ORIGINAL ARTICLE

Bali Medical Journal (*Bali MedJ*) 2022, Volume 11, Number 2: 671-675
P-ISSN.2089-1180, E-ISSN: 2302-2914

The effectiveness of using peek acuity in vision screening for the admission of elementary school students

Christina Aritonang[1*], Salsabila Auliya Putri[1], Budi Utomo[1]

[1]Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

*Corresponding to:
Christina Aritonang; Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia;
christina@fk.unair.ac.id

Received: 2022-05-24
Accepted: 2022-07-15
Published: 2022-07-31

ABSTRACT

Background: Limiting close physical contact is key to helping reduce the spread of the coronavirus by using the portable eye examination kit (Peek Acuity), which has been recognized as a reliable and valid tool to measure visual acuity. This study is aimed to compare the effectiveness of the Peek Acuity and ETDRS (Early Treatment Diabetic Retinopathy Study) chart as the gold standard for screening in school-age students.

Methods: This study used an observational research design with cross-sectional data collection methods to compare the effectiveness of the Peek Acuity application diagnostic test and ETDRS chart for screening in school-age students. Sample collection was done by total sampling technique on students aged 6-12 from one of the elementary schools in Surabaya. The study was conducted from October 2019 to November 2019. OpenEpi analyzed the validity and reliability of the results to compare the effectiveness of Peek Acuity and the ETDRS chart.

Results: There were 231 students with details aged 6-9 years, as many as 150 students and aged 10-12 years, as many as 81 students. On examination of visual acuity using peek acuity and ETDRS chart, it indicated that the number of subjects with refractive errors was more than normal eyes. Peek acuity has been shown to have low sensitivity and high specificity. Higher specificity was found in children aged 10-12 years compared to 6-9 years.

Conclusion: The Peek Acuity application has higher effectiveness in screening than the ETDRS chart. It is practical, fast, and easy to use. The Peek Acuity application is considered effective for screening school-age students due to its high rate of specificity

Keywords: ETDRS, high rate, peek acuity, screening, specificity, visual acuity.
Cite This Article: Aritonang, C., Putri, S.A., Utomo, B. 2022. The effectiveness of using peek acuity in vision screening for the admission of elementary school students. *Bali Medical Journal* 11(2): 671-675. DOI: 10.15562/bmj.v11i2.3445

INTRODUCTION

The prevalence of myopia is increasing globally worldwide, with considerable increases in the risks of vision impairment due to pathologic disorders linked with high myopia, including retinal damage, cataract and glaucoma. The highest prevalence of visual impairment due to uncorrected refractive errors occurs in Southeast Asia, which is around 153 million people, 13 million of whom are children aged 5-15 years.[1-3] One of the efforts to reduce the number of blindness in children is to provide the right technology and infrastructure at an affordable range of price, using the best quality and, in this case, to immediately identify refractive errors so that they can take immediate action. Correction is done by giving assistive devices such as glasses to improve vision.[4]

In the current era of the coronavirus (COVID-19) pandemic, a health service that minimizes face-to-face interactions between humans in an effort to prevent virus transmission is urgently needed. Telemedicine is a service that is considered appropriate and safe to receive our health necessities during these difficult circumstances. These health services save various crucial things, including but not limited to money, time, and travel allowances for patients. By using smartphones, users, especially people with a lower middle class as their socioeconomic background, can access information, especially in the health sector, without the need to access facilities in areas designed for measuring visual acuity.[5,6]

The discovery of the logMAR (Logarithm of the Minimum Angle of Resolution) card, which was developed in the form of the ETDRS (Early treatment diabetic retinopathy study) card, which is currently the gold standard in visual acuity examinations. In spite of the mentioned fact, the ETDRS card is considered inconvenient, expensive, and difficult to obtain (6). The medical community is leveraging mobile technology as a potential means for disseminating health information, monitoring patients in real-time, collecting research data, and providing medical advice remotely to remote locations. One of the available smartphone applications that have been tested for assistance in eye examinations, especially visual acuity, is the Peek Acuity application (Portable Eye Exam Kit) developed by Peek Vision Company.[7]

