Association between Socioeconomic Status and Vision Screening Outcomes among Preschool Children in Klang Valley, Malaysia: A Cross-Sectional Study

Humairah KAMARUDDIN1, Naufal NORDIN1, Nurlin Erina ABDUL MANAP1, Sumithira NARAYANASAMY1, Sharanjeet SHARANJEET-KAUR2, Mohd Izzuddin HAIROL1

1 Centre for Community Health Studies (ReaCH), Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia
2 Centre for Rehabilitation & Special Needs Studies (iCaReRehab), Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia

Submitted: 29 Apr 2021
Accepted: 2 Sep 2021
Online: 21 Apr 2022

Abstract

Background: Vision screening programmes’ outcomes are routinely used to report the prevalence of vision anomalies in children. However, the association between vision screening outcomes and the children’s socioeconomic status remains underexplored. This cross-sectional study determined the association between socioeconomic and birth status with vision screening outcomes in a sample of children in Klang Valley.

Methods: Total 411 children (mean age: 5.49 ± 0.47 years old) attending preschools were selected via stratified cluster sampling. Habitual distance visual acuity, near visual acuity, and stereoacuity were measured. The fail criteria were distance visual acuity ≥ 0.3 logarithm of the Minimum Angle of Resolution (logMAR), near visual acuity ≥ 0.4 logMAR or stereoacuity ≥ 300 arcsec. Socioeconomic and birth history data were obtained using parent-report questionnaires. The association between socioeconomic factors and screening outcomes were determined with binary logistic regression.

Results: Sixty-two children (15.1%) failed the screening, with a significantly higher failure rate for Bumiputera children (16.34%) compared to non-Bumiputera children (4.08%) \( (\chi^2 (1, 410) = 5.21; P = 0.024) \). After adjusting for confounders, Bumiputera children were four times more likely to fail vision screening (OR: 4.54; 95% confidence intervals [CI]: 1.07, 17.76; \( P = 0.044 \)). Other socioeconomic factors were not significant predictors for failing vision screening.

Conclusion: Preschool children’s ethnicity is associated with vision screening outcomes. Bumiputera children are more likely to fail vision screening than their non-Bumiputera peers.

Keywords: vision screening, socioeconomic status, preschool children, visual acuity, stereopsis

Introduction

Early comprehensive eye and vision examination should be considered for children aged between 3 years old and 5 years old (1), as effective treatment and intervention for any visual anomalies in young children may improve the children’s visual-motor function (2) and educational performance (3). It has been reported that 45%–68% of parents never
Methods

This cross-sectional study was conducted from September 2019 to February 2020 and involved 5-years-old and 6-years-old children with no reported physical, pathological or cognitive disabilities and who attended selected public or private preschools located in Klang Valley. The sample size was calculated based on 136,032 live births recorded in 2014 for Selangor and the Federal Territory of Kuala Lumpur (20). This population was anticipated to enrol in preschool during the data collection period. Krejcie and Morgan (21)'s formula, with the desired confidence level of 95% and precision of ±5, was used to calculate a minimum sample size of 380. Participants were recruited using stratified cluster sampling. The preschools were stratified by type, i.e. public and private preschools. The list of public and private preschools was accessible through the Community Development Department (KEMAS) (22) and Ministry of Education Malaysia (23), respectively. For each type of preschool, they were selected using simple random sampling, and all students from the selected preschools were included as participants.

Study Parameters

A structured and self-administered questionnaire was distributed to the parents or legal guardians to collect data on the child’s demographic and socioeconomic characteristics. The items assessed were defined by two categories for each variable of interest, which covered: i) the children’s demographics: gender and ethnic groups (10). Individuals from low household income and poor educational attainment were at high risk for visual impairment in both urban and rural regions (11). Specifically for children, those from the most disadvantaged backgrounds were reported more likely to suffer from undetected vision problems (12–14) and reduced visual-motor integration skills (15). However, children from socioeconomically secure families also reported unnoticed vision problems (9, 16). Therefore, the assumption that the inequity of access to health care results in vision problems is inconclusive, as vision defects may arise regardless of children’s socioeconomic backgrounds.

While several studies have examined the prevalence of vision problems among preschool children in Malaysia (17–19), research on the association between vision problems and the socioeconomic status of these children remains to be explored. In addition, the vision parameter measured was mainly habitual visual acuity and did not consistently include other important measures such as near acuity and stereoaucity. The primary objective of this study was to identify the socioeconomic factors associated with the outcomes of vision screening in preschool children in Klang Valley, Malaysia. The other objective of this study was to report the outcomes of vision screening in preschool children that consisted of the measurements of distance visual acuity, near visual acuity and stereoaucity. This study may provide an overview of the demographic and socioeconomic influences on preschool children’s visual outcomes in urbanised areas. This information could be valuable to quantify the need to implement a vision screening program targeted towards specific groups within the population and identify priority research areas.
the median household income for the bottom 40% of household earners in Malaysia (24). Based on the provided address, classification of urban and suburban areas was based on whether the respondents were living under jurisdiction of the City Council (Majlis Bandaraya) or the Municipal Council (Majlis Perbandaran), respectively (25).

