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The Effectiveness of "Retako" Mobile Application on Proactive Coping Strategies for Smoking Cessation among Adolescents in Bandung, Indonesia

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ABSTRACT

Background: Mobile health (mHealth) applications offer innovative solutions for health interventions, particularly in culturally diverse settings such as Indonesia. This study aimed to evaluate the effectiveness of the "Retako" mobile application in improving proactive coping strategies for smoking cessation among adolescents in Bandung, Indonesia. **Methods:** A quasi-experimental study with repeated measures was conducted among 240 adolescents aged 15–18 years. Participants were divided into intervention and control groups, and data were collected at baseline, 6 weeks, and 12 weeks using the Proactive Coping Inventory (PCI). Repeated measures ANOVA and post-hoc tests were used to evaluate changes in proactive coping scores, with effect sizes calculated to determine the magnitude of differences. **Results:** The intervention group showed a statistically significant increase in proactive coping mean scores, from a baseline of 20.5 ± 3.2 to 30.1 ± 2.9 at 12 weeks, indicating a large effect size (Cohen's d = 3.25, $p < 0.001$). Post-hoc analysis revealed statistically significant improvements both within the intervention group over time and between the intervention and control groups. The control group showed minimal change, emphasizing the app's specific contribution to enhancing proactive coping. **Conclusion:** The "Retako" mobile application significantly enhances proactive coping strategies among adolescents, demonstrating its efficacy as a culturally tailored and scalable smoking cessation tool. Future research should explore its long-term effects and potential for broader implementation in diverse populations.

Keywords: Adolescents; Mhealth; Mobile Application; Proactive Coping; Smoking Cessation Indonesia

INTRODUCTION

Adolescence represents a critical developmental period marked by rapid physical, cognitive, and psychosocial changes. During this stage, individuals are particularly vulnerable to initiating health-risk behaviours, including tobacco use, which can result in lifelong addiction and adverse health outcomes (WHO, 2020). Globally, smoking continues to be one of the leading causes of preventable death, contributing to over 8 million deaths annually, with many of these deaths linked to smoking behaviours established in adolescence (Torazzi *et al*., 2024). The early initiation of smoking increases the risk of chronic respiratory conditions, cardiovascular disease, and various cancers in adulthood (Ofori, Amponsah, & Pathak, 2023). In Indonesia, adolescent smoking continues to pose a substantial public health challenge.

According to the 2018 Basic Health Research (RISKESDAS), approximately 9.1% of adolescents aged 10–18 years were active smokers (Ministry of Health Republic of Indonesia, 2018). However, more recent data suggest that this figure may be even higher. A cross-sectional study by Ekawati *et al*. (2024) reported that nearly 19.6% of adolescents in rural Indonesia engage in smoking, with up to 85% being exposed to tobacco smoke.

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This upward trend in tobacco use among youth underscores the urgency of implementing effective, context-specific interventions.

One contributing factor to the high prevalence of adolescent smoking in Indonesia is the widespread availability of single-stick or "loose" cigarettes, which are more affordable and accessible to minors. A mixed-methods study by Melinda *et al*. (2025) found that nearly 68% of young smokers in Indonesia had purchased loose cigarettes, a behavior significantly associated with early smoking initiation. In response to this ongoing issue, the Indonesian government enacted stronger tobacco control policies in July 2024. These included raising the minimum legal age for purchasing cigarettes from 18 to 21, banning the sale of single-stick cigarettes, and prohibiting cigarette sales within 200 meters of schools and playgrounds (Ekawati *et al*., 2024). These regulatory measures aim to reduce adolescents' access to tobacco products and discourage early smoking initiation.

Despite regulatory efforts, there remains a critical need for behavioural interventions tailored to adolescents. Pharmacological treatments for smoking cessation, such as cytisine, have shown promise. A recent systematic review and meta-analysis revealed that cytisine is more effective than placebo and nicotine replacement therapy and offers efficacy comparable to varenicline, with fewer adverse effects (Ofori, Amponsah, & Pathak, 2023). However, pharmacological approaches alone may not sufficiently address the psychosocial and environmental factors influencing adolescent smoking.

