The Effect of Providing Digital Education Through Smartphone Applications on Control Level of Asthma Patients at Outpatient Clinic University of North Sumatra Hospital Medan

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ARTICLE INFO	ABSTRACT
	Introduction: Asthma is a chronic airway disease where achieving and maintaining asthma control is the main goal of management. Effective asthma control requires good patient self-management, including the ability to recognize symptoms and take appropriate action. This study aimed to assess the effect of digital education through the Paru Sehat smartphone application on asthma control levels in patients at the Outpatient Clinic of the University of North Sumatra Hospital, Medan. **Method**:This study used a quasi-experimental within-subject (pre-post) design. Asthma control levels were measured using the Asthma Control Test (ACT) before and after the use of the Paru Sehat application. Data analysis was conducted using a paired t-test for normally distributed data and the Wilcoxon test for non-normal data. A p-value <0.05 was considered statistically significant. **Results**: Before the intervention, 56% of patients had partially controlled asthma, 40% were uncontrolled, and only 4% were fully controlled. After using the Paru Sehat application, the proportion of fully controlled patients increased to 20%, partially controlled decreased to 48%, and uncontrolled cases reduced to 32%. However, this improvement was not statistically significant (p = 0.058). **Conclusion**: The use of the Paru Sehat application showed a trend toward improved asthma control, but the change was not statistically significant. Further research with a larger sample size and longer intervention duration may be needed to determine its effectiveness.
Keywords	

INTRODUCTION

Asthma is a chronic airway disease resulting from an inflammatory process which generally affects 1-18% population, characterized by symptoms varying from wheezing, shortness of breath, feeling of heaviness in the chest and/or coughing as well as varying expiratory airflow limitation.[1] Asthma is estimated to affect around 262 million people worldwide in 2019 and causes 455,000 deaths.[2] The prevalence in Singapore reaches 11.9% (2021), Japan 10% (2022), Taiwan 5.1% (2019), and Korea 2.2% (2020).[3-6]

Asthma is among the top ten causes of morbidity and mortality in Indonesia. Nationally, the 10 districts/cities with the highest prevalence of asthma are West Aceh (13.6%), Buol (13.5%), Pohuwato (13.0%), West Sumba (11.5%), Boalemo (11. .0%), South Sorong (10.6%), Kaimana (10.5%), Tana Toraja (9.5%), Banjar (9.2%), and Manggarai (9.2%).[7]

Achieving and maintaining controlled asthma is the main goal of asthma management, namely, optimal conditions that allow asthma patients to carry out their life activities like other healthy people. Indications of controlled asthma are no symptoms, no activity limitations, no symptoms at night, no need for relievers, normal lung function and no asthma attacks throughout the year.1 The level of asthma control can be achieved with medical treatment and good self-management of asthma patients, where one of the factors that can affect asthma control level is knowledge about asthma, patients can recognize and carry out self-management of asthma effectively.[8]

In a study by Atmoko regarding asthma control level at the Asthma Clinic, Friendship Hospital, Jakarta in 2011 using the Asthma Control Test (ACT), it was shown that out of 107 subjects studied, 81 subjects (75.5%) had uncontrolled asthma and 26 (24.3%) had controlled asthma. This is in line with research conducted at Asthma Polyclinic, General Hospital Dr. M. Djamil Padang and General Hospital Dr. Achmad Mochtar Bukittinggi in 2013, which based on ACT score found 36 people (55.4%) with uncontrolled asthma, 18 people (27.7%) with partially controlled asthma, and 11 people with totally controlled asthma (16.9%).[9,10]

The Department of Pulmonology, Faculty of Medicine, University of North Sumatra has developed an application called "Paru Sehat" which can be downloaded via PlayStore. This application aims to be a medium for pulmonary disease education, which contains educational content in the form of videos and text that facilitates information exchange between patients and health professionals. This study aimed to determine whether providing digital education through the "Paru Sehat" smartphone application affects asthma control level, as measured by the Asthma Control Test (ACT) questionnaire in asthma patients.

METHOD

The research design was a quasi-experimental within-subject (pre-post) study, which was carried out to determine asthma control level as measured by the ((ACT) before and after the provision of digital education through the "Paru Sehat" smartphone application at the Outpatient Clinic University of North Sumatra Hospital. The study was conducted for three months, from April to June 2023.

