Jurnal Aisyah: Jurnal Ilmu Kesehatan

Volume 8, Issue 1, March 2023, p. 85–92
ISSN 2502-4825 (print), ISSN 2502-9495 (online)

mHEALTH Apps for Visual Acuity Check: A Review

Hanna Nurul Husna[1*)], Azril Pratama [1], Daniel Firmansyah [1], Itmam Milataka [1]

[1] Optometry Department, Health Science Faculty, Universitas Bakti Tunas Husada

ARTICLE INFO

Article history:

Received 10 October 2022
Accepted 31 January 2023
Published 20 March 2023

Keyword:

mHealth apps
visual acuity check

A B S T R A C T

Home-testing VA can be done using a smartphone application. This study aimed to identify the mHealth application that can be used for independent visual acuity examination and in accordance with the rules of clinical eye examination. Visual acuity applications are identified through a systematic Google Play Store platform search. A total of 44 identified applications can be used for visual acuity checks. The public and experts can use 15 (34%) applications, and 73% of applications have a self-testing. The calibration features and detailed settings in the application will affect the accuracy of the results of the visual acuity measurement using the application. This research is expected to be the basis for further research that focuses on testing the accuracy of the application of visual acuity examination compared to conventional examination instruments

Kata kunci:

aplikasi mHealth
pemeriksaan tajam penglihatanh

**) corresponding author*

Hanna Nurul Husna, M.Pd

Optometry Department, Health Science Faculty, Universitas Bakti Tunas Husada
Jl. Cilolohan No. 36 Kec. Tawang, Kota Tasikmalaya 46115

Email:
hannanurulhusna@universitas-bth.ac.id

DOI: 10.30604/jika.v8i1.1453

A B S T R A K

Pengecekan tajam penglihatan (visual acuity/VA) di rumah (home-testing VA) dapat dilakukan dengan menggunakan aplikasi ponsel pintar. Tujuan dari penelitian ini adalah untuk mengidentifikasi aplikasi mHealth yang bisa digunakan untuk pemeriksaan ***tajam penglihatan*** secara mandiri dan sesuai dengan kaidah pemeriksaan klinis mata. Aplikasi tajam penglihatan diidentifikasi melalui penelusuran sistematik melalui platform Google Play Store. Sejumlah 44 aplikasi yang teridentifikasi bisa digunakan untuk pemeriksaan tajam penglihatan. Terdapat 13 (30%) aplikasi bisa digunakan oleh umum dan tenaga ahli, dan 73% aplikasi yang memiliki fitur self-testing. Fitur kalibrasi dan pengaturan detail pada aplikasi menjadi variabel yang akan berpengaruh terhadap keakuratan hasil pengukuran tajam penglihatan menggunakan aplikasi. Penelitian ini diharapkan bisa menjadi dasar untuk penelitian selanjutnya yang fokus pada uji keakuratan aplikasi pemeriksaan tajam penglihatan dibandingkan dengan instrumen pemeriksaan konvensional

INTRODUCTION

The use of smartphones in everyday life is something that cannot be separated. Based on the results of the Statista survey (S. O′ Dea, 2022), it is stated that smartphone users worldwide have exceeded six million and are expected to increase to several hundred million in the next few years. In Indonesia, smartphone use is estimated to have reached 199.2 million users in 2021 (Statista Research Department, 2022). Currently, Indonesia has become the fourth largest smartphone market after China, India and America.

The Covid-19 pandemic had a significant impact on changes in behavior and intentions in health-related technology. The use of technology in health is known as Tele-health. This technology began to develop since the invention of radio, and continues to grow rapidly since the

internet, iOS, and Android began to be widely used (Board on Health Care Services; Institute of Medicine, 2021). Applications in the smartphones have the potential to develop into medical devices (Gkrozou, Tsonis, Godden, Siafaka, & Paschopoulos, 2019). Smartphone applications that can be used in the function of treatment or health services are called mobile health (mHealth). The number of mHealth apps available through the Google Play Store continues to increase, reaching 65.3 million by the end of 2021 (Ceci, 2022). The use of mHealth allows health workers to monitor patient health remotely and allows people to monitor their own health (Slomian, Reginster, Ethgen, Appelboom, & Bruyère, 2014).