Adolescents are particularly susceptible to peer influence and environmental triggers, necessitating interventions that enhance psychological resilience and self-regulatory capacities. Proactive coping is a vital skill that enables individuals to anticipate and manage potential stressors before they escalate, thus reducing their dependence on reactive or avoidant behaviours (Galla *et al.*, 2014). Adolescents who employ proactive coping strategies are more likely to resist social pressures to smoke and maintain abstinence (Yang & Jiang, 2022). This aligns with developmental theories emphasizing the importance of fostering autonomy, self-regulation, and resilience during adolescence (Cummins *et al.*, 2021). Nevertheless, traditional smoking cessation programs often neglect the unique developmental and psychosocial needs of adolescents, underscoring the need for innovative approaches (Gliwska & Mańczuk, 2024).

Mobile health (mHealth) applications represent a promising modality for delivering adolescent-centred smoking cessation interventions. These digital tools offer real-time feedback, interactive content, and personalised support, making them particularly appealing to tech-savvy adolescents (Agulleiro *et al*., 2023). A meta-analysis by Cummins *et al*. (2021) found that mHealth apps incorporating behavioural reinforcement and gamification were effective in reducing smoking prevalence among young users. However, most existing apps are not culturally adapted, limiting their effectiveness in diverse populations such as Indonesian adolescents (Plaitano *et al*., 2025). Sociocultural norms, familial smoking behaviours, and peer influence significantly shape adolescents' smoking behaviour in Indonesia, indicating a need for culturally sensitive, locally grounded interventions (Listiyandini *et al.*, 2023).

To address this gap, the "Retako" mobile application was developed as a culturally adapted, evidence-based intervention integrating proactive coping strategies and cognitive-behavioural techniques tailored for Indonesian adolescents. It includes features such as scenario planning, peer support forums, motivational content, and interactive modules. Early evidence suggests that culturally relevant digital tools can significantly enhance engagement, self-regulation, and long-term behavior change among adolescents (Guo *et al*., 2023).

Nurses play a critical role in advancing adolescent smoking cessation through health education, behavioural counselling, and the implementation of tailored digital health tools (Lee, & Yu, 2025). Positioned at the forefront of adolescent healthcare, nurses can identify at-risk youth, deliver proactive coping interventions, and support sustained behaviour change. Moreover, their involvement in the development, implementation, and evaluation of culturally appropriate mHealth applications ensures that interventions are accessible, relevant, and grounded in practice.

While the evidence for mHealth in smoking cessation is growing, few studies have specifically evaluated the impact of proactive coping-based digital interventions among adolescents in Indonesia. Most existing research has focused on short-term behavioural outcomes, with limited data on long-term sustainability

(Ekawati *et al*., 2024). Additionally, few studies have examined how individual interventions interact with broader social and environmental influences, such as peer norms and urbanisation in low- and middle-income countries (Azzopardi *et al*., 2019). Therefore, this study aims to evaluate the effectiveness of the Retako mobile application in enhancing proactive coping and promoting smoking cessation among adolescents in Bandung, Indonesia. By addressing both developmental and contextual factors, this research seeks to inform the design of scalable, culturally relevant interventions to reduce adolescent smoking in Indonesia.

METHODOLOGY

Research Design

This study applied a quasi-experimental design with a repeated measures approach to evaluate the effectiveness of the "Retako" mobile application on proactive coping for smoking cessation among adolescents in Bandung, Indonesia. Data were collected at baseline, 6 weeks, and 12 weeks. The repeated measures design allowed the assessment of changes in proactive coping over time in both the intervention and control groups. The hypothesis of this study was adolescents who use the "Retako" mobile application will demonstrate significantly greater improvements in proactive coping for smoking cessation over time (from baseline to 6 and 12 weeks) compared to those in the control group receiving standard health education.

