Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Effectiveness of an educational mobile-app intervention in improving the knowledge of COVID-19 preventive measures

M.T. Ghozali *, Izdihar Dinah Amalia Islamy, Bagus Hidayaturrohim

School of Pharmacy, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia

ARTICLE INFO

Keywords:
Apps
COVID-19
EduCovid-19
Preventive measures

Patient education plays an essential role in the modern digital era when the spread of COVID-19 can be prevented using smartphone apps as an alternative learning medium. Although previous studies have shown that the app provides more benefits than any conventional media, its implementation in learning has not been evaluated in hospitalized patients in Indonesia. Therefore, this study aimed to determine the effectiveness of an educational mobile app intervention in improving the knowledge of COVID-19 preventive measures. This quasi-experiment included a pretest-posttest control group design involving 140 participants from various backgrounds. The comparison and treatment categories were randomly selected before and after each educational intervention. Based on the mode of data collection, an EduCovid-19® app and a knowledge-based questionnaire were utilized, with the total pre-test and post-test scores being statistically analyzed descriptively and hypothetically (Mann-Whitney and Wilcoxon). The comparison between pre-test and post-test scores of control and treatment groups were to determine the impact levels of the mobile app-assisted educational intervention for subsequent development. The results confirmed that this intervention significantly improved the knowledge of COVID-19 preventive measures. The mean value of the pre-test and post-test of the treatment group was found to increase as many as 3.46, and the difference of the test scores was significant at a 0.001 significance level. For both hypothetical tests (Mann-Whitney and Wilcoxon), the p-values were smaller than 0.001. From the study results, the mobile app-assisted educational intervention significantly improved patients’ knowledge, suggesting that the implementation of the mobile apps as a learning medium needs to be part of the educational environment to teach about COVID-19 preventive measures.

1. Introduction

A coronavirus belongs to a group of viruses causing various diseases in humans. It is shaped like a crown, corresponding to the Latin term “corona”. Several types of the virus cause respiratory tract infections, ranging from colds to more serious illnesses, such as MERS (Middle-East Respiratory Syndromes) and SARS (Severe Acute Respiratory Syndromes) [1]. COVID-19 is a new infectious variant known to cause a zoonotic disorder due to its transmissible capabilities between animals and humans. However, the occurrences of transmission among animals are unknown. Based on scientific evidence, COVID-19 was transmitted among humans through coughing or sneezing droplets, with the most vulnerable individuals often in close contact with infected patients. Irrespective of the variations in this infection’s common signs and symptoms, several acute respiratory distress, such as fever, cough, and shortness of breath, are still involved. In severe cases, pneumonia, acute respiratory syndrome, kidney failure, or death are also observed [2–5].

One of the factors contributing to the rapid spread of the COVID-19 disease is the lack of public knowledge, which is needed to avoid significant risks, such as anxiety, panic, and stress [6,7]. These psychological conditions also affect professional health workers, including general practitioners, pharmacists, nurses, and others [8]. The term “anxiety” is characterized by somatic, vegetative, and cognitive symptoms involving a lack of security or an inability to cope with a problem. “Panic” is the sudden appearance of excessive fear or anxiety for an unknown reason, generally characterized by accelerated heart rate, shortness of breath, dizziness, muscle tension, or shaking. Meanwhile, physical and emotional stress describes a person’s reaction when...
environmental changes require adjustments [9,10]. During the COVID-19 pandemic, increased numbers of people experienced these conditions, the severity of which needs to be minimized by various counselling services. In this case, the spread of the virus tends to be uncontrollable due to the public’s ignorance of the symptoms and preventive measures [11–13]. Therefore, this fundamental knowledge is very important in decreasing the number of infectious cases. Education is one of the effective methods to improve public knowledge. Therefore, an attractive and interactive learning medium is highly required. According to previous studies, many users, ranging from teenagers to adults (19–34 years), demanded a mobile app-assisted medium because of its simplicity, attractiveness, and comprehensibility [14–16]. Many positive literature reviews reported that mobile apps are effective for patient education due to their efficient multimedia-based educational materials that inspire and trigger users’ imagination and understanding [17–19]. Despite these descriptions, app utilization in patient education has not been widely evaluated in Indonesia. Therefore, this study aimed to determine the effectiveness of mobile app-assisted educational interventions in increasing users’ COVID-19 knowledge. The results were expected to support using mobile apps as an alternative, effective, attractive, and innovative learning medium. No prior studies were identified on the effectiveness of app usage as an alternative educational medium for Indonesians, supporting the novelty of this study.

