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Mobile App-Assisted Patient Education in the Public Health: Minimizing Vaccine Anxiety and Managing Long-Term and Post-Covid-19 Effects

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ABSTRACT

Vaccine hesitancy, notably for COVID-19 immunization, is intensified by the extensive transmission of misinformation, leading to increased fear among prospective recipients. This study sought to assess the efficacy of an app-supported health promotion in easing COVID-19 vaccine-related anxiety, while concurrently determining the baseline prevalence of such anxiety among the target demographic. The research employed a pre-test–post-test design and was conducted from early March to the end of August in rural regions of Yogyakarta. The intervention utilized a mobile application that delivered precise and current vaccine information. Anxiety levels of participants were assessed pre- and post-intervention utilizing a standardized questionnaire, and the results were analyzed using the Wilcoxon signed-rank test.Preliminary findings indicated that 56.90% of participants (n=268) exhibited "mild to moderate" anxiety levels before to the intervention. Following the intervention, this figure markedly diminished, with merely 171 or 36.30% of all participants reporting "mild to moderate" levels and 129 or 27.39% of all participants indicating "moderate to severe" anxiety levels. The decrease in anxiety levels was statistically significant, with a p-value of 0.001. The results indicate that mobile app-based educational interventions can significantly alleviate COVID-19 vaccination-related fear among rural residents in Yogyakarta, Indonesia. This method possesses the potential to mitigate vaccine reluctance and improve vaccine acceptability, providing a significant strategy for managing the COVID-19 pandemic and facilitating future global immunization initiatives.

Keywords: anxiety, covid-19, long covid, patient education, post-covid syndrome, self-management, vaccine

INTRODUCTION

In the early March of 2020, the World Health Organization (WHO) officially declared COVID-19 a global pandemic, signifying the onset of an unparalleled global health crisis (Chintalapudi et al., 2020; Ferreira et al., 2021; Iftinan et al., 2021). Initially identified in Wuhan, China, in December 2019, the virus rapidly disseminated across continents, resulting in extensive morbidity and mortality (Lu et al., 2020). While COVID-19 symptoms frequently mimic those of the common cold, they can progress to severe complications such as pneumonia and acute respiratory distress syndrome, contributing to significant health burdens (Jiao, 2020). The extraordinary transmissibility and swift proliferation of the virus overwhelmed healthcare frameworks worldwide, necessitating an urgent and coordinated response

from both scientific and medical communities to mitigate its impacts (Haldane et al., 2021; Stawicki et al., 2020).

The development of vaccines has been a pivotal milestone in managing the COVID-19 pandemic. Despite their critical role, vaccine hesitancy has emerged as a significant barrier, undermining public health initiatives globally. Indonesia, which has experienced a high burden of COVID-19 cases, reported the third-highest number of COVID-19-related deaths in Asia by early 2021 (Atehortua & Patino, 2020; Bhat et al., 2021; Ghozali & Murni, 2023). The nation's vast population and geographically diverse landscape have posed substantial challenges to implementing effective public health interventions, including widespread vaccination campaigns. Furthermore, the proliferation of misinformation and conspiracy theories surrounding COVID-19 vaccines has exacerbated vaccine hesitancy, fostering anxiety among the population and jeopardizing the success of immunization programs (Caycho-Rodríguez et al., 2022; Skafle et al., 2022). This climate of anxiety has been further intensified by the relentless dissemination of alarming reports on the pandemic's impact, which has also contributed to a surge in mental health issues across the population (Adane et al., 2022; Nguyen, 2021; Zimand-Sheiner et al., 2021).

The COVID-19 pandemic has significantly contributed to the proliferation of misinformation, exacerbating public anxiety, particularly in relation to vaccine safety and efficacy (Hornsey et al., 2020). Misinformation surrounding the vaccination process has amplified fear, leading to adverse societal behaviors, such as the hoarding of medical supplies, and fostering an overarching sense of uncertainty and distrust (Caceres et al., 2022). Effectively addressing vaccine-related anxiety is critical not only for improving vaccination uptake but also for enhancing broader public health outcomes by mitigating fears rooted in false narratives. Furthermore, as the pandemic continues to evolve, addressing the long-term and post-COVID-19 implications, including persistent anxiety and mental health challenges, has become a pressing public health priority (Zimmerman et al., 2023).

