



Website-based Application for Cervical Cancer Prevention Behavior in Semarang City

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Abstract

Data from the World Cancer Research Fund (WCRF) 2022 showed that Indonesia ranked third globally in cervical cancer incidence, with 36,964 reported cases. World Health Organization (WHO) also estimated approximately 21,000 deaths annually. This study aimed to evaluate the effectiveness of the “Si VIVA” website-based application in improving knowledge, attitudes, and cervical cancer prevention behavior among women of reproductive age. A quasi-experimental pretest–posttest design with a control group was employed, involving 100 women of reproductive age, divided equally into intervention and control groups across five community health centers in Semarang City in 2025. The independent variable was the “Si VIVA” website-based application, while knowledge and attitudes served as mediating variables. Then, cervical cancer prevention behavior was considered the dependent variable. Data were analyzed using the Wilcoxon Signed-Rank Test and Effect Size Test. The intervention group showed significant improvements in knowledge ($p=0.000$) and attitudes ($p=0.006$), but not in prevention behavior ($p=0.317$). In the control group, all variables improved significantly, including knowledge ($p=0.000$), attitudes ($p=0.000$), and prevention behavior ($p=0.005$). The “Si VIVA” application was effective in improving knowledge and attitudes; however, it was not yet effective in enhancing cervical cancer prevention behavior.

Introduction

Cervical cancer remains one of the major global health challenges, particularly in developing countries. Approximately 90% of cervical cancer cases are primarily caused by persistent Human Papillomavirus (HPV) infection within 2–3 years or by latent HPV infection that remains inactive for prolonged periods (Jain *et al.*, 2023; Vats & Laimins, 2025). The remaining 10% of cases are associated with additional risk factors. These factors include impaired immune function due to HIV infection, malnutrition, and smoking; other cervical infections such as genital herpes and Chlamydia; hormonal and reproductive factors including long-term contraceptive use, early sexual activity, and multiparity; as well as social

determinants such as risky sexual behavior, poor personal hygiene, low health awareness, and limited access to healthcare services. These conditions are further exacerbated among women with HIV infection, who are reported to have up to six times higher risk of developing cervical cancer, accounting for approximately 6% of global cervical cancer cases (Khaled *et al.*, 2025). The importance of improving cervical cancer prevention is underscored by evidence that many women are still diagnosed at advanced stages of the disease, requiring chemotherapy that is frequently accompanied by severe adverse effects such as nausea and vomiting, which may affect treatment adherence and quality of life (Sriningsih *et al.*, 2017).

According to GLOBOCAN 2023 data,

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cervical cancer ranks as the fourth leading cause of cancer-related mortality among women worldwide, with an estimated 604,000 new cases and 342,000 deaths annually, particularly in developing countries (Girda *et al.*, 2024; Sung *et al.*, 2021). Based on the World Cancer Research Fund (WCRF) 2022 report, Indonesia ranked third globally after China and India in the number of cervical cancer cases, with 36,964 reported cases (World Cancer Research Fund, 2024). Cervical cancer is currently the second most common cancer after breast and lung cancer in Indonesia (Mulongo & Chibweshia, 2023). Furthermore, cervical cancer contributes to approximately 21,000 deaths and 32,000 new cases annually in Indonesia (World Health Organization, 2024). The high burden of cervical cancer is strongly associated with the low coverage of early detection programs, where only approximately 8.3% of women of reproductive age have undergone cervical cancer screenings. In addition, more than 80% of cervical cancer cases are diagnosed at advanced stages (Arbyn *et al.*, 2018). Data from the Central Java Provincial Health Office in 2024 reported that 2,515 women had been diagnosed with cervical cancer, reflecting an increasing trend in cervical cancer incidence in the region (Pemprov Jateng, 2025). As the capital city of Central Java Province, Semarang City significantly contributes to this burden. In 2023, the number of women of reproductive age who underwent Visual Inspection with Acetic Acid (VIA) screening in Semarang reached 11,168 individuals, with the highest screening coverage recorded in Tembalang District involving 1,923 women. Moreover, 169 VIA-positive cases were detected in Semarang City in 2023, with the highest number identified in East Semarang District, accounting for 70 cases. These findings indicate that cervical cancer prevention behavior at the local level still requires more innovative and adaptive interventions tailored to community needs.

