ORIGINAL RESEARCH ARTICLE

A Randomized Controlled Trial of a Mobile Application to Improve HIV Preventive Behaviors among Youth Men Who Have Sex with Men in Thailand

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DOI: 10.55489/njcm.170520266222

ABSTRACT

Background: Human Immunodeficiency Virus (HIV) remains highly prevalent among young men who have sex with men (YMSM), necessitating innovative, theory-driven prevention strategies. The objectives of this study were to evaluate the effectiveness of a Cognitive Behavioral Group Counseling (CBGC)-based mobile application in improving HIV prevention knowledge, attitudes, and behaviors among YMSM.

Methods: A randomized controlled trial was conducted among 60 YMSM aged 18-24 years, allocated equally into experimental and control groups. The intervention group received a CBGC-based mobile application over 10 weeks, followed by 14 weeks of follow-up. Outcomes were assessed using validated questionnaires measuring knowledge, attitudes, and preventive behaviors. Data were analyzed using paired and independent t-tests with a significance level of 0.05.

Results: The experimental group demonstrated significant improvements in HIV prevention knowledge, attitudes, and behaviors compared to the control group. Post-intervention scores were significantly higher in the intervention group, with notable increases in high-level knowledge, positive attitudes, and consistent preventive practices. No significant changes were observed in the control group.

Conclusion: The CBGC-based mobile intervention was effective in enhancing HIV preventive outcomes among YMSM. Digital, theory-based interventions offer a promising approach for targeted HIV prevention in high-risk youth populations.

Keywords: HIV prevention, adolescent males who have sex with men, mobile health application, cognitive behavioral intervention, preventive behaviors

ARTICLE INFO

Financial Support: Faculty of Public Health, Maha Sarakham University, Maha Sarakham, Thailand. (Award No. PHD001/2023)

Conflict of Interest: The authors have declared that no conflict of interest exists.

Received: 19-11-2025, **Accepted**: 20-02-2026, **Published**: 01-05-2026

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How to cite this article: Unrit K, Glangkarn S, Promarak T. A Randomized Controlled Trial of a Mobile Application to Improve HIV Preventive Behaviors among Youth Men Who Have Sex with Men in Thailand. Natl J Community Med 2026;17(5):337-344. DOI: 10.55489/njcm.170520266222

www.njcmindia.com | pISSN: 0976-3325 | eISSN: 2229-6816 | Published by Medsci Publications

INTRODUCTION

Human Immunodeficiency Virus (HIV) infection remains a major global public health challenge despite substantial advances in prevention, diagnosis, and treatment. The World Health Organization (WHO), in collaboration with the Royal Thai Government, has established a strategic goal to end AIDS as a public health threat by 2030.[1] In Thailand, HIV infection remains highly prevalent among key populations, particularly men who have sex with men (MSM), with a substantial proportion occurring among youth under the age of 25, commonly referred to as youth men who have sex with men (YMSM).[2,3] Surveillance data from the Integrated Biological Behavioral Surveillance (IBBS) system indicate that HIV prevalence remains disproportionately high among young key populations. In addition, local data from Romyen Clinic at Mahasarakham Hospital revealed that a large proportion of newly diagnosed HIV cases were among MSM, with nearly half of these cases occurring in individuals under 25 years of age. These findings underscore the urgent need for targeted and age-appropriate HIV prevention strategies for YMSM.

Multiple behavioral, psychological and social factors contribute to the continued transmission of HIV among YMSM. These include inconsistent condom use, low uptake of pre-exposure prophylaxis (PrEP), inadequate screening for sexually transmitted infections and engagement in sexual activity following alcohol or substance use.[4] Furthermore, misconceptions and negative attitudes toward condom use such as concerns about reduced sexual pleasure, perceived trust in a single partner and the occurrence of unplanned sexual encounters further elevate the risk of HIV transmission.[5] These behavioral patterns highlight the importance of interventions that address not only knowledge deficits but also attitudes, motivation and self-efficacy related to HIV preventive behaviors.