In the context of widespread misinformation and increasing vaccine hesitancy, there is a pressing need for innovative strategies to disseminate accurate information and mitigate public concerns. Mobile applications for health education present a scalable and accessible platform to reach diverse populations effectively. Although various studies have evaluated educational interventions aimed at reducing vaccine hesitancy, limited attention has been directed toward mobile applications specifically designed to alleviate vaccine-related anxiety. Addressing this critical gap, the EduCovid-19® app was developed to deliver accurate, evidence-based information about COVID-19 and vaccines. This innovative approach integrates patient education with digital health technology, highlighting its potential impact. Notably, the perceived usefulness of the app was found to significantly enhance vaccine acceptance, while its ease of use further amplified its perceived value (Faturohman et al., 2021). By leveraging the accessibility of mobile technology, this study underscores the role of digital health interventions in improving mental well-being and fostering vaccine acceptance during public health crises, providing a model for future applications in similar contexts.

This study aims to investigate the prevalence of vaccine-related concerns within the target population and to assess the efficacy of an educational intervention delivered through the EduCovid-19® mobile application. The intervention is specifically tailored to disseminate comprehensive and evidence-based information about COVID-19 and its vaccines, with the goal of alleviating vaccine-related anxiety and enhancing acceptance rates. By leveraging this digital tool, the study seeks to address the psychological and informational barriers exacerbated by the COVID-19 pandemic, particularly in rural and underserved communities. This research endeavors to provide actionable insights into the role of mobile technology in mitigating public health challenges and fostering equitable access to accurate health education.

MATERIALS AND METHODS

Study Design and Participants

This study adopted a pre-experimental design, specifically utilizing a "one-group pre-test and post-test" framework, to evaluate the efficacy of a mobile application in reducing anxiety related to COVID-19 vaccinations. The research was conducted between March and August 2021 in the Special Region of Yogyakarta, Indonesia, and centered on the hypothesis that an educational intervention delivered via the mobile application could significantly alleviate vaccine-related anxiety among participants.

Participants were recruited through convenience sampling over a two-week period using various social media platforms, including Facebook, Instagram, and WhatsApp, to ensure broad outreach and diversity. Eligibility criteria required participants to be between 19 and 34 years old, unvaccinated at the time of the study, possess an Android-based mobile phone, be willing to install the EduCovid-19® application, and provide informed consent to participate (Gusdorf et al., 2021). This approach aimed to engage individuals representative of target demographic to assess intervention's effectiveness in addressing their anxiety regarding COVID-19 vaccination.

To ensure adequate statistical power to detect meaningful differences, the sample size was calculated using G*Power 3.1 software. The calculation assumed a medium effect size of 0.30, a significance level (α) of 0.05, and a statistical power of 0.80, resulting in a minimum required sample size of 300 participants. To account for potential attrition and non-responsiveness, a target of 500 participants was established. Recruitment efforts yielded interest from 568 potential participants, but after eligibility screening, 89 individuals were excluded due to non-responsiveness, and 8 were disqualified because of technical issues with app installation. This process culminated in a final analytical sample of 471 participants.

Research Instruments

The primary analytical framework of this study is grounded in the utilization of two core instruments for data collection: the EduCovid-19® mobile application and the Hamilton Anxiety Rating Scale (HARS) (Shear et al., 2001).

The EduCovid-19® app served as the central tool for delivering the educational intervention. This app was purposefully developed to provide participants with accurate, evidence-based information on COVID-19 and vaccination, aiming to address vaccine-related anxiety. The content was comprehesively curated to make sure clarity, accessibility, and cultural relevance, specifically tailored to the target population in Indonesia. The app featured five modules: (a) General information on the COVID-19 virus, which covered symptoms, transmission, and prevention strategies; (b) Vaccine Information, emphasizing the benefits of vaccines, mechanisms of action, and their role in achieving herd immunity; (c) Myths and Facts about Vaccines, which debunked misinformation through factual counterpoints; (d) Vaccination Procedures and What to Expect, detailing the vaccination process from registration to managing potential side effects; and (e) COVID-19 Statistics and News Updates, offering real-time information on pandemic developments and vaccination campaigns within Indonesia.

