

Effectiveness of digital media-based health education in improving adolescent health literacy on the prevention of sexually transmitted diseases

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Received: 2026-06-01

Revised: 2026-07-02

Accepted: 2026-07-30

Published: 2026-08-02

ABSTRACT

Introduction: Sexually transmitted diseases (STDs) continue to pose significant health risks among adolescents, partly due to inadequate access to accurate health information and limited health literacy. Digital media has emerged as a promising platform for health promotion, yet evidence regarding its effectiveness in enhancing adolescent health literacy specifically related to STD prevention remains limited. This study aimed to evaluate the effectiveness of digital media-based health education in improving adolescent health literacy regarding the prevention of sexually transmitted diseases.

Research Methodology: A quasi-experimental study employing a pretest–posttest control-group design was conducted among 142 adolescents aged 15–19 years recruited from selected senior high schools in Makassar, Indonesia. Participants were allocated into intervention ($n = 71$) and control ($n = 71$) groups. The intervention group received digital media-based health education through educational videos, infographics, and interactive online modules for four weeks, while the control group received conventional health education. Data were analyzed using descriptive statistics, paired and independent t-tests, chi-square tests, and multiple linear regression using SPSS version 29.0.

Results: Health literacy scores in the intervention group increased significantly from 63.1 ± 8.2 to 82.7 ± 7.4 ($p < 0.001$), whereas the control group showed no significant improvement (62.4 ± 8.5 to 66.1 ± 8.3 ; $p = 0.056$). Post-intervention scores were significantly higher in the intervention group than in the control group (82.7 ± 7.4 vs. 66.1 ± 8.3 ; $p < 0.001$). A large intervention effect was observed (Cohen's $d = 1.91$). Multiple linear regression identified digital media intervention as the strongest predictor of post-intervention health literacy ($\beta = 0.503$, $p < 0.001$), with the model explaining 49% of outcome variance ($R^2 = 0.49$).

Conclusion: Digital media-based health education is highly effective in improving adolescent health literacy related to STD prevention. Integrating evidence-based digital health education into school and community health programs may strengthen preventive behaviors, expand access to reliable sexual health information, and support adolescent health promotion efforts.

Keywords: adolescent health literacy; digital health education; health promotion; sexually transmitted diseases; sexual health.



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INTRODUCTION

Sexually transmitted diseases (STDs) remain a major public health concern among adolescents worldwide. This age group is particularly vulnerable due to the convergence of biological maturation, psychosocial development, increasing curiosity regarding sexual behavior, and limited access to accurate reproductive health information¹. Despite ongoing prevention efforts, the incidence of STDs among adolescents continues to be reported across both developed and developing countries, indicating persistent gaps in preventive knowledge and risk awareness². The consequences extend beyond immediate physical health problems and may include infertility, chronic reproductive complications, adverse pregnancy outcomes, psychological distress, and increased susceptibility to other infectious diseases³.

Health literacy has been recognized as one of the most important determinants of adolescent sexual health behavior. Adolescents with adequate health literacy are more likely to understand disease transmission mechanisms, evaluate health information critically, adopt safer sexual practices, and seek professional healthcare services when necessary⁴. Conversely, low levels of health literacy have been associated with misconceptions regarding STD transmission, delayed treatment-seeking behavior, and engagement in high-risk sexual activities⁵. In many settings, however, conventional health education approaches delivered through classroom lectures or printed materials have shown limited effectiveness in capturing adolescents' attention and sustaining behavioral engagement. The changing patterns of information consumption among adolescents require innovative educational strategies that align with their digital lifestyles^{6,7}.

The rapid expansion of digital technology has transformed the way health information is accessed, shared, and consumed⁸. Digital media platforms, including mobile applications, social media, educational videos, interactive websites, and online learning systems, have emerged as promising channels for health promotion. Several studies have reported that digital health education can improve knowledge acquisition, facilitate self-directed learning, and enhance engagement among young populations⁹. Interactive features such as multimedia content, gamification, instant feedback, and peer interaction may increase learning motivation compared with traditional educational methods. Furthermore, digital interventions offer scalability and accessibility, allowing health information to reach adolescents regardless of geographical constraints¹⁰.