The vision screening programme consisted of habitual distance visual acuity measurements, near visual acuity and stereovision testing. Habitual distance and near visual acuity were assessed for each eye using the LEA Symbols® Pediatric Test Book and LEA Symbols® Near Vision Card (Good-Lite Co, Elgin, IL), respectively. The total number of symbols that correctly named or matched was recorded as the logarithm of the Minimum Angle of Resolution (logMAR) notation. A combination of distance and near visual acuity test was reported to be more accurate for detecting significant refractive errors rather than either of the two tests alone (26). Stereopsis was assessed using the Frisby Stereotest (Frisby Stereotests, Fulwood, United Kingdom). As poor stereovision is often linked to strabismus and amblyopia (27–28), the stereoacuity test was included in the screening.

All procedures were performed in the preschools’ classrooms under sufficient room lighting by a postgraduate researcher with a Bachelor’s degree in Optometry and assisted by five undergraduate Optometry students. The vision screening was monitored and validated by three supervisory team members, all with more than 10 years of experience in the paediatric optometry field.

**Classification of Vision Screening Outcomes**

In this study, the vision screening outcomes were categorised as pass or fail. A child was classified to have failed the vision screening if they failed at least one of the three vision screening elements. The fail criteria for distance visual acuity were 0.3 logMAR and worse in either eye or both eyes (29–30). The fail criteria for near visual acuity were 0.4 logMAR or worse in either eye or both eyes (31–32). The fail criteria for stereovision were stereoacuity of 300 arcsec or worse with the Frisby stereotest (33).

**Statistical Analysis**

All data were analysed using the IBM SPSS version 25.0 (IBM Corp, Armonk, New York, USA). Multiple imputations were conducted to handle any missing data, preserve the sample size and produce unbiased estimates (34–35). Twenty imputed datasets were generated under a multivariate normal model to reduce sampling variability from the imputation process (36–37). Descriptive analysis was used to assess the distribution of preschool children’s demographic and socioeconomic characteristics and vision screening outcomes. Comparative analyses were conducted using the Pearson’s Chi-square test or Fisher’s exact test, as appropriate. The predictor variables that produced a $P$-value of 0.20 or below were included in binary logistic regression models. Binary logistic regression was performed to assess the socioeconomic risk factors on the likelihood that participants would fail the vision screening. The first regression model was unadjusted, where the confounding variables were analysed separately. The second model was adjusted by the confounding variables. The significance level was determined at $P < 0.05$ with 95% confidence intervals (CI).

**Results**

The mean age of the 411 participants was 5.94 ± 0.47 years old (range: 5.08 to 6.83 years old) and males comprised 52.6% of the participants. The majority of participants were ethnically Malay ($n = 344$ [83.9%]). The number of indigenous children was combined with Malay children and categorised as Bumiputera ($n = 361$ [88.0%]), while children from other ethnicities (Chinese, Indians and others) were categorised as non-Bumiputera ($n = 49$ [12.0%]). This was done for two reasons: i) it is the legal ethnic classification as outlined by the country’s constitution and ii) the number! of participants of each non-Bumiputera ethnicity was relatively small (between 3.2% and 6.3%). Table 1 summarises the distribution of sociodemographic characteristics of the study participants.
Original Article | Vision screening outcomes in preschool children

Table 1. The distribution of the study participants’ socioeconomic characteristics and birth history status

| Variables                        | N (%)          |
|----------------------------------|----------------|
| Gender                           |                |
| Male                             | 216 (52.6)     |
| Female                           | 195 (47.4)     |
| Ethnicity                        |                |
| Bumiputera                       | 361 (88.0)     |
| Non-Bumiputera                   | 49 (12.0)      |
| Birth history                    |                |
| Normal                           | 267 (91.8)     |
| Abnormal                         | 24 (8.2)       |
| Preschool type                   |                |
| Public                           | 232 (56.4)     |
| Private                          | 179 (43.6)     |
| Preschool enrolment age          |                |
| 3 years old–4 years old          | 85 (21.1)      |
| 5 years old–6 years old          | 318 (78.9)     |
| Maternal education level         |                |
| Secondary education and below    | 215 (53.6)     |
| Above secondary education        | 186 (46.4)     |
| Paternal education level         |                |
| Secondary education and below    | 240 (60.9)     |
| Above secondary education        | 154 (39.1)     |
| Maternal employment status       |                |
| Employed                         | 266 (66.5)     |
| Unemployed                       | 134 (33.5)     |
| Paternal employment status       |                |
| Employed                         | 390 (98.7)     |
| Unemployed                       | 5 (1.3)        |
| Household Income                 |                |
| < RM3,000                        | 267 (65.4)     |
| ≥ RM3,000                        | 141 (34.6)     |
| Living area                      |                |
| Urban                            | 343 (83.9)     |
| Suburban                         | 66 (16.1)      |
| Sibship size                     |                |
| 1–3                              | 304 (74.0)     |
| 4 and above                      | 107 (26.0)     |