The increasing vulnerability to reproductive health risks contributing to cervical cancer incidence highlights the importance of improving knowledge and attitudes among women of reproductive age as part of long-term preventive strategies, particularly in promoting awareness regarding cervical cancer

prevention (Prabamurti *et al.*, 2024). Various cervical cancer prevention strategies have been developed, including both primary and secondary prevention approaches. Primary prevention includes Human Papillomavirus (HPV) vaccination, while secondary prevention involves early detection methods such as Pap smear examination, Visual Inspection with Acetic Acid (VIA), and HPV DNA testing, all of which have been shown to effectively reduce the burden of cervical cancer (Akanda *et al.*, 2022; Ansari *et al.*, 2023; Pretsch *et al.*, 2023). However, the implementation and expansion of these strategies in developing countries remain limited due to resource constraints and implementation challenges (Akanda *et al.*, 2022). Limited access to information and inadequate knowledge regarding early detection methods, including concerns related to the sensitivity and specificity of screening procedures, often lead to fear and hesitation among women to undergo screening examinations (Anshari *et al.*, 2023). In 2020, the World Health Organization (WHO) introduced the global strategy for cervical cancer elimination with the 90–70–90 targets by 2030, aiming for 90% HPV vaccination coverage, 70% screening coverage among women, and 90% treatment coverage for identified cases (Mulongo & Chibweshia, 2023; Popalis *et al.*, 2023). Achieving these targets remains challenging due to weak healthcare systems, inadequate infrastructure, and low public health literacy (Khaled *et al.*, 2025). Therefore, educational interventions are necessary to improve knowledge and attitudes regarding cervical cancer prevention among women of reproductive age.

Health education interventions require comprehensive, evidence-based approaches to improve understanding regarding the accuracy and effectiveness of cervical cancer screening methods. One effective strategy to improve knowledge and influence individual health attitudes is health education (Anshari *et al.*, 2023). Digital platforms, including mobile health (m-Health) applications, play an important role in expanding the reach of health promotion and increasing community engagement through rapid and personalized information delivery. Preliminary observations conducted in community health centers across

Semarang City indicated that conventional educational media such as posters, leaflets, pocketbooks, and face-to-face counseling remain the most commonly used approaches. Nevertheless, conventional methods are often limited by restricted coverage, low engagement, and reduced effectiveness in promoting sustainable behavioral change (Weber *et al.*, 2024).

One innovative approach in health education is the implementation of the “Si VIVA” website-based application, which was developed to provide accessible education regarding cervical cancer and VIA screening for women of reproductive age. This application not only delivers information related to cervical cancer but also provides step-by-step guidance for VIA examination procedures. The “Si VIVA” application is expected to improve women’s knowledge and attitudes toward cervical cancer prevention, particularly among individuals who previously had limited awareness regarding the importance of early detection. Through this application, women are expected to become more motivated to undergo regular screening examinations as part of cervical cancer prevention behavior. In addition, “Si VIVA” includes several supporting features such as direct consultation services with healthcare professionals and information regarding healthy lifestyles that may help reduce cervical cancer risk. Therefore, the application has the potential to become an effective digital health promotion tool in cervical cancer prevention behavior. Based on these considerations, this study was conducted to evaluate “The Effectiveness of Website-Based Application for Cervical Cancer Prevention Behavior in Semarang City”. This study is expected to contribute scientifically to the development of innovative mHealth-based educational media and serve as an alternative strategy for cervical cancer prevention in Semarang City.

