ORIGINAL ARTICLE

Mobile Application Intervention for Prevention of Multiple Risk Behaviors among Thai Female Adolescents: A Quasi-experimental Study

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Abstract

Background: Multiple risk behaviors (MRB) among adolescents are correlated with adverse health outcomes. We have devised and examined the effect of a mobile application, STOP Multiple Risk Behaviors ("STOPMRB"), on perceived behavioral control and intention to avoid multiple risk behaviors (MRB) among Thai female adolescents.

Methods: We conducted a two-group pre-post-test, quasi-experimental study involving Thai female adolescents aged 13–15 (N=60) in Samut Prakarn province, Thailand, between March and May 2021. Participants selected for the intervention group (N=30) were provided with access to a mobile application in conjunction with text messages for 8 weeks, whereas the control group (N=30) received standard education curricula. The primary outcome was self-reported risk behaviors. Secondary outcomes encompassed perceived behavioral control and intention to avoid MRB. Outcomes were analyzed using repeated measures ANOVA, Bonferrini test, Fisher's Exact test, and independent t-test through the software IBM SPSS version 28. A significance level was established at a P-value of less than 0.05.

Results: Following a two-month intervention, no MRB was reported among the intervention group, whereas the control group showed 6.7% (P=0.492). The intervention group demonstrated significantly higher mean scores of perceived behavioral control (P<0.001) and the intention to avoid (P<0.001) in comparison to the control group at weeks 4 and 8.

Conclusion: Mobile application, according to STOPMRB, could enhance perceived behavioral control and intention to evade MRB and less self-reported frequency of MRB.

Keywords: Adolescents, Health risk behaviors, Mobile application, Theory of planned behavior

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Introduction

Risk behaviors are the actions or activities that increase the likelihood of harm, injury, or negative consequences for an individual or others, encompassing a wide range of behaviors like substance abuse and unprotected sex. Risk behaviors typically manifest during the period of adolescence, persist into adulthood, and frequently co-occur.[1] Engaging in multiple risk behaviors (MRB) significantly increases the likelihood of chronic disease and all-cause mortality, surpassing the cumulative effects of individual behaviors.[2] Moreover, young individuals who take part in MRB exhibit a greater prevalence of mental health disorders in comparison to their counterparts.[3] MRB are linked with a myriad of adverse health and economic consequences for adolescents and their families, particularly affecting adolescents residing in lower-income nations at a heightened rate.[4] In Thailand, among the adolescent population, MRB such as alcohol consumption, cigarette smoking, and engaging in unprotected sexual activity were considered as the top three risk behaviors and correlated with unintended pregnancies, depression, and diminished quality of life.[5] Findings from the Thailand Health Survey conducted in 2020 indicated that Thai adolescents experience a greater average frequency of these risk behaviors than they express a desire for.[6] In addition, the Thailand National Health Survey in 2022 addressed a staggering number of new HIV infections resulting from unprotected sexual encounters. Half of them were youths aged 15-24 years old.[7] These findings suggest that in the absence of risk reduction programs, the overall rate of these risk behaviors would likely exceed the current figures.

Interventions that concurrently target MRB represent a promising strategy for enhancing lifelong health. The foundational approach leverages evidence demonstrating that modifications in one lifestyle behavior could bolster self-efficacy to effectuate improvements in other behaviors.[8]

Recognizing the co-occurrence of alcohol consumption, cigarette smoking, and engagement in unprotected sexual activity and shared antecedents has led to recommendations for interventions that address multiple, rather than single, risk behaviors in an efficient approach that can provide a cost-effective means of prevention.[9] However, there are few examples of reviews that examine the effectiveness of interventions targeting MRB. Typically, a study focuses on interventions that target behaviors such as alcohol use, tobacco use, and illicit drug use in isolation.[10] The impact of interventions that address multiple substance use risk behaviors, as well as the differential impact of universal versus targeted approaches, is unclear, given that the findings from systematic reviews have been mixed.[11]