Based on a report from Riskesdas in 2013 (Riskesdas, 2013), visual impairment and blindness in Indonesia continues to increase with a prevalence of 1.5% and being the highest compared to the blindness rate in Southeast Asian regional countries. The causes of visual impairment and blindness are glaucoma (13.4%), refractive error (9.5%), retinal disorders (8.5%), corneal abnormalities (8.4%), and other eye diseases. The situation is getting worse with online activities carried out by the community through gadgets with long duration of use and routinely. This behavior will have an impact on visual acuity. One of the solutions offered to maintain good eye health is checking visual acuity (VA) regularly and being independent in monitoring eye health by using the mHealth application.

Home-testing VA is a simple, inexpensive, and useful way of screening eye health. There are three ways to screen visual acuity at home, namely printed optotypes, web-based tools, and mobile applications (Kawamoto, Stanojcic, Li, & Thomas, 2021). There are many software markets for download mHealth applications such as Google Play Store, Apple App Store, etc. There are more than 271 and 170 applications related to eye health (ophthalmology) on the Google Play Store and Apple App Store (Hogarty, Hogarty, & Hewitt, 2020). The number of applications for visual acuity will certainly continue to grow every year. However, this increase in the quantity of applications is not followed by research on the accuracy of these applications. Therefore, the accuracy of the application for medical use and general use will continue to be questioned.

The purpose of this study is to identify and review the mHealth application that can be used for independent visual acuity examination in accordance with the rules of clinical eye examination. Visual acuity examination is an important first step in the identification of visual impairment (Sidarta, 2004). With this research, it is hoped that the public will know the types and haracteristics of visual acuity examination applications and their conformity with conventional examination. This research is initial research that can be the basis for further research in identifying the accuracy of the application of visual acuity examination.

METHODS

Systematic search is carried out to search for applications that can be used for visual acuity examination. Google Play Store was chosen as the search platform for these applications. In the Google Play Store, there are 52,565 mHealth applications (Ceci, 2022) and there are more than 271 applications related to eye health (ophthalmology) (Hogarty et al., 2020). The criteria of application chosen is can be used to check visual acuity. The keywords used are "visual acuity", "eye test", "Snellen chart test", "optometry test", and "eye test".

Researchers obtained application information data based on the preview listed on the application web page. In addition, direct application exploration is carried out. This research was carried out in June-July 2022. There was no contact with the application developer, but the data available on the web page and application is the result of the description provided by the developer. This study did not examine user reviews. This research focuses on identifying the price of the application, the number of downloads, user ratings, and features and how to use the application. Applications that are downloaded and explored must be able to run well on cellphones with Android 8 and 11. The selected visual acuity application has an examination card (chart) feature, has an optotype(s), do measurement for far and near vision acuity. The exclusion criteria are: applications in languages other than English and Indonesian, no clear instructions for use, and duplication of applications.