Although existing studies generally support the use of digital media in health education, the evidence remains fragmented. Many investigations focus primarily on short-term knowledge improvement without examining broader dimensions of health literacy, such as information appraisal, critical decision-making, and application of knowledge in real-life situations¹¹. In addition, substantial heterogeneity exists across intervention types, educational content, implementation duration, and outcome measures. Some studies evaluate mobile-based learning applications, whereas others focus on social media campaigns or web-based educational modules, making it difficult to determine which approaches are most effective for enhancing health literacy¹². Furthermore, findings from different contexts have yielded varying levels of effectiveness, suggesting that sociocultural and technological factors may influence intervention outcomes¹³.

Another limitation in the current literature is the insufficient synthesis of evidence specifically addressing STD prevention among adolescents. Previous reviews often combine multiple reproductive health topics, including contraception, menstrual health, HIV prevention, and sexual behavior, without isolating the specific contribution of digital media interventions to STD-related health literacy¹⁴. Consequently, the extent to which digital media-based education

effectively improves adolescents' understanding and preventive capacity regarding STDs remains inadequately clarified. This lack of focused evidence presents a challenge for educators, healthcare professionals, and policymakers seeking to design evidence-based interventions targeting adolescent sexual health. Given these limitations, a clear research gap exists regarding the comprehensive evaluation of digital media-based health education as a strategy for improving adolescent health literacy related specifically to STD prevention. Existing evidence has not sufficiently integrated findings across diverse digital platforms while simultaneously examining the multidimensional aspects of health literacy. Moreover, limited attention has been paid to identifying the characteristics of digital interventions that contribute to successful educational outcomes among adolescents.

The novelty of this study lies in its focused examination of digital media-based health education within the context of STD prevention and adolescent health literacy. Unlike previous studies that broadly address sexual and reproductive health education, this research specifically synthesizes evidence on how digital educational interventions influence adolescents' ability to access, understand, evaluate, and apply information related to STD prevention. By concentrating on this specific public health issue, the study aims to provide a more precise understanding of intervention effectiveness and generate practical recommendations for future health promotion programs. Therefore, this study aims to analyze the effectiveness of digital media-based health education in improving adolescent health literacy regarding the prevention of sexually transmitted diseases. The findings are expected to contribute to the development of evidence-based educational strategies that are responsive to adolescents' digital engagement patterns and capable of strengthening preventive efforts against STDs in diverse settings.

RESEARCH METHODOLOGY

Study Design

This study employed a quantitative, quasi-experimental design with a pretest–posttest control-group framework. The design was selected because it allows the evaluation of changes in health literacy outcomes before and after exposure to a digital media-based health education intervention while facilitating comparison with a control group receiving conventional health education. This approach is considered appropriate for assessing intervention effectiveness in educational and community settings where random allocation may not be feasible.

Setting and Participants

The study was conducted in selected senior high schools in Makassar, Indonesia, from January to April 2026. The target population comprised adolescents aged 15–19 years enrolled in grades 10–12. Participants were eligible if they were actively registered as students, possessed access to a smartphone or internet-connected device, and provided informed consent. Students who had previously participated in structured sexual health education programs within the last six months or who were absent during either the pretest or posttest assessment were excluded from the study. A multistage sampling technique was applied. First, schools were selected purposively based on willingness to participate and availability of digital learning facilities. Subsequently, eligible students were recruited using simple random sampling from school enrollment lists.

Sample size was calculated using G Power version 3.1 for a comparison of mean differences between two independent groups, assuming a medium effect size ($d = 0.50$), a statistical power of 80%, and a significance level of 5%. The minimum required sample was 128 participants. To account for potential attrition, an additional 10% was added, resulting in a final target sample of 142 adolescents.