The WHO and the Thailand AIDS Guideline (2020), advocate a combination prevention strategy that integrates biomedical, behavioral and structural interventions tailored to the specific needs and contexts of each target population.[5,6] In parallel, rapid advancements in digital technology, particularly the widespread use of smartphones and mobile applications, have transformed communication patterns and access to health information among adolescents and young adults.[7] Mobile health interventions offer a promising platform for delivering HIV prevention programs due to their accessibility, privacy, scalability and ability to provide personalized and interactive content.[7,8] Given the challenges of reaching vulnerable and marginalized populations such as YMSM through conventional health services, digital interventions grounded in behavioral theory may represent an effective approach to HIV prevention.[9,10] Cognitive Behavioral Therapy (CBT) interventions have demonstrated effectiveness in reducing HIV risk behaviors and substance use by addressing psychological factors and enhancing self-regulation among high-risk populations.[11] Despite the proliferation of mHealth tools, a systematic review has indicated that many interventions lack a robust theoretical foundation such as CBGC and few are specifically designed to address the unique developmental needs of adolescent YMSM.[12,13] study aimed to evaluate a CBGC-based mobile application designed to promote HIV preventive behaviors among adolescent YMSM.

METHODOLOGY

Methods: This study employed a randomized controlled trial (RCT) design with two parallel groups: an experimental group and a control group. The study was conducted over a 24-week period, comprising a 10-week intervention phase followed by a 14-week follow-up phase.

Participants and data collection: The sample size was determined using a power analysis via G*Power software. For an independent t-test with a medium effect size (d = 0.7), an alpha level of 0.05, and a statistical power of 0.80, the required sample size was calculated at 57 participants.[13] After inflating by 5% to account for potential attrition, the final sample size was 60 participants (30 per group).[14] Participants were selected using systematic random sampling, matched in pairs based on age, education level, occupation, and average monthly income, and then randomly allocated to either the experimental or control group using simple randomization.[15].[14]

Eligibility Criteria: Participants eligible for inclusion in the study were young men who have sex with men (YMSM) aged 18–24 years, who expressed willingness to participate and provided informed consent for HIV testing. Additionally, participants were required to have access to a mobile device with internet or Wi-Fi connectivity and be available to take part in all scheduled study activities. Individuals were excluded if they refused to participate, had a known HIV-positive status prior to enrollment, or were unable to consistently participate in the study procedures and follow-up activities.

The participant recruitment and allocation process is illustrated in Figure 1.

Data Collection Tool: Data collection was conducted using two primary instruments: 1) a CBGC-based mobile application serving as the intervention platform, which was adapted from evidence-based digital health frameworks for HIV prevention.[16] and 2) a structured self-administered questionnaire for pre- and post-intervention assessments, developed based on the Operational Manual for Integrated Biological and Behavioral Surveillance (IBBS) by the Ministry of Public Health, Thailand.[17]

1) CBGC-Based Mobile Application: The mobile application was developed based on Cognitive Behavioral Group Counseling (CBGC) principles to promote HIV prevention knowledge, attitudes, moti-

vation, and preventive behaviors among YMSM. The intervention was delivered over a 10-week period and comprised core components including HIV prevention educational content, behavioral skills training (e.g., condom use, PrEP utilization, and risk assessment), embedded pre- and post-intervention assessments, and automated reminders to support participant engagement and adherence. Detailed descriptions of intervention modules are provided in the supplementary material.

2) Questionnaire: A structured questionnaire was used to assess HIV prevention outcomes and consisted of four sections: 1) general information 2) HIV prevention knowledge (50 multiple-choice items; total score range 0-50, with ≥80% indicating adequate knowledge), 3) attitudes toward HIV prevention, and 4) HIV preventive behaviors. Attitudes and preventive behaviors were measured using Likert-scale items, with higher scores indicating more favorable attitudes and more consistent engagement in HIV preventive practices.