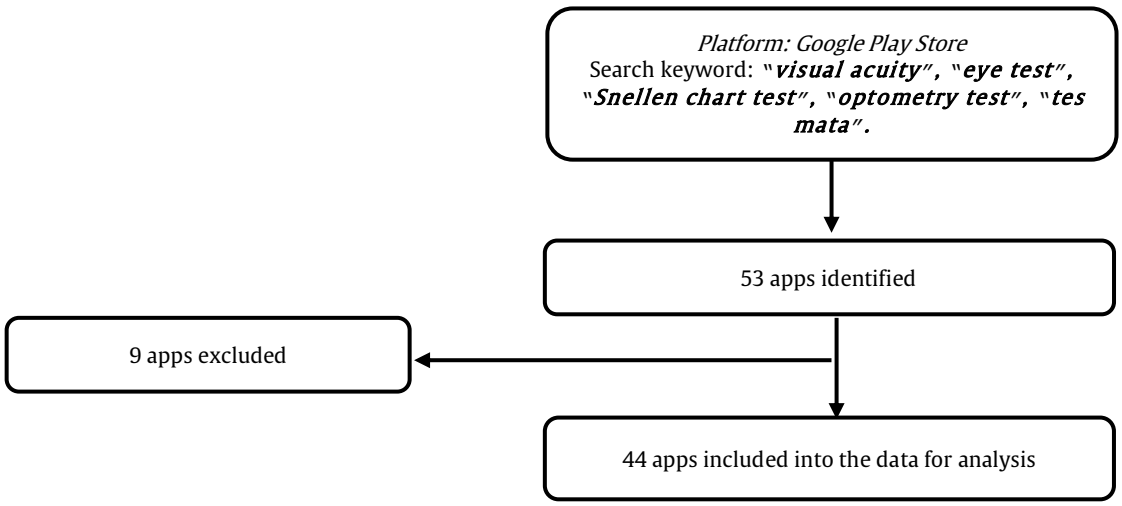

Figure 1. Screening process for analyzing visual acuity apps

RESULTS AND DISCUSSION

Visual acuity (visus/VA) is a measure of the good or bad eye function (Husna, Milataka, & Yulianti, 2022). Visual acuity testing instruments can be in the form of printed examination cards such as the Snellen Chart, the LogMAR Chart, Tumbling-E Chart, Landlot C-Ring Chart, etc. Along with the development of technology, the conventional visual acuity check in the form of a card has changed shape into an application.

A total of 53 applications have been identified from search results on the Google Play Store. This Android OS was chosen with the consideration that the mHealth application on the Google Play Store is more widely available than on the Apple App Store (Ceci, 2022). In addition, in Indonesia, the number of Android users is more found than iPhone users. From all the data that has been identified, the selected applications are applications that can only work on mobile phones and none of them can also be used on computers. Inclusion criteria have been defined, and some applications do not meet them. There are 9 applications excluded from the list. The final total of data is 44 applications, which will enter the analysis stage (Figure 1). The results of the identification of the visual acuity examination application are presented in table 1. Criteria for aspects analyzed in the application include: instructions for use, recording of examination results, self-assessment, chart variations, optotype(s) variations, application calibration, detailed settings, free downloads, fees in the middle of using the application (mid cost), and education.

Tabel 1. Visual acuity examination apps

Apps	Target user	Charge	Rating
Visual acuity test-	General	Free	4.6
Peek acuity	General and expert	Free	4.8
Visual acuity chart	General and expert	Paid	0
Snellen chart	General and expert	Free	4.9
Visual acuity test. Eye test	General	Free	0
Smart optometry	General	Free	4.6
Eye test charts	General	Free	4.2
Visual acuity test	General	Free	0
Eye exam	General	Free and paid for pro version	4.3
Eye chart visual acuity	General	Free and paid for special feature	0
Eye chart for eye care professional	General and expert	Free	0
Eye test	General	Free and paid for special feature	4.4
Eye vision board check test	General	Free	3.8
REST: rapid eye screening test	General and expert	Free	0
Ocular check: Acuity exam	General and expert	Free	0
Optocharts – all eye test	General and expert	Free and paid for special feature	5
Eye test: Drishti	General	Free and paid for special feature	4.4
Eye and vision test – color blindness	General	Free	0
Eye test girls	General	Free	0
Eye chart mobile	General	Free	0
Tumbling E chart	General and expert	Free	0
Eye handbook	General and expert	Free	4.5
Near vision chart	General	Free	0
Eye patient	General and expert	Free	0
Eye exercise, eye test and care	General	Free and paid for special feature	0
Eye care: eye test, excercise, and blue light	General	Free	4.5
Eye vision test	General	Free	0
EyeQue PVT	General and expert	Free, need additional device	3.7
EyeQue vision check	General and expert	Free, need additional device	0
Eye verification: defect test	General	Paid	0
Eye sight test	General	Free	0
Go check vision at home	General	Free	0
Vision test	General	Free	0
Easy vision exam using smartphone	General	Free	0
EyeRis	General	Free	0
VisionCheck2	General and expert	Free	0
Mat-ta	General	Free	3.5
Snellen chart (Fonlow)	General	Free	0
Netra Autorefractometer	General and expert	Free and need additional device	5
Eye test 2023	General	Free	0
Sight check	General	Free	0
Eye tester ultra	General	Free	4.2
Home eye check	General	Free	0
Distant play	General and expert	Paid	0

All visual acuity check applications can be downloaded freely by users through the Google Play Store. Specific information explain that the application is intended for the general public and experts (ophthalmologists and optometrists) are rarely found. Categorization of applications can be used by experts based on the results of apps' feature exploration. Applications are categorized as can be used by experts if the application has a certain examination distance

in meters and feet, has calibration features, has optotype(s) commonly used on conventional charts, has notations such as fraction, decimal, and logMAR, and has the following steps according to the visual acuity examination procedure. Because all applications can be downloaded for free, the application is categorized as usable by the public. However, there were 15 (34%) applications identified that could also be used by professional experts for scientific and clinical purposes.