2. Material and methods

This quasi-experiment utilized a pretest-posttest control group design. The comparison and treatment classes were randomly selected and administered tests before and after the educational intervention. Fig. 1 shows the systematic design of this study, while Fig. 2 shows the screenshots of the Educovid-19 app user interface.

2.1. Study participants

A quota sampling technique was used to recruit the potential participants. The sample size was estimated according to a sample size formula developed by Lemeshow and Lwanga [20]. The eligible criteria included (1) living in the Special Region of Yogyakarta, Indonesia, (2) being 19–34 years old, (3) owning a smartphone, (4) not being a professional health worker or a potential candidate, and (5) willing to fill out the consent form. Meanwhile, those who could not complete questionnaires and resigned due to technical troubles related to smartphones or apps were excluded. A public announcement was distributed through social media, such as Facebook, Instagram, WhatsApp, and direct calling, to recruit the participants.

2.2. Procedures

These study procedures followed three steps: preparation, implementation, and data processing. The preparation phase involved (1) submitting a permit application to the KEPK (Health Research Ethics Committee) of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia, (2) seeking potential participants through social media, such as Facebook, Instagram, and WhatsApp, and (3) preparing data collection instruments, such as the EduCovid-19® mobile app and COVID-19 preventive-measure questionnaire, which includes validation and reliability tests. In the implementation phase, the recruited participants were divided into control and treatment groups. The treatment group was asked to download and use the educational mobile app, while the control class could use only printed materials (e.g., books, leaflets, posters, etc.) or other learning sources. A pre-test and post-test analyses were conducted before and after a 1-month treatment period to determine the participants’ preventive measure knowledge. The obtained data were then statistically analyzed with a descriptive and hypothetical analysis to evaluate the effectiveness of mobile app-based educational interventions in improving the quality of users’ knowledge.

2.3. Instruments

The instruments included the EduCovid-19® app and a COVID-19 knowledge questionnaire. This educational app contained several learning materials sourced from the Decree of the Indonesian Minister of Health (HK.01.07/Menkes/413/2020), which serves as a guideline for the prevention and control of COVID-19 [21]. Meanwhile, a previously developed questionnaire containing 30 preventive measure items was utilized to determine public knowledge [22], as shown in Table 1. In this instrument, a good, moderate, and low level emphasized the correct answers at values ≥75%, between 56 and 74%, and ≤55%, respectively. The mobile apps’ effect on users’ knowledge levels was analyzed using the IBM SPSS Version 22.0. In this case, the hypothesis was accepted (rejected) when its p-value was smaller (greater) than 0.05.

2.4. Data analysis

Data were collected from July to December 2021 using a COVID-19 questionnaire. In this process, the participants were instructed to complete this data instrument, which measured COVID-19 knowledge and demographic characteristics, such as gender, age, and educational level. After a 4-week intervention period, all the participants were instructed to complete the post-test analysis. Subsequently, the obtained data were statistically compared to determine the level of COVID-19 knowledge in the control and treatment groups. The comparison was also conducted to effectively prove the study hypothesis. Before the descriptive analyses and hypotheses testing, a normality test was performed to determine whether the obtained data were normally distributed. The data were considered to be normally distributed if their p-value was greater than 0.05 (a confidence level of 95%). With the involvement of 140 participants, a Kolmogorov-Smirnov model was used in this analysis, with the results shown in Table 2.

2.5. Ethical consideration

This study was officially approved by the KEPK (Health Research Ethics Committee) of the Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia (no. 238/EC-KEPK FKIP UMY/VIII/2021).