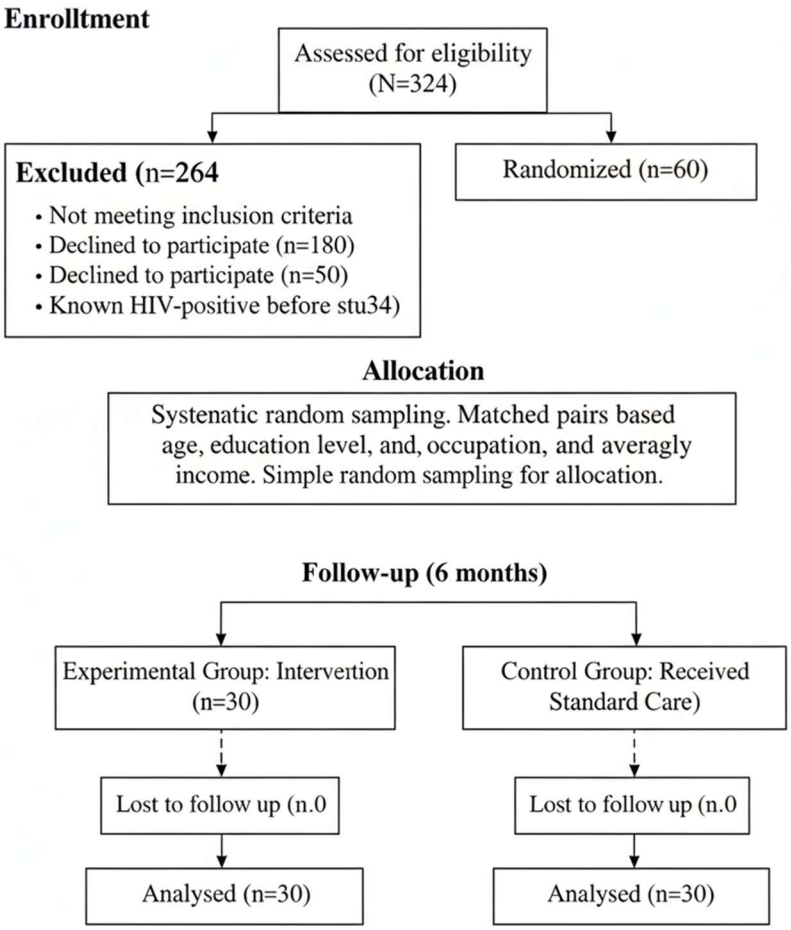

Figure 1: Study design; a random control trial

Instrument Validity and Reliability: Content validity of the questionnaire was assessed by three experts in HIV prevention, behavioral science and public health, with Index of Congruence (IOC) values ranging from 0.67 to 1.00. Internal consistency reliability of the knowledge section was evaluated using the Kuder-Richardson Formula 20 (KR-20), yielding a coefficient of 0.78. Reliability of the attitude and HIV preventive behavior scales was assessed using Cronbach's alpha with coefficients of 0.88 and 0.91, respectively.

Intervention Development: The intervention was developed based on Cognitive Behavioral Group Counseling (CBGC) principles, informed by a literature review and expert consultation in health education, HIV prevention among men who have sex with men, behavioral modification, and digital health. The program integrated cognitive-behavioral strategies with digital learning and self-management support delivered through a mobile application. It comprised a 10-week intervention followed by a 14-week follow-up period, yielding a total study duration of 24 weeks.

The experimental group received the CBGC-based mobile intervention structured into three sequential phases. Phase 1 (baseline assessment and initiation) focused on study orientation, application training, goal setting, and baseline assessment of HIV prevention knowledge, attitudes, and preventive behaviors, followed by self-directed learning on core HIV prevention content. Phase 2 (behavioral skills training and self-management support) emphasized motiva-

tional enhancement, cognitive-behavioral skill development (e.g., condom negotiation and use, PrEP utilization), ongoing self-monitoring, and individualized digital follow-up sessions to reinforce behavior change. Phase 3 (follow-up and program evaluation) assessed maintenance of HIV preventive behaviors, continued application use, and participant satisfaction three months after completion of the intervention.

Group orientations, assessments, counseling sessions, and follow-up contacts were conducted using online communication platforms integrated with the mobile application. Detailed descriptions of weekly activities and module content are provided in the supplementary material. In table 1

Data analysis: Descriptive statistics were used to summarize participant characteristics and outcome variables. Inferential analyses were conducted to evaluate differences in HIV prevention knowledge, attitudes, and preventive behavior scores between the experimental and control groups using independent t-tests, and within groups across time points using paired t-tests. Effect estimates were reported as mean differences with 95% confidence intervals (95% CI) and corresponding p-values.

Ethical approval: The study received approval from the Human Research Ethics Committee at Mahasarakham University (approval number 287-071/2022). It followed standard procedures, with researchers clearly explaining the study's purpose, advantages, and methods, as well as the responsibilities of participants. Data were kept private and used only for research purposes. Participants could refuse participation or withdraw at any time without negative consequences. All participants provided informed consent before joining the study.

RESULTS

General Information: A total of 60 participants were included, with 30 individuals each in the experimental and control groups. The two groups were comparable in terms of age, educational status, income level, sexual debut characteristics, HIV testing history, condom use, residence, and relationship status. Overall, most participants were undergraduate students with low monthly income, initiated sexual activity before the age of 18, and reported condom use as the primary HIV prevention method. These similarities indicate baseline equivalence between the groups (Table 2).