The application fee can be determined in two ways. First, it is listed on the page when you will download the application. If the user downloads the application, then the user is required to make a payment. After confirmation of payment, the application will be downloaded automatically. Second, a fee is charged for users who want to access the pro features. On several application information pages it is written that the application has various visual acuity check features. However, after the application is downloaded and explored, it turns out that some features cannot be accessed freely because these features are premium features. Of the total applications analyzed there are 86% of applications that can be downloaded for free; 14% of apps are not free and require additional device purchases; and 14% of applications that are initially free and then charge additional fees for access to premium features.

Each application on the Google Play Store is usually presented with information in the form of the number of downloads, ratings, and reviews of application usage. Users can leave reviews for everything downloaded or rented from the Google Play Store. The goal is for users to share the user experience with other users. Users are asked to rate them with stars, ranging from 1 star being the worst, to 5 star - the best. App rating is calculated based on the rating given in the nearest timeframe, not from the overall rating (NN, 2022). Of the total applications, 34% of visual acuity applications are rated, and 66% are not rated. The number of downloads also varies, from the range of 10+ to 1 million. Based on the findings of the application exploration and related to the objectives of this study, the rating and the number of downloads are not a guarantee of the suitability of the application measurement results with conventional inspection tools and methods.

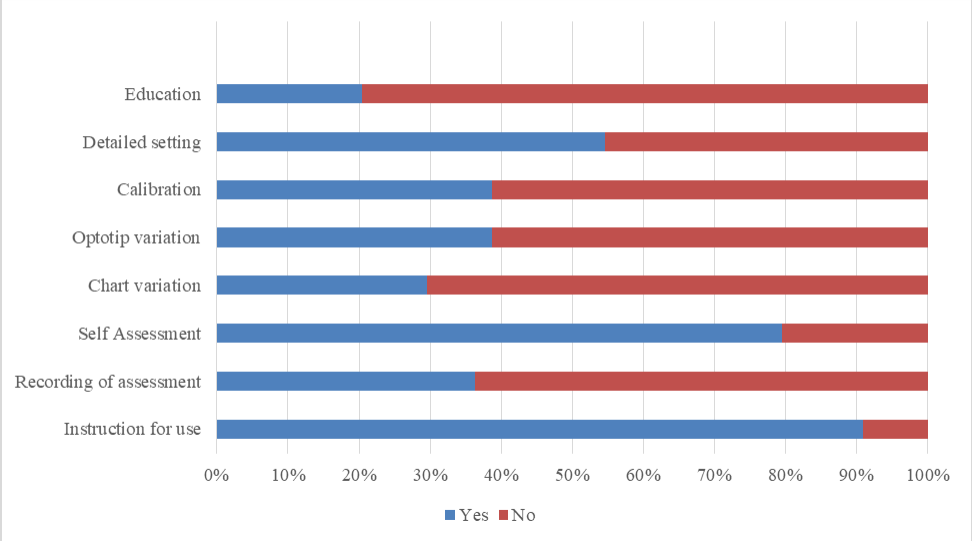

Figure 2. Summary of visual acuity check app features

Visual acuity examination applications have their own characteristics. The features contained in the application that have been collected are presented in Figure 2 above. Aspect criteria analyzed in the application include: instructions for use, recording of examination results, self-assessment, chart variations, optotypes variations, application calibration, detailed settings, free downloads, costs in the middle of using the application (mid cost), and education. Not all visual acuity checking applications have a self-assessment feature. There are about 80% of applications that have self-assessment features and 20% have chart features only. The use of charts, whether for self-assessment or not, usually uses a Snellen chart with optotypes in the form of alphabets, numbers, and symbols. There are 39% of applications that have variations in the use of visual acuity examination optotypes, including alphabetical optotypes, numbers, tumbling E-charts, landlot C-rings, lea symbols, and others. The features presented in the application are not only in the form of a visual acuity check but also in the form of education. There are about 20% of applications that include eye education and eye health features into the application.

