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Effectiveness of a Mobile Application in Improving Knowledge of Early Cervical Cancer Detection among Women of Reproductive Age

Vina Aditya Astuti^{*1}, Bedjo Santoso², Supriyadi³

¹Master of Applied Midwifery Postgraduate Program, Poltekkes Kemenkes Semarang, Indonesia

²Department of Dental Health, Poltekkes Kemenkes Surakarta, Indonesia

³Department of Nursing, Poltekkes Kemenkes Surakarta, Indonesia

Jl. Tirto Agung, Pedalangan, Kecamatan Banyumanik, Kota Semarang, Jawa Tengah 50268.

Corresponding author: Vina Aditya Astuti

Email: vinaaditya@poltekkes-smg.ac.id

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ABSTRACT

Cervical cancer is one of the most common types of cancer found among women of reproductive age. Early detection of cervical cancer is crucial, as it can increase survival rates and improve recovery outcomes. One of the main factors contributing to the low participation rate of women in cervical cancer screening is the lack of knowledge and awareness of its importance. Efforts to enhance knowledge can be carried out through educational application-based interventions that provide practical and engaging information. This study aimed to determine the effectiveness of the Cervical Cancer Prevention Application in improving the knowledge of women of reproductive age in the working area of Bandarharjo Public Health Center, Semarang City. This research employed a quasi-experimental design with a pre- and post-test control group approach. Samples were selected using a purposive sampling technique consisting of 18 respondents. Data were collected using a validated questionnaire and analyzed using a paired sample t-test for within-group comparisons and a Mann-Whitney test for between-group comparisons. The results showed a significant difference between the intervention and control groups ($p = 0.000$). Therefore, the Cervical Cancer Prevention Application was proven effective in increasing knowledge regarding the early detection of cervical cancer among women of reproductive age.

Keywords: application; cervical cancer; education; knowledge

Introduction

Cervical cancer is a type of cancer that develops in the cervix and is primarily caused by infection with the Human Papillomavirus (HPV). HPV is the main etiological factor in cervical cancer. As a DNA virus that infects epithelial cells (skin and mucosa), HPV has a high potential to cause precancerous lesions known as Cervical Intraepithelial Neoplasia (CIN) [1].

Globally, in 2022, approximately 662,301 new cases of cervical cancer were reported. In Asia, about 57.3% or 199,795 female deaths were attributed to cervical cancer. In Indonesia, cervical cancer ranks second after breast cancer as the most common cancer among women. Data show that there were 36,964 new cases of cervical cancer with an incidence rate of approximately 23.3 per 100,000 women and 20,708 deaths recorded in the same year [2]. In Central Java Province, the number of cervical cancer cases increased significantly from 1,545 cases in 2021 to 2,444 cases in 2022, representing a 57.9% increase [3].

Risk factors for cervical cancer include early sexual activity (before the age of 17), multiple sexual partners, parity of more than three children, oral contraceptive use for more than five years, smoking habits, a family history of cervical cancer, impaired immune system, and chronic infections such as genital herpes or chlamydia [4]. In addition, the lack of knowledge and awareness among women regarding early detection is one of the contributing factors to the high incidence and mortality rates of cervical cancer [5].

Data from 2021 in Indonesia show that only 6.83% of women aged 30–50 years underwent cervical cancer screening using the Visual Inspection with Acetic Acid (VIA) method. This figure increased slightly to 7.02% in 2023, which remains far below the national target of 70%. In Semarang City, the coverage of early detection of cervical cancer was only 11.2% in 2022 [3]. The low screening coverage is influenced by several factors, including insufficient knowledge, limited access to information, and low exposure to educational initiatives about cervical cancer screening [6].

Knowledge about cervical cancer significantly influences women's attitudes and behaviors toward early detection. Women with better knowledge of cervical cancer tend to be more proactive in participating in screening programs [7]. However, many women of reproductive age (WRA) still lack understanding of the importance of early detection and do not feel the need to undergo screening, as this disease often presents no symptoms in its early stages [8]. Limited accessibility and awareness of reliable information sources also contribute to the low level of knowledge in the community regarding early detection of cervical cancer [9].