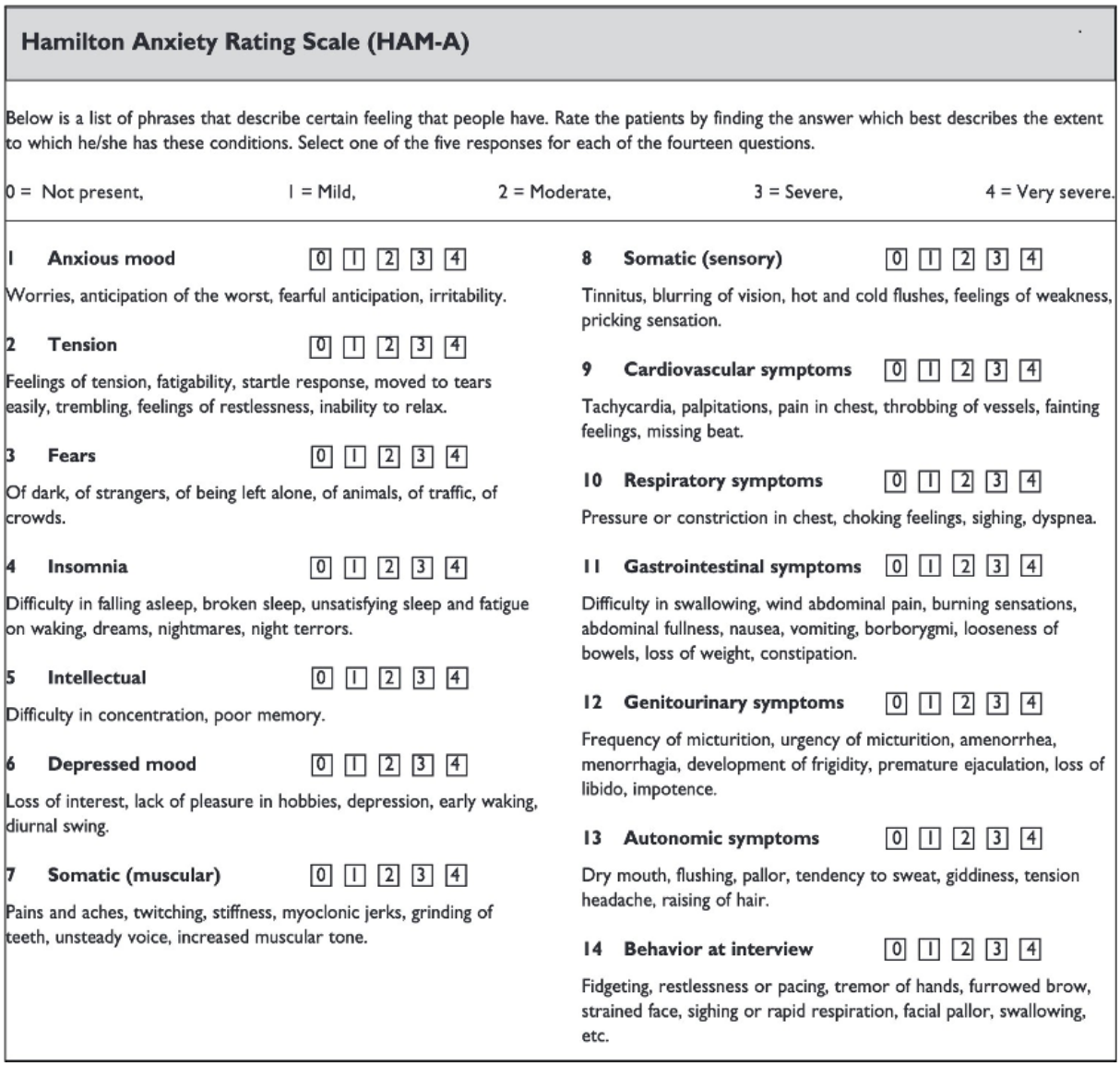
All the educational content was presented in Bahasa Indonesia, aligning with the cultural and linguistic context of rural communities, notably in areas of Yogyakarta. To address diverse learning-related preferences, the app implemented multiple educational formats, including text-based contents, infographics, and videos. All the participants were encouraged to engage with the app regularly over a two-week period to maximize its effectiveness.

The app underwent a preliminary validation through a pilot study with 50 participants from the target demographic. Feedback from this cohort informed adjustments to app's language, interface, and content to make sure cultural relevance and usability. The pilot confirmed the app's efficacy as a digital educational tool for promoting COVID-19 vaccination in rural areas (Figure 1).

