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Short Communication

Role of digital education through smartphones in improving knowledge among asthma patients: A preliminary study

Indah TS. Pohan[1], Amira P. Tarigan[2*], Pandiaman Pandia[2] and Erna Mutiara[3]

[1]Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [2]Division of Asthma and COPD, Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; [3]Division of Population and Biostatistics, Faculty of Public Health, Universitas Sumatera Utara, Medan, Indonesia

*Corresponding author: amira@usu.ac.id

Abstract

Asthma is a chronic inflammatory airway disorder and is among the top ten causes of morbidity and mortality in Indonesia, highlighting the need for effective management strategies. This study aimed to evaluate changes in asthma knowledge levels before and after using the "*Paru Sehat*" smartphone application for digital education. A quasi-experimental study using a pre- and post-test design was conducted over three months at the outpatient clinic of Universitas Sumatera Utara Hospital, Medan, Indonesia, among asthma patients aged over 18 years. The patients completed the Patient Asthma Knowledge Questionnaire (PAKQ) before installing the "*Paru Sehat*" application to establish baseline knowledge. Once a week, patients received reminders to access materials covering an asthma overview, peak flow meter use, medication differences, and management techniques. After four weeks of intervention, the participants' knowledge was reassessed using the PAKQ. Data were analyzed using either paired Student's t-test or Wilcoxon test to assess the improvement in knowledge. The results showed increases in knowledge about asthma in general, asthma triggers, and asthma diagnosis domains, with the median score in each domain rising by one point (p=0.003, p=0.001, and p=0.002, respectively). The asthma management domain exhibited the largest change, with a median increase of two points (p<0.001). The total scores increased by an average of five points (p<0.001), indicating an overall improvement in patient knowledge about asthma. The "*Paru Sehat*" application demonstrated significant potential in enhancing asthma knowledge across multiple domains. Further research is warranted to explore the long-term effectiveness of the application in diverse populations and settings, ultimately contributing to improved asthma management and patient outcomes.

Keywords: Asthma, asthma control test, digital education, mobile health, *Paru Sehat* application

Introduction

Asthma is a chronic inflammatory disorder of the airways involving various cells and cellular elements, such as mast cells, eosinophils, T lymphocytes, macrophages, neutrophils, and epithelial cells [1]. It causes significant global health challenges, as indicated by data from the World Health Organization (WHO) [2] and the Global Initiative for Asthma (GINA) [3]. Asthma affects 3–5% of adults and 7–10% of children worldwide [2]. The WHO estimates that 100–150 million people have asthma, and the number is projected to grow by 180,000 cases annually, reaching over 200 million by 2025 [2]. In Indonesia, asthma is among the top ten causes of

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morbidity and mortality [4,5], further emphasizing the importance of effective management strategies.

Advances in technology have enabled telemedicine to play an increasingly important role in asthma care. Qualitative studies suggest that smartphone applications can significantly improve the self-management of asthma patients [6,7]. Mobile health (mHealth) applications provide comprehensive information about asthma management through portable devices, helping patients bridge gaps in healthcare systems by enabling real-time symptom monitoring and facilitating seamless information exchange between patients, caregivers, and healthcare professionals. These applications also offer valuable educational content to help patients manage their condition more effectively [8,9].

Recent studies have demonstrated that multifunctional mHealth applications hold significant promise for improving asthma management and enhancing the quality of life for affected individuals [10,11]. Some applications have shown encouraging outcomes like improved medication adherence and better self-management [12,13]. By streamlining communication between patients and healthcare providers and providing personalized reminders and educational resources, mHealth applications could boost adherence to prescribed therapy and significantly enhance current clinical efforts in managing asthma [8]. A deeper understanding of user behavior, personalized reminders, and data analysis will be crucial in refining these tools for maximum impact [14]. The aim of this study was to evaluate the improvement of asthma knowledge levels before and after using one of the mHealth smartphone applications developed in Indonesia, "*Paru Sehat*", in asthma patients.