The results of vision screening are shown in Figure 1. Eighty-eight percent of the children passed the distant visual acuity test, 94.4% passed the near visual acuity test and 97.6% passed the stereoacuity test. Overall, 84.9% of children passed all three vision assessments. Table 2 summarises the distribution of vision screening outcomes based on the participants’ demographic and socioeconomic characteristics. A significantly higher proportion of Bumiputera
children failed the vision screening (16.34%) compared to non-Bumiputera children (4.08%) \( [\chi^2 (1, 410) = 5.21; \ P = 0.02] \). Four predictor variables had a \( P \)-value of 0.20 or below (ethnicity, birth history, paternal employment status and maternal employment status). Therefore, these variables were included in the binary logistic regression analyses.

![Figure 1. Vision screening assessment](image)

### Table 2. Socioeconomic characteristics and birth history status of participants based on vision screening outcomes

| Variables                  | Pass n (%) | Fail n (%) | Chi-square statistic (df) | \( P \)-value |
|----------------------------|------------|------------|---------------------------|--------------|
| Gender                     |            |            |                           |              |
| Male                       | 183 (84.7) | 33 (15.3)  | 0.01 (1)                  | 0.909        |
| Female                     | 166 (85.1) | 29 (14.9)  |                          |              |
| Ethnicity                  |            |            |                           |              |
| Bumiputera                 | 302 (83.7) | 59 (16.3)  | 5.12 (1)                  | 0.024*       |
| Non-Bumiputera             | 47 (95.9)  | 2 (4.1)    |                          |              |
| Birth history              |            |            |                           |              |
| Normal                     | 236 (88.4) | 31 (11.6)  |                          | 0.196†       |
| Abnormal                   | 19 (79.2)  | 5 (20.8)   |                          |              |
| Preschool type             |            |            |                           |              |
| KEMAS (public)             | 201 (86.6) | 31 (13.4)  | 1.24 (1)                  | 0.266        |
| Private                    | 148 (82.7) | 31 (17.3)  |                          |              |
| Preschool enrolment age    |            |            |                           |              |
| 3 years old–4 years old    | 73 (85.9)  | 12 (14.1)  | 0.05 (1)                  | 0.822        |
| 5 years old–6 years old    | 270 (84.9) | 48 (15.1)  |                          |              |
| Maternal education level   |            |            |                           |              |
| Secondary education and below | 184 (85.6) | 31 (14.4)  | 0.11 (1)                  | 0.743        |
| Above secondary education  | 157 (84.4) | 29 (15.6)  |                          |              |

(continued on next page)
Table 2. (continued)

| Variables                        | Pass n (%)     | Fail n (%)    | Chi-square statistic (df) | P-value |
|----------------------------------|----------------|--------------|--------------------------|---------|
| Paternal education level         |                |              |                          |         |
| Secondary education and below    | 205 (85.4)     | 35 (14.6)    | 0.20 (1)                 | 0.656   |
| Above secondary education        | 129 (83.8)     | 25 (16.2)    |                          |         |
| Maternal employment status       |                |              |                          |         |
| Employed                         | 221 (83.1)     | 45 (16.9)    | 2.29 (1)                 | 0.130†  |
| Unemployed                       | 119 (88.8)     | 15 (11.2)    |                          |         |
| Paternal employment status       |                |              |                          |         |
| Employed                         | 331 (84.9)     | 59 (15.1)    | -                        | 0.172** |
| Unemployed                       | 3 (60.0)       | 2 (40.0)     |                          |         |
| Household income                 |                |              |                          |         |
| < RM3,000                        | 231 (86.5)     | 36 (13.5)    | 1.31 (1)                 | 0.253   |
| ≥ RM3,000                        | 116 (82.3)     | 25 (17.7)    |                          |         |
| Living area                      |                |              |                          |         |
| Urban                            | 292 (85.1)     | 51 (14.9)    | 0.14 (1)                 | 0.709   |
| Suburban                         | 11 (50.0)      | 11 (50.0)    |                          |         |
| Sibship size                     |                |              |                          |         |
| 1–3                              | 255 (83.9)     | 49 (16.1)    | 0.97 (1)                 | 0.324   |
| 4 and above                      | 94 (87.9)      | 13 (12.2)    |                          |         |

Notes: † Fisher's exact test; * Significant at P < 0.2 and parameters are included in binary logistic regression analysis

Table 3 shows the odds ratios of the logistic regression models. In the unadjusted model, the four confounding variables were analysed separately. In the adjusted model, all the factors were included together in the analysis. With the adjusted model, it was found that Bumiputera children were four times more likely to fail vision screening [OR: 4.54; 95% CI: 1.07, 17.76; P = 0.044]. Meanwhile, the other demographic and socioeconomic factors were not significant predictors for failing vision screening.