This study was conducted on school-age children because the potential for progression of myopia is high during that age range, so preventive measures are needed to prevent it.[8,9] Preventive action that can be taken is to quickly identify

and determine children's vision so that it will speed up the treatment of refractive errors. School-age children have different concentration power at each increasing age. This increases by 2 to 3 minutes with each increase in age. Elementary school-age children at the 6th-grade education level have a higher concentration power than 3rd graders.[10-12]

Based on the description that has been presented, this study was conducted to determine the validation of visual acuity measurements using the Peek Acuity application compared to the ETDRS card for school-age children and to compare the age group of 6-9 years with those aged 9-12 years. We hypothesize that the Peek Acuity application has the same effectiveness for screening as compared to the ETDRS chart.

METHODS

Design and participants

This study used an observational analytic research design with cross sectional data collection of the school-aged student. Students aged 6-12 were recruited from one of the elementary schools in Surabaya. We conducted over two months from October to November 2019. The sampling technique used in this study is total sampling with inclusion criteria of students aged 6-12 who are willing to do visual acuity examination using the Peek Acuity application and ETDRS chart. All participants gave their informed consent in the form. Exclusion criteria in this study were participants with anterior segment abnormalities such as conjunctivitis, iritis, uveitis, keratitis, and corneal ulcers. A total of 231 students with details aged 6-9 years, as many as 150 students aged 10-12 as many as 81 students agreed to participate in the study and gave their consent. The ETDRS chart used in this study is the ETDRS Tumbling E chart. Participants with a visual acuity examination with a LogMAR value > 0.1 are considered to have refractive errors, and LogMAR < 0.1 is considered normal. This study was approved by the Health Ethics Committee, Faculty of Dental Medicine, Airlangga University. All the methodologies were performed in conformity with the appropriate rules and regulations.

Procedures

This study used primary data obtained from the visual acuity examination using the Peek Acuity Application and ETDRS chart of the participants. All examinations are performed by general practitioners who have been trained in the use of the Peek Acuity application. Visual acuity was tested using the Peek Acuity within 2 meters from the student and using the ETDRS chart at a distance of 4 meters from the student with an interval of 10 minutes of rest after examining 20 subjects. The results of the visual acuity examination will be displayed on a LogMAR value scale. The examination was carried out using a Samsung Galaxy S10 Android smartphone. The acquired findings are placed into a 2x2 table to be tested for validity and reliability.

RESULTS

Characteristics of the participants

The characteristics of the participants are shown in Table 1. We received results from 231 students who agreed to participate in this study between October to November 2019. The demographic characteristics showed a higher number of females (54.98%) than males. The number of students aged 6-11 years old dominated over students aged 12 years old with a similar average number (16.30%). Additional information on the characteristics of participants is shown in Table 1.

Validity and reliability test

Table 2 illustrates the result of the visual acuity examination using the Peek Acuity Application compared with the ETDRS chart as the gold standard after being entered into the 2x2 table. Peek acuity

Table 1. Characteristics of participants (n = 231)

Variable	n	%
Sex		
Male	104	45.02
Female	127	54.98
Age		
6 years old	35	15.15
7 years old	36	15.58
8 years old	41	17.74
9 years old	38	16.45
10 years old	39	16.88
11 years old	37	16.02
12 years old	5	2.16

Table 2. Validity and reliability of Peek Acuity application compared with ETDRS Chart in school-aged students

Variable	Sn (%)	Sp (%)	PPV (%)	NPV(%)	LR (+)	LR (-)	AUC
Right eye	71.01	98.92	98.99	69.7	66.04	0.293	0.850
Left eye	63.01	96.47	96.84	60.29	17.85	0.383	0.797
6-9 years old	57.14	96.15	96.55	54.35	14.86	0.445	0.766
10-12 years old	75	96.97	97.3	72.73	24.75	0.257	0.860

***Sn: Sensitivity; Sp: Specificity; PPV: Positive Predictive Value; NPV: Negative Predictive Value; LR: Likelihood Ratio; AUC: Area Under Curve**

showed a high rate of specificity (97.69%) but a low rate of sensitivity (<80%) on the right and left eyes. Validity result were found to be higher in students aged 10-12 [Sn=75; Sp=96.97; PPV=97.3; NPV=72.3; LR(+)=24.75; LR(-)=0.257; AUC=0.860] compared to students aged 6-9 years old [Sn=57.14; Sp=96.15; PPV=96.55; NPV=54.35; LR(+)=14.86; LR(-)=0.445; AUC=0.766].