Variables and Measurement

The independent variable was digital media-based health education, defined as structured educational content on sexually transmitted disease (STD) prevention delivered through digital platforms, including educational videos, infographics, and interactive online modules. The dependent variable was adolescent health literacy regarding STD prevention, defined as the ability to access, understand, evaluate, and apply health information related to STD prevention. Health literacy was measured using a modified Adolescent Sexual Health Literacy Questionnaire comprising 25 items across four domains: information access, comprehension, appraisal, and application. Responses were recorded using a five-point Likert scale, with higher scores indicating better health literacy. Content validity was evaluated by a panel of three public health and adolescent health experts. The instrument demonstrated satisfactory content validity (Content Validity Index = 0.89). Reliability testing conducted during a pilot study involving 30 adolescents yielded a Cronbach's alpha coefficient of 0.91, indicating excellent internal consistency. Primary data were obtained directly from participants through self-administered questionnaires, while demographic information was collected using a structured participant profile form.

Data Collection

Data collection was performed in four stages. First, eligible participants were recruited and provided informed consent. Second, baseline health literacy assessments (pretest) were administered to both intervention and control groups. Third, participants in the intervention group received digital media-based health education over four weeks through an online learning platform, while the control group received standard school-based health education materials. Finally, posttest assessments were conducted immediately after completion of the intervention. To ensure data quality, research assistants received standardized training before field implementation. Pilot testing was conducted to assess instrument clarity and feasibility. Data completeness was verified immediately after questionnaire submission, and double-entry procedures were applied during database management to minimize transcription errors.

Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 29.0. Descriptive statistics were used to summarize participant characteristics and study variables, including frequencies, percentages, means, and standard deviations. Bivariate analysis was performed using independent t-tests and paired t-tests to examine differences in health literacy scores between and within groups. Chi-square tests were applied for categorical variables where appropriate. To identify factors independently associated with post-intervention health literacy scores, a multiple linear regression analysis was conducted, controlling for age, sex, grade level, and baseline health literacy. Assumptions of normality, homoscedasticity, and multicollinearity were assessed before model estimation. Statistical significance was determined at a two-tailed alpha level of 0.05.

Ethical Approval

Ethical approval for this study was obtained from the Health Research Ethics Committee (Approval No. 145/UN4.14.1/KEP/2026). Participation was entirely voluntary, and all respondents were informed about the study objectives, procedures, potential benefits, and confidentiality measures before enrollment. Written informed consent was obtained from all participants, and parental consent was secured for respondents younger than 18 years. Personal identifiers were removed from the dataset to ensure anonymity and data protection throughout the research process.

RESULTS

Table 1. Characteristics of Participants (N = 142)

Variable	Intervention (n = 71)	Control (n = 71)	Total (N = 142)	p-value
Age (Mean ± SD)	15.9 ± 1.1	15.7 ± 1.2	15.8 ± 1.1	0.348
Female, n (%)	41 (57.7)	39 (54.9)	80 (56.3)	0.734
Male, n (%)	30 (42.3)	32 (45.1)	62 (43.7)	
Grade 10, n (%)	25 (35.2)	27 (38.0)	52 (36.6)	0.801
Grade 11, n (%)	23 (32.4)	21 (29.6)	44 (31.0)	
Grade 12, n (%)	23 (32.4)	23 (32.4)	46 (32.4)	
Baseline Health Literacy Score (Mean ± SD)	63.1 ± 8.2	62.4 ± 8.5	62.8 ± 8.3	0.621

The study included 142 adolescents, equally distributed between the intervention and control groups. No statistically significant differences were observed in demographic characteristics or baseline health literacy scores, indicating comparability between groups before the intervention.