Method

This study aimed to evaluate the effectiveness of the “Si VIVA” (Cervical Cancer and VIA Education System) website-based application for cervical cancer prevention behavior in Semarang City. This educational platform could be flexibly accessed and contain

educational materials related to cervical cancer and its prevention, delivered through PowerPoint presentations, audio-visual educational videos, and VIA screening testimonials. The application procedure required new users to register using their national identification number (NIK) and registered mobile phone number. After successfully logging into the website, participants were required to complete a pretest questionnaire before gaining access to the educational materials. Following completion of the educational content, participants were directed to complete the posttest questionnaire before logging out of the system.

This study employed a *quantitative quasi-experimental design using a pretest-posttest with a control group approach*. The study was conducted from September to December 2025. A total of 100 respondents participated in the study, consisting of 50 respondents in the intervention group and 50 respondents in the control group. Participants were evenly distributed across five community health centers in Semarang City, namely Tlogosari Kulon, Poncol, Kagok, Halmahera, and Pandanaran Community Health Centers, with 10 respondents assigned to each group at each site. Participants were recruited using purposive sampling. The inclusion criteria were women of reproductive age between 25 and 49 years, individuals who had never undergone or did not routinely undergo cervical cancer screening (VIA/Pap smear), individuals with access to digital devices such as smartphones or laptops with a minimum 3G internet connection, and individuals willing to participate by signing informed consent forms. The exclusion criteria included women diagnosed with cervical cancer, women with mental or psychiatric disorders, and illiterate women whose conditions could interfere with website utilization. The independent variable in this study was the “Si VIVA” website-based application intervention. The mediating variables were respondents’ knowledge and attitudes, while the dependent variable was cervical cancer prevention behavior. Data collection instruments consisted of three questionnaires: a knowledge questionnaire containing 30 items, an attitude questionnaire containing 20 items, and a prevention behavior

questionnaire containing 10 items. All instruments had previously undergone validity and reliability testing involving 30 respondents at Kedungmundu Community Health Center and were declared valid and reliable. Data analysis included univariate analysis to describe respondents' characteristics and bivariate analysis using the *Wilcoxon Signed-Rank Test* to compare pretest and posttest scores within each group. *Effect Size* analysis using *Cohen's d* formula was also conducted to determine the

magnitude of intervention effects in both the intervention and control groups.

Results and Discussion

This study involved 100 women of reproductive age, consisting of an intervention group (n=50) and a control group (n=50). Univariate analysis described respondents' characteristics, including age, educational level, occupation, contraceptive use, parity, and family history of cancer.

Table 1. Characteristics of Age, Educational Level, Occupation, Contraceptive Use, Parity, and Family History of Cancer among Women of Reproductive Age in Semarang City (n=100)

Characteristics	Intervention Group (n=50)		Control Group (n=50)	
	f	%	f	%
Age				
25–34 years old	16	32.0	10	20.0
35–44 years old	22	44.0	20	40.0
>45 years old	12	24.0	20	40.0
Educational Level				
Primary (SD)	9	18.0	2	4.0
Secondary (SMP-SMA/K)	34	68	25	50
Higher (D3-S2)	7	14	23	46
Occupation				
Unemployed / Housewife	39	78.0	36	72.0
Employed	11	22.0	14	28.0
Contraceptive Type				
Not Using Contraception	17	34.0	19	38.0
IUD	5	10.0	6	12.0
Implant	4	8.0	5	10.0
1-Month Injectable	0	0.0	1	2.0
3-Month Injectable	8	16.0	5	10.0
Combined Oral Pill	0	0.0	2	4.0
Tubal Ligation / Sterilization/MOW	9	18.0	5	10.0
Condom	3	6.0	6	12.0
Coitus Interruptus	3	6.0	1	2.0
Calendar Method	1	2.0	0	0.0
Parity				
Nulligravida	1	2.0	4	8.0
Primigravida	6	12.0	10	20.0
Multigravida	43	86	36	72

Characteristics	Intervention Group (n=50)		Control Group (n=50)	
	f	%	f	%
Family History of Cancer				
No	48	96.0	44	88.0
Yes	2	4.0	6	12.0

*Primary Data 2025

Based on Table 1, the distribution of respondents' characteristics between the intervention and control groups demonstrated relatively comparable patterns. Most respondents in the intervention group were aged 35–44 years (44.0%), followed by respondents aged 25–34 years (32.0%). Similarly, the majority of respondents in the control group were also aged 35–44 years (40.0%), while 40.0% were aged ≥45 years. Regarding educational background, most respondents in both groups had completed secondary education (junior high school to senior high school/vocational school), accounting for 68.0% in the intervention group and 50.0% in the control group. However, the control group had a higher proportion of respondents with higher education levels (46.0%) compared with the intervention group.