Interventions that simultaneously tackle MRB are especially beneficial within educational settings.[12] Notably, considering the limited time available for instruction, Internet technology is progressively being integrated into school curricula. eHealth is defined as the cost-effective and secure use of information and communication technologies in support of health.[13] eHealth interventions that provide health education through the Internet, computers, tablets, and mobile devices facilitate increased student engagement, fidelity, and scalability.[9] Previous reviews have established the effectiveness of eHealth school-based interventions targeting single health behaviors; however, there remains a paucity of knowledge regarding interventions on multiple behaviors.[14-17] The previous reviews which focused on MRB change interventions have predominantly concentrated on adult populations, with limited evidence concerning adolescents.[9] Specifically, women in Asian societies are typically more risk-averse than men in individual risk-taking decisions.[18] The gender differences in social risk taking are predominant in culture-specific contexts with power imbalance among younger age. The adolescent-centric reviews that are available suggest that while universal interventions

for multiple health behavior change may be efficient and cost-effective,[9, 14, 19] further evidence is necessary to ascertain their effectiveness. Although a recent Cochrane review has identified eHealth interventions implemented within school settings to address multiple health behaviors, as effective in enhancing the consumption of fruits and vegetables, promoting physical activity, and diminishing screen time, it did not explicitly address efficacy concerning alcohol consumption or tobacco use.[20] A mobile application, STOP Multiple risk behaviors (STOPMRB) available on mobile devices, permits a more dynamic interaction and engagement between the user and the technology than previously tested digital interventions.[21] In addition, This application was derived from the Theory of Planned Behavior (TPB), whose systematic reviews show its effectiveness in understanding and predicting heterosexual risk behaviors, particularly in adolescents.[22] The TPB posits that behavior is predicted by intention, which is influenced by perceived behavioral control.[5] To the best of our knowledge, this constitutes the inaugural trial assessing an MRB intervention delivered via mobile Health in Thailand. The outcomes contribute to a deeper understanding of how to assist adolescents in Thailand in evading MRB. This study aimed to examine the effect of a mobile application intervention for the prevention of MRB among Thai female adolescents.

Materials and Methods

This investigation was conducted as a quasi-experimental study. The sample comprised 60 female adolescents enrolled in secondary educational institutions located in a Samut Prakarn province, Thailand, from March to May 2021. To determine the sample size based on the findings from a similar previous study,[23] we conducted a power analysis of the F-test using ANOVA Repeated measures for 80% study power, 3 as the number of measurements, and a statistically significant level of 0.05. The effect size was moderated as mentioned in Polit and Hungler[24] and modeled on a previous study that resembles the current research on risk behavior outcomes in obtaining messages online.[23] The desired sample size was calculated to be 24 participants per group. The requisite sample size was ascertained to be 25 participants per group. This sample size calculation presupposed a 20% attrition rate over one year. Consequently, the total number of participants targeted for this study was 60 individuals designated for each group.

Two eligible schools were randomly selected to comprise either the control or intervention school, thereby ensuring the concealment of allocation. These schools were located in different areas but had similar curricula. In order to enhance research credibility, in each school, three classrooms (grades 7-9) were selected, and only 30 female students who were interested in the program were contacted. The first researcher briefly provided an information statement to see if the female adolescents were interested. The inclusion criteria were informed consent from parents and adolescents to participate in the study, 13–15 years of age, experience in either cigarette smoking or drinking alcohol, or sexual activity, possession of a smartphone, and voluntary participation in the program for two months. The exclusion criteria included withdrawing from school, having mental health issues, and being unwilling to continue participation in the intervention.

Each participant assigned to the intervention group had personal login credentials for the mobile application, and the study questionnaires were sent within sealed envelopes, while the control group received logins that permitted only the downloading of study questionnaires. The researchers were accessible to assist in downloading the study questionnaires and were also equipped to train the participants in the use of the mobile application. Baseline data were collected after the inclusion of participants in the study.