The second instrument utilized in this study was the Hamilton Anxiety Rating Scale (HARS), developed by Max Hamilton (1959) (Figure 2). This scale is widely recognized as a standard measure for evaluating the severity of anxiety symptoms. Comprising 14 symptom domains, the HARS allows for the assessment of anxiety on a continuum, with scores ranging from 0 (absence of symptoms) to 4 (severe symptoms). The scale has demonstrated robust validity and reliability in clinical contexts, with coefficients of 0.93 and 0.97, respectively (Yang, 2021), underscoring its precision and consistency in anxiety measurement.

To ensure its cultural and linguistic appropriateness for the Indonesian context, the HARS was translated into Bahasa Indonesia and validated in a prior study conducted among Indonesian populations. This version exhibited high reliability, with a Cronbach's alpha value of 0.756 for anxiety symptoms (Ramdan, 2019), confirming its suitability for assessing anxiety in the context of COVID-19 vaccination. The scoring framework of the HARS categorizes anxiety into three levels: scores below 17 indicate "mild" anxiety; scores between 18 and 24 denote "mild to moderate" anxiety; and scores between 25 and 30 reflect "moderate to severe" anxiety (Shear et al., 2001). This scoring system provides a nuanced understanding of anxiety severity, enhancing the precision of assessment and the targeted effectiveness of the interventio.

Figure 1. EduCovid-19 App Interface Overview, featuring (a) Main Menu with comprehensive functionalities, (b) Educational Materials List, (c) Detailed View of Educational Content, (d) Symptom Checker Interface, (e) Symptom Checker Results, (f) Vaccine Information Links, (g) Latest COVID-19 News, and (h) Real-Time COVID-19 Statistics, designed to educate and assist users in navigating pandemic-related information



Hamilton Anxiety Rating Scale (HAM-A)

Below is a list of phrases that describe certain feeling that people have. Rate the patients by finding the answer which best describes the extent to which he/she has these conditions. Select one of the five responses for each of the fourteen questions.

0 = Not present, 1 = Mild, 2 = Moderate, 3 = Severe, 4 = Very severe.

1 Anxious mood [0] [1] [2] [3] [4]
Worries, anticipation of the worst, fearful anticipation, irritability.

2 Tension [0] [1] [2] [3] [4]
Feelings of tension, fatigability, startle response, moved to tears easily, trembling, feelings of restlessness, inability to relax.

3 Fears [0] [1] [2] [3] [4]
Of dark, of strangers, of being left alone, of animals, of traffic, of crowds.

4 Insomnia [0] [1] [2] [3] [4]
Difficulty in falling asleep, broken sleep, unsatisfying sleep and fatigue on waking, dreams, nightmares, night terrors.

5 Intellectual [0] [1] [2] [3] [4]
Difficulty in concentration, poor memory.

6 Depressed mood [0] [1] [2] [3] [4]
Loss of interest, lack of pleasure in hobbies, depression, early waking, diurnal swing.

7 Somatic (muscular) [0] [1] [2] [3] [4]
Pains and aches, twitching, stiffness, myoclonic jerks, grinding of teeth, unsteady voice, increased muscular tone.

8 Somatic (sensory) [0] [1] [2] [3] [4]
Tinnitus, blurring of vision, hot and cold flushes, feelings of weakness, pricking sensation.

9 Cardiovascular symptoms [0] [1] [2] [3] [4]
Tachycardia, palpitations, pain in chest, throbbing of vessels, fainting feelings, missing beat.

10 Respiratory symptoms [0] [1] [2] [3] [4]
Pressure or constriction in chest, choking feelings, sighing, dyspnea.

11 Gastrointestinal symptoms [0] [1] [2] [3] [4]
Difficulty in swallowing, wind abdominal pain, burning sensations, abdominal fullness, nausea, vomiting, borborygmi, looseness of bowels, loss of weight, constipation.

12 Genitourinary symptoms [0] [1] [2] [3] [4]
Frequency of micturition, urgency of micturition, amenorrhea, menorrhagia, development of frigidity, premature ejaculation, loss of libido, impotence.

13 Autonomic symptoms [0] [1] [2] [3] [4]
Dry mouth, flushing, pallor, tendency to sweat, giddiness, tension headache, raising of hair.

14 Behavior at interview [0] [1] [2] [3] [4]
Fidgeting, restlessness or pacing, tremor of hands, furrowed brow, strained face, sighing or rapid respiration, facial pallor, swallowing, etc.