DISCUSSION

Uncorrected refractive errors are one of the most common causes of visual disturbances.[13,14] Generally, blindness caused by refractive errors begins to manifest at an early age. The number of people who are blind yearly due to refractive errors is about two times higher than blindness due to cataracts in developing countries.[15-17] Socio-cultural and personal factors also happen to contribute to a person's inability to visit an ophthalmologist. Visual impairment in children can be prevented through screenings and early intervention using corrective lenses. Thus, an accurate screening tool for measuring visual acuity is important in determining further management.[18,19] In many European countries, early vision screening is mandatory and is generally carried out in children before the start of primary school education at the age of 4-5 years. After that age, parents or guardians are responsible for following the development of the child's eye health.[13,20] A screening test can be assessed if it has high sensitivity and specificity, meaning it has high validity. The validity of a screening test is based on its accuracy in identifying and classifying individuals into ill and not ill.[21-23] During the current pandemic, it is necessary to have a visual acuity check that has minimum face-to-face interaction to prevent transmission of the COVID-19 virus. Examination using the Peek Acuity application is considered the most effective compared to other examinations, namely SmartOptometry, Reduced Snellen near vision, and COMPlog.[5]

A previous study in Kenya in 2015 showed that the Peek Acuity application had a very good correlation compared to the Snellen chart.[6] Research conducted in Kenya and Paraguay on children aged 6-16 has also shown that Peek Acuity has high specificity.[24] In this study, the results of visual acuity examination using peek acuity were compared with the ETDRS card as the gold standard for the right ocular, namely sensitivity 71.01%, specificity 98.92%, positive predictive value 98.99%, negative predictive value 69.7%. The result of the other side, the left ocular, shows a percentage of sensitivity rate on 63.01%, a specificity of 96.47%, a positive predictive value of 96.84%, and a negative predictive value of 60.29%. There was no significant difference in the examination of the right and left eyes.[25] Tests that can be considered good hold a sensitivity and specificity between 80-90%.[26] Therefore, the sensitivity of this application is considered still lacking. Peek Acuity application tends to give higher examination results than the real one because the population studied are children whose literacy power is lower, and there is no time limit feature in order for children to guess which way the letters appear on the screen.[25-27] This can be assessed if the child answers in a longer time than the others, and there is a possibility that the child's guess is correct and therefore is able to reduce the sensitivity of the test. However, the high specificity of Peek Acuity significantly predicts the number of children who do not require further evaluation, and it can indeed help screening programs in areas with limited resources.[24]

This study also determined the sensitivity and specificity by age group. Children aged 6-9 years show a sensitivity of 57.14%, specificity of 96.15%, a positive predictive value of 96.55%, a negative predictive value of 54.35% and children aged 10-12 years show a sensitivity of 75%, specificity of 96.97%, positive predictive value 97.3%, the negative predictive value of 72.73% which indicates the sensitivity of this application is higher in children aged 10-12 years. The area under the curve is 0.850 (**Table 2**) and is considered good. In the comparison of the area under the curve for children aged 6-9 years and aged 10-12 years, it was shown that the examination of visual acuity in children aged 10-12 years is considered more accurate than in children aged 6-9 years due to the light of the fact that children aged 10-12 years have higher literacy and education power so that they are accustomed to reading with high concentration and good reasoning compared to children aged 6-9 years.[11,24]