Table 3. Factors associated with failed vision screening in a sample of Malaysian preschool children

|                        | Unadjusted model | Adjusted model |
|------------------------|------------------|----------------|
|                        | OR   | 95% CI       | P-value | OR   | 95% CI       | P-value |
| Ethnicity              |      |              |         |      |              |         |
| Non-Bumiputera         | 1.00 | 1.00          | 0.039†  | 1.00 | 1.07, 17.76  | 0.044†  |
| Bumiputera             | 4.57 | 1.08, 19.36  | 0.039†  | 4.54 | 1.07, 17.76  | 0.044†  |
| Birth history          |      |              |         |      |              |         |
| Normal                 | 1.00 | 1.00          |         | 1.00 | 1.00          | 0.263   |
| Abnormal               | 2.00 | 0.74, 5.40   | 0.167   | 2.00 | 0.65, 4.78   | 0.263   |
| Maternal employment status |    |              |         |      |              |         |
| Unemployed             | 1.00 | 1.00          |         | 1.00 | 1.00          | 0.263   |
| Employed               | 1.58 | 0.84, 2.96   | 0.153   | 1.67 | 0.82, 2.95   | 0.179   |

(continued on next page)
Discussion

Overall, 15.1% of the children who participated in this study failed at least one of the three assessments conducted under vision screening. Our findings are favourable with the outcomes of earlier studies in Malaysia, where 12.5% of preschool children in Segamat District had visual acuity worse or equal than 0.25 logMAR (18) and 9% of preschool children in Manjung, Perak failed vision screening (17). However, only 5% of preschool children in urban Kuching, East Malaysia, had distant visual acuity worse than or equal to 6/12 in one or both eyes measured with the Sheridan Gardiner chart (18). The lower incidence rate of reduced vision in young children is possibly related to using a letter chart, instead of symbols, for acuity screening. Indeed, the Lea Symbols chart offers a better visual impairment detection rate for preschool vision screening than the Sheridan Gardiner chart (30, 39). The results reported in this study compared well with those of other countries, where the failure rate was 11.9% for children aged 4 years old–5 years old in Scotland (12) and up to 19% failure rate for children in economically disadvantaged areas of New York City (40). However, when measured with the Sheridan Gardiner chart, only 2.7%–3.8% of Hong Kong children aged 2 years old–6 years old presented with visual acuity worse than or equal to 6/12 (41).

The current study found that Bumiputera children had a significantly higher risk of failing vision screening, indicating the presence of some form of uncorrected refractive error. In an earlier study, it was found that non-Bumiputera children had a significantly higher odds ratio (up to 7.98) for having a refractive error (42). Although most refractive error variation within a population is thought to be due to genetics, several studies agreed that environmental factors might also be crucial in determining individual risks of refractive error (43–45). Evidence of this interaction may be seen in a previous study on the prevalence of refractive error among children between ethnicities in Singapore and Malaysia. Regardless of their ethnicity, Singaporean children had a higher prevalence of refractive errors than their Malaysian peers (46). This finding suggests that environmental factors may contribute to the higher rates of refractive error rather than genetics alone.

Prematurity has been associated with increased vision problems in preterm populations (47–48). Thus, these children may have a higher odds of failing vision screening. Preterm infants possess a higher risk of amblyopia, strabismus and uncorrected refractive error compared to full-term infants when they reach six years old of age (49). However, the current study did not find a significant association between these measures. It is worth noting that Malaysian Clinical Practice Guidelines on Retinopathy of Prematurity asserts that premature infants should be screened for their ocular conditions after 4 weeks–6 weeks of birth and periodically monitor its progress till they reach preschool years, if applicable (50). This indicates a reality wherein our systems and healthcare facilities are available for early detection, intervention and ongoing support for high-risk populations, specifically in preterm infant groups.

The current study did not find significant associations between parental employment status and children’s vision screening outcomes. Indeed, a previous study did not find a statistically significant association between parental employment status and their commitment to seeking a comprehensive eye examination after their child had failed visual acuity screening (51). Pieters and Rawlings (52) reported that the unemployment of a father was a disadvantage for their child’s health, but the unemployment of a mother

Table 3. (continued)

| Paternal employment status | Unadjusted model | Adjusted model |
|----------------------------|-----------------|---------------|
|                            | OR              | 95% CI        | P-value       | OR              | 95% CI        | P-value       |
| Employed                   | 1.00            |                |               | 1.00            |                |               |
| Unemployed                 | 1.86            | 0.35, 0.80     | 0.464         | 1.84            | 0.31, 13.04   | 0.462         |

Note: *OR is significant at P < 0.05
was beneficial to their child’s health status. It was suggested that having unemployed fathers would, on average, reduce family income, creating barriers to obtaining health care for their children. Meanwhile, employed mothers would be required to reorient their time to meet their dual demands of working and childcare, which could significantly impact child health outcomes (53–54). Our present data could not address these hypotheses as the current study found no significant associations between parental employment status and children’s vision screening outcomes.