The two-month (8 weeks) intervention consisted of a mobile application designed to mitigate the risk behaviors among the youth,

designated as 'STOPMRB'. The application was developed based on the results of a prior study,[5] individual interviews, and focus group discussions with female adolescents; it was underpinned by health behavior change models, the TPB.[25] This application disseminated youth-friendly snippets of information pertinent to risk prevention directly to the participants' mobile devices. Furthermore, it encompassed an interactive component that featured weekly quizzes, brief films, diverse scenarios, news updates, and counseling services. Individual reminders related to risk-taking behavior were narrated by peers. The activities and information snippets were subject to periodic updates throughout the 2-month intervention. Participants in the intervention group received between two to four novel activities or information snippets each week throughout the entirety of the study period (Table 1). They also received a standard education plan in formal curricula.

All follow-up assessments were conducted remotely via the Internet. Data were gathered at baseline, at week 4, and week 8 after the intervention. Identical follow-up questionnaires were integrated into the application for both groups. Responses submitted electronically by the participants were securely stored within a protected database. The control group only received the standard education plan in formal curricula during the study. They were able to log in to the STOPMRB mobile application at the end of the study.

The primary outcome was the self-reported risk behaviors exhibited by youth over the preceding month, specifically the percentage of female adolescents who engaged in smoking, alcohol consumption, or sexual activity. Individuals exhibiting at least two risk behaviors were categorized as 'having MRB,' whereas those demonstrating one or fewer risk behaviors were classified as "not having MRB." A panel of three experts (one registered nurse, one university instructor with expertise in adolescent care, and one medical doctor with expertise in mental health) examined the content validity.

The secondary outcomes were perceived behavioral control and intention to avoid MRB. Perceived behavioral control was determined using a scoring questionnaire from a 10-item scale to evaluate the participants' perceptions

Table 1: Content of the intervention to reduce multiple risk behaviors among female adolescents in Thailand

Week	Topics	Activities
Week 1	- Introduction for mobile app "STOPMRB"[a] - Strengthen perceive behavior control	- Daily diary to monitor risk behaviors including alcohol, smoking, sexual encounters - Personal skill development "Ability to say NO" - Share experiences with lived model and interactive short movie on how to avoid potential risk situations
Week 2	- Strengthen perceive behavior control	- Reviewed and reflective feedback for individual diary through private chat - Understanding techniques to avoid risk taking through puzzle games and quiz - Individual counselling via private chat
Week 3	- Strengthen intentions to avoid MRB[b]	- Reviewed and reflective feedback for individual diary through private chat - Learning about risk situations from short movie including alcohol, smoking, sexual encounters - Emotional arousal related to risk situations and plan how to avoid selected situations - Group discussion on bulletin board
Week 4	- Strengthen intentions to avoid MRB	- Reviewed and reflective feedback for individual diary through private chat - Learning about risk situations in current news and discuss for strategies to avoid risk taking - Group discussion on bulletin board
Week 5-8	- Strengthen intentions to avoid MRB	- Weekly messages to monitor risk behavior control

[a]STOPMRB: Stop Multiple Risk Behaviors; [b]MRB: Multiple Risk Behaviors

regarding behavior management. The scoring was conducted on a 4-point Likert scale, ranging from "less likely" (1) to "very strong" (4). The total score could vary from 10 to 40 points, with higher scores indicating superior behavior control. In this study, a S-CVI and CVR were 0.92 and 1, respectively. In a pilot study conducted among Thai adolescents who had similar characteristics to the studied participants for testing the reliability of the outcome measures, Cronbach's alpha coefficient was 0.95.

Intention to avoid MRB was assessed based on a score from an 8-item scale, developed by the research team to gauge the participants' decisions to avoid MRB. This was also scored on a 4-point Likert scale, from "less likely" (1) to "very strong" (4). The scoring range was from 8 to 32, with higher scores indicating a stronger intention to avoid MRB. In this study, an S-CVI and CVR equaled 1. In a pilot study that was conducted among Thai adolescents who had similar characteristics with the studied participants, Cronbach's alpha coefficient was 0.81.

