to an uncorrected refractive error affects the children adversely in their vision-related daily activities, academic achievement, and self-esteem. Refractive errors can be easily managed by using eyeglasses to attain a normal vision. However, many children with refractive errors remain uncorrected because they do not comply with using spectacles. This study estimates the magnitude of the problems caused by uncorrected refractive errors in children and investigates the associated factors causing the children not using their eyeglasses. The results of the study benefit the policymaker to create program for handling visual impairment due to uncorrected refractive errors in children.
refractive errors were found to be highly prevalent among school children in suburban areas in Bandung Regency. The availability of visual assessment services for children needs to be improved.

Subjects: Population Health; Preventative Medicine; Ophthalmology

Keywords: uncorrected refractive errors; school children; associated factors

1. Introduction
Uncorrected refractive errors (UREs) are the commonest cause of visual impairment in children (Resnikoff et al., 2008; World Health Organisation [WHO], 2018a). According to the World Health Organization, visual impairment was estimated to affect 19 million children globally in 2010, with UREs being the cause in 12.8 million children (Resnikoff et al., 2008; WHO, 2012). Visual impairment due to UREs can unfavourably affect children’s academic achievement, quality of life, and visual function (Dandona & Dandona, 2006; Morjaria et al., 2016; Resnikoff et al., 2008).

According to the International Classification of Diseases, 11th revision, visual impairment is diagnosed if the presenting visual acuity (PVA) is less than 6/12 in the better eye. There are four categories of visual impairment: mild (PVA 6/12–6/18), moderate (PVA 6/18–6/60), severe (PVA 6/60–3/60), and blindness (PVA <3/60) (WHO, 2018a, 2018b).

All types of REs can lead to UREs if they are not adequately corrected. The most common cause of UREs is myopia (Holden et al., 2015). Myopia commonly begins at the age of 9–10 years and worsens during adolescence. Hyperopia starts earlier in children and may resolve by the age of 10 years. Astigmatism starts at any age and does not usually progress over time (Morjaria et al., 2016).

REs can be identified straightforwardly and treated by prescribing spectacles to achieve normal vision. However, REs are uncorrected in a high proportion of children because they do not wear their spectacles (Dandona & Dandona, 2001; Morjaria et al., 2019; Resnikoff et al., 2008). Various factors can contribute to UREs in children: lack of knowledge to detect problems at the level of individuals, families, and communities/schools; low access to services for visual assessment; inadequate supply of affordable corrective lenses; and cultural barriers (Mahayana et al., 2017; Resnikoff et al., 2008).

UREs are also prevalent in Indonesia. A study conducted in Jogjakarta, Indonesia, found that the prevalence of UREs among school children in urban and suburban areas was 10.1% and 12.3%, respectively (Mahayana et al., 2017). In another study conducted in Bandung, Indonesia, the reported prevalence of REs in school children was 18.39%, with 56.3% being UREs (Nikmah, 2016). However, studies on associated factors of UREs in Indonesia are limited. The purpose of this study was to investigate the prevalence and associated factors of UREs among school children in the suburban area in Bandung, Indonesia.

2. Methods

2.1. Ethical considerations
The Ethical Board of Padjadjaran University, Bandung, Indonesia, approved the study prior its commencement. All research procedures were sufficiently informed to the participants and their parents, and their participation was entirely voluntary.

2.2. Study design and population
This was a cross-sectional observational study to estimate the prevalence and associated factors of UREs among school children aged 11–15 years in Bandung Regency, West Java Province, Indonesia based on a school-based RE screening. The study participants were recruited from the junior high schools (secondary schools) in the area of study. Bandung Regency is a suburban
district surrounding Bandung City. Suburban districts are the districts bordering with a large town or city and have a population of 10,000 to 1,000,000 (Mahayana et al., 2017). The population of children 11–15 years old in Bandung Regency was 328,211 (Pemerintah daerah Kabupaten Bandung, 2019).