The sample of this study included asthmatic patients who met the inclusion criteria and were not included in the exclusion criteria. Sample selection used a non-probability sampling technique with consecutive sampling types. The minimum sample size required was 22. To anticipate the loss of research subjects to follow-up, the sample size was increased to 25 people

The inclusion criteria for this research were patients diagnosed with asthma and not in a state of exacerbation, aged over 18 years, asthma patients who came for control to outpatient clinics, patients who had received asthma treatment according to asthma degree, patients who were willing to be research sample and have signed an informed consent form, are able to use Android smartphone applications or companions who are able to use Android smartphone applications. The exclusion criteria were asthmatic patients who were unable to read and write, patients who were not willing to be the research sample and did not sign informed consent, and asthmatic patients who were unable to operate Android smartphone devices or did not have companions who were able to use Android smartphone applications. Each research participant included in this study understood and signed the consent form after an explanation (informed consent). The research subjects completed the ACT questionnaire. The research subjects were introduced to the "Paru Sehat" smartphone application and given time to understand the contents of the application regarding asthma information. The time given was 4 weeks, and the patient was exposed to material about asthma once a week. The research subjects completed the ACT questionnaire again after 4 weeks of using the "Paru Sehat" smartphone application.

The Department of Pulmonology, Faculty of Medicine, University of North Sumatra, has developed a "Paru Sehat" application that can be downloaded via the Play Store. This application aims to provide digital education to patients with asthma, COPD, and pulmonary TB and treatment monitoring.

The features of the "Paru Sehat" application consist of the patient's personal data, namely name, date of birth, height, city/district, address, cellphone number, family name, and family cellphone number. Then there

are questions regarding the history of covid infection and the "mMRC Congestion Scale" which, if the answers have been selected, will provide suggestions for steps that should be taken going forward. There is also a "Smoking History" and "Pulmonary Disease History" which will raise other questions if chosen. The Info & Educational Videos at a Glance section is divided into three sections based on pulmonary disease: asthma, COPD, and post-TB infection. Each section contains disease-related information and educational videos that briefly explain the disease. The content of "Benefits of Exercise for Lung Patients" is a brief explanation and guide regarding exercise that is beneficial for patients with lung diseases. Videos can also be played to guide sports-related movements.
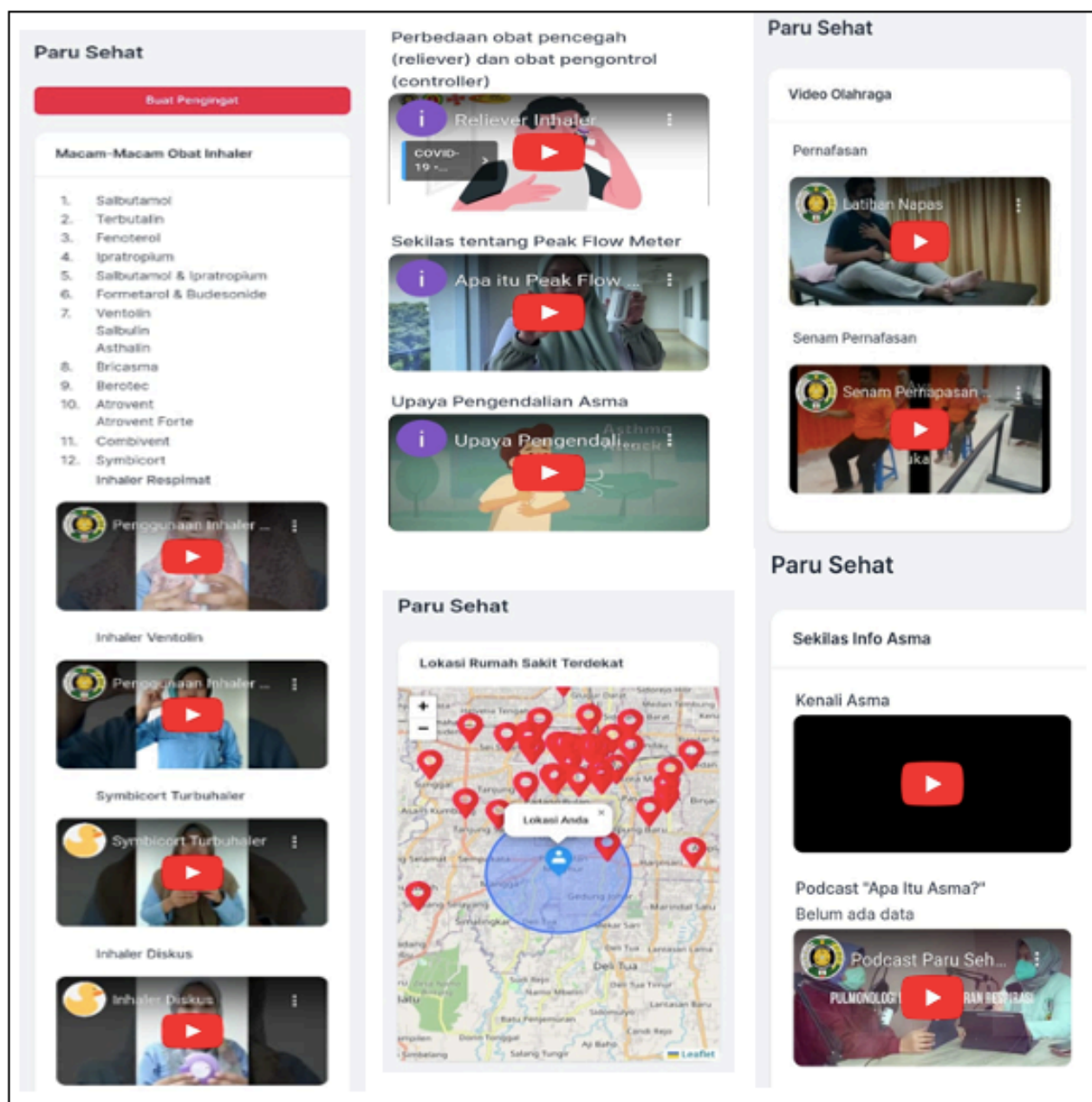