The research data were analyzed using IBM SPSS version 28. Personal descriptive statistics were computed for all outcomes and demographic characteristics. The continuous variables were tested for normality distribution and assumption testing with parametric statistics before the analysis. Between- and within-groups comparisons of the perceived behavioral control and intention to avoid MRB were done using an independent t-test, repeated ANOVA measurement, and Bonferroni correction. A significance level was established at a P-value of less than 0.05.

Given sufficient information and time to decide whether to become involved were made voluntarily before deciding with parental consent, all relevant information was provided to both the individual and parents to decide whether or not to participate in the research before signing a written informed consent form. The human rights and confidentiality of all participants were ensured in the whole research process. All participants had the right to withdraw at any time without penalty or effect on their studies. During the participation in the program, any mental health problems were monitored by the research team. All personal privacy information was anonymized and remained confidential. The research data and all documents will be destroyed after five years.

The study protocol received the Ethics Certificate of Research Project in Humans from the Boromarajonani College of Nursing, Bangkok Institutional Review Board (COA. #BCNB-2563-01).

Results

The participants in the intervention and control groups were not statistically different in age, education level, grade point average (GPA), money allowance, living status, parental marital status, and family relationship (P>0.05) (Table 2). The intervention group had a mean age of 13.87±0.77 years, mean GPA of 3.36±0.34, and an average daily money allowance of 110.60±25.51 Thai Baht (3.2 USD). The control group had a mean age of 14.07±0.82 years, mean GPA of 3.22±0.59, and an average daily money allowance of 103.67±20.08 Thai Baht (3USD).

The results showed that the mean score of perceived behavior control in the intervention group was higher than the control group after attending the program at week 4 (P<0.001) and Week 8 (P<0.001). The differences in the mean of perceived behavior control score within the intervention group were statistically significant (P<0.001), whereas there was no statistically significant difference within the control group (P=0.411) (Table 3). In addition, pairwise comparison showed that the differences in the mean of perceived behavior control score between the pre-test and week 4 (P<0.001), pre-test and week 8 (P<0.001), and week 4 and week 8 (P<0.001) were statistically significant (Table 4).

The mean score of intention to avoid MRB in the intervention group was higher than that in the control group after attending the program at week 4 (P<0.001) and week 8 (P<0.001).

Table 2: Comparison of demographic characteristics between the intervention and control groups

Variables	Intervention (N=30) N (%)	Control (N=30) N (%)	P value*
Age			
13	11 (36.70)	9 (30.00)	
14	12 (40.00)	10 (33.30)	0.530
15	7 (23.30)	11 (36.70)	
GPA[a]			
2.01-2.50	1 (3.30)	6 (20.00)	
2.51-3.00	4 (13.30)	7 (23.30)	0.584
>3.01	25 (83.40)	17 (56.70)	
Education level			
Grade 7	10 (33.30)	10 (33.30)	
Grade 8	11 (36.70)	9 (30.00)	0.819
Grade 9	9 (30.00)	11 (36.70)	
Daily expenses (Thai Baht)			
51–100	17 (56.70)	20 (66.70)	0.426
>100	13 (43.30)	10 (33.30)	
Living status			
Living with father/mother/siblings	26 (86.70)	23 (76.70)	
Living with father/mother	3 (10.00)	2 (6.60)	0.218
Living with relatives	1 (3.30)	5 (16.70)	
Parental marital status			
Married	21 (70.00)	24 (80.00)	
Divorced/Separated	8 (26.70)	6 (20.00)	0.476
Widowed	1 (3.30)	0 (0.00)	
Family relationship			
Estrangement	1 (3.30)	0 (0.00)	
Fighting	0 (0.00)	2 (6.70)	0.221
Affectionate	29 (96.70)	28 (93.30)	