2.3. Sample size calculation and school selection
The sample size was determined using a formula for cluster sampling as follow:

\[
\text{Sample size} = \text{Deff} \times \frac{z^2 \times p \times (1 - p)}{d^2}
\]

Deff: design effect

\[z\]: alpha risk expressed in z-score

\[p\]: expected prevalence

\[d\]: precision

The expected prevalence considering a similar study in Yogyakarta, Indonesia, was assumed to be 18.36% (Mahayana et al., 2017). Using a 95% confidence interval (CI; z-score = 1.96), a worst acceptable prevalence rate of 16.52%, a non-response rate of 10%, and a design effect of 1.5, the minimum sample size was calculated to be 2630. The average number of students in each school in Bandung Regency was 500; therefore, we randomly selected six schools to obtain the required sample size.

The schools were selected proportionately to size. A sampling frame was made by creating a list of all junior high schools in Bandung Regency district in Microsoft Excel. The list contained four columns: subdistrict, school's name, number of children (frequencies) in each school, and cumulative frequencies. A sampling interval was calculated by dividing the total number of children in the sampling frame by the required number of schools. The numbers of zero and sampling interval plus one were applied in the randbetween formula in Microsoft Excel to select one random number as the starting point. The first school was selected as the school that contained the starting point number in the cumulative frequency column. The second school was determined by the starting point plus the interval sampling. The third school was selected by the second cluster number plus the interval sampling. The process was continued until the specified sample size was obtained.

2.4. RE screening
All students in the selected schools were examined to identify the children with REs. The visual acuity tests were performed by a trained refractionist. Students were tested for uncorrected, presenting, and best-corrected visual acuity using standard tumbling E cards size 12, 18, and 60 at a distance of 4 m. They were asked to wear their spectacles, if any, for the PVA tests. Best-corrected visual acuity tests were done using a pinhole. The tests were performed separately for each eye. The students were asked to point their fingers to indicate the direction of the given tumbling E cards. If they could not correctly identify a tumbling E size 60 at 4 m, the counting fingers test was performed at 3 m and at 1 m. The smallest size read successfully was assigned as the visual acuity for the tested eye. Pinhole examination was performed if the students could not identify a tumbling E card size 12.

The students who had uncorrected visual acuity less than 6/12 that improved to 6/12 or better with pinhole were diagnosed as having REs. The students who had PVA less than 6/12 that improved to 6/12 or better with pinhole were diagnosed as having UREs. All students with UREs underwent full refractive correction and received spectacles accordingly.

Students who had visual acuity less than 1/60, amblyopia, or other ocular abnormalities were excluded from the study and referred to the nearest ophthalmologists.
2.5. Associated factors assessment
The parents of the students with REs were invited for a guided interview using a structured questionnaire to compile information about the associated factors. The questionnaire contained a list of associated factors: age, sex, distance to visual assessment services, parents’ education, parents’ occupation, parents’ income, spectacles use by parents, and spectacles use by siblings. All information were compiled in a Microsoft Excel sheet by doubled data entry procedures.

2.6. Statistical analysis
The prevalences of REs and UREs were calculated using the following formulas:

\[
\text{Prevalence of REs} = \frac{\text{No of Refractive Errors}}{\text{Total Number of children screened}}
\]

\[
\text{Prevalence of UREs} = \frac{\text{No of Uncorrected Refractive Errors}}{\text{Total Number of children screened}}
\]

We conducted a stepwise procedure to select the independent variables (the associated factors) that would be included in the final analysis (Bursac et al., 2008; Hosmer & Lemeshow, 2000). The analysis was divided into three steps.

1. Univariate analysis. All variables were included in the univariate analysis performed using Pearson’s Chi-square test to select those that would be included in the initial multivariate analysis model. Variables with \(p\) values lower than 0.25 were included in the next step.

2. Initial multivariate analysis model. The selected variables in step 1 were included in this model to select those that would be included in the final analysis using logistic regression. Variables with \(p\) values lower than 0.25 were included in the next step.

3. Final multivariate analysis model. The selected variables in step 2 were included in this model to determine the associated factors of UREs using logistic regression.