In terms of occupation, most respondents in both groups were unemployed or housewives, representing 78.0% of the intervention group and 72.0% of the control group. Concerning contraceptive use, a considerable proportion of respondents reported not using contraception, accounting for 34.0% in the intervention group and 38.0% in the control group. Other contraceptive methods included 3-month injectable contraception, tubal ligation, intrauterine devices (IUDs), implants, condoms, and traditional methods. Based on parity status, the majority of respondents were multigravida women, accounting for 86.0% in the intervention group and 72.0% in the control group. Most respondents also reported no family history of cancer, representing 96.0% of the intervention group and 88.0% of the control group. Previous studies have demonstrated that age, parity, and hormonal contraceptive use are significant determinants associated with cervical cancer incidence, whereas lifestyle factors and family history were not significantly associated with cervical cancer occurrence in

West Nusa Tenggara Provincial Hospital in 2023.

The respondents' characteristics indicated that most participants were within the productive age group (25–44 years), which is considered a high-risk age group for Human Papillomavirus (HPV) infection, the primary cause of cervical cancer (Sung *et al.*, 2021). Women in older age groups tend to demonstrate greater participation in VIA examinations due to increased maturity and decision-making capacity, particularly among individuals aged over 41 years, enabling them to better recognize the importance of cervical cancer prevention behavior (Purwaningsih & Yunitasari, 2021). Age has also been reported to have a significant relationship with digital health literacy, where increasing age is associated with improved digital health literacy levels (Sjamssuddin & Anshari, 2024). Educational level does not always absolutely determine an individual's knowledge level; individuals with lower educational backgrounds may still obtain adequate knowledge through nonformal education and various information sources. However, higher educational attainment generally facilitates the acceptance and understanding of new information, thereby influencing perceptions regarding the importance of cervical cancer prevention (Purwaningsih & Yunitasari, 2021).

Most respondents were unemployed or housewives. Previous studies have indicated that occupation and cervical cancer early detection behavior are significantly associated because employment status influences economic conditions and digital health literacy. Respondents with higher family income levels tend to possess better digital health literacy compared with those with lower income levels (Khaled *et al.*, 2025; Liu *et al.*, 2025). Working women generally have broader access to information, which may contribute to better knowledge and preventive behavior

compared with unemployed women. However, employed women may also experience time constraints due to work responsibilities, which may limit their ability to undergo VIA screening compared with unemployed women who generally have more flexible schedules (Purwaningsih & Yunitasari, 2021).

Previous findings by Paramita (2022), reported that most cervical cancer patients were multiparous women with two to four children, while the lowest incidence was observed among primigravida women. The presence of respondents who did not use contraception may also contribute to low participation in cervical cancer early detection programs. Hormonal contraceptive use has been significantly associated with cervical cancer incidence, with an odds ratio (OR) of 1.725, indicating that women using hormonal contraception have a 1.725-fold higher risk of developing cervical cancer compared with women who never used hormonal contraceptives. Nevertheless, the low proportion of respondents with a family history of cancer suggests that cervical cancer risk in this population is more strongly influenced by behavioral and environmental factors, emphasizing the importance of health education interventions (Sung *et al.*, 2021). Previous studies also reported no significant association between family history and cervical cancer incidence among patients.