Although the present study includes a population-based design and standardised vision assessments, several limitations were subjected to this study. Firstly, the study derived the socioeconomic status of participants based on parent-reported questionnaires, which might not accurately depict the actual socioeconomic status of the sample. Parents or legal guardians might misreport their response to several items that were seen as their personal worth, such as educational level, employment status and income (55–56). Classification of a child’s ethnicity was determined based on the questionnaires filled in by their parents, which could be questionable in the case of mixed-parentage. However, they were provided with the option of ‘Others’ if their children did not classify as Malay/indigenous, Chinese or Indian ethnicity. In addition, the current study’s questionnaire grouped those born preterm or with complications as having an abnormal birth history, where these conditions may affect children’s development differently (57–58). However, with the relatively low number of participants who indicated that the birth was preterm or with complications (n = 24 [8.2%]), the analysis outcome was unlikely to change had the preterm and complicated birth data been categorised separately. Secondly, a large percentage of the participants were Bumiputera children, which might have skewed the study’s findings and affected the power of the study, widening the 95% confidence interval for the odds ratio (59). The samples’ ethnicity also did not reflect the ethnicity distribution of the Malaysian population. Thus, generalisation of the results is not possible. In a future study, the ethnicity proportion of the sample should be made to reflect the ethnicity proportion of the population. Furthermore, the study did not measure the refractive error of the participants and probably underestimated the vision screening outcomes. This could be a disadvantage for children who may have had latent hyperopia, astigmatism and low myopia since the cut-off values used in the visual acuity screening do not reliably detect them (60–61). Hence, performing cycloplegic refraction should be considered to improve the detection rate of uncorrected refractive errors among preschool children in a future study.

Conclusion

Preschool children’s ethnicity is associated with vision screening outcomes, where Bumiputera children are more likely to fail vision screening tests than their non-Bumiputera peers. However, other demographic and socioeconomic factors are not significant predictors for the outcomes of vision screening.

Acknowledgements

Special thanks to Mahadir Ahmad, Masne Kadar and Manisah Mohd-Ali for being part of the supervisory team. This study was supported by the Ministry of Higher Education, Malaysia through the Fundamental Research Grant Scheme (grant number: FRGS/1/2019/SSI09/UKM/02/4).

Ethics of Study

Ethical approval was granted by the Universiti Kebangsaan Malaysia’s Research Ethics Committee (UKM/PPI/800-1/1/5/JEP-2019-476) and the Ministry of Rural Development, Malaysia (BPAK620-02/01/01 Jld 15). Permission was also obtained from the authorities of the preschools involved in the study. The study conformed to the tenets of the Declaration of Helsinki involving human participants. Written informed consent from the parents or legal guardians and the children’s assent for study participation were sought before data collection. Children who did not give assent or whose parents did not provide consent were excluded from the study.

Conflict of Interest

None.
Funds
None.

Authors’ Contributions
Conception and design: NN, SN, SSK, MIH
Analysis and interpretation of the data: HK, SN, MIH
Drafting of the article: HK, SSK
Critical revision of the article for important intellectual content: SN, MIH
Final approval of the article: MIH
Provision of study materials or patients: NN, NEAM
Statistical expertise: HK, SN
Obtaining of funding: SN, SSK, MIH
Administrative, technical, or logistic support: SSK
Collection and assembly of data: NN, NEAM

Correspondence
Dr Mohd Izzuddin Hairol
PhD (Anglia Ruskin University), B Optometry (Universiti Kebangsaan Malaysia)
Centre for Community Health Studies (ReaCH), Faculty of Health Sciences,
Universiti Kebangsaan Malaysia,
Kuala Lumpur, Malaysia.
Tel: +603 9289 7447
E-mail: izzuddin.hairol@ukm.edu.my