A screening test is considered good if it is easy to conduct as well as to execute, only gives the slightest amount of discomfort, is valid, able to distinguish ill people from those who are not, and is reliable (consistent).[21,26] The advantages of the Peek Acuity application lie in its duration and accessibility in its use. Research shows that the Peek Acuity application has a shorter examination duration than the Snellen card. The duration of the peek acuity check was 136.59 seconds, and the Snellen card was 309.16 seconds.[7,25] Peek acuity also improves adherence to hospital referrals compared to the standard approach in children at school and can be used in patients who are unfamiliar with the letters of the alphabet. This shows the potential of technology in improving health services in real-time and helping to target resources.[8] This application is also free to download, so it is cost-effective and practical in terms of usage, considering that there are currently numerous mobile phone users. This application allows non-experts to participate in evaluating visual acuity accurately through a simple handheld device.[24,28] Measurement of visual acuity using the peek acuity application by teachers who have been given training and independent learning shows more accurate results than the results of visual acuity examinations by experts. The results will be displayed using LogMAR or Snellen units (metric and imperial). A visual picture of the results of visual acuity compared to normal vision is accessible to make the results more understandable. Another plus is that no personally identifiable information is required for testing. Although this application does not test near vision, peek vision is developing the possibility to produce comparable applications to test near vision in the future to complement Peek Acuity.[28]

The weakness of this application lies in its sensitivity, which is still lacking and can only be accessed in English, so users who do not understand English may find it difficult to understand and use it. This application has a high level of reliability for the age group above 6 years to adults.

At the age of 4-6 years, a moderate level of reliability was found, and it is not recommended for use under 4 years of age. Another drawback is that this application is only downloadable on Android software, so it cannot be obtained evenly, namely on the Apple IOS software.[28]

This research was carried out by general practitioners so that they cannot be compared with ordinary people, but the examination can be carried out by training ordinary people first, especially for workers such as teachers, nurses, and students at UKS (School Health Business) and at the '*Posyandu*' so that they can do screening starting from an early stage. This research is expected to increase public awareness about the importance of visual hygiene and reduce the progression and complications of refractive errors.[29,30] The government also plays an important role in contributing to children's vision health. Many governments have the potential to regulate children's vision health but do not communicate with each other. The government, improved communication, and technology have high potential in supporting screening for school-age children. What is currently being noted is that in involving schools in screening activities, a uniform screening method is needed, which includes functional vision screening and following its development. Technology has great potential in realizing non-experts in screening, providing measurable results, and connecting communication between the governments involved.[13,19]

This study has limitations on the number of research subjects and the time of examination conducted during the day, causing eye fatigue, and affecting the examination results. Another limitation of this research is that it was conducted using only the Peek Acuity application with the latest software and cellular phones, so it is not comparable to older software. The addition of research samples of pre-school children aged 3-5 years can also be considered to compare the development of children's visual acuity.[24] Further research can be carried out in schools with more students to represent a refractive error in one city and carried out in the morning to prevent eye fatigue. Re-examination 6 months later is also necessary to check whether the subject with refractive error has received further treatment.

CONCLUSION

The results of the visual acuity examination using the Peek Acuity application show lower accuracy than the ETDRS card as the gold standard because the Peek acuity application has less sensitivity and specificity than expected. The use of the Peek Acuity application to screen admission to school-age students can be considered because it has high specificity. Peek acuity application is considered effective in terms of use during a pandemic because it is faster, easier, and requires less physical interaction.

ETHICAL CLEARANCE

This study was approved by the Health Ethics Committee, Faculty of Dental Medicine, Airlangga University. All the methodologies were performed in conformity with the appropriate rules and regulations.

CONFLICT OF INTEREST

No conflict of interest.

FUNDING

Self-funded.

AUTHOR CONTRIBUTIONS

All authors have the same contribution in writing the report on the results of this study, from the stage of proposal preparation, data search, and data analysis to the interpretation of research data and presentation of the final report.