3. Results
Six junior high schools from Bandung Regency District participated in the study. None of the students refused the examination. A total of 3,35 school children, 1,193 (39.3%) boys and 1,842 (60.7%) girls, underwent RE screening. Among them, 484 (15.9%) were found to have REs (Table 1).

| Name of the Schools       | n     | %    |
|---------------------------|-------|------|
| SMPN 1 Cimenyan           | 1018  | 33.5 |
| SMPN 1 Dayeuh kolot       | 643   | 21.2 |
| SMPN Banjaran             | 250   | 8.2  |
| SMPN 1 Cileunyi           | 247   | 8.1  |
| SMPN 1 Cangkuang          | 572   | 18.8 |
| SMPN 1 Cicalengka         | 305   | 10.0 |

| Gender                    |       |      |
|---------------------------|-------|------|
| Boys                      | 1193  | 39.3 |
| Girls                     | 1842  | 60.7 |

| Refractive status         |       |      |
|---------------------------|-------|------|
| Non-refractive errors     | 2551  | 84.1 |
| Refractive errors         | 484   | 15.9 |
The characteristics of children with REs and their parents are shown in Table 2. REs were identified in 114 (23.6%) boys and 370 (76.4%) girls. They were corrected in 116 (24.0%) and uncorrected in 368 (76.0%) children. Most children with REs were 14 years old (n = 189; 39.0%). The distance to visual assessment and primary healthcare services was 2–5 km in most cases (n = 183, 37.8% and n = 200, 41.3%; respectively). Most of the children had moderate visual impairment (n = 232; 47.9%). Four children (0.8%) were diagnosed with blindness. The majority of children with REs did not have siblings who wore spectacles (n = 368; 76.0%).

Nine children did not have a father or lived with their mothers alone; thus, the total number of fathers included in the study was 475. The majority of fathers had middle education (n = 228; 48.0%), worked in informal sectors (n = 255; 53.7%), had income less than Rp. 2,600,0 (n = 288; 60.6%), and did not use spectacles (n = 344; 72.4%). Most mothers had middle education (n = 241; 49.8%), no jobs (n = 312; 64.5%), no income (n = 315; 65.1%), and did not use spectacles (n = 342; 70.7%).

Table 3 shows the prevalence of REs and UREs. The prevalence of REs was 15.9% (95% CI: 14.7–17.3%), whereas that of UREs was 12.1% (95% CI: 11.0–13.4%). The prevalence of UREs in girls (14.9%; 95% CI: 13.3–16.6%) was higher than that in boys (7.8%; 95% CI: 6.3–9.5%).

In the associated factors analysis, the following eight variables from the univariate analysis (step 1) were eligible to be included in the initial multivariate analysis model: sex, distance to visual assessment services, distance to primary healthcare services, visual impairment status, father’s income, mother’s spectacle use, mother’s income, and sibling’s spectacle use (Table 4).

Five variables from the initial model (step 2) were eligible to be included in the final multivariate analysis model: age, distance to primary healthcare services, visual impairment status, father’s income, and mother’s spectacle use. In the final model of multivariate analysis (step 3), a lower
Table 2. Characteristics of children with refractive errors and their parents