Participants

Participants for this study were adolescents aged 15–18 years who met the following inclusion criteria: (1) currently smoking at least one cigarette per day, (2) able to operate a smartphone with internet access, and (3) provided informed consent (with parental consent required for participants under 18). Adolescents were excluded if they had a medical condition that contraindicated participation in the intervention or were enrolled in another smoking cessation program during the study period.

The required sample size was calculated using G*Power version 3.1.9.7 for a repeated measures analysis of variance (ANOVA), with an alpha level of 0.05, a power of 0.95, and a medium effect size of 0.25. The estimated minimum sample size was 240 participants, including adjustments for potential attrition.

Participants were recruited through convenience sampling from senior high schools in Bandung, Indonesia. Schools were selected based on the following criteria: (1) Accessibility to the research team in terms of geographic location and administrative permission; (2) Willingness to participate, indicated by approval from school administrators and support for data collection activities; (3) Representation from both public and private sectors, including general academic high schools and vocational high schools, to ensure diversity in student demographics; and (4) Affiliation with local education authorities, ensuring the schools were officially recognised under the Ministry of Education or equivalent regulatory bodies. Eligible students from selected schools were invited to participate following an initial screening process to confirm compliance with inclusion and exclusion criteria.

Intervention Protocol

The intervention employed the "Retako" mobile application, designed to enhance proactive coping for smoking cessation among adolescents based on Proactive Coping Theory and Social Cognitive Theory. Over a 12-week period, participants in the intervention group accessed weekly sessions combining brief theoretical content (5–10 minutes) with practical exercises. The theoretical sessions introduced key concepts, such as self-efficacy, trigger management, and relapse prevention, while the practical sessions included interactive coping tasks, mindfulness exercises, and problem-solving challenges to reinforce behavioural change.

The intervention's general objective was to assess the effectiveness of the app in promoting proactive coping and smoking cessation. Each weekly module had specific goals, including building motivation, identifying triggers, practising mindfulness, and developing relapse prevention strategies. Teaching strategies included microlearning, gamification, peer modelling, and self-monitoring. Participants completed end-of-session quizzes and weekly reflective journals, while researchers tracked engagement through an integrated dashboard. Reminders and motivational messages were sent to participants with low activity, and optional virtual counselling was available via the app's chat feature.

Educational materials included interactive in-app modules, a digital booklet titled "Quit Smart with Retako", audio-guided mindfulness tracks, and visual progress charts. The control group received standard printed pamphlets on the risks of smoking. Assessments were conducted at baseline, week 6, and week 12 to evaluate smoking status, coping behaviours, and app usability. After the study, intervention participants could continue using the app, while control participants were granted access post-evaluation.

Instrument

The Proactive Coping Inventory (PCI), developed by Greenglass *et al*. (1999), was employed to assess participants' proactive coping strategies. The inventory consists of 21 items, each rated on a 4-point Likert scale, ranging from 1 (not at all true) to 4 (completely true). Total scores are calculated by summing the responses, with higher scores reflecting a stronger tendency toward proactive coping.

Reliability of the instrument was tested using Cronbach's alpha test. The PCI demonstrated strong reliability with a Cronbach's alpha of 0.85 in the original study. The translated version showed a Cronbach's alpha of 0.82 in a pilot test conducted among adolescents in Indonesia.

Data Collection or Field Work

The actual work of the study was carried out over a period of five months, encompassing recruitment, intervention delivery, and follow-up assessments. The researcher was available in the study setting, selecting schools in Bandung for three days per week to coordinate data collection, monitor intervention adherence, and provide technical support. Data were collected directly by the researcher through individual interviews or in small supervised group settings, depending on the school's schedule and participant availability. Each participant required approximately 20–30 minutes to complete the structured questionnaire, which included demographic data and the PCI. During school-based sessions, participants were informed about the study's objectives and procedures, and informed consent was obtained from all adolescents and their parents, when applicable. Baseline assessments were conducted prior to group assignment. Participants in the intervention group received training on how to use the "Retako" mobile application, while the control group received standard health education materials. At the end of the 12-week intervention, participants in the intervention group were asked to complete an online survey to provide feedback on the app's usability and perceived effectiveness.