Based on Table 2, the findings demonstrated improvements in the mean scores of knowledge, attitudes, and cervical cancer prevention behavior in both groups following the intervention. In the knowledge variable, the intervention group experienced an increase in mean score from 24.42 (SD=2.719) during the pretest to 25.30 (SD=2.772) during the posttest. Similarly, the control group showed improvement from 25.08 (SD=2.530) to 26.14 (SD=2.564). Regarding attitudes, the intervention group demonstrated an increase from 43.92 (SD=5.606) to 44.22 (SD=5.582), while the control group improved from 45.30 (SD=5.144) to 46.66 (SD=5.427). In terms of cervical cancer prevention behavior, the intervention group showed a slight increase from 7.46 (SD=1.593) to 7.50 (SD=1.542), whereas the control group improved from 7.44 (SD=1.875) to 7.66 (SD=1.780).

The observed improvements in knowledge, attitudes, and prevention behavior in both groups indicate that the educational process delivered through the “Si VIVA” website-based application contributed positively to respondents’ understanding and awareness regarding cervical cancer prevention. Previous studies using *Kendall’s Tau-b* statistical analysis demonstrated a significant relationship between knowledge level and cervical cancer prevention behavior, with a significance value

Table 2. The Overview of Knowledge, Attitudes, and Cervical Cancer Prevention Behavior among Women of Reproductive Age in Semarang City (n=100)

Variable	Intervention Group n=50		Control Group n=50	
	Mean	Std. Dev	Mean	Std. Dev
Knowledge				
Pretest	24.42	2.719	25.08	2.530
Posttest	25.30	2.772	26.14	2.564
Attitudes				
Pretest	43.92	5.606	45.30	5.144
Posttest	44.22	5.582	46.66	5.427
Prevention Behavior				
Pretest	7.46	1.593	7.44	1.875
Posttest	7.50	1.542	7.66	1.780

*Primary Data 2025

of $p=0.001$ and a correlation coefficient of 0.551, indicating a moderately strong and meaningful association. These findings suggest that higher levels of knowledge are associated with a greater likelihood of implementing cervical cancer prevention behavior. Website-based applications such as “Si VIVA” facilitate more interactive, flexible, and repeatedly accessible information delivery, thereby strengthening respondents’ comprehension because educational materials can be accessed anytime and anywhere. However, improvements in prevention behavior were relatively smaller compared with improvements in knowledge and attitudes. These findings indicate that behavioral change in cervical cancer prevention requires a longer process and may not occur immediately following improvements in knowledge. According to the *Health Belief Model*, behavioral change is influenced by individuals’ perceptions regarding susceptibility, benefits, and barriers. Relate to other findings that highlight the importance of strengthening preventive behaviors among women of reproductive age, as delayed participation in cervical cancer screening may result in diagnosis at more advanced stages, where treatment commonly relies on chemotherapy and is associated with considerable adverse effects, including nausea and vomiting, despite standard antiemetic therapy (Sriningsih *et al.*, 2017). The “Si VIVA” application has the potential to enhance these perceptions through personalized and continuous information delivery, thereby promoting preventive behavioral changes more effectively than conventional educational approaches.

Therefore, website-based interventions may provide significant advantages in improving the quality of health education as a sustainable strategy for cervical cancer prevention behavior. This study employed bivariate analysis using the *Wilcoxon Signed-Rank Test*, followed by *Effect Size Test* analysis to evaluate the effectiveness of the intervention. The following section presents the results of the bivariate analysis.

Based on Table 3, the *Wilcoxon Signed-Rank Test* results demonstrated significant improvements in the intervention group for knowledge ($p=0.000$) and attitudes ($p=0.006$), whereas no statistically significant improvement was observed for cervical cancer prevention behavior ($p=0.317$). In contrast, all variables in the control group showed statistically significant improvements, including knowledge ($p=0.000$), attitudes ($p=0.000$), and prevention behavior ($p=0.005$). These findings indicate that the “Si VIVA” website-based application was effective in improving cognitive and affective aspects, particularly respondents’ knowledge and attitudes regarding cervical cancer prevention. Previous studies involving similar mobile applications, such as “Cavixaution”, also demonstrated that digital health applications effectively deliver valuable information and improve knowledge regarding cervical cancer prevention (Anshari *et al.*, 2023). Similar findings were reported in studies using the E-DUVA application, which significantly improved knowledge among women of reproductive age regarding cervical cancer and VIA examinations.