3. Results

3.1. Study participants

The quota sampling technique led to the recruitment of 140 participants categorized into two groups. As seen in Table 2, most participants were female (45.29%; n = 77) aged between 19 and 23 years (71.746%; n = 122) with undergraduate degrees (71.17%; n = 121). Almost half of them (47.64%; n = 81) had medium knowledge of COVID-19 preventive measures (56–74% of correct answers). Meanwhile, all participants (100%; n = 140) had experience in using mHealth apps. Table 3 shows the background data of these participants.
3.2. Validity and reliability of the questionnaire

The validity test is often used to ensure the accuracy of the questionnaire regarding the measurement of variables and data collection. The reliability, commonly expressed in numbers (coefficients), refers to whether the test produces the same results consistently across time and situations. In this analysis, 4 experts validated the content validity, two general practitioners and two public health experts. Based on the results, the average score of all questions (100%; n = 30) was 3 out of 4 on the Likert scale, indicating a relevant categorization. For construct validity, more than half of the questions (63.33%; n = 19) were had a strong correlation with the content of the question items, with 30% (n = 9) having a very strong correlation. Meanwhile, only 2 questions (6.67%; n = 2), CO10 and CO23, had moderate correlations with the content of the question items. Table 4 shows the content and construct validity results obtained from the COVID-19 knowledge questionnaire.

Regarding the reliability, shown in Table 5, the Cronbach’s Alpha value was 0.971, indicating that the questionnaire is a highly reliable measuring tool.

3.3. Inferential statistical analysis

The results of the inferential statistical analysis of this study found a significant decrease of 0.09 observed in the control group’s mean value (21.43–21.34) at a 0.05 level (p = 0.471) after intervention period. Meanwhile, an increase of the questionnaire scores (pre-test and post-test) of 3.46 was found in the treatment group, with a significance of 0.001. These results explained that the utilization of the EduCovid-19® app helped improve participants’ knowledge of COVID-19 preventive measures. This analysis is summarized in Table 6.

3.4. Hypothesis test

3.4.1. Mann whitney

Since the obtained data were not normally distributed, the Mann-Whitney approach was adopted to prove the study hypothesis. This non-parametric test determines the presence or absence of a difference between two independent samples. The results shown in Table 7 support the proposed hypothesis, as indicated by the p-value of 0.001.

3.4.2. Wilcoxon

Wilcoxon statistical method is used to test the difference between two paired data. In this analysis, a p-value of less than 0.001 confirmed the study hypothesis (Table 8).
The normality test (Kolmogorov-Smirnov).

Table 2

| Groups          | Test    | p-Value | Information          |
|-----------------|---------|---------|----------------------|
| Control         | Pre-test| 0.025   | Non-normal distribution |
|                 | Post-test| 0.007  | Non-normal distribution |
| Treatment       | Pre-test| 0.001  | Non-normal distribution |
|                 | Post-test| 0.001  | Non-normal distribution |

Table 3

| Statements Code | Content Validity | Construct Validity |
|-----------------|------------------|-------------------|
| CO01            | 3.75 Relevant     | 0.93 Very Strong  |
| CO02            | 3.75 Relevant     | 0.93 Very Strong  |
| CO03            | 3.75 Relevant     | 0.93 Very Strong  |
| CO04            | 3.75 Relevant     | 0.93 Very Strong  |
| CO05            | 3.75 Relevant     | 0.93 Very Strong  |
| CO06            | 3.75 Relevant     | 0.93 Very Strong  |
| CO07            | 3.75 Relevant     | 0.93 Very Strong  |
| CO08            | 3.75 Relevant     | 0.93 Very Strong  |
| CO09            | 3.75 Relevant     | 0.93 Very Strong  |
| CO10            | 3.75 Relevant     | 0.93 Very Strong  |
| CO11            | 3.75 Relevant     | 0.93 Very Strong  |
| CO12            | 3.75 Relevant     | 0.93 Very Strong  |
| CO13            | 3.75 Relevant     | 0.93 Very Strong  |
| CO14            | 3.75 Relevant     | 0.93 Very Strong  |
| CO15            | 3.75 Relevant     | 0.93 Very Strong  |
| CO16            | 3.75 Relevant     | 0.93 Very Strong  |
| CO17            | 3.75 Relevant     | 0.93 Very Strong  |
| CO18            | 3.75 Relevant     | 0.93 Very Strong  |
| CO19            | 3.75 Relevant     | 0.93 Very Strong  |
| CO20            | 3.75 Relevant     | 0.93 Very Strong  |
| CO21            | 3.75 Relevant     | 0.93 Very Strong  |
| CO22            | 3.75 Relevant     | 0.93 Very Strong  |
| CO23            | 3.75 Relevant     | 0.93 Very Strong  |
| CO24            | 3.75 Relevant     | 0.93 Very Strong  |
| CO25            | 3.75 Relevant     | 0.93 Very Strong  |
| CO26            | 3.75 Relevant     | 0.93 Very Strong  |
| CO27            | 3.75 Relevant     | 0.93 Very Strong  |
| CO28            | 3.75 Relevant     | 0.93 Very Strong  |
| CO29            | 3.75 Relevant     | 0.93 Very Strong  |
| CO30            | 3.75 Relevant     | 0.93 Very Strong  |

a Average value of 4-point Likert Scale (4 = highly relevant; 3 = relevant; 2 = irrelevant; 1 = highly irrelevant).
b Pearson’s correlations (0.25 = very low; 0.26–0.49 = low; 0.5–0.69 = moderate; 0.7–0.89 = strong; 0.90–1.0 = very strong) (de Barros Ahrens et al., 2020).