Knowledge of HIV Prevention: Changes in HIV prevention knowledge were observed across the pre- and post-intervention periods. In the experimental group, the distribution of knowledge levels shifted notably after the intervention, with an increase in participants demonstrating high knowledge and a marked reduction in those with low knowledge. In contrast, the control group showed only minor changes, with most participants remaining at a moderate knowledge level.

Intra-group analysis revealed a statistically significant improvement in mean knowledge scores in the experimental group following the intervention ($p < .001$), whereas no significant change was observed in the control group. Inter-group comparisons indicated no significant difference at baseline; however, post-intervention knowledge scores were significantly higher in the experimental group than in the control group. These findings suggest that the intervention was effective in enhancing HIV prevention knowledge (Tables 3 and 4).

Tabel 1: Overview of the CBGC-Based Mobile Intervention Phases, Objectives, Activities, and Outcomes

Phase	Objectives	Key Activities	Outcomes
Phase 1: Baseline Assessment and Intervention Initiation	• Introduce study procedures and intervention framework • Establish individual and group HIV prevention goals • Collect baseline outcome measures	• Online group orientation and application training • Goal setting and introduction to CBGC principles • Baseline assessment of HIV prevention knowledge, attitudes, and preventive behaviors • Self-directed learning on core HIV prevention content	• Baseline (pre-test) scores for knowledge, attitudes, and preventive behaviors • Participant readiness and engagement with the intervention
Phase 2: Behavioral Skills Training and Self-Management Support	• Enhance motivation and risk perception • Develop cognitive-behavioral skills for HIV prevention • Support sustained behavior change through self-management	• Digital learning modules focusing on motivation and HIV prevention skills • Skills training (e.g., condom negotiation and use, PrEP utilization) • Ongoing self-monitoring and individualized digital follow-up sessions	• Improved HIV prevention knowledge and attitudes • Increased consistency of HIV preventive behaviors • Strengthened self-management skills
Phase 3: Follow-up and Program Evaluation	• Assess maintenance of behavior change • Evaluate long-term application use and program acceptability	• Follow-up assessment conducted three months post-intervention • Evaluation of preventive behaviors and application engagement • Participant feedback on intervention usability and satisfaction	• Follow-up outcome measures for knowledge, attitudes, and preventive behaviors • Evidence of sustainability of behavior change

Table 2: Personal Information (N=60)

Personal Information	Experimental group (n=30)	Control group (n=30)
Age (years old)		
20 years old	3 (10)	3 (10)
21 years old	18 (60)	18 (60)
22 years old	5 (16.67)	5 (16.67)
23 years old	1 (3.33)	1 (3.33)
24 years old	3 (10)	3 (10)
Mean ± SD	21.43 ± 1.07	21.43 ± 1.19
Median; Max - Min	21; 20 -24	21; 20 -24
Education Level		
High school (M.6 or vocational certificate)	4 (13.33)	3 (10)
Undergraduate student	24 (83.33)	26 (86.67)
Postgraduate student	1 (3.33)	1 (3.33)
Current occupation		
Student	27 (90)	27 (90)
Government employee	3 (10)	2 (6.67)
Company/Factory employee	0 (0)	1 (3.33)
Average monthly income (Baht)		
Less than 10,000	28 (93.34)	28 (93.34)
10,001-20,000	2 (6.67)	1 (3.33)
20,001 or higher	0 (0)	1 (3.33)
Median; Max - Min	7000; 2500 - 20000	7000; 3000 - 21000
Age for the first sexual experience (years old)		
Younger than 18	16 (53.33)	17 (56.67)
18 years or older	14 (46.67)	13 (43.33)
Mean ± SD	17.07 ± 2.24	17.27 ± 2.30
Median; Max - Min	17; 13 - 20	17; 13 - 22
History of HIV testing		
Have been tested	17 (56.67)	15 (50)
Never been tested	13 (43.33)	15 (50)
HIV preventive method		
Condom use	26 (86.66)	24 (80)
Condom use and take PrEP medication	2 (6.67)	4 (13.33)
Take PrEP medication	2 (6.67)	2 (6.67)
Current residence location		
Within Mahasarakham Municipality	17 (56.67)	16 (53.33)
Outside Municipality	2 (6.67)	4 (13.33)
Another province	11 (36.66)	10 (3.34)
Currently in a relationship or have a sexual partner		
No	17 (56.67)	15 (50)
Yes	13 (43.33)	15 (50)