References
1. American Optometric Association. Comprehensive pediatric eye and vision examination [Internet]; 2017. Available at: https://www.aoa.org/AOA/Documents/Practice%20Management/Clinical%20Guidelines/Comprehensive%20Pediatric%20Eye%20and%20Vision%20Exam.pdf
2. Roch-Levecq AC, Brody BL, Thomas RG, Brown SI. Ametropia, preschoolers’ cognitive abilities, and effects of spectacle correction. Arch Ophthalmol. 2008;126(2):252–258. https://doi.org/10.1001/archophthalmol.2007.36
3. Ma X, Zhou Z, Yi H, Pang X, Shi Y, Chen Q, et al. Effect of providing free glasses on children’s educational outcomes in China: cluster randomized controlled trial. Br Med J. 2014;349:g5740. https://doi.org/10.1136/bmj.g5740 %J BMJ
4. McCullough S, Saunders K. Visual profile of children who passed or failed the UK School Vision Screening Protocol. Br Ir Orthopt J. 2019;15(1):36–46. https://doi.org/10.22599/bioj.121
5. Alsaqr AM, Masmali AM. The awareness of amblyopia among parents in Saudi Arabia. Ther Adv Ophthalmol. 2019;11:2515841419868103. https://doi.org/10.1177/2515841419868103
6. Dikova SP, Dragoev SA, Chernodrinska VS. Prevalence of amblyopia in Bulgaria. Strabismus. 2018;26(4):163–167. https://doi.org/10.1080/09273972.2018.1530266
7. Sukati VN, Moodley VR, Mashige KP. Knowledge and practices of parents about child eye health care in the public sector in Swaziland. Afr J Prim Health Care Fam Med. 2018;10(1):e1–e13. https://doi.org/10.4102/phcfm.v10i1.1808
8. Ministry of Health Malaysia. School Health Service 2013 [Internet]. Available at: http://www.myhealth.gov.my/en/school-health-service/
9. Hairol MI. Comparison of habitual visual acuity and stereoeacuity between children attending KEMAS and urban private preschools. Med Health. 2020;15(1):225–236. https://doi.org/10.17576/mh.2020.1501.21
10. Wah W, Earnest A, Sahanayagam C, Cheng CY, Pang ME, Wong TY, et al. Composite measures of individual and area-level socio-economic status are associated with visual impairment in Singapore. PLoS ONE. 2015;10(11):e0142302. https://doi.org/10.1371/journal.pone.0142302
11. Dai WW, Gao JM, He P, Ma Z, Tian XX, Zheng XY. The association between socioeconomic status and visual disability among older adults in China. Int J Ophthalmol. 2019;12(1):106–113. https://doi.org/10.18240/ijo.2019.01.17
Original Article | Vision screening outcomes in preschool children

12. O’Colmain U, Low L, Gilmour C, MacEwen CJ. Vision screening in children: a retrospective study of social and demographic factors with regards to visual outcomes. Br J Ophthalmol. 2016;100(8):1109–1113. https://doi.org/10.1136/bjophthalmol-2015-307206

13. Williams C, Northstone K, Howard M, Harvey I, Harrad RA, Sparrow JM. Prevalence and risk factors for common vision problems in children: data from the ALSPAC study. Br J Ophthalmol. 2008;92(7):959–964. https://doi.org/10.1136/bjo.2007.134700

14. Vila-Vidal N, Guisasola L, Rius A, Alonso J, Tresserras R. Children’s visual impairment and visual care related to socioeconomic status in Catalonia (Spain). Child Care Health Dev. 2021;47(1):94–102. https://doi.org/10.1111/chc.12826

15. Hairoll MI, Nordin N, P’ng J, Sharanjeet-Kaur S, Narayanasamy S, Mohd-Alli M, et al. Association between reduced visual-motor integration performance and socioeconomic factors among preschool children in Malaysia: a cross-sectional study. PloS ONE. 2021;16(3):e0246846. https://doi.org/10.1371/journal.pone.0246846

16. Abdolrahimzadeh S. Importance of vision screening in children regardless of socioeconomic status. Eye (Lond). 2012;26(3):478. https://doi.org/10.1038/eye.2011.311

17. Omar R, Hussin DA, Knight VF. Profil gangguan visual di kalangan kanak-kanak prasekolah. Jurnal Sains Kesihatan Malaysia. 2009;7(1).

18. Chew FLM, Thavaratnam LK, Shukor INC, Ramaasmy S, Rahmat J, Reidpath DD, et al. Visual impairment and amblyopia in Malaysian pre-school children - the SEGPAEDS study. Med J Malays. 2018;73(1):25–30.

19. Premzenthil M, Manju R, Thanaraj A, Rahman SA, Kah TA. The screening of visual impairment among preschool children in an urban population in Malaysia; the Kuching pediatric eye study: a cross sectional study. BMC Ophthalmol. 2013;13(1):16. https://doi.org/10.1186/1471-2415-13-16

20. Department of Statistics Malaysia. Live births by state and sex: 2009–2018 (Updated December 30, 2020) [Retrieved 2021 February 7]. Available at: https://www.dosm.gov.my/v1/uploads/files/4_Portal%20Content/2_%20Statistics/Open%20Data/PopulationDemography/Live_births_by_state_and_sex_2009-2018.xlsx

21. Krejie RV, Morgan DW. Determining sample size for research activities. Educ Psychol Meas. 1970;30(3):607–610. https://doi.org/10.1177/001316447003000308

22. Community Development Department (KEMAS). Senarai alamat Tabika; 2019 [Retrieved 2021 February 7]. Available at: https://www.kemas.gov.my/tabika/#toggle-id-7