Methods

Study design and patients

A quasi-experimental study with pre- and post-test was conducted at the outpatient clinic of Universitas Sumatera Utara Hospital, Medan, Indonesia, over the span of three months (April to June 2023). A non-probability purposive sampling technique was used to recruit the patients. This study included patients with asthma, aged over 18 years, who had received asthma treatment according to their asthma degrees and were able to use an Android smartphone application or had a companion who could operate an Android smartphone application to assist them. Asthma patients who were in a state of exacerbation and those with severe cardiovascular disorders (such as acute coronary syndrome) were excluded from the study.

Data collection

Prior to the intervention, all eligible patients were asked to sign a consent form. Following this, patients were asked to fill in the Patient Asthma Knowledge Questionnaire (PAKQ), a paper-based questionnaire, before being exposed to the "*Paru Sehat*" smartphone application to assess their baseline (pre-test) knowledge scores on asthma. Afterward, the "*Paru Sehat*" application was installed on their Android smartphones, and they were trained to use it. For four weeks, patients were exposed to asthma-related content delivered by pulmonologists in both text and video formats. Once a week, the patients received a notification reminder to read and watch the specific materials on the application. These materials included an overview of asthma, the use of a peak flow meter, differences between asthma drugs, and management in controlling asthma. All of the contents were always accessible at any time as long as the application remained installed. After the intervention period, the knowledge of asthma was re-assessed using the paper-based PAKQ to obtain the post-test scores.

Study instrument

The PAKQ questionnaire was used to measure the patient's knowledge level of asthma. The questionnaire has been translated into Bahasa Indonesia through the Language Center of Universitas Sumatera Utara, Medan, Indonesia and has been tested for validity and reliability. The PAKQ was valid based on the product-moment correlation validity test with r=0.596, p=0.010. The PAKQ was also reliable since the repeated analysis of variance (ANOVA) showed the reproducibility of PAKQ (n=21: F(1)=3.578, p=0.07, ηp^2=0.152) and its responsiveness (n=21:

F(1)=26.041, p<0.05, ηp^2=0.566) [15]. The PAKQ comprises 54 questions with "true/false/do not know" answer options. These questions are grouped into four domains, including general asthma knowledge (13 items), asthma triggers (15 items), asthma diagnosis (19 items), and management of asthma (7 items). Each question is scored similarly: one point for each correct answer and zero points for an incorrect answer or a "do not know " response. Consequently, the PAKQ yields a total score ranging from 0 to 54 [16].

"*Paru Sehat*" smartphone application

The "*Paru Sehat*" application, developed by the Department of Pulmonology at the Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia, was designed for managing pulmonary diseases and is available for Android. Initially, it collects essential demographic and health information from users, such as name, date of birth, height, and contact details. The "*Paru Sehat*" application features video tutorials on inhaler use, reminders for medication adherence, and advice on what actions to take when symptoms worsen, including when to seek health provider care. Further details of the application are available elsewhere [17].

For asthma patients, the application begins with an "Asthma Overview" menu section designed for asthma patients. This section provides general asthma information about the condition, its nature, and the basics of management. It also offers guidance on using a peak flow meter to monitor lung function and provides detailed information on various asthma medications. Additionally, the application includes strategies and tips for managing asthma, with an emphasis on avoiding triggers and maintaining daily management routines.

Statistical analysis

The normality of the knowledge scores was tested using the Shapiro-Wilk test for each domain of PAKQ and the total score for pre- and post-tests. The Student's paired t-test was used to analyze differences between pre- and post-tests if the data exhibited normal distribution, while the Wilcoxon test was employed for non-normally distributed data. All statistical analyses were performed using SPSS version 25 (SPSS Inc., Chicago, USA).

Results

Characteristics of patients

A total of 35 asthma patients were included in the study, as presented in **Table 1**. The majority of the patients were female (80%) and aged between 26 to 45 years (40%). More than half of the patients were unemployed (65.7%) and had normal body mass index (60%). Only nine patients had a comorbid condition (25.7%) (**Table 1**).