Efforts to improve public knowledge, particularly among women of reproductive age, can be achieved through the use of digital technology. Nowadays, most people use smartphones as their primary means of accessing information. Therefore, developing mobile-based educational applications represents a potential strategy to enhance awareness and understanding of cervical cancer screening [10].

A preliminary survey conducted among 20 women of reproductive age in the working area of the Primary Health Center of Semarang revealed that approximately 95% of respondents considered it important to understand early detection of cervical cancer. About 45% obtained information through social media, 35% from printed media such as leaflets, and 20% from community health workers or healthcare providers. Moreover, 95% of respondents expressed the need for more educational resources regarding cervical cancer detection, and 90% showed interest in using an educational application for this purpose.

Based on these findings, there is a need for innovative, technology-based educational interventions to increase awareness and knowledge of cervical cancer screening among women of reproductive age. Therefore, this study aims to analyze the effectiveness of the Cegah Kanker Serviks (Cervical Cancer Prevention) application in improving knowledge of early cervical cancer detection among women of reproductive age in the working area of the Primary Health Center of Bandarharjo, Semarang City.

Methods

This study employed a quasi-experimental design using a pre- and post-test with control group approach. The research instrument used to measure the level of knowledge was a validated and reliable questionnaire. Ethical approval for this study was obtained from the Ethics Committee of Poltekkes Kemenkes Semarang, with approval number 213/EA/F.XXIII.38/2025. A preliminary study at the Bandarharjo Community Health Center (Puskesmas) showed that education on cervical cancer prevention through HPV DNA testing has been conducted using social media (Instagram) and leaflets. However, HPV DNA testing coverage in the Bandarharjo Community Health Center's work area remains low, reaching only 60%. The study was conducted in the working area of the Primary Health Center of Bandarharjo, Semarang City, from February to March 2025.

The study population consisted of women of reproductive age (WRA) who were married and owned a smartphone within the working area of the Primary Health Center of Bandarharjo, Semarang City. The total sample comprised 36 respondents, consisting of 18 participants in the intervention group and 18 participants in the control group, selected using a purposive sampling technique.

The research instrument was a validated knowledge questionnaire consisting of 20 items, with a Cronbach's α value of 0.888, indicating high reliability. Knowledge data were collected before and after the intervention. The Shapiro–Wilk test was used to assess data normality. Data with a normal

distribution were analyzed using the paired sample t-test to examine differences between pre-test and post-test scores within groups, while comparisons of knowledge improvement between groups were analyzed using the Mann–Whitney test.

The intervention group received education through the Cegah Kanker Serviks (Cervical Cancer Prevention) application for 21 days. Respondents accessed educational materials through the application. Knowledge levels were measured before (pre-test) and after (post-test) the intervention to evaluate the effectiveness of the mobile-based application in improving women's knowledge of early detection of cervical cancer.

Results and Discussion

The total sample size in this study was calculated using a formula for determining the sample size for hypothesis testing on two independent groups for ratio data, resulting in 18 respondents in each group. Women of reproductive age (WAM) from Bandarharjo Community Health Center served as the intervention group, and women from Bangetayu Community Health Center served as the control group. Respondent characteristics were analyzed to provide a general overview, as presented in the following table.

Table 1.
Characteristics of Respondents in the Bandarharjo Community Health Center Work Area, Semarang City

Variables	Category	Group			
		Intervention		Control	
		n=18	%	n=18	%
Age	< 30 years	4	22.2	6	33.3
	≥ 30 years	14	77.8	12	66.7
Education	Secondary	12	66.7	11	61.1
	Higher	6	33.3	7	38.9
Work	Work	13	72.2	10	55.6
	Doesn't work	5	27.8	8	44.4
Economic Status	Low	13	72.2	10	55.6
	Tall	5	27.8	8	44.4

The results of the respondent characteristics test showed that the age of the respondents who were sampled in this study in the intervention group was ≥ 30 years as many as 14 people (77.8%) and <30 years as many as 4 people (22.2%), while the control group aged ≥ 30 years as many as 12 people (66.7%) and <30 years as many as 6 people (33.3%). The frequency of respondents based on education was mostly secondary education in the intervention group as many as 12 people (66.7%) and the control group as many as 11 people (61.1%). The frequency of respondents based on occupation in the intervention group as many as 13 people (72.2%) were unemployed and as many as 5 people (27.8%) were employed, while in the control group as many as 10 people (55.6%) were unemployed and 8 people (44.4%) were employed. The frequency of respondents based on economic status was the highest low economic status with a salary less than the minimum wage, namely 72.2% in the intervention group and 55.6% in the control group.