Detail adjustment and calibration are important components in visual acuity examination applications. Several factors that may be variables that can affect the measurement results include: ratio and pixel of the device screen, contrast, and screen brightness level (Kawamoto et al., 2021). However, not all applications have detailed settings for each device. There are 55% of applications have detailed settings on these things, and only 45% of applications have a calibration feature.

There are 20% of applications also included educational features in the application. The education in question is information on atlas of eye anatomy, eye diseases, refractive errors, medicines, glasses, etc. The Eye Handbook application even provides a discussion forum feature to discuss questions raised by users around the world.

Visual acuity can be determined from the formation of the smallest image on the retina that can be measured using the smallest object that can be seen clearly at a certain distance (Mukherjee, 2009). Visual acuity examination is used to determine the cause of eye disorders that cause decreased in visual acuity. Visual acuity examination is usually carried out using pictures or examination cards-

called charts-consisting of optotypes. An optotype is a symbol that varies in size, usually in the form of an alphabet or a simple image (Cantor, Rapuano, & McCannel, 2019). On the examination chart, the optotype letters are arranged in horizontal rows of different sizes and are graded. The top letter is large which is then continued down and the size is getting smaller and smaller (Maksus, 2016). Visual acuity testing instruments can be in the form of printed examination cards such as the Snellen Chart, the ETDRS LogMAR Chart, etc. The optotypes used on these two charts also vary in the form of alphabets, numbers, Tumbling-E, Landlot-C, and Lea Symbols. The disadvantages of using a printed examination card are that an independent visual acuity check cannot be carried out and there is no calibration of the printed output (Kawamoto et al., 2021). Visual acuity checks using printed cards require face-to-face services with medical personnel. Limited circumstances, space, time, and human resources are the inhibiting factors for this service. Visual acuity examination is not possible for the general public. In addition, the calibration of the printout from the examination card will affect the size and contrast of the optotype, and will also affect the visual acuity test results even though they are small (Kawamoto et al., 2021). With the development of technology, there has been a change in form from the conventional in the form of a card changing shape into an application.

Smartphone-based medical applications are very likely to affect the patient-health practitioner relationship and can improve the health system. Health applications on smartphones can be used as patient assessment tools, patient visual-education aids, education and health care professional references, patient records administration tools, and various functions (Bastawrous, Cheeseman, & Kumar, 2012). Innovations in technology and their use in research, education and information sharing make smartphones the future of ophthalmology and medicine (Zvornicanin, Zvornicanin, & Hadziefendic, 2014).

Of the 44 visual acuity applications analyzed, 86% of the applications were free to download; 14% of apps are not free and some require additional device purchases; and 14% of apps that are initially free and then charge extra for access to pro features. Use of the basic visual acuity feature is usually free. An application fee is given to access advanced refraction test features such as Duochrome test, Amsler Grid test, etc. Users can download the application for free but in order to use the application the user must purchase additional devices. The goal is to obtain more accurate visual acuity measurement results and correction measures such as those found in the EyeQue PVP, EyeQue Vision Check, and Netra Autorefractometer applications.

Having no fees charged for free app downloads is actually an advantage and also poses a problem to watch out for. Many free applications are considered too hasty to be launched to the public (Gkrozou et al., 2019). This causes the application to be considered "less competent" and updates the application were made based on negative reviews from users. In addition, free applications are also quite risky for personal data leakage (Gkrozou et al., 2019). Some applications also include a statement that no personal information is collected through the application. But the possibility of data leakage no one knows.

One of the analytical criteria of the application in this study is the ability to carry out self-assessment. The purpose of this criterion is that the clients can have their visual acuity checked at home for screening, and then the results of the examination can be considered by optometrist. Some visual acuity checking applications have a self-assessment feature and some do not. Applications that do not have this feature usually only display charts in the form of Snellen Charts, ETDRS LogMAR Charts, color blind tests, etc. Both applications that have self-assessment or those that only display charts need help from others. The difference is, the self-assessment application requires another person as the operator of the equipment operation, while the application that displays the chart requires another person (optometrist or medical personnel) to examine and interpret the results.

When using the visual acuity check application, features such as user manual and calibration are available. Instructions for use are very helpful in using the application, especially for common people. The instructions given can be in the form of determining the examination distance, optotype legibility, and interpretation of the results. Calibration is an important step in measurement (Husna et al., 2022). The calibration process in a visual acuity examination application ensures that the size of the optotype presented matches the ratio and pixels of the screen and matches the testing distance. The calibration process can be done automatically and manually. Some applications detect the specifications of the mobile phone that the user is using and automatically adjust the optotype. Manual settings can be done through the settings menu. Usually the user is asked to measure the optotype sample that is on the application screen using a ruler.