| Characteristics                             | n   | %   |
|---------------------------------------------|-----|-----|
| **Children (n = 484)**                      |     |     |
| Gender                                      |     |     |
| Boy                                         | 114 | 23.6|
| Girl                                        | 370 | 76.4|
| Corrected vs uncorrected                    |     |     |
| Corrected                                   | 116 | 24.0|
| Uncorrected                                 | 368 | 76.0|
| Age                                         |     |     |
| 11 year old                                 | 10  | 2.1 |
| 12 year old                                 | 80  | 16.5|
| 13 year old                                 | 161 | 33.3|
| 14 year old                                 | 189 | 39.0|
| 15 year old                                 | 44  | 9.1 |
| Distance to refractive services             |     |     |
| <2 km                                       | 177 | 36.6|
| 2–5 km                                      | 183 | 37.8|
| >5 km                                       | 124 | 25.6|
| Distance to Primary Health Care (PHC)       |     |     |
| <2 km                                       | 165 | 34.1|
| 2–5 km                                      | 200 | 41.3|
| >5 km                                       | 119 | 24.6|
| VI status (in the better eyes)              |     |     |
| Normal                                      | 9   | 1.9 |
| Mild VI                                     | 206 | 42.6|
| Moderate VI                                 | 232 | 47.9|
| Severe VI                                   | 33  | 6.8 |
| Blind                                       | 4   | 0.8 |
| Sibling spectacle users                     |     |     |
| Yes                                         | 116 | 24.0|
| No                                          | 368 | 76.0|
| **Fathers (n = 475)**                       |     |     |
| Level of Education                          |     |     |
| High                                        | 122 | 25.7|
| Middle                                      | 228 | 48.0|
| Low                                         | 125 | 26.3|
| No                                          | 0   | 0.0 |
| Occupation                                  |     |     |
| Formal                                      | 197 | 41.5|
| Informal                                    | 255 | 53.7|
| Retired                                     | 15  | 3.2 |
| No job                                      | 8   | 1.7 |
| Spectacle users                             |     |     |
| Yes                                         | 131 | 27.6|
| No                                          | 344 | 72.4|

(Continued)
father’s income (OR: 1.69; 95% CI: 1.6–2.69; p = 0.26) was associated with a higher prevalence of UREs, while a longer distance to primary healthcare services (OR: 0.50; 95% CI: 0.37–0.69; p = 0.1) and worse visual impairment status (OR: 0.38; 95% CI: 0.27–0.55; p = 0.1) were associated with a lower prevalence of UREs (Table 5).

### 4. Discussion

The prevalence of REs in this study was 15.9% (484/3035), which is lower than that found by Pi et al. in China (20.69%) (Pi et al., 2012). Comparing with similar studies in a bordering country, Malaysia, the prevalence in this study was higher than those in the studies of Hashim et al. (7%) and Goh et al. (10.1%) (Goh et al., 2005; Hashim et al., 2008). The variability in demographic and ethnic factors and visual assessment services availability could have contributed to these differences.

In this study, we determined the prevalence of UREs by comparing the number of children who had PVA less than 6/12 with all children examined. The prevalence of UREs in this study (12.1%) is comparable with that found in the study by He et al. in Shanghai, China (13.33%), whereas it is higher than that among school children in Ethiopia (9.5%) (He et al., 2014; Sewunet et al., 2014). A low spectacles wearing compliance and inadequate access to visual assessment services relate to the lack of infrastructures and human resources for RE treatment. Therefore, the provision of sufficient infrastructures and well-trained human resources to identify REs would address the problem of the high number of UREs. The health systems ought to provide affordable spectacles and accessible visual assessment services (Dandona & Dandona, 2001).

In this study, the children’s age was not found to be a risk factor for UREs. Similarly, Messer et al. and Gogate et al. did not find an association between age and UREs in their studies in Arizona...
In contrast, the studies by Congdon et al. in rural areas in China and Khandekar et al. in Oman found that age was a risk factor for UREs. The different age group categories of the participants could be the reason for these varied results. Congdon et al. conducted their study in participants aged 11–17 years, while Khandekar et al. performed their research among participants aged 18–22 years (Congdon et al., 2008; Khandekar et al., 2002).

The above mentioned studies found that women were more likely to wear spectacles (Congdon et al., 2008; Khandekar et al., 2002). In contrast, Sewunet et al. found that girls are at higher risk for UREs (Sewunet et al., 2014). In the present study, we failed to observe an association between sex and UREs. Likewise, Holguin et al. and Messer et al. found no significant association between sex and UREs in their studies conducted in Mexico (Holguin et al., 2006; Messer et al., 2012). Cultural aspects and personal preferences may be the reasons for these different findings.