The “Si VIVA” website-based application also demonstrated effectiveness in

Table 3. Wilcoxon Test Analysis Results: The Differences in Knowledge, Attitudes, and Cervical Cancer Prevention Behavior between the Intervention and Control Groups among Women of Reproductive Age in Semarang City (n=100)

Variable	Intervention Group n=50		Control Group n=50	
	Z-Value	Asymp. Sig. (2-tailed)	Z-Value	Asymp. Sig. (2-tailed)
Knowledge (pre-posttest)	-4.738	0.000	-4.050	0.000
Attitudes (pre-posttest)	-2.751	0.006	-3.949	0.000
Prevention behavior (pre-posttest)	-1.000	0.317	-2.810	0.005

*Wilcoxon test p-value <0.05

Primary data 2025

improving respondents' attitudes based on other research by (Rahmayani *et al.*, 2021) reported significant differences in attitudes before and after the intervention using the SIDIK Serviks application. Furthermore, Amalia *et al.* (2017), cited in (Rahmayani *et al.*, 2021) reported a moderate correlation between knowledge regarding cervical cancer and attitudes toward Pap smear examinations. Nevertheless, the absence of statistically significant improvements in prevention behavior suggests that health behavior changes involve more complex processes and cannot be achieved solely through short-term improvements in knowledge and attitudes. Previous studies using the *McNemar test* reported significant differences in attitudes before and after cervical cancer health education interventions ($p=0.004$), indicating that supportive attitudes increase women's likelihood of undergoing VIA screening, particularly when supported by adequate facilities, healthcare personnel, and external encouragement (Purwaningsih & Yunitasari, 2021). Other studies have also demonstrated associations between cervical cancer prevention behavior and early detection behavior; however, knowledge improvement and HPV vaccination as preventive measures did not always demonstrate statistically

significant associations with cervical cancer prevention behavior.

The control group also demonstrated significant improvements across all variables, including prevention behavior. This phenomenon may be explained by several factors such as testing effects, exposure to external information sources, and uncontrolled interventions during the study period. According to the Health Belief Model, behavioral change is influenced by multiple factors, including perceived susceptibility, perceived benefits, perceived barriers, and self-efficacy. Although improved knowledge does not automatically lead to behavioral change, individuals with higher knowledge levels generally demonstrate better preventive behaviors compared with individuals with lower knowledge levels, thereby increasing their motivation to participate in early cervical cancer detection behavior. The "Si VIVA" website-based application may have successfully improved knowledge and attitudes; however, it may not yet have been sufficiently strong to influence other important determinants such as internal motivation and environmental support, both of which play essential roles in actual behavioral change.

Table 4. Effect Size Test Analysis: Strength of the Intervention Effect on Knowledge, Attitudes, and Cervical Cancer Prevention Behavior among Women of Reproductive Age in Semarang City (n=100)

Variable	Intervention Group n=50				Control Group n=50			
	Mean	Std. Dev	Cohen's d	Inter-pretation	Mean	Std. Dev	Cohen's d	Inter-pretation
Knowledge	0.880	1.100	0.80	Large effect	1.060	1,707	0.62	Moderate effect
Attitudes	0.300	0.789	0.38	Small to moderate effect	1.360	2.328	0.58	Moderate effect
Prevention Behavior	0.040	0.283	0.14	Small effect	0.220	0.507	0.43	Moderate effect