Table 2.
Results of Respondents' Knowledge Measurement

Variables	Mean	Standard Deviation	Min	Max
Pre-test intervention	10.56	1,977	7	15
Post-test intervention	16.67	1,645	14	20
Pre-test control	10.28	1,179	8	12
Post-test control	12.83	1,465	11	15

The pretest scores of the intervention group showed significant variation with a range of scores between 7 and 14. The mean of the pretest score was 10.56, with a standard deviation of around 1.977. At the posttest stage, a marked increase was seen with a range of scores between 14 and 20. The mean

of the posttest reached 16.67 and a standard deviation of 1.645 indicating considerable variability within the group.

In contrast, in the control group, pretest scores ranged from 8 to 12, with a mean of approximately 10.28 and a standard deviation of approximately 1.179. In the posttest, scores increased from a range of 11 to 15. The posttest mean was 12.83 and a standard deviation of approximately 1.465, indicating lower variation compared to the intervention group. These results provide an initial overview of the effects of an educational intervention model on both groups of women of childbearing age.

Table 3.
Results of Data Normality Test

Variables	P-value	Conclusion
Pre-test knowledge score	0.146	Normally distributed data
Post test knowledge score	0.407	Normally distributed data
Δ intervention knowledge score	0.032	Data is not normally distributed
Δ control knowledge score	0.213	Normally distributed data

Table 4.
Paired Sample t-test Results

Variables	Mean	Standard Deviation	Std. Error Mean	Lower	Upper	t	Sig. (2-tailed)
Pre-test knowledge score	-6.111	1,811	0.427	-7,012	-5,210	-14,314	0.000
Post test knowledge score							

Table 4 explains the pre-test and post-test difference tests on the knowledge data of the intervention group using a difference test and obtained a p-value ($0.000 < 0.05$), which means that there is a significant difference in the knowledge value of the intervention group before and after treatment was given.

The paired sample t-test showed a significant difference between pre-test and post-test knowledge scores ($t = -14.314$, $p < 0.001$). The effect size was extremely large (Cohen's $d = 3.37$), indicating a substantial improvement in knowledge after the intervention.

Table 5.
Mann-Whitney Test Results

Variables	Mann-Whitney U Test	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Δ intervention knowledge score	18,500	189,500	-4,585	0.000
Δ control knowledge score				

The Mann-Whitney test results indicate that the control and intervention groups were significantly different in the posttest context. The observed U-value was 18.500, with a Z-value of -4.585. The negative sign on the Z-value indicates that the control group tended to have lower rankings than the intervention group. A p-value of $0.000 < 0.05$ indicates that this difference is statistically significant.

Characteristics of Respondents in the Working Area of the Primary Health Center of Bandarharjo, Semarang City

The results showed that most respondents were aged ≥ 30 years. Age is a factor influencing behavior in performing early detection of cervical cancer [13]. As individuals grow older, their maturity and health awareness tend to increase. This finding aligns with Nadia [14], who reported that 70.9% of respondents aged 36–40 years demonstrated high motivation to undergo early detection after receiving health education. This suggests that adults are generally more responsive to educational interventions and more aware of the importance of early detection [15].

Most respondents had a secondary education level. Educational attainment affects an individual's ability to understand health information [16]. Those with lower education levels may have more difficulty comprehending health messages. Previous studies reported that respondents with junior and senior high school education (66.7%) had lower knowledge levels compared to those with higher

education (33.3%) [17]. However, behavior is influenced not only by education but also by experience, social interaction, and environmental factors [18]. Thus, although respondents had moderate educational backgrounds, well-designed and engaging application-based education can effectively improve knowledge.

The majority of respondents were housewives who did not work outside the home. Employment status can influence access to health information and motivation for early detection [19]. Sumarti [20] found a significant relationship between employment, knowledge, and motivation regarding VIA examination among women of reproductive age. Employment that provides broader access to information and supportive environments may enhance awareness. However, Nadia [21] reported that housewives could also have high motivation when provided with appropriate education. This indicates that employment status is not the sole determinant of knowledge; the mode of information delivery is equally important.