Table 1. Characteristics of asthma patients included in the study (n=35)

Characteristics	Category	Frequency (percentage)
Gender	Male	7 (20)
	Female	28 (80)
Age (years)	18–25	4 (11.4)
	26–45	14 (40)
	46–65	12 (34.3)
	>65	5 (14.3)
Working	Yes	12 (34.3)
	No	23 (65.7)
Body mass index (BMI)	Normal	21 (60)
	Overweight	10 (28.6)
	Obese	4 (11.4)
Comorbid condition	Yes	9 (25.7)
	No	26 (74.3)

Patients' knowledge before and after intervention

Overall, significant improvements were observed in mean scores of the general asthma knowledge domain (pre-test: 9.91, post-test: 10.8), asthma triggers (pre-test: 11.14, post-test: 12.46), asthma diagnosis (pre-test: 9.91, post-test: 11.23), and management of asthma (pre-test: 2.74, post-test: 4.17). The mean total score of the pre-test was 33.74, and the post-test mean total score was 38.74.

All of the domains showed non-normal distributions, while the total scores demonstrated normal distributions (**Table 2**).

Table 2. Patients' knowledge levels before and after using the "*Paru Sehat*" smartphone application

PAKQ domain	Pre-intervention		Post-intervention	
	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)
General asthma knowledge	9.91±1.31	10 (9–11)	10.8±1.21	11 (10–12)
Asthma triggers	11.14±1.9	11 (10–12)	12.46±1.44	12 (12–14)
Asthma diagnosis	9.91±1.81	10 (9–11)	11.23±1.46	11 (10–12)
Management of asthma	2.74±1.25	3 (2–3)	4.17±1.58	5 (3–6)
Total score	33.74±4.72	34 (31–37)	38.74±3.42	39 (36–41)

PAKQ: patient asthma knowledge questionnaire

The general asthma knowledge, asthma triggers, and asthma diagnosis domains had increases in the median score of approximately one, with p=0.003, p=0.001, and p=0.002, respectively. The management of the asthma domain had the largest change, with a median score increase of two (p<0.001). The total score differences expressed both mean and median total score increments of five (p<0.001), indicating a significant overall improvement in patient knowledge levels post-intervention (**Table 3**).

Table 3. Differences in patients' knowledge level before and after using the "*Paru Sehat*" smartphone application

PAKQ domains	Differences (post-intervention - pre-intervention)		
	Δ Mean	Δ Median	p-value
General asthma knowledge	0.89	1	0.003[a]
Asthma triggers	1.32	1	0.001[a]
Asthma diagnosis	1.32	1	0.002[a]
Management of asthma	1.43	2	<0.001[a]
Total score	5	5	<0.001[b]

PAKQ: patient asthma knowledge questionnaire
[a] Analyzed with Wilcoxon test
[b] Analyzed with Student's paired t-test

Discussions

This study found that asthma patients were predominantly female, indicating gender differences in asthma prevalence. Men have a higher prevalence than women during childhood, but the trend reverses in adulthood, with women more likely to suffer from severe asthma than men. This prevalence shift around adolescence coincides with hormonal changes, suggesting that sex hormones may influence asthma pathogenesis [18]. As adults, women have a higher prevalence of asthma and are more likely to be hospitalized due to asthma-related complications. This gender difference persists until menopause when a decrease in asthma prevalence is noted among women [19].

This study found that the "*Paru Sehat*" application effectively increased patient knowledge in all measured domains. Both formal and informal education, whether through direct interactions with healthcare providers or multimedia, play a crucial role in helping patients understand their conditions and treatment plans. A previous study in 2022 assessed the impact of a mobile app education intervention on asthma knowledge. Compared to the control group, the treatment group showed significant improvement, with a 4.81-point increase in post-test scores (p=0.01). This suggests that the application effectively enhances asthma knowledge [20]. These results emphasized the positive impact of digital health interventions in educating patients with chronic conditions. A study reported that education via mobile applications significantly increased asthma knowledge among school-age children in Malaysia [21]. Initially, both control and experimental groups had moderate knowledge levels. However, post-intervention results in the experimental group showed a higher proportion with high knowledge levels. The study suggests that mobile application-based education surpasses traditional teaching methods like lectures or handbooks [21].