Figure 2. The Hamilton Anxiety Rating Scale

Intervention

This study employed a digital intervention approach using a mobile application named EduCovid-19®, designed to enhance participants' knowledge about the COVID-19 pandemic, with a specific focus on the importance of immunization efforts. The intervention included all participants in a single group without a control group. A flow diagram (Figure 3) illustrates the study design, detailing the timing of the pre-test, intervention, and post-test phases.

Prior to the pre-test, participants had not yet interacted with the application. The pre-test served to establish a baseline measure of anxiety related to COVID-19 vaccination, utilizing the Hamilton Anxiety Rating Scale (HARS). After this baseline assessment, all these participants were instructed to download and install the EduCovid-19® app on their smartphones. The application offered a curated selection of educational content aimed at addressing misinformation and fostering an understanding of COVID-19, its modes of transmission, and the vital role of vaccination in mitigating the pandemic's impact. The content was particularly designed to be user-friendly and accessible, encouraging active engagement with the material.

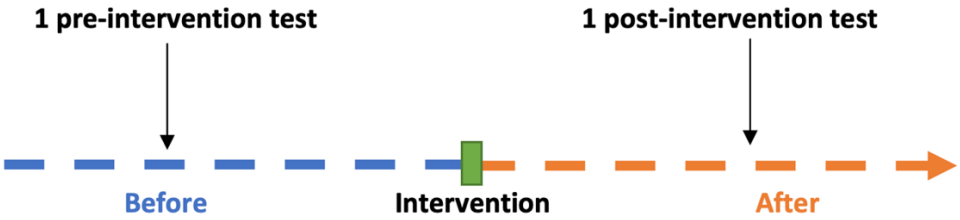


Figure 3. Design of the Study

Table I. Results of Data Normality

	Group	p-value	Note
Intervention	Pre	0.0001	Not normally distributed
	Post	0.0001	Not normally distributed

Participants were required to interact with the app's educational resources consistently over a two-week period to ensure effective knowledge acquisition. Researchers implemented monitoring strategies to confirm app usage and engagement. These included in-app usage logs to track interactions, such as installation confirmation, time spent on modules, and completion rates for educational content. Additionally, follow-up surveys or notifications were used to address potential technical difficulties and ensure sustained participant engagement. These methods strengthened the reliability of the intervention outcomes by ensuring active participation.

At the end of the two-week intervention, participants completed a post-test using the HARS to assess changes in anxiety levels relative to the pre-test baseline. The results of the pre- and post-intervention assessments were analyzed statistically to evaluate the intervention's effectiveness in reducing vaccine-related anxiety. A detailed timeline of the pre-test, intervention, and post-test phases is depicted in the accompanying flow diagram (Figure 3).

Data Analysis

For the analysis of the data collected in this study, the IBM® SPSS® Statistics 25 software was utilized, implementing a comprehensive statistical analysis suited for the size of the dataset, including over 50 participants. The analysis was carefully chosen to accommodate the complexity and scale of the dataset. The Kolmogorov-Smirnov test was selected to assess the distribution of the sample data due to its robustness in evaluating normality across large samples. Upon reviewing outcomes (Table I), the Kolmogorov-Smirnov test found significant findings concerning distribution of the participant's scores before and after the test. It was found that the distribution of the scores significantly deviated from normality. This pivotal discovery underscored the necessity of adopting non-parametric statistical model instead of traditional parametric one, which presuppose a normal data distribution. In light of this, Wilcoxon test was subsequently employed to strictly test the study's theory. Utilization of this statistical model was important, as it is well-suited for instances where the data do not follow a normal distribution. The findings from this test are employed to proof the hypothesis's validity, thus affirming this research's methodological integrity and scientific validity.

Ethical Considerations

This research received formal approval from the Health Research Ethics Committee of the FKIK, UMY, Indonesia no. 238 in 2021. It underscores the commitment to adhering to the highest ethical standards in conducting research involving human participants, making sure that all procedures were carried out with utmost respect for the participant welfare and following ethical guidelines.

RESULTS AND DISCUSSION

The persistent COVID-19 pandemic era has notably exacerbated anxiety, further intensified by vaccine availability. This disorder can be attributed to the widespread misinformation dissemination, which has not only escalated the fear but also led to adverse reactions, resulting in the psychosomatic disorders in certain individuals.