Table 3: Knowledge, Attitude and behaviours towards HIV prevention in the experimental group (n=30) and the control group (n=30) in pre-experimental and post-experimental periods

Variables	Experimental Group (n=30)		Control Group (n=30)	
	Before experiment (%)	After experiment (%)	Before experiment (%)	After experiment (%)
Knowledge level				
High Level	3 (10)	11 (36.67)	3 (10)	6 (20)
Moderate Level	18 (60)	18 (60)	20 (66.67)	20 (66.67)
Low Level	9 (30)	1 (3.33)	7 (23.33)	4 (13.33)
Level of attitude and motivation				
High level	16 (53.33)	28 (93.33)	19 (63.33)	20 (66.67)
Moderate level	14 (46.67)	2 (6.67)	11 (36.67)	10 (33.33)
Low level	0 (0)	0 (0)	0 (0)	0 (0)
Level of preventive behaviors				
High level	16 (53.33)	22 (73.33)	17 (56.67)	17 (56.67)
Moderate level	14 (46.67)	8 (26.67)	13 (43.33)	13 (43.33)
Low level	0 (0)	0 (0)	0 (0)	0 (0)

Attitudes Toward HIV Prevention: Regarding attitudes toward HIV prevention, participants in the experimental group demonstrated a substantial improvement following the intervention, with a clear shift toward a high level of positive attitude. The control group exhibited minimal change, with attitude levels remaining largely stable over time.

Statistical analysis showed a significant increase in mean attitude scores within the experimental group ($p < .001$), while changes in the control group were

not statistically significant. Although baseline attitude scores did not differ significantly between groups, post-intervention scores were significantly higher in the experimental group, indicating a positive effect of the intervention on attitudes toward HIV prevention (Tables 3 and 4).

HIV Preventive Behaviors: A similar pattern was observed for HIV preventive behaviors. The experimental group demonstrated an increase in the proportion of participants with high-level preventive behaviors after the intervention, whereas the control group showed no notable change.

Intra-group comparison confirmed a statistically significant improvement in preventive behavior scores in the experimental group (p = .003), while no significant difference was detected in the control group. Baseline comparisons showed equivalence between groups; however, post-intervention preventive behavior scores were significantly higher in the experimental group. These results indicate that the intervention effectively improved HIV preventive behaviors among participants (Tables 3 and 4).

Table 4: Comparison of knowledge on HIV prevention within the experimental and the control groups and between the two groups in pre-experimental and post-experimental periods

Time Period	Experimental group (n=30) Mean ± SD	Control group (n=30) Mean ± SD	Mean difference	95%CI of mean diff.	P-value
For Knowledge					
Pre-experiment	10.13 ± 1.83	10.67 ± 1.60	0.53	-0.36 - 1.42	0.235
Post-experiment	12.13 ± 1.80	11.26 ± 1.50	0.87	0.01 - 1.72	0.048
Mean difference	2.00	0.60			
95%CI of mean diff.	1.06 - 2.94	-0.20 - 1.40			
P-value	<0.001	0.141			
For Attitude					
Pre-experiment	3.75 ± 0.27	3.79 ± 0.28	0.02	-0.22 - 0.22	0.983
Post-experiment	4.00 ± 0.23	3.85 ± 0.27	0.15	0.02 - 0.28	0.023
Mean difference	0.25	0.06			
95%CI of mean diff.	0.11 - 0.39	-0.08 - 0.20			
P-value	<0.001	0.397			
For prevention					
Pre-experiment	3.65 ± 0.44	3.65 ± 0.44	0.00	-0.22 - 0.22	0.983
Post-experiment	4.00 ± 0.43	3.70 ± 0.39	0.29	0.08 - 0.51	0.008
Mean difference	0.35	0.05			
95%CI of mean diff.	0.12 - 0.57	-0.15 - 0.26			
P-value	0.003	0.586			

DISCUSSION

The present study demonstrated that a Cognitive Behavioral Group Counseling (CBGC)-based mobile application significantly improved HIV prevention knowledge, attitudes, and behaviors among adolescent YMSM in Thailand. These findings suggest that digitalizing structured psychological frameworks can effectively bypass traditional barriers to care for high-risk youth.[16]