23. Ministry of Education Malaysia. Carian institusi berdaftar dengan KPM; 2017 [Retrieved 2021 February 7]. Available at: https://eprasekolah.moe.gov.my/index.php?o=dySm6J1JcnI-N1KfEiKxUDaITORHKZA6oDdM_7dQ6bwLHT-fRqJdNRAoW4_Jh

24. Department of Statistics Malaysia. Household income and expenditure; 2017 [Retrieved 2021 February 7]. Available at: https://www.dosm.gov.my/v1/index.php?r=column/ctwoByCat&parent_id=119&menu_id=amVoWU54UTl0a21NWmdhMjFMMWcyZ09

25. Jabatan Kerajaan Tempatan KPdKT. Matriks perbandingan kategori PBT; 2021 [Retrieved 2021 February 7]. Available at: http://jkt.kpkt.gov.my/ms/SUK%26PBT/PBT/KategoriPBT

26. Jin P, Zhu J, Zou H, Lu L, Zhao H, Li Q, et al. Screening for significant refractive error using a combination of distance visual acuity and near visual acuity. PloS ONE. 2015;10(2):e0117399. https://doi.org/10.1371/journal.pone.0117399

27. Read JC. Stereo vision and strabismus. Eye (Lond). 2015;29(2):214–224. https://doi.org/10.1038/eye.2014.279

28. Levi DM, Knill DC, Bavelier D. Stereopsis and amblyopia: a mini-review. Vision Res. 2015;114:17–30. https://doi.org/10.1016/j.visres.2015.01.002
29. Luo HD, Gazzard G, Liang Y, Shankar A, Tan DT, Saw SM. Defining myopia using refractive error and uncorrected logMAR visual acuity > 0.3 from 1334 Singapore school children ages 7–9 years. *Br J Ophthalmol.* 2006;90(3):362–366. https://doi.org/10.1136/bjo.2005.079657

30. Omar R, Hussin DA, Knight VF. Comparison of Lea Symbols chart and Sheridan Gardiner chart in assessing vision screening among pre-school children: a Malaysia perspective. *J Med Assoc Thai.* 2012;95(3):412–417.

31. Elliott DB. *Clinical procedures in primary eye care.* 5th ed. Elliott DB, Flanagan JG, editors: Elsevier; 2020. 336 p.

32. Azizan IA, Qi EY, Kaur S, Narayanasamy S. Visual acuity demands of different language mediums in modern primary school classrooms in Malaysia. *FioooResearch.* 2019;8(2143):2143. https://doi.org/10.12688/fiooo.2019.2143

33. Ohlsson J, Villarreal G, Abrahamsson M, Cavazos H, Sjostrom A, Sjostrand J. Screening merits of the Lang II, Frisby, Randot, Titmus, and TNO stereo tests. *J AAPOS.* 2001;5(5):316–322. https://doi.org/10.1067/mpa.2001.118669

34. Pigott TD. A review of methods for missing data. *Edu Res Eval.* 2010;7(4):353–383. https://doi.org/10.1076/edire.7.4.353.8937

35. White IR, Carlin JB. Bias and efficiency of multiple imputation compared with complete-case analysis for missing covariate values. *Stat Med.* 2010;29(28):2920–2931. https://doi.org/10.1002/sim.3944

36. Horton NJ, Lipsitz SR. Multiple imputation in practice. *Am Stat.* 2001;55(3):244–254. https://doi.org/10.1198/00031300131709826

37. Sterne JA, White IR, Carlin JB, Spratt M, Royston P, Kenward MG, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ.* 2009;338:b2393. https://doi.org/10.1136/bmj.b2393

38. Premkantil M, Manju R, Thanaraj A, Rahman SASA, Keh TA. The screening of visual impairment among preschool children in an urban population in Malaysia; the Kuching pediatric eye study: a cross sectional study. *BMC Ophthalmol.* 2013;13(1):16.

39. Paul CM, Satyam S. Comparison of the efficacy of Lea Symbol chart and Sheridan Gardiner chart for preschool vision screening. *Indian J Ophthalmol.* 2018;66(7):924–928. https://doi.org/10.4103/ijo.IJO_1078_17

40. Bodack MI, Chung I, Krumholtz I. An analysis of vision screening data from New York City public schools. *Optometry.* 2010;81(9):476–484. https://doi.org/10.1016/j.optm.2010.05.006

41. Fan DS, Lai C, Lau HH, Cheung EY, Lam DS. Change in vision disorders among Hong Kong preschoolers in 10 years. *Clinical & experimental ophthalmology.* 2011;39(5):398–403. https://doi.org/10.1111/j.1442-9071.2010.02470.x

42. Goh PP, Abqariyah Y, Pokharel GP, Ellwein LB. Refractive error and visual impairment in school-age children in Gombak District, Malaysia. *Ophthalmology.* 2005;112(4):678–685. https://doi.org/10.1016/j.ophtha.2004.10.048