Our findings underscore the value of comprehensive, technology-driven education that is accessible and user-friendly. Previous studies have established that such educational interventions can lead to improved disease knowledge and management, but some other studies have also noted challenges in sustaining long-term behavior change due to factors like limited access to digital resources and health literacy disparities [22,23]. However, the "*Paru Sehat*" application has demonstrated a distinct advantage by offering a comprehensive educational approach tailored specifically to asthma patients. This comprehensive approach across all four domains—general asthma knowledge, asthma triggers, asthma diagnosis, and management of asthma—addresses a broad range of patient needs, improving knowledge retention and practical application.

The results affirm our hypothesis that the "*Paru Sehat*" application effectively increases knowledge across all domains, suggesting that patients are receptive to structured, multimedia educational material and responsive to regular reminders and prompts. Smartphone applications offer distinct advantages in improving health literacy by being accessible, customizable, and interactive [24]. It is imperative to develop a customized educational approach that addresses the specific needs of individual patients to promote adherence and strengthen self-management capabilities [25]. Studies indicate that digital interventions improve asthma awareness, self-management, quality of life, and medication adherence [26,27]. However, misconceptions about asthma treatment remain a significant barrier. A study conducted in Zambia reported prevalent misconceptions among the surveyed population, with only 54.7% believing hospitalization could be prevented, 54.7% thinking asthma symptoms could be managed with appropriate medication, and 37% believing inhalers were addictive. Nearly 60% believed people with asthma couldn't exercise or play, and many thought tablets were better than inhalers (46% of people with asthma vs 30% of those without) [28].

Several limitations were identified in this study. The non-probability sampling method may limit the generalizability of the findings to a broader population. Additionally, the study only measured immediate post-intervention knowledge, so further research is needed to evaluate long-term knowledge retention and behavior change. Future studies should also include larger, randomized samples and consider additional demographic factors that may influence the effectiveness of the application.

Conclusion

Providing digital education through the "*Paru Sehat*" smartphone application demonstrated significant potential in enhancing asthma knowledge across multiple domains. This improvement suggests that technology-assisted education can play a vital role in empowering patients to better manage chronic diseases. As digital health tools become increasingly prevalent, developing comprehensive and patient-centered applications like "*Paru Sehat*" could significantly improve health literacy and patient outcomes in managing asthma and other pulmonary conditions. Further development of the "*Paru Sehat*" application features is needed to meet the needs of and improve the usability of a wider community.

Ethics approval

This research was approved by the Health Research Ethics Committee of Universitas Sumatera Utara, Medan, Indonesia, with the registered number 923/KEPK/USU/2022.

Competing interests

The authors declare that there is no conflict of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