Remarkably, these reactions have strongly been linked to the public's interpretation of content centered on COVID-19. A viable approach to get rid of prevalent challenge is through implementation of in-depth educational programs. These programs are designed to engage and provide the public with evidence-based, factual insights concerning the pandemic and its related aspects. By adopting this approach, there can be a significant enhancement in public knowledge, which, in turn, could lead to a positive shift in perceptions and behaviors towards the pandemic and ongoing vaccination efforts. Therefore, the involvement of healthcare as well as subject matter experts becomes crucial. Their role is to ensure the dissemination of accurate and reliable information regarding COVID-19 pandemic and its vaccine initiatives. Amid these challenging times, strategic communication emerges as a pivotal tool in combating the widespread impact of anxiety and its related complications within society.

Study Participants

In the process of participant selection for the research, a total of 471 individuals was established, predominantly comprising females (n=349), who represented 74.10% of overall participant group. With n=202 people aged 31–40 years, this age group accounted for 42.89% of the population. Of the participants, n=359, 76.22% had an undergraduate degree and many said they were unemployed (n=162, 34.39%). Furthermore, a noteworthy portion of the cohort—around 77 or 57.03% of participants —show minor to medium fears about the vaccine. From 76.22% (n=359) to 88.32% (n=416), a sizable fraction of survey participants—mostly relied on social media sites including WAG, FB, Tiktok, X, and IG as their main source of news and updates. This reliance on social media channels underscores the significant role these platforms play in the dissemination of information related to healthcare issues. A detailed breakdown of the demographic characteristics of participants is cataloged (Table II) representing a comprehensive overview of the cohort's demographic in addition to informational engagement profiles.

During the initial recruitment phase of the study, a total of 568 potential participants were identified. However, the screening process led to the disqualification of 89 individuals because of the unresponsiveness and an additional eight due to the technical challenges that prevented them from installing the required app. Consequently, the final participant count for the study was adjusted to 471.

The results of this study are in alignment with prior research, which has consistently found that women are roughly twice as likely to report experiencing anxiety compared to men, a disparity that notably intensifies within the context of the pandemic (Fawcett et al., 2020; Rogowska et al., 2020). This phenomenon can be attributed to the difference in terms of cognitive processing, realistic assessments, and the recall of emotional memories, many factors that may contribute to the increased vulnerability of females to anxiety-related health problems (Gamsakhurdashvili et al., 2021). Among age-related demographics evaluated, participants between the ages of 30 and 40 were identified as being particularly prone to anxiety, corroborating findings from previous studies that pinpoint this age bracket (30 to 44 years) as being significantly affected (Ferreira et al., 2021; Jaffe et al., 2020). Notably, anxiety prevalence represented a marked decrease within this age range, suggesting that maturity might play a role in the management of anxiety, with older individuals displaying greater adaptability and resilience (Ferreira et al., 2021). Concerning educational attainment, the survey found that many participants held undergraduate degree (Aguilera-Hermida, 2020). The study aligns with existing literature highlighting the impact of educational level on individual process of learning and cognitive engagement. A higher educational level enhances an individual's ability to absorb and comprehend complex information, which, in turn, can influence their response to anxiety-inducing situations such as COVID-19 pandemic (Elharake et al., 2023). It suggests that increased educational attainment facilitates a deeper understanding and application of relevant information in navigating daily challenges.

An analysis of the participant's employment status revealed that most were not engaged in the formal employment. Despite this, previous study indicated a lack of significant association between an individual's employment status and their level of anxiety concerning COVID-19 vaccinations (Akarsu et al., 2021; Hwang et al., 2022). The persistence of employment status, irrespective of vaccine-related anxiety in addition to apprehension, underscores a complex interplay of many factors influencing public perception and response to the pandemic.

Table II. Summary of Demographic Information of Participants (n=471)

Background	n (%)
Age (years old)	
20 – 30	151 (32.06)
31 – 40	202 (42.89)
41 – 50	98 (20.81)
51 – 60	14 (2.97)
≥ 60	6 (1.27)
Gender	
a) Male	122 (25.90)
b) Female	349 (74.10)
Level of education	
a) Undergraduate	359 (76.22)
b) Graduate	105 (22.29)
c) Postgraduate	7 (1.49)
Source of COVID-19 vaccine information	
a) Social media	359 (76.22)
b) News media	39 (8.28)
c) Patient Education	18 (3.82)
d) None	55 (11.68)
Received COVID-19 vaccine information	
a) Yes	416 (88.32)
b) No	55 (11.68)
Occupation	
a) Student	122 (25.90)
b) Housewife	97 (20.59)
c) Government employee	41 (8.70)
d) Private employee	15 (3.18)
e) Entrepreneur	34 (7.22)
f) Unemployed	162 (34.39)
Levels of COVID-19 vaccine anxiety	
a) Mild severity	46 (9.77)
b) Mild to moderate severity	268 (56.90)
c) Moderate to severe severity	157 (33.33)