4. Discussion

The coronavirus disease is capable of spreading and infecting anyone, regardless of the age group. A good understanding and knowledge of all related elements, including the community, are required to decrease its rapid spread. An understanding of this disease and its preventive measures can prevent the increase in the number of infectious
Informatics in Medicine Unlocked 34 (2022) 101112

5

preventive measures. These findings align with previous studies that modern era, digital-based patient educational interventions are being would significantly improve the participants

The Mann-Whitney and Wilcoxon tests were also significant, supporting

media, such as smartphone apps, should stimulate patients

menting a mobile app as a learning medium significantly enhanced the

icantly improved the participants

levels on COVID-19 preventive measures and experience in mHealth app

cases. Therefore, education is vital for improving the patient’s knowledge

Based on the present report, 140 participants with different demographic characteristics, such as gender, age, and educational background, were selected. These subsequently included the knowledge levels on COVID-19 preventive measures and experience in mHealth app utilization. According to Table 2, differences between control and treatment groups in demographic characteristics were insignificant, as all p-values were greater than 0.05. A previously developed COVID-19 questionnaire was used to measure their knowledge [22].

The results also proved that the utilization of EduCOVID-19® significantly improved the participants’ knowledge of COVID-19 preventive measures compared to several conventional methods. This was reinforced by the significant increase in the mean patient’s knowledge score from pre-test to post-test for the treatment group. The Mann-Whitney and Wilcoxon tests were also significant, supporting the study hypothesis that the mobile-app educational intervention would significantly improve the participants’ knowledge of COVID-19 preventive measures. These findings align with previous studies that reported statistically significant differences between the control and experimental groups [23]. Other reports have also found that implementing a mobile app as a learning medium significantly enhanced the quality of life, self-efficacy, and clinical outcomes [24,25]. In this modern era, digital-based patient educational interventions are being developed to improve knowledge and self-care skills to increase low health literacy [26]. These methods differ from the conventional

Table 5
The reliability test.

| Statement Code | Cronbach Alphaa | Note |
|----------------|-----------------|------|
| C001–C030      | 0.97            | Very High |

a Cronbach Alpha (0.81–1.00 = very high; 0.61–0.80 = high; 0.41–0.60 = moderate; 0.21–0.40 = low; and −1.00 – 0.20 = very low (not reliable) (Demir et al., 2021).

Table 6
The descriptive analysis.

| Groups        | Minimum | Maximum | Mean (SD) | Difference (p-value) |
|---------------|---------|---------|-----------|----------------------|
| Control Pre-test | 15      | 27      | 21.43 (±2.65) | −0.09 (0.471) |
| Posttest      | 17      | 25      | 21.34 (±2.23) |                  |
| Treatment Pre-test | 14      | 27      | 20.94 (±2.57) | 3.46 (0.001) |
| Posttest      | 21      | 30      | 24.4 (±2.68)  |                  |

Table 7
The mann-whitney statistical analysis.

| Groups | Mean Rank | p-value |
|--------|-----------|---------|
| Control | 50.41     | 0.001   |
| Intervention | 90.59   |         |

Table 8
The wilcoxon statistical analysis.

| Groups | Mean | p-value |
|--------|------|---------|
| Intervention Pre-test | 20.94 | 0.001   |
| Posttest | 24.40 |         |

5. Conclusion

The results confirmed that mobile app-assisted educational intervention significantly improved the knowledge of COVID-19 preventive measures. This was reinforced by an increase of 3.46 in the mean knowledge value for the treatment group from pre-test to post-test, with a p-value of 0.001. Based on these results, implementing mobile apps as a learning medium needs to be part of the educational system for teaching COVID-19 preventive measures.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors would like to thank the School of Pharmacy, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Indonesia.

