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Narrative Review

The Influence of Health Education via the "RATIH" Digital Booklet Application on Adolescent Knowledge Regarding Human Papillomavirus (HPV) Immunization: A Pre-Experimental Study in West Sumatra, Indonesia

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ABSTRACT

Background: Cervical cancer remains a major reproductive health burden globally and in Indonesia, driven primarily by persistent high-risk Human Papillomavirus (HPV) infection. Despite the proven efficacy of HPV vaccination, adolescent immunization coverage remains suboptimal due to significant knowledge gaps and sociocultural taboos. This study evaluated the effect of an innovative mobile health intervention—the "RATIH" (Remaja Aman Terlindung Imunisasi HPV) digital booklet application—on female adolescents' knowledge concerning HPV and its immunization.

Methods: A pre-experimental one-group pretest-posttest study was conducted in April 2026 at MTsN 15 Tanah Datar, West Sumatra, Indonesia. Total sampling was employed to recruit 20 grade IX female students. A validated 30-item questionnaire measured cognitive understanding before and after the application intervention. Data were analyzed using descriptive statistics and the paired sample t-test (data normality confirmed via Shapiro-Wilk, $p > 0.05$).

Findings: Baseline evaluation revealed a low mean knowledge score of 11.85 ± 2.39 (out of 30). Following the RATIH application intervention, the mean knowledge score rose significantly to 21.25 ± 2.38. The paired sample t-test demonstrated a highly significant effect ($t = -47.631$, $p = 0.000$, $p < 0.05$), indicating a mean score increase of 9.40 points.

Conclusion: The RATIH digital booklet application is an effective, accessible, and age-tailored tool for enhancing adolescent health literacy regarding HPV. Mobile health technology offers a scalable solution for school-based health promotion and cervical cancer prevention programs.

INTRODUCTION

International Cervical cancer remains one of the most formidable threats to female reproductive health worldwide, ranking as the fourth most common cancer in women globally. The World Health Organization (WHO) estimates that over 600,000 new cervical cancer cases and more than 340,000 associated deaths occur annually, with approximately 90% of these mortalities concentrated in low- and middle-income countries (LMICs). In Indonesia, cervical cancer represents the second most prevalent cancer among women, with an estimated 36,000 new diagnoses and 21,000 deaths every year. A critical public health concern is that over 70% of Indonesian cervical cancer patients are diagnosed at advanced clinical stages (Stage III or IV), drastically lowering five-year survival rates and imposing heavy financial burdens on the national healthcare system. In West Sumatra Province, the reported prevalence of cervical

cancer stands at approximately 0.9%, slightly above the national average of 0.8% [1,2].

Human Papillomavirus (HPV), a double-stranded DNA virus transmitted primarily via sexual contact, is established as the principal etiologic agent in over 95% of cervical cancer cases. High-risk HPV genotypes—most notably HPV-16 and HPV-18—are responsible for roughly 70% of cervical carcinomas globally. Molecularly, viral integration into the host cellular genome leads to the sustained overexpression of the viral E6 and E7 oncoproteins. E6 binds to and degrades the tumor suppressor protein p53, impairing DNA repair and apoptosis, whereas E7 inactivates the retinoblastoma protein (pRb), disrupting cell cycle regulation and driving uncontrolled cellular proliferation [3].

Primary prevention through HPV vaccination represents the most effective strategy to prevent infection and eliminate cervical cancer. Recombinant virus-like particle (VLP) vaccines induce high titers of neutralizing antibodies against the L1 major capsid protein, preventing viral entry into basal epithelial cells. The WHO recommends targeting young adolescent girls aged 9–14 years prior to sexual debut, when the vaccine demonstrates maximum immunogenicity and protective efficacy. In alignment with global goals, the Indonesian Ministry of Health integrated mandatory HPV vaccination into the School Children Immunization Month (Bulan Imunisasi Anak Sekolah / BIAS) nationwide program. However, reaching optimal coverage remains challenging due to logistical hurdles, lack of awareness, vaccine hesitancy, and sociocultural taboos surrounding reproductive health education for adolescents [1,3].