Statistical Analysis

Statistical analysis was performed using SPSS version 25 (Chicago, SPSS Inc.). Means, standard deviations, frequencies, and percentages were calculated for demographic variables. Repeated measures ANOVA was performed to compare changes in proactive coping scores over time between groups. Post-hoc tests were conducted to identify specific time-point differences. Effect sizes were calculated to assess the magnitude of changes.

Ethical Consideration

The researchers obtained ethical clearance from the Institutional Review Board (IRB) of STIKep PPNI Jawa Barat, Indonesia with approval number III/018/KEPK/STIKep/PPNI/Jabar/III/2024 on 3rd February 2024.

All research procedures complied with the ethical principles outlined in the Declaration of Helsinki and relevant national ethical guidelines. In terms of administrative procedures, formal approval was obtained from the principals and administrative heads of participating schools following a detailed explanation of the study's purpose, expected outcomes, implementation procedures, and timeline. This ensured full institutional cooperation and facilitated smooth execution of the study activities within the school setting. Prior to participation, all adolescents and their parents (for those under 18) received comprehensive information regarding the study's objectives, procedures, potential risks and benefits, and their rights as participants. Written informed consent was obtained from all participants and/or their legal guardians. Confidentiality was strictly maintained through the use of anonymised data and secure, password-protected databases. Participants were informed of their right to withdraw from the study at any time without penalty. To ensure psychological safety, support measures were in place, including referrals to counselling or support services for those

experiencing emotional distress during or after participation.

RESULTS

Table 1 presents the demographic characteristics of participants in the intervention and control groups, each consisting of 120 adolescents aged 15–18 years. The mean age of participants was 16.5 ± 1.2 years in the intervention group and 16.6 ± 1.1 years in the control group. Males constituted the majority in both groups (58.3% in the intervention group and 60.0% in the control group). Most participants were enrolled in senior high school, with 75.0% in the intervention group and 70.8% in the control group. The two groups were comparable across all demographic variables.

Table 1: Demographic Comparison between Intervention and Control Group

Demographic Characteristics	Intervention Group (n=120)	Control Group (n=120)	*p*-value
Age (mean ± SD)	16.5 ± 1.2	16.6 ± 1.1	0.458
Gender (% Male)	55%	58%	0.651
Smoking Duration (mean ± SD, years)	2.5 ± 0.9	2.6 ± 1.0	0.421
Cigarettes Per Day (mean ± SD)	10.5 ± 3.1	11.0 ± 3.0	0. 392

The results of the repeated measures ANOVA for proactive coping scores reveal significant differences within the intervention and control groups over time (Table 2). In the intervention group, the mean proactive coping score increased substantially from baseline (20.5 ± 3.2) to the 12th week (30.1 ± 2.9). This improvement was statistically significant with a *p*-value of <0.001 and a large effect size (Cohen's d = 3.25). In contrast, the control group showed minimal changes in mean proactive coping scores, which rose slightly from baseline (20.3 ± 3.1) to week 12 (22.0 ± 3.5). The changes in the control group were not statistically significant, with a *p*-value of 0.732 and a smaller effect size (Cohen's d = 0.75).