[a]GPA: Grade Point Average; *Chi-square test

Table 3: Comparison of behavior outcomes, perceived behavior control, and intention to avoid multiple risk behaviors between the intervention and control groups before the intervention, week 4 and week 8 after the intervention

Variables	Intervention group Mean±SD	Control group Mean±SD	P value*
Perceived behavior control			
Pretest	30.03±2.93	30.50±2.19	0.488
Week 4	32.80±1.88	30.70±2.15	<0.001
Week 8	34.70±2.57	30.83±1.96	<0.001
P value**	<0.001	0.411	
Intention to avoid MRB[a]			
Pretest	20.33±1.91	20.07±1.79	0.581
Week 4	22.53±1.75	20.30±2.10	<0.001
Week 8	25.20±2.60	20.73±2.44	<0.001
P value**	<0.001	0.152	
Reported MRB	**N (%)**	**N (%)**	
Week 8	0 (0.00)	2 (6.70)	0.492***

[a]MRB: Multiple Risk Behaviors; *Independent t-test; **Repeated measurement; ***Fisher's Exact test

Table 4: Pairwise comparison of perceived behavior control and intention to avoid multiple risk behaviors among the intervention groups at different times

Factors	Mean difference±SD	P value*
Perceived behavior control		
Week 4 vs. Pretest	2.77±0.49	<0.001
Week 8 vs. Pretest	4.67±0.69	<0.001
Week 8 vs. Week 4	1.90±0.38	<0.001
Intention to avoid MRB[a]		
Week 4 vs. Pretest	2.20±0.36	<0.001
Week 8 vs. Pretest	4.87±0.48	<0.001
Week 8 vs. Week 4	2.67±0.48	<0.001

[a]MRB: Multiple Risk Behaviors; *Bonferroni for pairwise comparisons

Within-group comparison showed that there was a statistically significant difference in the mean of intention to avoid MRB score in the intervention group (P<0.001), whereas there was no such difference within the control group (P=0.152) (Table 3). In addition, pairwise comparison showed that the differences in the means of intention to avoid MRB score between the pre-test and week 4 (P<0.001), pre-test and week 8 (P<0.001), and week 4 and week 8 (P<0.001) were statistically significant (Table 4).

At week 8, no MRB was reported among the intervention group, whereas 6.7% in the control group showed MRB (P=0.492) (Table 3).

Discussion

This investigation indicates that the mobile application studied has the potential to augment perceived behavioral control and the intention to eschew MRB among Thai female adolescents. The activities encompassed within this study amalgamated educational messages with motivational skills aiming at persuading and empowering participants to modify their behaviors. The application featured messages designed to remind female adolescents to refrain from engaging in risk behaviors associated with smoking, alcohol consumption, and sexual activities. The interactive film employed encouraged the adolescents to engage in episodic future thinking to help prepare for relationships and sexual health decision making.[26, 27] Film as an interactive teaching method promotes the type of engaged learning that is required in youth education. Emotions play a significant role in the formulation of new knowledge, attitudes, and behavior. Therefore, initiatives such as storytelling, theatre, and film have the capacity to target affective domains and enhance the learners' understanding of human experience.[28, 29]

The intervention that employed text-only messages exhibited no statistically significant differences between the control and intervention groups.[30] One plausible explanation for this phenomenon is that text messages, in isolation, enhance the participants' knowledge and psychosocial support. However, this methodology constitutes a unidirectional form of communication.[31] Consequently, a minimal impact on health outcomes maybe guaranteed. Therefore, it is conceivable that such an approach may not be deemed a standalone strategy.[30]

This study illustrates that the development of skills can be leveraged to augment the efficacy of theory-based text messages. This finding corroborates the conclusion drawn from a systematic review indicating that interventions should adhere to a theoretical model of behavior change to enhance the effectiveness of text messaging.[21] A review addressing behavior modification showed that knowledge could be provided through large-scale campaigns. Once an individual is aware that a behavior change could positively affect his/her current or future health, several other resources may be required to spike interest in behavior change and move into the motivational engagement phase.