Table III. Summary of the HARS Questionnaire's Frequency Distribution (n=471)

Level of anxiety	Before n (%)	After n (%)
1	46 (9.77)	346 (73.46)
2	269 (57.11)	98 (20.81)
3	156 (33.12)	27 (5.73)

1: Mild; 2: Mild to moderate; 3: Moderate to Severe

Table IV. Summary of Wilcoxon Test

Parameter	p-value
Anxiety levels (before and after)	0.001

Furthermore, the study uncovered that social media platforms, including WhatsApp Groups, Facebook, TikTok, Twitter, and Instagram, were the predominant media through which participants received information about COVID-19 vaccines, surpassing all the traditional or conventional electronic mass media (Gisondi et al., 2022; Hou et al., 2021; Zimand-Sheiner et al., 2021). This trend underscores the crucial roles of social media in shaping public discourse as well as perceptions about public health interventions. A significant correlation was identified between the extent of social media exposure and heightened anxiety levels associated with COVID-19 vaccines, highlighting the influential capacity of digital platforms in modulating public health responses and attitudes toward vaccination efforts (Gaikwad et al., 2023; Gisondi et al., 2022; Theng et al., 2023).

Descriptive Analysis

The quantitative assessment of the study's sample population revealed a notable shift in the severity levels of COVID-19-related anxiety, as determined through a structured analysis. Initially, a significant proportion of the sample, precisely 56.90% (equivalent to 268 study participants), was identified as experiencing anxiety of a mild to moderate degree. After the implementation of the educational intervention via the EduCovid-19® mobile app, there was a marked decrease in anxiety levels within this cohort. Specifically, 36.30% of these individuals, amounting to 171 participants, saw a reduction in their anxiety severity from "mild to moderate" down to "mild." In addition, the intervention had a positive impact on participants initially experiencing higher anxiety levels. Among those initially classified with "moderate to severe" anxiety, 27.39% (representing 129 participants) transitioned to a "mild" anxiety category post-intervention.

This transition contributed to a significant increase in the proportion of all study participants categorized under "mild" severity, which surged by 63.69%, totalling 300 individuals. These outcomes underscore the potential benefits of mobile app-based educational interventions in mitigating vaccine-related anxiety (Table III).

Hypothesis Test

Statistical evaluation of research hypothesis, conducted through the application of the Wilcoxon signed-rank test, yielded a p-value of 0.001. This value falls well below the conventional threshold for statistical significance, set at 0.050 (Table IV). The implications of the results strongly affirm the initial research hypothesis, indicating a statistically significant anxiety reduction related to COVID-19 vaccinations after the implementation of a patient education facilitated by mhealth app. The effectiveness of this approach suggests a promising strategy for alleviating concerns and dispelling myths surrounding COVID-19 vaccines, thereby enhancing public trust and motivation towards the vaccine acceptance and uptake as well. This outcome underscores these potential of digital educational tools to influence the health behaviors positively, especially in the context of pandemic response efforts. By providing accessible, reliable, and comprehensive information about COVID-19 vaccinations through mobile technology, such interventions represent a critical mechanism for combating vaccine hesitancy and fostering a more informed and health-conscious society.

The outcomes (Table III) reveal a marked reduction in anxiety levels following the educational intervention via the app. Specifically, individuals categorized within mild to moderate anxiety bracket observed a significant reduction in their anxieties by 51.11%, meanwhile those in the moderate to severe anxiety category confirmed a 12.6% decrease. This quantitative analysis found the efficacy of mobile app-assisted education in significantly altering the scores obtained from the HARS questionnaire. Furthermore, the use of the Wilcoxon yielded a p-value of 0.0001 (Table IV). This value falls well below accepted significance level of 0.05, underscoring the significant impact of educational interventions on mitigating anxiety related to the COVID-19 vaccine. These results aligned with prior studies, highlighting mobile app-based patient education's critical role and effectiveness in bolstering mental health amidst the pandemic (Islam et al., 2020, 2021).