REFERENCES

1. Bourne RRA, Steinmetz JD, Flaxman S, Briant PS, Taylor HR, Resnikoff S, et al. Trends in prevalence of blindness and distance and near vision impairment over 30 years: An analysis for the Global Burden of Disease Study. Lancet Glob Heal. 2021;9(2):e130–43. DOI: https://doi.org/10.1016/S2214-109X(20)30425-3
2. World Health Organization. The Impact of Myopia and High Myopia [Internet]. World Health Organization–Brien Holden Vision Institute. 2015. p1–40. Available from: https://www.who.int/blindness/causes/MyopiaReportforWeb.pdf
3. Theophanous C, Modjtahedi BS, Batech M, Marlin DS, Luong TQ, Fong DS. Myopia prevalence and risk factors in children. Clin Ophthalmol. 2018;12:1581-1587. Published 2018 Aug 29. doi: 10.2147/OPTH.S164641.
4. Ismandari F. Situasi Gangguan Penglihatan. InfoDATIN - Pusat Data dan Informasi Kementerian Kesehatan Republik Indonesia [Internet]. 2018. Available from: https://pusdatin.kemkes.go.id/download.php?file=download/pusdatin/infodatin/infodatin-Gangguan-penglihatan-2018.pdf
5. Satgunam P, Thakur M, Sachdeva V, Reddy S, Rani PK. Validation of visual acuity applications for teleophthalmology during COVID-19. Indian J Ophthalmol. 2021;69(2):385-390. doi: 10.4103/ijo.IJO_2333_20.
6. Bastawrous A, Rono HK, Livingstone IA, et al. Development and Validation of a Smartphone-Based Visual Acuity Test (Peek Acuity) for Clinical Practice and Community-Based Fieldwork [published correction appears in JAMA Ophthalmol. 2015 Sep;133(9):1096]. JAMA Ophthalmol. 2015;133(8):930-937. doi: 10.1001/jamaophthalmol.2015.1468.
7. Evani S, Witono AA, Junaidi FJ. Perbandingan Hasil Pemeriksaan Tajam Penglihatan Menggunakan Kartu Snellen dan Aplikasi Smartphone PEEK Acuity pada Anak Usia 5-6 Tahun. Cdk. 2019;46(8):492–6. DOI: http://dx.doi.org/10.55175/cdk.v46i8.445.
8. Rono HK, Bastawrous A, Macleod D, et al. Smartphone-based screening for visual impairment in Kenyan school children: a cluster randomised controlled trial [published correction appears in Lancet Glob Health. 2018 Oct;6(10):e1072]. Lancet Glob Health. 2018;6(8):e924-e932. doi: 10.1016/S2214-109X(18)30244-4.
9. Baird PN, Saw SM, Lanca C, et al. Myopia. Nat Rev Dis Primers. 2020;6(1):99. Published 2020 Dec 17. doi: 10.1038/s41572-020-00231-4.
10. Ma MY and Wei CC. A comparative study of children's concentration performance on picture books: age, gender, and media forms. Interactive Learning Environments. 2016;24(8). p1922-1937. DOI: 10.1080/10494820.2015.1060505.
11. Guo DD, Wu JF, Hu YY, et al. Stereoacuity and Related Factors: The Shandong Children Eye Study. PLoS One. 2016;11(7):e0157829. doi: 10.1371/journal.pone.0157829.
12. Wu JF, Bi HS, Wang SM, et al. Refractive error, visual acuity and causes of vision loss in children in Shandong, China. The Shandong Children Eye Study. PLoS One. 2013;8(12):e82763. doi: 10.1371/journal.pone.0082763.
13. Ali Q, Heldal I, Helgesen CG, Krumina G, Costescu C, Kovari A, et al. Current challenges supporting school-aged children with vision problems: A rapid review. Appl Sci. 2021;11(20). DOI: https://doi.org/10.3390/app11209673
14. Weiss RS, Park S. Recent updates on myopia control: preventing progression 1diopter at a time. Curr Opin Ophthalmol. 2019;30(4):215-219. doi: 10.1097/ICU.0000000000000571.
15. WHO. Global Data on. Glob Data Vis Impair 2010 [Internet]. 2010;17. Available from: http://www.who.int/blindness/GLOBALDATAFINALforweb.pdf