Figure 1. Some features in "Paru Sehat" application

Factors that can cause worsening symptoms include those that can precipitate exacerbations in COPD and asthma. Information on the first treatment of worsening symptoms if an exacerbation occurs was also provided to the patient and their family. However, if the complaint does not decrease, the patient should be immediately taken to the nearest hospital. Healthy Lung Community which includes several other features such as: information, programs, and documentation of "Paru Sehat" Community. There is also a WhatsApp

group/call center service available for the "Paru Sehat" community. In the inhaler medicine section, there are various kinds of inhaler medicines and video tutorials on how to use them. In addition, the application includes reminders when it is time to use the inhaler. It is hoped that the use of inhalers in patients who require them will become more routine. This application also displays the location of the hospital on a map that is within the radius of the patient when opening the application and displays the tips needed to start smoking cessation.

In this research, the data collected will be managed and analyzed using a computerized system with the Statistical Package for the Social Sciences (SPSS) program. The data obtained were tested for normality using the Shapiro–Wilk test. If the data are normally distributed, the hypothesis test used to analyze data with nominal independent variables and numerical dependent variables in the same research subject is the dependent t test (paired t test). Conversely, if the data were not normally distributed, the Wilcoxon test was used to test the hypothesis. The research results were considered significantly different if the statistical analysis found a p-value < 0.05.

RESULTS

Table 1. Distribution of Respondents Based on Demographic Data

Variable	Category	n	%
Age (years old)	12 – 25	3	12
	26 – 45	12	48
	46 – 55	2	8
	56 – 75	7	28
	>75	1	4
	Total	25	100
Gender	Male	5	20
	Female	20	80
	Total	25	100
Occupation	Housewife	12	48
	Civil Servant	1	4
	Enterpreneur	4	16
	Students	3	12
	Teacher	1	4
	Lecturer	2	8
	Nurse	1	4
	Architect	1	4
	Total	25	100
Body Mass Index	Normal	13	52
	Overweight	9	36
	Obesity	3	12
	Total	25	100
Comorbidities	None	17	68
	Heart Failure	1	4
	Grade I Hypertension	3	12
	Grade II Hypertension	3	12
	Pulmonary TB	1	4
	Total	25	100
Asthma Degrees	Persistent Intermittent	2	8
	Persistent Mild	3	12
	Persistent Moderate	9	36
	Persistent Severe	11	44
	Total	25	100

This study included 25 patients, including 5 male and 20 female patients. After obtaining the data, a descriptive analysis was performed for each research variable. A different test was performed to determine the differences between the two paired variables, namely asthma control level before and after receiving digital education through the "Paru Sehat" application.