Surprisingly, we found that a longer distance to primary healthcare services was associated with a lower prevalence of UREs. We identified some factors that may contribute to this finding. In Indonesia, eye health is not a priority program in primary healthcare services; hence, visual acuity examination is still not regularly performed. Moreover, most primary healthcare services in suburban areas, such as Bandung Regency, are located far from the centre, while most people are domesticated in the centre of the districts. Thus, people tend to visit higher-level health services, such as district hospitals, to obtain eye care services. It is necessary to increase the accessibility of visual assessment services at the primary level of healthcare services.

Children with REs may disregard their vision problems until they become severe before seeking healthcare services. This could be an important contributing factor for UREs. The study by Khandekar et al. showed that children with myopia of less than 2.5 D were at a higher risk of not wearing spectacles than those with myopia of more than 2.5 D (Congdon et al., 2008). Similarly, Gogate et al. found that children in India with visual acuity of ≤6/60 were more likely to use spectacles than those with a better vision (Gogate et al., 2013; Khandekar et al., 2002). Likewise, in this study, we observed that children who had worse visual acuity had a lower risk of UREs. Children with worse visual impairment have a greater need of wearing spectacles because they have more difficulties in carrying out daily activities without spectacles.

Alarmingly, in this study, four children (0.38%) were blind due to lack of adequate refractive correction. Despite the very low number, this finding represents the failure of public health application; the children had blindness because they did not receive appropriate spectacles. The wide-ranging eye care approaches ought to be a part of the existing health system and go deeper to the communities to prevent unnecessarily visual loss in children (Dandona & Dandona, 2001).

Higher education affects the ability to process and execute information. Hence, a higher education level contributes to a better utilisation of health services, including eye health services (Lindeboom et al., 2009; Ntsoane & Oduntan, 2010; Palagyi et al., 2008). The level of education also relates to the spectacles wearing compliance in RE management (Resnikoff et al., 2008; Ye et al., 2018). However, in this study, we

| Table 3. Prevalence of refractive errors and uncorrected refractive errors in school children |
|---------------------------------|---------------------------------|---------------------------------|
| Refractive Error | Uncorrected Refractive Error |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | n   | Prevalence (%) | 95% CI (%) | n   | Prevalence (%) | 95% CI (%) |
| Boys (n = 1193) | 114 | 9.6           | 7.9-11.4   | 93  | 7.8           | 6.3-9.5   |
| Girls (n = 1842)| 370 | 20.1          | 18.3-22.0  | 275 | 14.9          | 13.3-16.6 |
| Total (n = 3035)| 484 | 15.9          | 14.7-17.3  | 368 | 12.1          | 11.0-13.4 |
### Table 4. Univariate analysis for variable selection (Step 1)

| Variables                              | Corrected |     | Uncorrected |     | p values |
|----------------------------------------|-----------|-----|--------------|-----|----------|
|                                        | n         | %   | n            | %   |          |
| **Children (n = 484)**                 |           |     |              |     |          |
| Gender                                 |           |     |              |     |          |
| Boy                                    | 21        | 18.1| 93           | 25.3| 0.113*   |
| Girl                                   | 95        | 81.9| 275          | 74.7|          |
| Age                                    |           |     |              |     |          |
| 11-year-old                            | 2         | 1.7 | 8            | 2.2 | 0.42     |
| 12-year-old                            | 15        | 12.9| 64           | 17.4|          |
| 13-year-old                            | 33        | 28.5| 128          | 34.8|          |
| 14-year-old                            | 53        | 45.7| 137          | 37.2|          |
| 15-year-old                            | 13        | 11.2| 31           | 8.4 |          |
| Distance to refractive services        |           |     |              |     |          |
| <2 km                                  | 25        | 21.6| 152          | 41.3| 0.1*     |
| 2-5 km                                 | 44        | 37.9| 139          | 37.8|          |
| >5 km                                  | 47        | 40.5| 77           | 20.9|          |
| Distance Primary Health Care           |           |     |              |     |          |
| <2 km                                  | 16        | 13.8| 149          | 40.5| 0.1*     |
| 2-5 km                                 | 55        | 47.4| 145          | 39.4|          |
| >5 km                                  | 45        | 38.8| 74           | 20.1|          |
| VI status (in the better eyes)         |           |     |              |     |          |
| Normal                                 | 5         | 4.3 | 4            | 1.1 | 0.1*     |
| Mild VI                                | 23        | 19.8| 183          | 49.7|          |
| Moderate VI                            | 69        | 59.5| 163          | 44.3|          |
| Severe VI                              | 16        | 13.8| 17           | 4.6 |          |
| Blind                                  | 3         | 2.6 | 1            | 0.3 |          |
| Siblings spectacles users              |           |     |              |     |          |
| Yes                                    | 41        | 35.3| 75           | 20.4| 0.1*     |
| No                                     | 75        | 64.7| 293          | 79.6|          |
| **Fathers (n = 475)**                  |           |     |              |     |          |
| Level of Education                     |           |     |              |     | 0.697    |
| High                                   | 32        | 27.8| 89           | 24.7|          |
| Middle                                 | 55        | 47.8| 173          | 48.1|          |
| Low                                    | 28        | 24.4| 98           | 27.2|          |
| No education                           | 0         | 0.0 | 0            | 0.0 |          |
| Occupation                             |           |     |              |     | 0.437    |
| Formal                                 | 55        | 47.8| 142          | 39.4|          |
| Informal                               | 56        | 48.7| 199          | 55.3|          |
| Retired                                | 3         | 2.6 | 12           | 3.3 |          |
| No job                                 | 1         | 0.9 | 7            | 1.9 |          |
| Spectacle user                         |           |     |              |     | 0.373    |
| Yes                                    | 28        | 24.4| 103          | 28.6|          |
| No                                     | 87        | 75.7| 257          | 71.4|          |