Table 2: Repeated measures ANOVA for Proactive Coping Scores

Group	Baseline (Mean ± SD)	Week 6 (Mean ± SD)	Week 12 (Mean ± SD)	*p*-value	Effect Size (Cohen's d)
Intervention group	20.5 ± 3.2	28.2 ± 3.0	30.1 ± 2.9	<0.001	3.25
Control group	20.3 ± 3.1	21.5 ± 3.4	22.0 ± 3.5	0.732	0.75

The post-hoc analysis of the Retako App's effect on proactive coping scores reveals significant differences between groups (Table 3). When comparing the Retako App group to the Control group, there was a mean difference of 15.2 (SE = 3.4), with a p-value indicating significance (p = 1), and a 95% confidence interval ranging from 8.4 to 22.0. Similarly, the comparison between the Retako App group and their baseline scores showed a mean difference of 12.7 (SE = 3.2), which was statistically significant (p = 4), with the confidence interval ranging from 6.4 to 19.0. In contrast, the comparison between the control group and their baseline revealed a mean difference of 2.5 (SE = 1.8), which was not statistically significant (p = 234), with the confidence interval ranging from -1.2 to 6.2.

Table 3: Post-Hoc test of Retako App on Proactive Coping Score

Group Comparison	Mean Difference	Standard Error	*p*-value	95% Confidence Interval
Retako App vs Control	15.2	3.4	1	[8.4, 22.0]
Retako App vs Baseline	12.7	3.2	4	[6.4, 19.0]
Control vs Baseline	2.5	1.8	234	[-1.2, 6.2]

DISCUSSION

The findings of this study demonstrate that proactive coping scores improved significantly over time in the intervention group compared to the control group. This outcome suggests the effectiveness of the "Retako" mobile application as a tool to enhance proactive coping among adolescents aiming for smoking cessation. Proactive coping is critical in managing stressors like smoking addiction, as it equips individuals with the skills

needed to anticipate and address challenges effectively (Kaur *et al*., 2022). These findings align with previous studies that explored digital interventions to enhance coping mechanisms. For instance, Hoeppner *et al*. (2019) found that mobile applications focusing on skill-building and self-regulation significantly improved coping behaviours in adolescents with substance use disorders. Similarly, a study by Agulleiro *et al*. (2023) reported that adolescents using interactive modules for stress management demonstrated enhanced proactive behaviours compared to those receiving standard education.

In the context of smoking cessation, mobile applications have shown promising results. Hadiyani *et al*. (2023) found that incorporating daily reminders and personalised feedback significantly improved adherence to cessation programmes and proactive coping strategies. Additionally, Cheng and Chau (2022) highlighted the role of gamification in enhancing user engagement, which likely contributed to higher proactive coping scores in the intervention group. These studies corroborate the effectiveness of structured, technology-based interventions in fostering adaptive coping mechanisms. A study by White *et al.* (2024) examining a similar intervention noted variability in outcomes due to differences in user engagement and app adherence. Moreover, previous studies by Plaitano *et al*. (2025) and Listiyandin *et al*. (2023) introduced a smartwatch application that detects smoking-related hand movements and delivers supportive messages in real-time. Participants reported increased awareness and encouragement, suggesting that wearable technology could complement existing cessation tools. However, not all findings have been consistent. This study suggests that while mobile applications have potential, their impact is moderated by external factors, such as user motivation and contextual support.

The observed improvement in proactive coping scores in the intervention group can be attributed to several factors, including the following: First, the interactive nature of the "Retako" app, which includes personalised feedback and daily reminders, may have enhanced user engagement and facilitated skill acquisition. Research has shown that interactive technologies improve adherence to health interventions by promoting user autonomy and engagement (Wei *et al*., 2020). Second, the structured design of the modules likely provided adolescents with practical tools to anticipate and manage smoking-related challenges, aligning with principles of proactive coping theory (Perkins, 2025). Additionally, the inclusion of coping exercises within the app may have helped participants internalise and practice effective strategies, as suggested by similar findings in digital health interventions (Agarwal *et al*., 2025). Despite these strengths, several barriers may have influenced the outcomes. Limited access to smartphones or internet connectivity in certain participants might have restricted their engagement with the app, consistent with findings by Linardon (2023), who highlighted technological access as a significant barrier in digital interventions. Furthermore, individual differences in motivation levels and social support could have contributed to variations in proactive coping improvement. Prior studies (Wei *et al*., 2020) have emphasised the importance of supportive environments in enhancing the efficacy of such interventions, as social support often acts as a critical enabler of behaviour change (Guo *et al*., 2023).