Most respondents had low economic status, with family income below the regional minimum wage. Economic status affects access to healthcare services and information [22]. Wulandari et al. [23] found that women with lower economic status were less likely to undergo VIA testing. Limited financial resources, transportation costs, time constraints, and restricted access to health facilities may contribute to this condition.

Nevertheless, this study demonstrates that application-based education can help overcome these barriers. The Cervical Cancer Prevention Application provides low-cost, easy, and flexible access to information through smartphones. Therefore, digital health education has strong potential to improve knowledge and awareness of early cervical cancer detection, particularly among women with limited economic and educational resources.

Effectiveness of the Cervical Cancer Prevention Application

The statistical test results using the Paired Sample t-test in the intervention group showed a p-value = 0.000 ($p < 0.05$), indicating a significant effect of the Cervical Cancer Prevention Application educational model on improving knowledge about early detection of cervical cancer among women of reproductive age (WRA). This finding was supported by a delta value of 6.11 in the intervention group, demonstrating an increase in knowledge scores after the educational intervention. Furthermore, the Mann–Whitney test results showed a p-value = 0.000 ($p < 0.05$), indicating a significant difference between the intervention and control groups. The increase in the mean knowledge score in the intervention group was higher than that in the control group, suggesting that the Cervical Cancer Prevention Application had a greater effect on improving WRA knowledge compared to the leaflet medium.

Before the intervention, most respondents had only a moderate level of knowledge. The average number of correct answers on the questionnaire was approximately half of the total questions. Their understanding was mainly limited to the definition of cervical cancer, while knowledge about its causes, signs and symptoms, risk factors, and the HPV DNA test procedure remained low. After receiving education through the application, there was a significant increase in knowledge. Respondents gained a more comprehensive understanding of the definition, causes, signs and symptoms, risk factors, early detection methods, and HPV DNA testing procedures.

This improvement can be attributed to the interactive characteristics of digital educational media. The Cervical Cancer Prevention Application presents educational materials interactively through texts, images, and videos, which facilitate comprehension and reduce boredom during the learning process [24]. Digital educational media that incorporate audiovisual elements are proven to engage multiple senses, clarify information, and enhance user motivation to understand the material [25].

These findings are consistent with Permatasari et al. [26], who demonstrated that the use of the EDUMA mobile application significantly increased maternal knowledge after receiving mobile-based education. The improvement in knowledge occurred because the information was presented interactively through an appealing combination of text, color, and images, making it easier for respondents to understand the material [27].

This study also aligns with the findings of Bedjo Santoso et al. [28], which showed that audiovisual-based health education media significantly influence knowledge enhancement and even behavioral changes. Software-based and audiovisual media can package information in a more engaging and memorable way, thereby improving the effectiveness of the educational process [29].

Most respondents have low economic status, with family incomes below the regional minimum wage. Economic status impacts access to health services and information [22]. However, the use of mobile applications can be an effective solution to overcome these barriers. Health applications allow easy, flexible, and low-cost access to information without having to visit a health facility in person. Through smartphones, respondents can receive education anytime and anywhere, thereby reducing transportation costs and time constraints. Thus, application-based interventions have the potential to bridge the gap in access to health information among low-economic groups [12].

In conclusion, the findings of this study confirm that the Cervical Cancer Prevention Application has a positive and significant impact on increasing the knowledge of women of reproductive age regarding early detection of cervical cancer, particularly in understanding HPV DNA examination. Android-based educational media were proven to be more effective than printed materials such as leaflets, as they provide information interactively, are easily accessible, and are more engaging for users.

Conclusion

The Cervical Cancer Prevention Application (Aplikasi Cegah Kanker Serviks) was proven effective in increasing knowledge about early detection of cervical cancer among women of reproductive age. The use of digital education through smartphone-based applications can serve as an innovative and accessible medium to enhance awareness and participation in cervical cancer screening programs. Health institutions are encouraged to integrate smartphone-based educational applications into cervical cancer prevention programs to improve public knowledge, awareness, and early detection behavior.

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