According to the Socioecological Model (SEM), health behaviors in adolescents are influenced by multiple nested levels, including individual cognitive factors, interpersonal relationships, organizational school environments, and broader community norms. At the individual level, deficient knowledge regarding HPV transmission, vaccine safety, and cervical cancer risk serves as a primary barrier to vaccine acceptance. During early to middle adolescence (ages 12–15 years), cognitive development shifts toward abstract reasoning and digital self-directed learning. Consequently, health promotion strategies must transition from conventional didactic lectures to interactive digital platforms [8].

Mobile health (mHealth) applications offer an innovative avenue for delivering personalized, engaging, and accessible health education to digital-native adolescents. To address educational gaps in school settings, the "RATIH" (Remaja Aman Terlindung Imunisasi HPV) digital booklet application was developed as a specialized, user-friendly mobile learning tool. This study evaluates the effect of health education using the RATIH digital booklet application on the knowledge of female adolescents regarding HPV immunization at MTsN 15 Tanah Datar, West Sumatra, Indonesia[5.6]

METHODS

A quantitative pre-experimental research design utilizing a one-group pretest-posttest approach was conducted to measure changes in knowledge before and after the educational intervention. The study was carried out in April 2026 at MTsN 15 Tanah Datar, a public Islamic junior high school situated within the operational area of the UPT Puskesmas Tanjung Emas, Tanah Datar Regency, West Sumatra Province, Indonesia [4].

The study population comprised all female students enrolled in Grade IX at MTsN 15 Tanah Datar (N = 20). Total sampling was utilized, enrolling the entire eligible population. Inclusion criteria were: (1) active female students aged 12–18 years, (2) present during the research session, (3) possessing access to an Android smartphone capable of running the RATIH application, and (4) consenting to participate with signed parental/guardian informed consent and student assent. Students who withdrew prior to posttest completion or submitted incomplete questionnaires were excluded [4].

The "RATIH" (Remaja Aman Terlindung Imunisasi HPV) application is a mobile digital booklet engineered specifically for adolescent girls. The application presents six structured educational modules: (1) Definition and microbiology of HPV, (2) Transmission routes and high-risk behaviors, (3) Pathogenesis and clinical impacts of cervical cancer, (4) Primary prevention and benefits of HPV vaccination, (5) Immunization schedules under the national BIAS program (including catch-up doses for Grade IX students), and (6) Vaccine safety and side-effect

management. The interface incorporates age-appropriate visuals, color-coded infographics, and interactive summaries [5].

Data were collected using a validated 30-item closed-ended questionnaire measuring cognitive knowledge of HPV and its vaccine. Each item was scored dichotomously (correct = 1, incorrect = 0; total score range: 0–30). Content validity was verified by expert panels in midwifery and psychology. The instrument demonstrated high internal consistency (Cronbach's alpha = 0.84).

The research workflow was executed as follows: First, baseline knowledge was measured via a 20-minute pretest questionnaire. Immediately following the pretest, respondents participated in a structured 30-minute interactive educational session utilizing the RATIH mobile application. Following the session, respondents completed the posttest questionnaire using identical items.

Data were analyzed using SPSS software. Univariate analysis described respondent age distribution, baseline scores, and post-intervention scores (expressed as mean, standard deviation, minimum, maximum, and frequency percentages). Shapiro-Wilk test was conducted to test data normality due to the small sample size (n = 20). Because pretest (p = 0.079) and posttest (p = 0.243) scores were normally distributed (p > 0.05), a parametric Paired Sample t-test was employed for bivariate hypothesis testing at alpha = 0.05.