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References

1. McCracken JL, Veeranki SP, Ameredes BT, *et al.* Diagnosis and management of asthma in adults a review. J Am Med Assoc 2017;318(3):279-290.
2. Ebmeier S, Thayabaran D, Braithwaite I, *et al.* Trends in international asthma mortality: Analysis of data from the WHO mortality database from 46 countries (1993-2012). Lancet 2017;390(10098):935-945.
3. Reddel HK, Bacharier LB, Bateman ED, *et al.* Global initiative for asthma strategy 2021 executive summary and rationale for key changes. Am J Respir Crit Care Med 2022;205(1):17-35.
4. Badan Penelitian dan Pengembangan Kesehatan. Laporan nasional Riskesdas 2018. Jakarta: LPB; 2019.
5. Nisa H. Obesity and asthma risk in Indonesian adults: Findings from the 2018 Indonesia basic health research. Kesmas 2023;18(1):58-64.
6. Cook KA, Modena BD, Simon RA. Improvement in asthma control using a minimally burdensome and proactive smartphone application. J Allergy Clin Immunol Pract 2016;4(4):730-737.e1.
7. Saeed H, Abdelrahim MEA, Rabea H, *et al.* Impact of advanced patient counseling using a training device and smartphone application on asthma control. Respir Care 2020;65(3):326-332.
8. Farzandipour M, Nabovati E, Sharif R, *et al.* Patient self-management of asthma using mobile health applications: A systematic review of the functionalities and effects. Appl Clin Inform 2017;8(4):1068-1081.
9. Ramsey RR, Caromody JK, Voorhees SE, *et al.* A systematic evaluation of asthma management apps examining behavior change techniques. J Allergy Clin Immunol Pract 2019;7(8):2583-2591.
10. Piette JD, List J, Rana GK, *et al.* Mobile health devices as tools for worldwide cardiovascular risk reduction and disease management. Circulation 2015;132(21):2012-2027.
11. Holgate ST, Walker S, West B, *et al.* The future of asthma care: Personalized asthma treatment. Clin Chest Med 2019;40(1):227-241.
12. Khatun F, Heywood AE, Hanifi SMA, *et al.* Gender differentials in readiness and use of mHealth services in a rural area of Bangladesh. BMC Health Serv Res 2017;17(1):1-11.
13. Fernandez C, Vicente MA, Guilabert M, *et al.* Developing a mobile health app for chronic illness management: Insights from focus groups. Digit Health 2023;9:20552076231210662.
14. Pouls BPH, Vriezekolk JE, Bekker CL, *et al.* Effect of interactive eHealth interventions on improving medication adherence in adults with long-term medication: Systematic review. J Med Internet Res 2021;23(1):1-16.
15. Beaurivage D, Boulet LP, Foster JM, *et al.* Validation of the patient-completed asthma knowledge questionnaire (PAKQ). J Asthma 2018;55(2):169-179.
16. Peng B, Sun L, Shang Y, *et al.* Translation and validation of the Chinese version of patient-completed asthma knowledge questionnaire and its implementation in patient education. J Thorac Dis 2022;14(4):905-918.
17. Adida F, Pandia P, Pradana A, *et al.* Effectiveness of smartphone application in increasing knowledge on COPD and its non-pharmacological management in COPD patients. Narra J 2023;3(3):1-11.
18. Naeem A, Silveyra P. Sex differences in paediatric and adult asthma. Eur Med J 2019(6):27-35.
19. Zein JG, Denson JL, Wechsler ME. Asthma over the adult life course: Gender and hormonal influences. Clin Chest Med 2019;40(1):149-161.
20. Ghozali MT, Satibi S, Ikawati Z, *et al.* The efficient use of smartphone apps to improve the level of asthma knowledge. J Med Life 2022;15(5):625-630.

21. Al Raimi AM, Chong MC, Tang LY, *et al.* The effect of mobile applications in enhancing asthma knowledge among school children with asthma in Malaysia. J Pediatr Nurs 2022;65:e63-e71.
22. Al-Durra M, Torio MB, Cafazzo JA. The use of behavior change theory in internet-based asthma self-management interventions: A systematic review. J Med Internet Res 2015;17(4):89-96.
23. Alvarez-Perea A, Dimov V, Popescu FD, *et al.* The applications of eHealth technologies in the management of asthma and allergic diseases. Clin Transl Allergy 2021;11(7):e12061.
24. Sleurs K, Seys SF, Bousquet J, *et al.* Mobile health tools for the management of chronic respiratory diseases. Allergy Eur J Allergy Clin Immunol 2019;74(7):1292-1306.
25. Himes BE, Leszinsky L, Walsh R, *et al.* Mobile health and inhaler-based monitoring devices for asthma management. J Allergy Clin Immunol 2019;7(8):2535-2543.
26. Hui CY, Walton R, McKinstry B, *et al.* The use of mobile applications to support self-management for people with asthma: A systematic review of controlled studies to identify features associated with clinical effectiveness and adherence. J Am Med Inform Assoc 2017;24(3):619-632.
27. Tinschert P, Jakob R, Barata F, *et al.* The potential of mobile apps for improving asthma self-management: A review of publicly available and well-adopted asthma apps. JMIR MHealth UHealth 2017;5(8):1-13.
28. Marsden EJ, Wa Somwe S, Chabala C, *et al.* Knowledge and perceptions of asthma in Zambia: A cross-sectional survey. BMC Pulm Med 2016;16(1):1-8.