Table 2. Changes in Health Literacy Scores Following the Intervention: Within-Group Comparison

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean Difference	t-value	p-value	Cohen's d
Intervention (n=71)	63.1 ± 8.2	82.7 ± 7.4	19.6	14.82	<0.001	1.91
Control (n=71)	62.4 ± 8.5	66.1 ± 8.3	3.7	1.94	0.056	0.27

Between-Group Comparison

Outcome	Intervention Mean ± SD	Control Mean ± SD	Mean Difference	t-value	p-value
Post-test Health Literacy Score	82.7 ± 7.4	66.1 ± 8.3	16.6	12.51	<0.001

Adolescents exposed to digital media-based health education demonstrated a significant increase in health literacy scores from pre-test to post-test ($p < 0.001$). The effect size was large (Cohen's $d = 1.91$), indicating a substantial educational impact. By contrast, the control group experienced only a small, statistically nonsignificant improvement. Post-intervention comparisons revealed significantly higher health literacy scores among participants who received the digital intervention.

Table 3. Multiple Linear Regression Analysis Predicting Post-Intervention Health Literacy (N = 142)

Predictor	β	SE	95% CI	p-value
Digital media intervention	0.503	1.11	10.42 – 14.87	<0.001
Age	0.074	0.29	-0.14 – 1.03	0.201
Female sex	0.081	0.96	-0.82 – 2.96	0.164
Grade level	0.139	0.58	0.41 – 2.71	0.028
Baseline health literacy	0.337	0.07	0.22 – 0.50	<0.001

Model Fit

Statistic	Value
R^2	0.49
Adjusted R^2	0.47
F-statistic	26.83
Model p-value	<0.001

After adjusting for age, sex, grade level, and baseline health literacy, participation in the digital media intervention remained the strongest predictor of post-intervention health literacy ($\beta = 0.503$, $p < 0.001$). Baseline health literacy and grade level also contributed significantly to the

model, while age and sex showed no significant independent association. The model explained approximately 49% of the variance in health literacy outcomes.

The results provide strong evidence that digital media-based health education can substantially improve adolescents' health literacy related to sexually transmitted disease prevention. The large effect size observed suggests that digital learning environments offer more than simple information dissemination; they may facilitate active engagement, repeated exposure to educational content, and greater accessibility to health information. These characteristics are particularly important for adolescents, whose learning preferences increasingly align with technology-mediated communication. The findings also highlight the potential role of digital interventions in addressing persistent gaps in sexual health education. Enhanced health literacy can empower adolescents to critically evaluate health information, recognize risk factors, and make informed decisions regarding preventive behaviors. Given the widespread use of smartphones and social media among young people, integrating digital health education into school health programs may be a scalable, cost-effective public health strategy. Furthermore, the persistence of intervention effects after controlling for demographic and baseline factors suggests that digital media interventions may benefit adolescents across diverse educational backgrounds. Future programs should focus on integrating interactive features, peer-supported learning, and continuous reinforcement mechanisms.

DISCUSSION

The findings of this study provide compelling evidence that digital media-based health education can substantially improve adolescent health literacy regarding the prevention of sexually transmitted diseases (STDs). More importantly, the significance of these findings extends beyond the observed increase in literacy scores. The results suggest that digital platforms can serve as effective environments for facilitating meaningful learning processes that align with the communication habits, information-seeking behaviors, and technological preferences of contemporary adolescents. In an era in which young people increasingly rely on digital technologies as their primary sources of information, educational interventions delivered through digital media appear capable of bridging gaps between health knowledge and practical understanding. Health literacy involves more than the acquisition of factual information; it encompasses the ability to access, comprehend, evaluate, and apply health-related information in everyday decision-making. Therefore, the substantial improvement observed following the intervention indicates that digital media may support the development of broader competencies necessary for informed health choices and responsible sexual behavior^{15,16}.

The effectiveness of the intervention can also be understood through the unique characteristics of digital learning environments. Unlike conventional health education approaches that often rely on one-way information delivery, digital platforms facilitate greater interactivity, flexibility, and learner engagement¹⁷. Adolescents can access educational content at their own pace, revisit information when needed, and interact with visual and multimedia resources that enhance comprehension and retention. Such features may explain why the intervention demonstrated a strong effect even after controlling for demographic factors and baseline health literacy¹⁸. This finding suggests that digital health education can serve as an inclusive educational strategy that benefits adolescents from diverse backgrounds. In practical terms, this implies that digital interventions may help reduce disparities in access to reliable sexual health information, particularly among populations that face limitations in formal health education or healthcare access¹⁹.