RESULTS

1 Respondent Characteristics

A total of 20 female students completed the study without attrition. All respondents were aged between 13 and 15 years, with a mean age of 14.1 years. Specifically, 4 students (20.0%) were 13 years old, 10 students (50.0%) were 14 years old, and 6 students (30.0%) were 15 years old.

2 Univariate Analysis of Pretest and Posttest Knowledge

Before the intervention, respondents exhibited low knowledge regarding HPV and its immunization, with a mean pretest score of 11.85 ± 2.39 (range: 7–15 out of 30). Categorically, 17 respondents (85.0%) fell into the 'Poor' knowledge category (<15 score), 3 respondents (15.0%) into the 'Moderate' category, and zero respondents achieved 'Good' knowledge.

Following health education via the RATIH application, knowledge scores improved markedly, yielding a mean posttest score of 21.25 ± 2.38 (range: 17–25 out of 30). Categorically, 12 respondents (60.0%) achieved 'Moderate' knowledge, 8 respondents (40.0%) achieved 'Good' knowledge (≥21 score), and no respondents remained in the 'Poor' category.

Table 1. Distribution of Pretest and Posttest Knowledge Scores (n = 20)

Assessment Phase	N	Mean	Std. Deviation	Minimum	Maximum
Pretest (Before)	20	11.85	2.39	7	15
Posttest (After)	20	21.25	2.38	17	25

3.3 Normality Testing and Bivariate Hypothesis Analysis

Data normality was confirmed using the Shapiro-Wilk test. The resulting p-value for pretest scores was 0.079 and for posttest scores was 0.243. Because both p-values exceeded 0.05, the assumption of normality was met, justifying the use of the Paired Sample t-test.

Table 2. Paired Sample T-Test Results of Knowledge Scores Before and After Intervention (n = 20)

Pair Comparison	Mean Diff.	Std. Dev.	Std. Error	t-statistic	Df	p-value
Pretest - Posttest	-9.40	0.88	0.197	-47.631	19	**0.000**

As detailed in Table 2, the paired sample t-test revealed a significant mean difference of -9.40 points (95% CI: -9.81 to -8.98) between pre-intervention and post-intervention scores. The test produced a t-statistic of -47.631 with 19 degrees of freedom, yielding a statistically significant p-value of 0.000 (p < 0.05). This leads to the acceptance of the alternative hypothesis (Ha), demonstrating that health education using the RATIH digital booklet application significantly improves adolescent knowledge regarding HPV immunization.

DISCUSSIONS

1 Baseline Knowledge Deficits and Sociocultural Context

The pre-intervention baseline assessment revealed widespread cognitive deficits regarding HPV among adolescent girls at MTsN 15 Tanah Datar, evidenced by an average score of 11.85 (out of 30) and an 85% prevalence of 'Poor' knowledge. Misconceptions were especially pronounced regarding non-sexual transmission routes, asymptomatic clinical presentations, and vaccine mechanics. A substantial proportion of respondents incorrectly believed that HPV infection produces immediate symptoms or that the vaccine contains live infectious pathogens [4].

These findings reflect systemic barriers in adolescent reproductive health literacy across rural and semi-urban Indonesia. Within Minangkabau cultural contexts in West Sumatra, reproductive health topics are frequently considered taboos, leading parents and educators to avoid open discussion with adolescents. Furthermore, prior public health outreach in school settings focused primarily on general hygiene or mandatory childhood immunizations, omitting dedicated instruction on HPV and cervical oncogenesis. Without structured, age-appropriate educational interventions, adolescents remain reliant on unverified digital rumors, reinforcing vaccine hesitancy and anxiety regarding potential impacts on future fertility [4,7].

2 Mechanisms of Knowledge Acquisition via mHealth Platforms

The educational intervention utilizing the RATIH mobile application produced a statistically significant knowledge increase, raising the mean posttest score to 21.25 (+79.3% increase). This significant shift underscores the cognitive suitability of digital mHealth tools for modern digital-native adolescents [5,6].