Based on Table 1. It was found that the majority of patients were in the age group of 26–45 years, accounting for 48% of all study participants. As many as 20% of the patients were male and 80% were female. As many as 48% of patients were housewives, 16% were self-employed, 12% were female students, 8% were lecturers, and the rest were civil servants, high school teachers, nurses, and architects, each comprising 4%. As many as 52% of patients had a normal body mass index, but 36% of patients were overweight, and the remaining 12% were obese. Most of the patients did not have comorbidities; 4% of patients had heart failure, 12% had grade I hypertension, 12% had grade II hypertension, and the remaining 4% had pulmonary TB. As many as 44% of patients had severe persistent asthma, 36% had moderate persistent asthma, 12% had mild persistent asthma, and 8% had intermittent asthma.

Table 2. The Distribution of Research Subjects Based on Control Level Before and After Using "Paru Sehat" Application

Variable	Category	n	%
Asthma control level before using "Paru Sehat" application	Fully controlled	1	4
	Partially controlled	14	56
	Not controlled	10	40
	Total	25	100
Asthma control level after using "Paru Sehat" application	Fully controlled	5	20
	Partially controlled	12	48
	Not controlled	8	32
Total		25	100

Based on Table 2, it was found that 56% of asthma patients were partially controlled, 40% of asthma patients were not controlled, and only 4% of asthma patients were fully controlled before using the "Paru Sehat" application, but the rate of controlled asthma patients increased to 20%, partially controlled decreased to 48%, and uncontrolled asthma decreased to 32% of patients after using "Paru Sehat" application.

Table 3. Comparison of Asthma Control Level

Variable	Category	n	%	P value
Asthma control level before using "Paru Sehat" application	Fully controlled	1	4	
	Partially controlled	14	56	
	Not controlled	10	40	0,058
Asthma control level after using "Paru Sehat" application	Fully controlled	5	20	
	Partially controlled	12	48	
	Not controlled	8	32	
Total		25	100	

The Wilcoxon test was carried out on both variables, namely asthma control level before and after using the healthy lung application, and the results obtained were a better level of asthma control after using the "Paru Sehat" application, but these results were not statistically significant (p = 0.058).

DISCUSSION
This study evaluated the effect of using the "Paru Sehat" application to improve the control level of asthma patients. The application can control patient compliance and provide information and educational videos for patients with asthma. Asthma patients were dominated by women in this

research. The literature indicates that gender differences exist in asthma prevalence. As adults, women have a higher prevalence of asthma than men. Furthermore, women are more likely to have severe asthma and later asthma onset than men. Gender differences exist in asthma and change throughout life.[11] As children, boys had an increased asthma prevalence compared with girls (11.9% vs 7.5%, respectively).[12] and boys are

also twice as likely to be hospitalized for an asthma exacerbation.[13] However, during adolescence, there is a decrease in asthma prevalence and morbidity in males, along with an increase in females. By adulthood, women have an increased asthma prevalence compared with men (9.6% vs. 6.3%, respectively), and women are three times more likely than men to be hospitalized for asthma-related events. This is attributed to the effect of the hormone estrogen, which increases adhesion to endothelial cells in blood vessels, and the combination of hormones estrogen and progesterone can increase eosinophil degranulation, thereby facilitating bronchial asthma attacks. The increase in asthma prevalence in women compared to men is maintained until around the time of menopause, when a decrease in asthma prevalence is noted in women. The shift in asthma prevalence by sex coincides with changes in sex hormones and suggests that sex hormones modulate pathways associated with asthma pathogenesis.[14]

Data were collected on the patients' asthma control level before and one month after using the "Paru Sehat" application, and it was found that there was an improvement in asthma control level after 1 month of using "Paru Sehat" application, but after conducting statistical tests, there was no significant difference (p>0, 05). This could be due to the different conditions of the research subjects, different comorbidities, and the evaluation time span of 1 month, which might be too short to achieve a significant improvement in the patient's asthma control level. Mendozo et al. found that in asthma with a more severe degree or in long-standing asthma, the inflammatory process of the airways causes remodeling. The exact mechanism underlying this process is still being investigated. In contrast, persistent asthma with a more severe degree of obstruction requires more intensive treatment, higher drug doses, and tighter supervision. This is strongly related to patient compliance level to achieve controlled asthma.[15]

Research conducted by Setiahasti et al. reported that among patients with a high level of asthma knowledge, 14 (19.4%) had controlled asthma, while 58 (80.6 %) had uncontrolled asthma. In patients with a low level of knowledge, only six (24%) samples were controlled, whereas 19 (76%) samples were not controlled. The statistical test results obtained p value 0.843 which concluded that there is no significant relationship between asthma knowledge level and asthma control level.[16]