References

[1] Singhal T. A review of coronavirus disease-2019 (COVID-19). Indian J Pediatr 2020;87:281–6.
[2] He F, Deng Y, Li W. Coronavirus disease 2019: what we know? J Med Virol 2020;92:719–25. https://doi.org/10.1002/jmv.25766.
[3] Singhal T. A review of coronavirus disease-2019 (COVID-19). Indian J Pediatr 2020;87:281–6. https://doi.org/10.1007/s11684-020-03263-6.
[4] van der Hoek L, Pyrc K, Jebbink MF, Vermeulen-Oost W, Berkhout R, Wolthers KC, Wertheim-van Dillen PME, Kaandorp J, Spaargaren J, Berkhout B. Identification of a new human coronavirus. Nat Med 2004;10:568–73. https://doi.org/10.1038/nm1024.
[5] Zhou M, Zhang X, Qu J. Coronavirus disease 2019 (COVID-19): a clinical update. Front Med 2020;6:412–35. https://doi.org/10.1007/s11684-020-0707-8.
[6] Banerji A, Wickner PG, Saff R, Stone CA, Robinson LB, Long AA, Wolinsky AR, Williams P, Khan DA, Phillips E, Blumenthal KG. mRNA vaccines to prevent COVID-19 disease and reported allergic reactions: current evidence and suggested approach. J Allergy Clin Immunol Pract 2021;9:423–37. https://doi.org/10.1016/j.jaip.2020.12.047.
[7] Rommel A, von der Lippe E, Plass D, Ziese T, Diercke M, an der Heiden M, Haller S, Wengler A. The COVID-19 disease burden in Germany in 2020. Dtsch. Arztebl. Int. 2021;118:145–51. https://doi.org/10.3238/arztebl.m2021.0147.
[8] Saeed BA, Shabila NP, Aziz AJ. Stress and anxiety among physicians during the COVID-19 outbreak in the Iraqi Kurdistan Region: an online survey. PLoS One 2021;16:e0253903. https://doi.org/10.1371/journal.pone.0253903.

[9] Nikre N, Mkrlas K, Hrobat M, Gumsowski A, Vuong W, Surood S, Abba-Aji A, Urichuk L, Cao B, Greenham AJ, Agypavong VIO. COVID-19 pandemic: demographic predictors of self-isolation or self-quarantine and impact of isolation and quarantine on perceived stress, anxiety, and depression. Front Psychiatr 2021; 12. https://www.frontiersin.org/articles/10.3389/fpsyt.2021.553468. [Accessed 13 July 2022].

[10] Turma J, Zhong J, Lamberti N, Patterson B, Simpson W, Francisco AP, Bergmann CG, Ameringen MV. Anxiety, depression and stress during the COVID-19 pandemic: results from a cross-sectional survey. J Psychiatr Res 2021;137:96–103. https://doi.org/10.1016/j.jpsychires.2021.02.059.

[11] Agypavong VIO, Hrobat M, Shalaby R, Vuong W, Noble JM, Gumsowski A, Mkrlas K, Li D, Urichuk L, Snateme M, Surood S, Cao B, Li X-M, Greiner R, Greenham AJ. Text4Hope: receiving daily supportive text messages for 3 Months during the COVID-19 pandemic reduces stress, anxiety, and depression. Disaster Med Public Health Prep 2021;1:5. https://doi.org/10.1017/dmph.2021.27.

[12] Aly HM, Nemr NA, Kishk RM, bakr Elsait NMA. Stress, anxiety and depression among healthcare workers facing COVID-19 pandemic in Egypt: a cross-sectional online-based study. BMJ Open 2021;11:e045281. https://doi.org/10.1136/ bmjopen-2020-045281.

[13] Teo I, Chay J, Cheong VB, Sung SC, Tewani KG, Cheung YB, Sung SC, Tewani KG, Yeo LF, Yang GM, Pan FT, Ng JY, Agyapong VIO, Hrabok M, Shalaby R, Vuong W, Surood S, Abba-Aji A, Mrklas K, Turna J, Zhang J, Lamberti N, Patterson B, Simpson W, Francisco AP, Aldibbiat AM, Messenger G, Al Ozaire E, Hussain I, Masoena R, Assi M. Can weekly ‘foot alerts’ using a bespoke mobile app improve patient diabetic foot care knowledge and practices in Kuwait? Diabetic Foot Australia Annual meeting; 2019.