The empowerment aspect concerning skills and competencies could facilitate success in behavior change initiatives.[32] Education empowerment through formal education was seen as crucial in girls' development, from interactions with friends to cultural practices.[33] Digital literacy interventions such as mobile phones, mobile health tools, media exposure, access to the Internet, Internet-based educational strategies, and social media exposure are effective to empower adolescent girls to access health services and information, and also enhance access to educational resources.[34] The present study developed messages across diverse platforms about risk behaviors, each with a specific and clear outcome. Thus, concentrating on a particular outcome can enhance the efficacy of the intervention.[17]

Furthermore, it appears that participants who received text messages as reminders exhibited a greater intention to avoid MRB compared to those who did not. Text messages may serve as informational support to sustain behavior modification, as they enhance adaptation and emotional well-being throughout the adolescent phase. It is plausible that the younger age of the participants, coupled with a more individualized design, contributed to the favorable outcomes.[35, 36]

In summary, the efficacy of mobile health interventions seems to diminish over extended follow-up periods.[35] Interventions lasting 30 to 60 minutes and 60 to 180 minutes per week, including physical activity and exercise interventions, were effective in the short term in reducing depression.[35] Studies with follow-up durations ranging from 1 to 5 months demonstrated a more pronounced impact on behavioral outcomes than those with follow-up periods extending beyond 6 months.[35] Similarly, in our study, the intervention had a more favorable effect on the avoidance of MRB at the 2-month follow-up. It is conceivable that the intervention would yield greater benefits by targeting youth in the early stages of adolescence when desired behaviors are yet to be cultivated, rather than at later stages when behavior modification becomes increasingly arduous.[37] Early life intervention may be warranted for favorable lifelong health and decreased health inequalities later in life. In this study, it has been observed that since there were no instances of dropout or withdrawal before the study completion, the intervention appeared to be more attractive to female participants, thereby underscoring the need for interventions to be customized to the distinct needs of each gender.

One of the notable strengths of this study was that the content of the text messages encompassed all facets of the top 3 risk behaviors among Thai adolescents, ensuring that participants received valid information pertinent to their needs. Moreover, text messages can function as a supportive tool for participants. Lastly, with specific regard to avoiding MRB, interactive IT-based interventions demonstrate effectiveness in facilitating learning and exhibit positive effects on self-efficacy intentions and behavioral outcomes.

This study has the potential to augment perceived behavioral control and intention to avert MRB among Thai female adolescents, thereby mitigating instances of MRB. The mobile application encompassed educational content and motivational techniques designed to persuade and empower female adolescents to enhance their avoidance of risk behaviors related to smoking, alcohol consumption, and sexual activities. However, this investigation was specifically formulated to prevent MRB among female adolescents. To adapt this program for alternative demographics or varying populations, attention must be paid to the context of gender and its inherent characteristics. Furthermore, the limited sample size may potentially diminish the statistical power of the findings. Incorporating a dose-response mechanism via text messages over an extended duration may enhance the disparity in healthcare behaviors among different groups.

Conclusion

Mobile application, according to STOPMRB,

could enhance perceived behavioral control and intention to evade MRB and lower self-reported frequency of MRB among Thai Female Adolescents. Future research should concentrate on targeting diverse subgroups within the overarching risk population, such as older teenagers. The development of these interventions should occur in close collaboration with the target population's demographics. Educational institutions should integrate this mobile application into their curricula to ensure that adolescents acquire the critical skills necessary for preventing MRB.

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Authors' Contribution

PT, AP, and SB designed the study. PT and SB undertook mobile application development. Data collection was conducted by PT and YM. AP conducted data analysis and drafted the manuscript. All authors critically reviewed and approved the final version of the manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis. The corresponding author attests that all listed authors meet authorship criteria and that no others inclusion criteria have been omitted.

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Conflict of Interest

None declared

Declaration on the use of AI

The authors of this manuscript declare that no artificial intelligence (AI) was used during the writing process.

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