Scientific Justification for Knowledge and Attitude Shifts: The marked increase in HIV prevention knowledge and the shift toward positive attitudes in the experimental group can be scientifically justified through Cognitive Behavioral Theory (CBT) and Social Cognitive Theory.[18,19] The reason for this observation lies in the 'Interactive Learning' and 'Cognitive Restructuring' components of the application. Unlike passive brochures, the application prompted participants to engage in self-reflection and reactive learning in a private, non-judgmental space. This environment is crucial for YMSM, as it mitigates the 'internalized stigma' that often hinders cognitive retention in clinical settings.[20,21] By addressing cognitive distortions regarding risk perception and outcome expectancy, intervention moved participants from mere awareness to personal responsibility.[22]

Behavioral Change and Skill Acquisition: The significant improvement in preventive behaviors, such as condom negotiation and PrEP utilization, indicates a successful translation of theory into practice. This behavioral shift can be attributed to the inclusion of 'enactive mastery experiences' within the app specifically, the virtual skills-based training.[23] According to behavioral health literature, skills training combined with ongoing self-management support is essential for disrupting established high-risk patterns.[24] The reason the control group showed no change is likely due to the 'Information-Only Gap,' where routine exposure to health facts without a behavioral reinforcement mechanism fails to produce sustained change.[25]

Overall Implications: Overall, the findings highlight the potential of theory-driven, technology-assisted interventions to support HIV prevention efforts among adolescent YMSM.[26] The integration of cognitive-behavioral principles with mobile health technology offers a scalable and accessible approach, particularly for addressing the social isolation often felt by young MSM in high-risk environments.[27] This perspective is consistent with prior literature describing high levels of digital engagement and the benefit of building supportive online communities for this population.[24]

Several limitations of the present study should be acknowledged. First, the study relied on self-reported measures, which may be subject to social desirability bias. Participants may have overreported socially acceptable behaviors, such as condom use or PrEP adherence, to align with perceived researcher expectations. Second, the study sample was limited to YMSM with smartphone access and internet connectivity. While recruitment through digital platforms is an effective strategy for reaching YMSM, it may restrict the generalizability of the findings to those with lower digital literacy or limited technology access.[26,27]

Conclusion

This study provides empirical evidence supporting the effectiveness of a Cognitive Behavioral Group Counseling (CBGC)-based digital intervention in improving HIV prevention knowledge, attitudes, and preventive behaviors among adolescent males who have sex with men. Participants who received the intervention demonstrated significant improvements across all outcome measures compared with those in the control group.

The findings highlight the value of integrating cognitive-behavioral theory with mobile application-based delivery to facilitate health behavior modification. The intervention's structured educational content, motivational enhancement, skills training, and ongoing self-management support were associated with improvements in HIV preventive behaviors within the study period. From a public health perspective, the findings suggest that digital, theory-based interventions may have potential for HIV prevention among the specific high-risk adolescent population and setting studied. Further research is warranted to assess long-term behavioral sustainability, cost-effectiveness, and applicability in other populations and contexts.

In conclusion, the CBGC-based application represents an effective and feasible approach for enhancing HIV prevention efforts among adolescent males who have sex with men within the study context.

Recommendations

Future research should seek to address the limitations identified in the present study and further advance the evidence base for digital HIV prevention interventions among adolescent males who have sex with men.

First, randomized controlled trials with larger and more diverse samples are recommended to strengthen causal inference and enhance the generalizability of findings. Inclusion of participants from different geographic regions, socioeconomic backgrounds, and cultural contexts would provide a more comprehensive understanding of the intervention's effectiveness.

Second, future studies should incorporate objective measures of HIV preventive behaviours, such as biological markers, clinic-based PrEP adherence data, or HIV testing records, to complement self-reported outcomes and reduce potential reporting bias.

Third, longitudinal studies with extended follow-up periods are warranted to examine the long-term sustainability of knowledge gains, attitudinal changes, and preventive behaviours. Such studies would provide critical insights into whether digital interventions can support enduring behaviour change.

Finally, as an exploratory study, this research did not evaluate cost-effectiveness, scalability, or national-level implementation; these issues are therefore presented solely as hypothetical considerations for future research and Comparative effectiveness across platforms or theoretical frameworks was not examined and should be positioned as conceptual future work.

Acknowledgement: The authors wish to express their gratitude to all the participants. The completion of this study would not have been achievable without their valuable contributions.

Individual Authors' Contributions: KU and **SG** contributed to conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing of the original draft, and review and editing of the manuscript. **TP** contributed to investigation, methodology, project administration, resources, supervision, validation, visualization, and review and editing of the manuscript.

Availability of Data: Data supporting this study are openly available from Faculty of Public Health, Maha Sarakham University.

No use of generative AI tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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