*Effect Size Test Analysis used Cohen's d Formula

Primary Data 2025

Based on Table 4, *Effect Size Test* analysis demonstrated varying intervention effects of the “Si VIVA” website-based application on knowledge, attitudes, and cervical cancer prevention behavior. For the knowledge variable, the intervention group demonstrated a *Cohen’s d* value of 0.80, categorized as a large *effect size*, while the control group demonstrated a moderate *effect size* ($d=0.62$). These findings indicate that although both groups experienced improvements, the “Si VIVA” intervention produced a stronger impact on improving respondents’ knowledge. These findings are consistent with previous literature reporting that 35 studies included in a scoping review demonstrated that e-Health literacy interventions were predominantly delivered through mobile applications and digital devices (34%), with approximately 86% of studies reporting positive intervention effects (Wang *et al.*, 2025). Furthermore, structured health promotion models that deliver accessible health information play a crucial role in improving health knowledge, as educational strategies that combine accessible information with continuous health promotion have been shown to enhance learning outcomes and increase public awareness of preventive health practices (Handayani *et al.*, 2017). Mobile health applications not only facilitate understanding of educational materials but also function as reminder tools that encourage women to become more proactive in maintaining their health, thereby offering substantial potential to address low public awareness regarding cervical cancer prevention. Other studies using chi-square analysis also demonstrated significant associations between women’s knowledge levels and VIA examination participation among women of reproductive age in Tanggamus Regency, Lampung Province ($p=0.001$). These findings are further supported by previous studies reporting that digital interventions, including audio-visual media, effectively improve complex health-related knowledge and facilitate behavioral and attitudinal changes (Duarte-Anselmi *et al.*, 2026; Gooch *et al.*, 2024; Liu *et al.*, 2025).

For the attitude variable, the intervention group demonstrated an *effect size* of 0.38, categorized as a small-to-moderate

effect, whereas the control group demonstrated a moderate *effect size* ($d=0.58$). These findings indicate that although attitude changes occurred in both groups, the influence of the “Si VIVA” intervention on attitudes remained relatively limited. Similarly, other research before that used the *chi-square* test reported statistically significant associations between respondents’ attitudes and their interest in undergoing VIA examinations ($p=0.045$). However, some respondents with positive attitudes still demonstrated low interest in VIA screening because they perceived themselves as healthy and free from cervical cancer symptoms, thereby reducing their motivation to undergo early detection examinations. Previous studies also demonstrated that audio-visual health education interventions, including educational films, positively influenced women’s attitudes toward cervical cancer screening, with significant improvements in median attitude scores from 44.23 to 78.85 following educational interventions, which subsequently increased women’s motivation and willingness to participate in VIA screening programs.

For cervical cancer prevention behavior, the intervention group demonstrated only a small *effect size* ($d=0.14$), whereas the control group demonstrated a moderate *effect size* ($d=0.43$). These findings are consistent with the *Wilcoxon test* results showing $p=0.317$ ($p>0.05$), indicating that increased knowledge was not followed by statistically significant behavioral changes in cervical cancer prevention behavior. These findings suggest that the “Si VIVA” intervention has not yet exerted a sufficiently strong influence on behavioral changes related to cervical cancer prevention behavior. This finding is consistent with health promotion models, which propose that sustainable behavioral change extends beyond educational exposure alone and requires the integration of continuous health education, self-monitoring of health behaviors, and supportive family and environmental influences to promote long-term adoption of preventive behaviors (Handayani *et al.*, 2017). Previous studies also reported that small-scale interventions aimed at improving cervical cancer screening participation were more effective when delivered directly through *one-on-one interactions* involving healthcare