16. Pujari A, Modaboyina S, Agarwal D, Saluja G, Thangavel R, Rakheja V, Saxena R, Sharma N, Titiyal JS KA. Myopia in India. Clin Ophthalmol [Internet]. 2022;16:163–76. DOI: https://doi.org/10.2147/OPTH.S349393
17. Harb E. Hyperopia. In: Encyclopedia of the Eye [Internet]. Elsevier; 2010 [cited 2021 Jun 5]. p. 257–62. Available from: https://www.ncbi.nlm.nih.gov/books/NBK560716/
18. Thylefors B. A global initiative for the elimination of avoidable blindness. Am J Ophthalmol. 1998;125(1):90-93. doi: 10.1016/s0002-9394(99)80239-6.
19. Yared AW, Belaynew WT, Destaye S, Ayanaw T, Zelalem E. Prevalence of refractive errors among school children in gondar town, northwest ethiopia. Middle East Afr J Ophthalmol. 2012;19(4):372-376. doi: 10.4103/0974-9233.102742.
20. Laiginhas R, Figueiredo L, Rothwell R, Geraldes R, Chibante J, Ferreira CC. Long-term refractive outcomes in children with early diagnosis of moderate to high hyperopia. Strabismus. 2020;28(2):61-66. doi: 10.1080/09273972.2020.1752265.
21. Alberg AJ, Park JW, Hager BW, Brock MV, Diener-West M. The use of "overall accuracy" to evaluate the validity of screening or diagnostic tests. J Gen Intern Med. 2004;19(5 Pt 1):460-465. doi: 10.1111/j.1525-1497.2004.30091.x.
22. Caltrider D, Gupta A, Tripathy K. Evaluation Of Visual Acuity. In: StatPearls. Treasure Island (FL): StatPearls Publishing. 2022.
23. Morjaria P, Bastawrous A, Murthy GVS, et al. Effectiveness of a novel mobile health (Peek) and education intervention on spectacle wear amongst children in India: Results from a randomized superiority trial in India. EClinicalMedicine. 2020;28:100594. Published 2020 Oct 17. doi: 10.1016/j.eclinm.2020.100594.
24. de Venecia B, Bradfield Y, Trane RM, Bareiro A, Scalamogna M. Validation of Peek Acuity application in pediatric screening programs in Paraguay. Int J Ophthalmol. 2018;11(8):1384-1389. Published 2018 Aug 18. doi: 10.18240/ijo.2018.08.21.
25. Suo L, Ke X, Zhang D, et al. Use of Mobile Apps for Visual Acuity Assessment: Systematic Review and Meta-analysis. JMIR Mhealth Uhealth. 2022;10(2):e26275. Published 2022 Feb 14. doi: 10.2196/26275.
26. Power M, Fell G, Wright M. Principles for high-quality, high-value testing. Evid Based Med. 2013;18(1):5-10. doi: 10.1136/eb-2012-100645.
27. Tiraset N, Poonyathalang A, Padungkiatsagul T, Deeyai M, Vichitkunakorn P, Vanikieti K. Comparison of Visual Acuity Measurement Using Three Methods: Standard ETDRS Chart, Near Chart and a Smartphone-Based Eye Chart Application. Clin Ophthalmol. 2021;15:859-869. Published 2021 Feb 26. doi: 10.2147/OPTH.S304272.
28. Rono H, Bastawrous A, Macleod D, Wanjala E, Gichuhi S, Burton M. Peek Community Eye Health - mHealth system to increase access and efficiency of eye health services in Trans Nzoia County, Kenya: study protocol for a cluster randomised controlled trial. Trials. 2019;20(1):502. Published 2019 Aug 14. doi: 10.1186/s13063-019-3615-x.
29. Jin P, Zhu J, Zou H, et al. Screening for significant refractive error using a combination of distance visual acuity and near visual acuity. PLoS One. 2015;10(2):e0117399. Published 2015 Feb 17. doi: 10.1371/journal.pone.0117399.
30. Livingstone IA, Tarbert CM, Giardini ME, Bastawrous A, Middleton D, Hamilton R. Photometric Compliance of Tablet Screens and Retro-Illuminated Acuity Charts As Visual Acuity Measurement Devices. PLoS One. 2016;11(3):e0150676. Published 2016 Mar 22. doi: 10.1371/journal.pone.0150676.