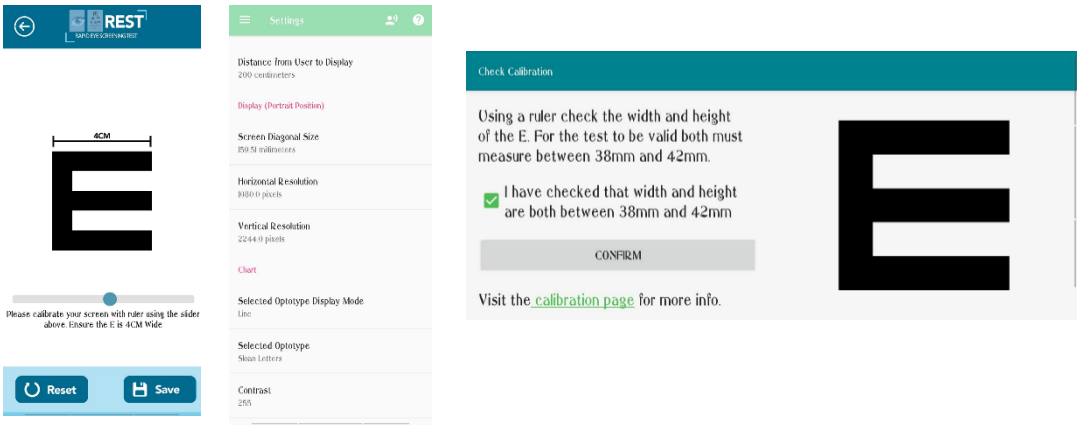

Figure 3. Calibration step of VA apps: manually and automatically

This study has identified 44 applications from the Google Play Store that can be used in measuring visual acuity. There are standards for clinical testing of visual acuity put forward by The Committee on Vision of the National Academy of Sciences-National Research Council (NAS-NRC) such as chart design (optotypes and chart layout), testing procedure (acuity testing distance, luminance and contrast, and test administration). Although there are many applications that can be downloaded and used for visual acuity examination, only a few applications have potential as a visual acuity examination tool that is in accordance with the examination rules in the science of Optometry. Applications that are judged not to have one of these standards are considered unable to be used for clinical examination by medical personnel. Based on this research, there are 15 (34%) articles categorized as usable by the general public and experts such as Peek Acuity, Snellen Chart, REST, etc. This finding is also in accordance with the results obtained by Kawamoto (Kawamoto et al., 2021) which states that of the 100 applications of visual acuity that have been identified, only 8 applications can be used in clinical measurements.

The rapid growth and development of examination applications is a limitation in this study. Every year mobile phone hardware and software will continue to grow. Along with this, there will be updates from existing applications and similar applications will appear. Therefore, the results presented in this study will not continue to be relevant in the future. However the formation and renewal of visual acuity applications in the future, measurement accuracy is a factor that must be considered.

To increase the level of user confidence, some applications include a statement that the use of the application cannot replace clinical examination by medical personnel. This description is quite confusing for users because the updates provided by many applications have diagnostic, self-assessment, and educational functions. Based on this, apart from the features and information listed by the application, a supervisory function and certification from the Government, namely the Ministry of Health, is also required. In the UK, an application is considered a "health application" if it is registered with the Medicine and Healthcare Product Regulatory Agency (MHRA) and certified by the Food and Drug Administration (FDA) (Kawamoto et al., 2021). In addition, testing research on the accuracy of the application of conventional measuring instruments should be increased with the help of professional organizations. The results of the research on the accuracy of the application are then widely published so that the public can carry out accurate health screenings at their homes.

LIMITATION OF THE STUDY

This article only discusses application evaluation in terms of the availability of instructions for use, recording inspection results, self-testing, chart variations, optotype variations, application calibration, detailed settings, free downloads, mid-cost applications, and education. Other variables such as comparison of application results and gold standard instruments have not been carried out.