[14] Chao DY, Lin TM, Ma W-Y. Enhanced self-efficacy and behavioral changes among patients with diabetes: cloud-based mobile health platform and mobile app service. JMIR Diabetes 2021;5:e1017. https://doi.org/10.2196/27791.

[15] Wonggom P, Kourbelis C, Newman P, Du H, Clark RA. Effectiveness of avatar-based storytelling on professional practice and healthcare outcomes. Cochrane Database Syst Rev 2015;35:420. https://doi.org/10.1002/14651858.CD004395.

[16] Ghozali MT, Mobile app for COVID-19 patient education – development process using the analysis, design, development, implementation, and evaluation models. Nonlinear Eng 2022;11:549–57. https://doi.org/10.1515/neng-2022-0241.

[17] Darrini D, Aryani HP, Nia Ns. Validitas dan reliabilitas kuesioner pengetahuan tentang covid-19 (SARS-CoV-2). J. Keperawatan 2020;13. 9–9.

[18] Aldhabef W, Davis M, Rainford L, Craddock A, McGee A. Validation of the educational effectiveness of a mobile learning app to improve knowledge about MR imaging quality optimisation and artefact reduction. Insights Imag. 2018;9:721–30. https://doi.org/10.1017/x1244-018-0635-0.

[19] Alsharif W, Davis M, Rainford L, Craddock A, McGee A. Validation of the educational effectiveness of a mobile learning app to improve knowledge about MR image quality optimisation and artefact reduction. Disaster Med Public Health Prep 2021:1101

[20] Song S, Zhao YC, Yao X, Ba Z, Zhu Q. Short video apps as a health information source: an investigation of affordances, user experience and users’ intention to continue the use of TikTok. Internet Res 2021;31:2120–42. https://doi.org/10.1080/10611022.2020-05993.

[21] Lwanga SK, Lemeshow S, Organization WH. Sample size determination in health studies: a practical manual. World Health Organization; 1991. https://apps.who.int/iris/handle/10665/40062. [Accessed 23 June 2022].

[22] Ghozali MT. Mobile app for COVID-19 patient education – development process using the analysis, design, development, implementation, and evaluation models. Nonlinear Eng 2022;11:549–57. https://doi.org/10.1515/neng-2022-0241.

[23] Darrini D, Aryani HP, Nia Ns. Validitas dan reliabilitas kuesioner pengetahuan tentang covid-19 (SARS-CoV-2). J. Keperawatan 2020;13. 9–9.

[24] Aldhabef W, Davis M, Rainford L, Craddock A, McGee A. Validation of the educational effectiveness of a mobile learning app to improve knowledge about MR imaging quality optimisation and artefact reduction. Insights Imag. 2018;9:721–30. https://doi.org/10.1017/x1244-018-0635-0.

[25] Wonggom P, Kourbelis C, Newman P, Du H, Clark RA. Effectiveness of avatar-based storytelling on professional practice and healthcare outcomes. Cochrane Database Syst Rev 2015;35:420. https://doi.org/10.1002/14651858.CD004395.

[26] DeWalt DA, Malone RM, Bryant ME, Kosnar MC, Cerr KE, Rothman RL, Sueta CA, Pignonne MP. A heart failure self-management program for patients of all literacy levels: a randomized, controlled trial [ISRCTN11535170]. BMC Health Serv Res 2006;5:30. https://doi.org/10.1186/1472-6963-6-30.

[27] Darsini D, Aryani HP, Nia Ns. Validitas dan reliabilitas kuesioner pengetahuan tentang covid-19 (SARS-CoV-2). J. Keperawatan 2020;13. 9–9.

[28] Azevedo ARP, de Sousa HML, Monteiro JAF, Lima ARNP. Future perspectives of digital health interventions in the Egyptian health sector: a systematic review. J Med Internet Res 2022;24:e30766. 10.2196/30766.

[29] Hager-Small M. Behavioral effects of the COVID-19 pandemic and the impact of mobile health apps: secondary analysis of app analytics and expert app reviews. JMIR Human Factors 2022;9:e30766. https://doi.org/10.2196/27791.

[30] Ghozali MT. Mobile app for COVID-19 patient education – development process using the analysis, design, development, implementation, and evaluation models. Nonlinear Eng 2022;11:549–57. https://doi.org/10.1515/neng-2022-0241.