From a cognitive processing perspective (Edgar Dale's Cone of Experience), passive learning modalities (such as text-heavy lectures) yield poor information retention compared to visual, interactive platforms. The RATIH application integrates structured infographics, micro-learning text segments, visually engaging characters, and immediate interactive feedback. By breaking complex biological mechanisms—such as E6/E7 oncogenesis and VLP immune responses—into digestible visual modules, the application facilitates cognitive encoding, working memory consolidation, and long-term retention [4].

Our results mirror findings from recent global mHealth literature. Rahmawati (2023) demonstrated that digital booklet interventions achieved superior knowledge retention compared to traditional printed flyers among secondary school students in Java. Similarly, international trials by Wulandari (2020) and Handayani (2022) established that mobile applications effectively bridge health information gaps among young females by providing private, self-paced, and non-judgmental learning environments [5,6,7]

3 Theoretical Integration: Health Belief Model and Socioecological Impact

The observed knowledge enhancement directly aligns with the Health Belief Model (HBM) and Lawrence Green's PRECEDE-PROCEED framework. Under the HBM, individual decision-making regarding preventive health behaviors is governed by four key perceptions: Perceived Susceptibility, Perceived Severity, Perceived Benefits, and Perceived Barriers. Prior to the intervention, low knowledge fostered a low perception of susceptibility and severity, as adolescents viewed cervical cancer as an exclusive concern of older women. The RATIH application successfully restructured these cognitive frameworks by clarifying that HPV infection occurs during early adolescence and that asymptomatic viral persistence leads to malignant transformation later in life [9,10]

Furthermore, the application directly dismantled Perceived Barriers by providing factual evidence regarding vaccine safety, clarifying that recombinant VLP vaccines contain no live viral DNA and do not impair reproductive fertility. Under Green's framework, knowledge serves as a critical predisposing factor that enables positive health attitudes and compliance with immunization programs like BIAS [9].

At the organizational and community levels of the Socioecological Model, integrating mHealth tools into School Health Units (Usaha Kesehatan Sekolah / UKS) empowers school

midwives and community health workers (Puskesmas) to deliver standardized health promotion. By equipping adolescents with accurate knowledge, they become peer educators who can positively influence family discussions and community acceptance of national vaccination campaigns [8].

4.4 Strengths, Limitations, and Future Directions

This study possesses several notable strengths, including the novel development of a tailored digital mHealth tool (RATIH), the use of a validated comprehensive 30-item instrument, and robust parametric statistical testing. However, certain methodological limitations must be acknowledged. First, the pre-experimental design lacked an unexposed control group, which prevents complete control over external confounding information sources. Second, the sample size was relatively small (n = 20) and localized to a single Islamic junior high school, limiting immediate generalizability to broader rural or non-Islamic educational settings. Third, data collection occurred immediately post-intervention, assessing short-term knowledge acquisition rather than long-term cognitive retention or actual vaccine uptake rates.

Future research should employ randomized controlled trial (RCT) designs with larger multi-center cohorts, incorporating long-term follow-up assessments (e.g., 3 and 6 months) to evaluate knowledge retention, parental consent conversion rates, and verified HPV vaccine administration.

CONCLUSIONS

Health education delivered via the "RATIH" digital booklet application exerts a statistically significant positive effect on adolescent knowledge regarding HPV immunization at MTsN 15 Tanah Datar ($t = -47.631$, $p = 0.000$). The mobile application transformed adolescent health literacy, elevating average knowledge scores from a deficient baseline of 11.85 to an advanced post-intervention mean of 21.25.

Integrating age-tailored mHealth tools into school health programs (UKS) and primary care outreach (Puskesmas) offers a scalable, cost-effective, and culturally acceptable strategy to overcome educational taboos, eliminate vaccine hesitancy, and accelerate global efforts toward cervical cancer elimination.

Author Contribution Statement

The author performed all aspects of this study.

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