CONCLUSIONS AND SUGGESTIONS

Visual acuity check applications can be used to improve eye health services. This study aims to identify the application of visual acuity examination. Of the 44 applications for visual acuity, there are 15 applications that can be used by the public and medical personnel for clinical examinations. This research is expected to be the basis for further research that focuses on testing the accuracy of the application of visual acuity examination compared to conventional examination instruments.

Acknowledgment

The authors would like to thank the Ministry of Education and Culture, Research and Technology (Kemendikbud-Ristek) in particular to the Academic Directorate of Vocational Higher Education for grant funding in the Beginner Lecturer Research Scheme (PDP).

ETHICAL CONSIDERATIONS

Funding Statement.

This study was funded by Academic Directorate of Vocational Higher Education for grant funding in the Beginner Lecturer Research Scheme (PDP)

Conflict of Interest Statement

There are no conflict interest in this paper.

REFERENCES

Bastawrous, A., Cheeseman, R. C., & Kumar, A. (2012). iPhones for eye surgeons. *Eye*, *26*(3), 343–354. https://doi.org/10.1038/eye.2012.6

Board on Health Care Services; Institute of Medicine. (2021). *The Role of Telehealth in an Evolving Health Care Environment: Workshop Summary*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK207141/

Cantor, L. B., Rapuano, C. J., & McCannel, C. A. (2019). Clinical Optics. In *Basic and Clinical Science Course*. San Fransisco: American Academy of Ophthalmology.

Ceci, L. (2022). Google Play: number of available medical apps as of Q1 2022. Retrieved from Statista website: https://www.statista.com/statistics/779919/health-apps-available-google-play-worldwide/

Gkrozou, F., Tsonis, O., Godden, M., Siafaka, V., & Paschopoulos, M. (2019). Mobile Health (mHealth) apps focused on menopause: Are they any good? *Post Reproductive Health*, *25*(4), 191–198. https://doi.org/10.1177/2053369119878978

Hogarty, D. T., Hogarty, J. P., & Hewitt, A. W. (2020). Smartphone use in ophthalmology: What is their place in clinical practice? *Survey of Ophthalmology*, *65*(2), 250–262. https://doi.org/10.1016/j.survophthal.2019.09.001

Husna, H. N., Milataka, I., & Yulianti, A. M. (2022). *Fisika pada Lensa. Pengantar Kajian Permukaan Lensa*. Yogyakarta: Deepublish.

Kawamoto, K., Stanojcic, N., Li, J.-P. O., & Thomas, P. B. M. (2021). Visual Acuity Apps for Rapid Integration in Teleconsultation Services in all Resource Settings: A Review. *Asia-Pacific Journal of Opthalmology*, *10*(4), 350–354. https://doi.org/10.1097/APO.0000000000000384

Maksus, A. I. (2016). *Standar Prosedur Pemeriksaan Refraksi untuk Refraksionis Optisien (Diploma Optometris)*. Depok: Badan Penerbit Fakultas Kedokteran Universitas Indonesia.

Mukherjee, P. (2009). *Optics for Optometry Student*. India: Jaypee Brother Medical Publisher.

NN. (2022). How Ratings are Calculated. Retrieved July 4, 2022, from Google website: https://play.google.com/intl/en_hk/about/comment-posting-policy/

Riskesdas. (2013). Riset Kesehatan Dasar. *Penelitian Dan Pengembangan Kesehatan Kementrian Kesehatan RI, Jakarta*.

S. O′Dea. (2022). Smartphone subscriptions worldwide 2016-2027. Retrieved July 26, 2020, from Statista website: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Sidarta, I. (2004). *Kelainan Refraksi dan Koreksi Penglihatan*. Jakarta: Balai Penerbit FKUI.

Slomian, J., Reginster, J.-Y., Ethgen, O., Appelboom, G., & Bruyère, O. (2014). Opportunity and Challenges of eHealth and mHealth for Patients and Caregivers. *Austin Journal of Public Health and Epidemiology*, *1*(2).

Statista Research Department. (2022). Smartphone users in Indonesia 2017-2026. Retrieved July 9, 2022, from Statista website: https://www.statista.com/statistics/266729/smartphone-users-in-indonesia/

Zvornicanin, E., Zvornicanin, J., & Hadziefendic, B. (2014). The Use of Smart phones in Ophthalmology. *Acta Informatica Medica*, *22*(3), 206. https://doi.org/10.5455/aim.2014.22.206-209