Steady increases in global prevalence of asthma have been reported by World Allergy Organization, especially in countries such as Australia, United Kingdom, and United States.[17] The global burden of asthma is estimated to affect more than 300 million people.[18] There are serious challenges in the day-to-day management of asthma, including medication adherence and symptom control. As with any long-term chronic disease, asthma self-management is an integral part of healthcare. Self-management can be defined as the tasks that individuals must perform to live with their chronic condition, such as medical management, role management and emotional management.[19] Self-management interventions encourage patients to actively participate in their care and increase their responsibility for controlling symptoms and complications of their disease.[20] Qur'an et al. in their review suggested that intervention studies reported positive effects of smartphone applications on asthma control, medication adherence, and self-efficacy. Smartphone applications can be an effective asthma control tool, especially among adolescents who are the main users of smartphones.[21] Baptist et al in their research revealed the same thing, that technology-based interventions have high levels of user satisfaction among minorities and urban/low-income individuals with asthma and can improve asthma outcomes.[22] This differs from the results of this study due to the smaller sample size and shorter time coverage; further large-scale studies are needed to assess whether these interventions can reduce health inequalities in asthma.

Ghozali et al. (2022) provided interventions in the form of education using applications and assessed the pre- and post-tests to determine the increase in asthma patient knowledge. The results showed that the pretest AGKQA values of the control group (minimum, maximum, and average) were 9, 25, and 19.04 ± 2.56, respectively, while the post-test values were 10, 27, and 18.79 ± 3, 59 (p=0.47). In the treatment group, the mean pre-test values were 13, 25, and 19.11 ± 2.87, while the post-test scores were 16, 31, and 23.6 ± 3.95 (p = 0.01). There was a difference between the post-test scores of the control and treatment groups, namely 4.81 (p=0.01). This shows that the educational content in the application significantly increases asthma knowledge level.[23]

Education plays a fundamental role in the management of patients with asthma with poor knowledge, skills, and adherence. To address this problem, a comprehensive educational strategy aimed at promoting patient compliance and enhancing their self-management knowledge and skills must be adapted to meet the needs of individual patients.[12] Technology-based digital methods, such as instant messaging, smart healthcare devices, and immersive websites, have received rapid attention in recent years. Many such methods have been devised and validated to improve patient adherence to disease management strategies. Research has shown that digital interventions are successful in increasing asthma awareness and self-management such as application of action plans to improve quality of life and optimize medication adherence.[24] The literature suggests that poor knowledge interferes with the quality of life of patients with asthma. Poor asthma control is a recognized public health problem. This causes respiratory health problems and limits physical activity.[25]

Atmoko et al investigated risk factors that affect asthma control level in patients with uncontrolled asthma and found that based on a statistical comparison between general asthma awareness level and asthma management level, there was no significant effect.[17] This could be due to confounding factors that were not included in the study and could impact the findings. Confounding variables in this study could include elements related to general asthma knowledge, such as inappropriate drug use, inappropriate drug selection, and inappropriate dosage. Theoretically this contradicts the study by Gecko B et al (p 0.0001), who came to the conclusion that level of patients awareness about their asthma contributes to a higher control level in these asthma patients.[18]

This study has several limitations that might have caused the hypothesis testing to be insignificant, such as the small sample size and patient data characteristics without smoking history data and history of drug use. Therefore, in future research, the sample should be chosen randomly to represent the population. Further research on other risk factors for asthma control, such as history of smoking, history of previous drug use, and assessment of treatment responses, is needed.

CONCLUSION
Providing digital education was not found to significantly affect the control level in patients with asthma.. The development of "Paru Sehat" application features is urgently needed, such as development of asthma diary feature which contains records of daily APE values, and medication reminders therefore "Paru Sehat" application can assist in self-management asthma plans.

DECLARATIONS
This study was approved by the Health Research Ethics Committee of Universitas Sumatera Utara wregistration number: 195/KEPK/USU/2023).

CONSENT FOR PUBLICATION
The Authors agree to publication in the Journal of Society Medicine.

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COMPETING INTERESTS
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AUTHORS' CONTRIBUTIONS
All authors significantly contributed to the work reported in the execution, acquisition of data, analysis, and interpretation, or in all these areas. Contributed to drafting, revising, or critically reviewing the article. Approved the final version to be published, agreed on the journal to be submitted, and agreed to be accountable for all aspects of the work.

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