A comprehensive review corroborates the assertion that app-based educational interventions serve as an instrumental framework for navigating the multifaceted challenges presented by COVID-19 pandemic. This innovative approach empowers the general populace, healthcare practitioners, and policymakers to tackle pressing concerns. These include easing the burden on healthcare systems, disseminating the factual information, monitoring individual symptoms and psychological well-being, in addition to identifying novel predictive markers (Kondylakis et al., 2020).

The prevalent anxieties surrounding vaccine safety, effectiveness, possible adverse side effects, misunderstandings on necessity for immunization,

and a general mistrust in healthcare infrastructure and the public awareness have contributed to the community's apprehension towards the COVID-19 vaccination initiative. Such apprehensions might deter individuals from participating in vaccination effort. Nonetheless, education facilitated by mobile applications have shown tremendous potential in diminishing vaccine-related anxiety. By leveraging this modern method, crucial information as well as knowledge are efficiently relayed to the populace, fostering increased engagement, elevating patient knowledge, and influencing changes in attitudes and behaviors towards vaccination.

Strengths and Limitations of the Study

This study outlines many notable strengths, significantly contributing to public health and medical research domains. Foremost among its strengths is the deployment of the EduCovid-19® mobile app, an innovative approach to mitigating vaccine-related anxiety. This strategy capitalizes on the ubiquity of smartphone technology to deliver precise and current information on COVID-19 vaccinations, marking a pioneering venture in the application of digital solutions to public health predicaments. The study's rigorous quantitative methodology, utilizing the HARS questionnaire for assessments both before and after the intervention, guarantees the robustness and authenticity of the results. This methodology lays a solid groundwork for appraising the intervention's impact. Notably, the significant statistical outcomes, evidenced by a p-value of 0.001 from the Wilcoxon signed-rank test, strongly validate the efficacy of the mobile application in relieving vaccine anxiety. Moreover, by engaging diverse participants, the research's implementation within the rural confines of the Special Region of Yogyakarta, Indonesia, broadens the finding's applicability, which offered insightful perspectives for analogous interventions in rural contexts worldwide.

To ensure the app remains relevant and reflects current conditions, it can be developed with features that allow for regular updates to the educational content, particularly with the latest information on COVID-19 variants, vaccination developments, and evolving public health guidelines. This adaptability will ensure that the app aligns with current trends, including updates from health authorities such as the World Health Organization (WHO) and Indonesia's Ministry of Health. By integrating real-time updates and notifications, the app can continue to serve as a reliable source of information. This dynamic approach eliminates the concern of the app becoming outdated and ensures that it remains an effective tool in addressing vaccine-related anxiety and public health challenges. Therefore, rather than being a limitation, the app can be continuously enhanced to conform with ongoing developments, enhancing its long-term impact and usability.

However, this study has several limitations, delineating further exploration and refinement avenues. The main geographic limitation to rural Yogyakarta might restrict the extrapolation of the findings to other settings, especially urban locales or different cultural environments where vaccine hesitancy and digital technology access may vary significantly. The brief duration of the intervention, spanning two weeks, raises pertinent questions about the enduring nature of the observed anxiety reductions, suggesting a need for extended follow-up to assess long-term effects. Furthermore, the reliance on participants' self-reported data via the HARS questionnaire may have biases, potentially compromising the anxiety assessment's accuracy, so it needs a qualitative study. The absence of a control group in the study's design precludes a definitive attribution of anxiety level changes directly to the intervention, given that many external factors could also exert an influence. Lastly, presuming digital literacy and access among the participants could inadvertently marginalize individuals lacking in these areas, underlining the imperative for public health strategies inclusive of diverse technological proficiency levels., meaning that it did not investigate the relationship between participant demographics and changes in anxiety levels before and after the intervention. Future studies should explore these demographic factors to gain deeper insights into how different subgroups may respond to the intervention, enabling more tailored educational approaches.

CONCLUSION

This study found a pronounced prevalence of anxiety related to COVID-19 vaccination within the Indonesians. Importantly, it demonstrates that an educational intervention facilitated through a mobile app was highly effective in alleviating this anxiety. This effectiveness is substantiated by a substantial decrease in scores on the HARS questionnaire following the intervention. These results emphasize the critical role of digital health initiatives in mitigating vaccine hesitancy and addressing its associated psychological impacts in communities.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the content of this article. This statement affirms our commitment to transparency and integrity in our research process, ensuring that the findings and conclusions are unbiased and based solely on the study's empirical evidence.

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