The "Retako" mobile application represents a scalable and cost-effective solution for promoting proactive coping strategies among adolescents. This app aligns with recent trends in digital health interventions, which leverage technology to enhance self-regulation and resilience in younger populations (Giovanelli, Ozer, & Dahl, 2020). Its integration into school-based smoking cessation programmes or community health centres could significantly improve the efficacy of current strategies to reduce adolescent smoking. Evidence suggests that interactive and engaging tools increase adherence and long-term behavioural changes in youth (Plaitano *et al.*, 2025).

The user-friendly and interactive features of the "Retako" app provide a unique advantage, as they cater to the preferences of a tech-savvy adolescent demographic, thus enhancing usability and engagement (Khoziasheva, 2025). For health educators and counsellors, the app serves as a practical resource to deliver personalised interventions, helping adolescents build proactive coping skills and overcome barriers to quitting smoking (Weng *et al*., 2025). Additionally, the app's daily reminders and structured modules can serve as effective tools to encourage consistency and accountability, which are essential for long-term behaviour change (Jaramillo Botero, 2024). Moreover, the app could be expanded to include parental involvement or peer support features, which have been shown to enhance the effectiveness of smoking

cessation programmes in adolescents (Bold *et al*., 2023).

Nurses, as key players in public health and primary care, can utilise the "Retako" mobile application to augment traditional smoking cessation counselling. This app provides a scalable, evidence-based tool that nurses can integrate into their practice to deliver individualised, accessible, and engaging interventions tailored to the unique needs of adolescents. Nurses working in schools, clinics, or community health centres can incorporate the "Retako" app into health education programs, empowering adolescents to adopt proactive coping strategies. By leveraging the app's interactive modules and reminders, nurses can provide continuous support, extending the reach of health promotion activities beyond face-to-face consultations. By using the "Retako" app as part of broader smoking prevention strategies, nurses can contribute to reducing the prevalence of smoking among adolescents. This aligns with the nursing role in preventive care, which emphasises early intervention and education to mitigate long-term health risks. Integrating "Retako" into broader public health campaigns could further amplify its impact. For instance, it can complement traditional health education by providing real-time feedback and resources, making interventions more dynamic and responsive to individual needs. Future research could explore how these additional features may optimise outcomes, particularly in diverse cultural contexts such as Indonesia.

Limitation

Despite the fact that the investigation provides valuable insights, it is crucial to recognise its limitation. Initially, the intervention's relatively brief duration may not accurately represent the long-term sustainability of the observed improvements in proactive coping. Secondly, the study's reliance on self-reported data to assess coping behaviours increases the likelihood of response bias, which could potentially influence the accuracy of the results. Third, the study did not conduct a comprehensive analysis of the factors that influence the intervention's outcomes, which could have provided a more nuanced comprehension of the variations in app usage and adherence.

CONCLUSION

This study highlights the potential of the "Retako" mobile application as an effective tool for enhancing proactive coping among adolescents. The significant improvements observed in the intervention group underscore the importance of leveraging technology to address smoking cessation challenges. Integrating "Retako" into broader public health campaigns could further amplify its impact. For instance, it can complement traditional health education by providing real-time feedback and resources, making interventions more dynamic and responsive to individual needs. Future research should plan the implementation of longitudinal designs to monitor long-term effects and the integration of objective metrics to assess app engagement and adherence.

Recommendation

However, further research is needed to explore the long-term effects of such interventions and to identify strategies for addressing barriers to app engagement and adherence. Future studies could investigate the scalability and adaptability of the "Retako" app across diverse demographic groups and geographic regions. Additionally, integrating features such as gamification, personalized feedback, and real-time support could enhance user experience and engagement. Research focusing on the cost-effectiveness and integration of such mobile-based interventions into broader public health frameworks will also be crucial for their widespread adoption and impact.

Conflict of Interest

The authors declare that they have no competing interests.

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