(Continued)
failed to observe a relationship between parental education and UREs. The fathers’ income was more influencing than the parental education in Bandung Regency, Indonesia. Similarly, Messer et al. did not find any association between parental education and the risk of UREs (Messer et al., 2012).

Parents’ occupation is related to the socio-economic status. Informal sector workers tend to have a lower income than formal sector workers. Moreover, formal workplaces require a higher education level than those in the informal sectors. However, parent’s occupation in this study did not show any effect on the use of spectacles. Similarly, Gogate et al. found that the father’s occupation was not associated with UREs. Information dissemination about the beneficiaries of spectacles use for RE seems to have a greater impact than the type of parent’s workplaces (Gogate et al., 2013).

Parental income was found to contribute to URE prevention. Krishnatray et al. found that parental income has an impact on RE correction (Krishnatray et al., 2008). In this study, a lower father’s income was a risk factor for UREs, whereas mother’s income did not affect the spectacles wearing compliance. However, the research conducted by Messer et al. did not show any relationship between the socioeconomic status and the use of spectacles (Messer et al., 2012).

This study had several limitations. Although we performed random cluster sampling, more schools should be included to meet the level of participant representation and accommodate

### Table 4. (Continued)

| Variables              | Corrected |     | Uncorrected |     | p values |
|------------------------|-----------|-----|-------------|-----|----------|
|                        | n | % | n | % |          |
| Income                 |   |   |   |   |          |
| ≥ Rp 2,600,000         | 54 | 47.0 | 123 | 34.2 | 0.28*    |
| < Rp 2,600,000         | 60 | 52.2 | 230 | 63.9 |          |
| No Income              | 1  | 0.9 | 7  | 1.9 |          |
| Mothers (n = 484)      |   |   |   |   |          |
| Level of Education     |   |   |   |   | 0.546    |
| High education         | 19 | 16.4 | 52 | 14.1 |
| Middle education       | 62 | 53.5 | 179 | 48.6 |
| Low education          | 35 | 30.2 | 136 | 37.0 |
| No education           | 0  | 0.0 | 1  | 0.3 |          |
| Occupation             |   |   |   |   | 0.609    |
| Formal sectors         | 15 | 12.9 | 50 | 13.6 |
| Informal sectors       | 21 | 18.1 | 85 | 23.1 |
| Retired                | 0  | 0.0 | 1  | 0.3 |          |
| No job                 | 80 | 69.0 | 232 | 63.0 |          |
| Spectacle user         |   |   |   |   | 0.98*    |
| Yes                    | 43 | 37.1 | 99 | 26.9 |
| No                     | 73 | 62.9 | 269 | 73.1 |          |
| Income                 |   |   |   |   | 0.153*   |
| ≥ Rp 2,600,000         | 18 | 15.5 | 54 | 14.7 |
| < Rp 2,600,000         | 16 | 13.8 | 81 | 22.0 |
| No Income              | 82 | 70.7 | 233 | 63.3 |          |