43. Wojciechowski R. Nature and nurture: the complex genetics of myopia and refractive error. *Clin Genet.* 2011;79(4):301–320. https://doi.org/10.1111/j.1399-0004.2010.01592.x

44. French AN, Morgan IG, Mitchell P, Rose KA. Risk factors for incident myopia in Australian schoolchildren: the Sydney adolescent vascular and eye study. *Ophthalmology.* 2013;120(10):2100–2108. https://doi.org/10.1016/j.ophtha.2013.02.035

45. Morgan IG, French AN, Ashby RS, Guo X, Ding X, He M, et al. The epidemics of myopia: aetiology and prevention. *Prog Retin Eye Res.* 2018;62:134–149. https://doi.org/10.1016/j.preteyeres.2017.09.004

46. Saw SM, Goh PP, Cheng A, Shankar A, Tan DT, Ellwein LB. Ethnicity-specific prevalences of refractive errors vary in Asian children in neighbouring Malaysia and Singapore. *Br J Ophthalmol.* 2006;90(10):1230–1235. https://doi.org/10.1136/bjo.2006.093450

47. Pai AS, Wang JJ, Samarawickrama C, Burlutsky G, Rose KA, Varma R, et al. Prevalence and risk factors for visual impairment in preschool children the sydney paediatric eye disease study. *Ophthalmology.* 2011;118(8):1495–1500. https://doi.org/10.1016/j.ophtha.2011.01.027
O’Connor AR, Wilson CM, Fielder AR. Ophthalmological problems associated with preterm birth. Eye (Lond). 2007;21(10):1254–1260. https://doi.org/10.1038/sj.eye.6702838

49. Robaei D, Kifley A, Gole GA, Mitchell P. The impact of modest prematurity on visual function at age 6 years: findings from a population-based study. Arch Ophthalmol. 2006;124(6):871–877. https://doi.org/10.1001/archopht.124.6.871

50. Ministry of Health Malaysia. Clinical practice guidelines: retinopathy of prematurity Putrajaya, Malaysia: 2005 [Retrieved 2021 February 7]. Available at: https://www.moh.gov.my/moh/attachments/3917.pdf

51. Su Z, Marvin EK, Wang BQ, van Zyl T, Elia MD, Garza EN, et al. Identifying barriers to follow-up eye care for children after failed vision screening in a primary care setting. J AAPOS. 2013;17(4):385–390. https://doi.org/10.1016/j.jaapos.2013.05.008

52. Pieters J, Rawlings S. Parental unemployment and child health in China. Review of Economies of the Household. 2019;18(1):207–237. https://doi.org/10.1007/s11150-019-09457-y

53. Kuhlthau KA, Perrin JM. Child health status and parental employment. Arch Pediatr Adolesc Med. 2001;155(12):1346–1350. https://doi.org/10.1001/archpedi.155.12.1346

54. Duncan GJ, Magnuson K, Votruba-Drzal E. Children and socioeconomic status. In: Bornstein MH, Leventhal T, editors. Handbook of child psychology and developmental science, Vol. 4: ecological settings and processes in developmental systems. New York: Wiley; 2015. pp. 534–573.

55. Demetriou C, Özer BU, Essau C. Self-report questionnaires. In: Cautin R, Lilienfield S, editors. The encyclopedia of clinical psychology. Malden MA: John Wiley & Sons., Inc; 2015. https://doi.org/10.1002/9781118625392.wbecp507

56. van de Mortel TF. Faking it: social desirability response bias in self-report research. Aust J Adv Nurs. 2008;25(4):40–48.

57. Leung MP, Thompson B, Black J, Dai S, Alsweiler JM. The effects of preterm birth on visual development. Clin Exp Optom. 2018;101(1):4–12. https://doi.org/10.1111/cxo.12578

58. Blake JA, Gardner M, Najman J, Scott JG. The association of birth by caesarean section and cognitive outcomes in offspring: a systematic review. Soc Psychiatry Psychiatr Epidemiol. 2021;56(4):533–545. https://doi.org/10.1007/s00127-020-02008-2

59. Rusticus S, Lovato C. Impact of sample size and variability on the power and type I error rates of equivalence tests: a simulation study. Practical Assessment, Research and Evaluation. 2014;19(19):1–10.

60. O’Donoghue L, Rudnicka AR, McClelland JF, Logan NS, Saunders KJ. Visual acuity measures do not reliably detect childhood refractive error — an epidemiological study. PloS ONE. 2012;7(3):e34441. https://doi.org/10.1371/journal.pone.0034441

61. Leone JF, Mitchell P, Morgan IG, Kifley A, Rose KA. Use of visual acuity to screen for significant refractive errors in adolescents: is it reliable? Arch Ophthalmology. 2010;128(7):894–899. https://doi.org/10.1001/archophthalmol.2010.134

%JArchivesofOphthalmology