The present findings are consistent with a growing body of international evidence demonstrating the effectiveness of digital health education in improving adolescents' knowledge, attitudes, and preventive behaviors²⁰. Previous studies have shown that technology-based interventions can enhance learning outcomes across a variety of health domains, including sexual and reproductive health, mental health, nutrition, and substance use prevention²¹. The current study reinforces these observations while providing additional insight into the multidimensional nature of health literacy as an outcome²². Whereas many earlier investigations have primarily focused on knowledge acquisition, the present findings suggest that digital interventions may also strengthen adolescents' capacity to interpret health information and use it in decision-making critically²³. This distinction is particularly important in the context of STD prevention, where individuals are frequently required to evaluate complex information, assess personal risk, and make decisions that have long-term implications for their health and well-being^{24,25}.

The results further support contemporary perspectives that conceptualize health literacy as a critical determinant of public health outcomes. From this viewpoint, improving adolescent health literacy should not be regarded solely as an educational objective but also as a preventive public health strategy. Adolescents with higher levels of health literacy are generally better equipped to recognize health risks, evaluate the credibility of information sources, communicate effectively with healthcare providers, and adopt protective behaviors²⁶. In the context of sexually transmitted diseases, these competencies are particularly relevant because misinformation, stigma, and limited access to accurate information continue to represent significant barriers to prevention efforts²⁷. The findings therefore suggest that digital media-based education may contribute not only to individual learning outcomes but also to broader efforts to strengthen population health and reduce future disease burden²⁸.

Another important contribution of this study lies in its implications for health equity. Access to comprehensive sexual health education remains uneven across many educational and social settings. Differences in school resources, teacher preparedness, community norms, and healthcare availability often result in unequal opportunities for adolescents to acquire accurate sexual health information²⁹. Digital health education offers a scalable, cost-effective mechanism for addressing these disparities. By enabling the widespread dissemination of evidence-based information, digital platforms can extend educational opportunities beyond traditional classroom boundaries and reach adolescents who might otherwise have limited exposure to structured health education programs³⁰. Consequently, the findings support the growing recognition of digital technologies as important tools for promoting equitable access to health information and preventive services³¹.

Despite these promising outcomes, several considerations should be taken into account when interpreting the results. First, health literacy was assessed using self-reported measures, which may be influenced by social desirability and individual perceptions of competence. Although self-report instruments remain common in health literacy research, they cannot fully capture actual behavioral capabilities or real-world decision-making processes. Therefore, caution is warranted when interpreting improvements in literacy scores as direct indicators of behavioral change. Second, the study evaluated outcomes shortly after the intervention, making it difficult to determine whether the observed improvements will be sustained over time. Health literacy is a dynamic construct that evolves in response to new experiences, information sources, and social influences. Long-term follow-up studies are therefore necessary to establish the durability of intervention effects.

Additional caution is required regarding the generalizability of the findings. The study was conducted within a specific educational context, and the effectiveness of digital interventions may vary according to cultural norms, technological infrastructure, educational policies, and patterns of digital engagement. Adolescent perceptions of sexual health, information credibility, and healthcare utilization are shaped by broader social and cultural factors that may differ across populations. Furthermore, sexual health behavior is influenced by numerous determinants beyond health literacy, including peer relationships, family communication, socioeconomic conditions, social norms, and access to healthcare services. Consequently, while improved health literacy is a valuable outcome, it should be viewed as one component within a broader system of factors that shape adolescent sexual health outcomes.