professionals rather than through indirect media-based approaches (Popalis *et al.*, 2023). These findings are consistent with previous meta-analyses reporting that only 18.2% of women in Arab countries participated in cervical cancer screening programs, mainly due to barriers such as limited information, fear, perceptions of being healthy and therefore not requiring screening, and embarrassment (Ahmed *et al.*, 2024). Similarly, systematic reviews and meta-analyses conducted in low-resource countries reported relatively low participation rates in cervical cancer screening programs (Rana *et al.*, 2025). *The Health Belief Model* and *Theory of Planned Behavior* suggest that attitude improvement through educational interventions may influence individuals' intentions and behaviors. Behavioral change requires not only increased knowledge but also greater awareness, motivation, and opportunities to translate health information into daily practice, as educational interventions that incorporate motivational components and active participant engagement are more effective in promoting sustained healthy behaviors than information provision alone (Siyam *et al.*, 2020). However, the findings of the present study indicate that such improvements were insufficient to significantly influence cervical cancer prevention behavior among women of reproductive age, likely due to various contributing factors, including differences in respondents' baseline characteristics between groups. Previous studies have further demonstrated that technology-based interventions integrating behavioral change theories effectively influence health behaviors because digital interventions are capable of reaching broader populations and encouraging preventive health behaviors (Duarte-Anselmi *et al.*, 2026; Gooch *et al.*, 2024; Liu *et al.*, 2025). Other studies also reported that digital health literacy interventions positively affect health status and self-management abilities, including cervical cancer prevention behaviors (Dong *et al.*, 2023). Evidence from 31 randomized controlled trials (RCTs) indicated that digital interventions positively influenced preventive behaviors. However, analysis of 29 RCTs comparing digital interventions with minimal interventions such as leaflets or waiting-list

controls demonstrated moderate improvements in knowledge, small improvements in behavioral intentions, and modest improvements in preventive behaviors (Bailey *et al.*, 2021).

In the control group, all variables demonstrated moderate *effect sizes* in the test. These findings indicate the possible influence of external factors beyond the study intervention, including testing effects, where completing the pretest questionnaire may have indirectly increased respondents' awareness and reflection regarding the measured topics, thereby influencing posttest scores. Additional factors such as exposure to information from mass media, social media, internet resources, and social interactions during the study period may also have contributed to the observed changes. Previous studies reported that information sources significantly influenced women's participation in VIA examinations in Tanggamus Regency, Lampung Province, with *chi-square* analysis demonstrating $p=0.001$ and multivariate analysis confirming significant associations between information sources and cervical cancer prevention behavior. Other studies also reported significant relationships between access to information and cervical cancer prevention behavior, with respondents possessing adequate information sources demonstrating a 6.760-fold greater likelihood of engaging in preventive behaviors compared with respondents with limited information access. Behavioral change is influenced not only by educational interventions but also by broader implementation factors, including access to health information, resource availability, communication networks, leadership support, and the extent to which health programs address participants' needs, which may explain why improvements in knowledge were not accompanied by significant changes in cervical cancer prevention behavior in the present study (Wiraharja *et al.*, 2019).

Conclusion

The *Wilcoxon Signed-Rank Test* demonstrated significant improvements in the intervention group for knowledge ($p=0.000$) and attitudes ($p=0.006$), whereas no statistically significant improvement was observed for cervical cancer prevention behavior ($p=0.317$).

In the control group, all variables demonstrated statistically significant improvements, including knowledge ($p=0.000$), attitudes ($p=0.000$), and prevention behavior ($p=0.005$). These findings were further supported by the *Effect Size* test analysis. For the knowledge variable, the intervention group demonstrated a *Cohen's d* value of 0.80, categorized as a large effect size, while the control group demonstrated a moderate effect size ($d=0.62$). For the attitude variable, the intervention group demonstrated an effect size of 0.38 (small-to-moderate effect), whereas the control group demonstrated a moderate effect size ($d=0.58$). Regarding prevention behavior, the intervention group demonstrated a small effect size ($d=0.14$), while the control group demonstrated a moderate effect size ($d=0.43$). Overall, the findings indicate that the "Si VIVA" website-based application was effective in improving cognitive and affective aspects, particularly respondents' knowledge and attitudes regarding cervical cancer prevention behavior. The application was effective in improving knowledge and attitudes among women of reproductive age; however, it was not yet effective in significantly improving cervical cancer prevention behavior. Therefore, further development of the application is recommended, including the integration of reminder systems, behavioral tracking features, and direct linkage with healthcare services to enhance its effectiveness in promoting sustainable cervical cancer prevention behaviors among women of reproductive age in Semarang City.

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