VI: Visual Impairment. Mild VI: PVA <6/12–6/18; Moderate VI: PVA <6/18–6/60; Severe VI: PVA <6/60–3/60; Blind: PVA < 3/60. Level of education: High: at least graduated from diploma degree; Middle: graduated from 12 years basic educational level; Low: did not graduate from 12 years basic educational level; no education: never attending formal education. Univariate analysis used Pearson Chi square. Variables with p value < 0.25 continued to step 2 (initial model of logistics regression).
variations in the target population. Moreover, the subjective factors for UREs, such as cultural barriers, children’s behaviour, and possible dizziness, were not examined. Information bias related to information distributed by the parents may still exist. Qualitative research is required to obtain more information about the subjective risk factors for UREs.

5. Conclusion

Lower father’s income was associated with a higher prevalence of UREs, while a longer distance to primary healthcare services and worse visual performance decreased the prevalence of UREs. The availability of visual assessment services for children in the suburban area of Bandung, Indonesia needs to be improved. The effect of the distance to primary healthcare services on UREs prevalence should be further investigated. In addition, future studies on comprehensive eye care services should be conducted.

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Table 5. Multivariate analysis for associated factors of URE

| Initial Model (Step 2) | OR  | SE  | Z    | P values | 95% CI     |
|------------------------|-----|-----|------|----------|------------|
| Gender (boys vs girls) | 0.71| 0.21| −1.17| 0.24*    | 0.40–1.30  |
| Longer distance to refractive services (reference: distance < 2 KM) | 1.18| 0.39| 0.51  | 0.61     | 0.63–2.24  |
| Longer distance to PHC (reference: distance < 2 KM) | 0.43| 0.15|−2.45 | 0.1*     | 0.22–0.85  |
| Worse VI status in the better eyes (reference: VA < 6/18) | 0.39| 0.7 | −5.11 | 0.1*     | 0.27–0.56  |
| Lower father’s income (reference: income > Rp, 2,600,0,-) | 1.68| 0.41| 2.13  | 0.3*     | 1.4–2.69   |
| Mother’s spectacle use (yes vs no) | 1.57| 0.40| 1.78  | 0.76*    | 0.95–2.58  |
| Lower mother’s income (reference: income > Rp, 2,600,0,-) | 0.88| 0.14|−0.77 | 0.44     | 0.64–1.21  |
| Sibling spectacle use (yes vs no) | 1.18| 0.25| 0.78  | 0.44     | 0.77–1.80  |

| Final Model (Step 3) | OR  | SE  | Z    | P values | 95% CI     |
|----------------------|-----|-----|------|----------|------------|
| Gender (boys vs girls) | 0.69| 0.20| −1.25| 0.21     | 0.39–1.23  |
| Longer distance to PHC (reference: distance < 2 KM) | 0.50| 0.8 |−4.28 | 0.1*     | 0.37–0.69  |
| Worse VI status (in the better eyes) (reference: VA < 6/18) | 0.38| 0.7 | −5.18 | 0.1*     | 0.27–0.55  |
| Lower father’s income (reference: income > Rp, 2,600,0,-) | 1.69| 0.40| 2.23  | 0.26*    | 1.6–2.69   |
| Mother’s spectacle use (yes vs no) | 1.60| 0.40| 1.90  | 0.6      | 0.98–2.61  |

PHC: Primary Health Centre. VI: Visual impairment. Multivariate analysis used logistics regression. Variables with p value < 0.25 in step 2 continued to step 3 (final model of logistics regression).
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Competing Interests
The authors declare no competing interest

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