Future research should therefore move beyond short-term educational outcomes and examine the long-term implications of digital health literacy interventions. Longitudinal studies would help clarify whether improvements in literacy are associated with sustained changes in preventive behaviors, healthcare-seeking practices, and sexual health outcomes. Researchers should also investigate the mechanisms through which digital interventions produce their effects. Understanding whether improvements are primarily driven by accessibility, interactivity, personalization, social engagement, or repeated exposure to information would provide valuable guidance for optimizing future intervention design. Comparative evaluations of different digital formats, including mobile applications, social media campaigns, gamified learning systems, and interactive online platforms, may further identify the most effective approaches for different adolescent populations.

Future studies should additionally adopt broader theoretical perspectives that acknowledge the social and ecological dimensions of health literacy. Integrating concepts from public health, education, communication science, and digital technology may provide a more comprehensive understanding of how adolescents acquire, interpret, and apply health information. Such interdisciplinary approaches could facilitate the development of interventions that address not only individual knowledge deficits but also the social and structural factors that influence adolescent health behaviors. Particular attention should be paid to digital equity, as disparities in internet access, digital skills, and technological resources may affect the reach and effectiveness of digital health education initiatives.

Overall, the findings indicate that digital media-based health education represents a promising strategy for strengthening adolescent health literacy regarding STD prevention. The intervention's effectiveness highlights the potential of digital technologies to transform traditional health education by creating more accessible, engaging, and learner-centered environments. At the same time, the broader implications of the study suggest that investments in digital health literacy programs may contribute to public health promotion, health equity, and disease prevention efforts on a larger scale. As digital technologies continue to shape how young people access and interact with information, integrating evidence-based digital education into adolescent health promotion strategies may become increasingly important for supporting healthier and more informed future generations.

CONCLUSIONS

This study demonstrates that digital media-based health education is effective in improving adolescent health literacy related to the prevention of sexually transmitted diseases. Adolescents who participated in the digital intervention showed significantly higher health literacy scores than those who did not, indicating that digital learning platforms can be effective tools for delivering sexual health information. The findings suggest that digital media not only

enhances knowledge acquisition but also supports adolescents' ability to access, understand, evaluate, and apply health information for preventive decision-making. These results highlight the potential of digital health education as a strategic approach to addressing persistent gaps in adolescent sexual health literacy. Given the widespread use of smartphones, social media, and online learning platforms among young people, digital interventions offer an accessible, scalable, and cost-effective means to strengthen health promotion efforts. The positive association between intervention exposure and post-intervention health literacy further indicates that digital approaches can complement existing school-based health education programs. Based on these findings, policymakers, educators, and public health practitioners should consider integrating evidence-based digital sexual health education into secondary school curricula and community health initiatives. Future programs should emphasize interactive, culturally relevant content, while ongoing evaluation is needed to sustain improvements in adolescents' health literacy and preventive health behaviors.

Funding Statement

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. All research activities, including data collection, analysis, and manuscript preparation, were conducted independently by the authors.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this study. The authors have no financial, professional, or personal relationships that could have influenced the research process, data interpretation, or reporting of findings.

Authors' Contributions — CRediT Taxonomy

Risna Ayu Rahmadania: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft Preparation, Visualization.

Etty Komariah Sambas: Supervision, Validation, Methodology, Writing – Review & Editing, Project Administration.

Matilda Martha Paseno: Literature Review, Data Curation, Investigation, Validation, Writing – Review & Editing, Resources.

Acknowledgments

The authors would like to express their sincere gratitude to the participating schools, students, and educational staff who contributed their time and cooperation to this study. Appreciation is also extended to all research assistants and field coordinators whose support facilitated the successful implementation of the intervention and data collection process. Their contributions were invaluable to the completion of this research.

Declaration of Generative AI Use

During the preparation of this manuscript, generative artificial intelligence (AI) tools were used solely to assist with language refinement, grammar improvement, and enhancement of manuscript readability. The authors carefully reviewed, revised, and verified all generated content to ensure its accuracy, integrity, and compliance with academic standards. The authors retain full responsibility for the content, interpretation of findings, and conclusions presented in this manuscript.

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