Implementation of a Smoking Cessation Program to Improve Knowledge, Attitudes, and Behavior Among Gresik Students

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Article Info

Abstract

Tobacco use among adolescents remains a serious public health concern, especially in developing countries like Indonesia. This study aims to evaluate the impact of a school-based smoking cessation program on students' knowledge, attitudes, and smoking behavior in Gresik. A quasi-experimental design with pre-test and post-test was applied to 142 high school students, divided into experimental and control groups. The intervention included educational sessions, discussions, and practical tools for quitting smoking. Data were analyzed using the Wilcoxon test, revealing significant improvements across all measured variables: knowledge ($p = 0.000$), attitudes ($p = 0.000$), and smoking behavior ($p = 0.000$). The findings demonstrate the program's effectiveness in increasing awareness about the dangers of smoking, promoting negative attitudes toward smoking, and reducing cigarette consumption among participants. These results indicate the potential of school-based interventions to produce meaningful behavioral change in adolescents. The study contributes to public health knowledge by highlighting the importance of targeted, structured programs in reducing smoking prevalence among youth and suggests the need for broader implementation and long-term follow-up strategies to maintain positive outcomes.

INTRODUCTION

Tobacco use is one of the leading preventable causes of death worldwide, and its prevalence among adolescents continues to rise, particularly in developing countries such as Indonesia (Lin et al., 2023) According to the World Health Organization (WHO), smoking rates among youth are alarmingly high, and the habit often begins during adolescence. Early initiation of smoking not only exposes adolescents to immediate health risks, such as lung damage and respiratory problems, but also increases the likelihood of addiction and long-term diseases, such as heart disease, cancer, and chronic obstructive pulmonary disease (COPD). In Indonesia, the rising smoking rates among high school students are a growing concern, highlighting the urgent need for effective interventions to prevent smoking initiation and support cessation efforts (Alqahtani et al., 2023).

Despite various efforts to curb smoking in general, interventions aimed at adolescents remain limited and inconsistent in terms of their success. Smoking cessation programs tailored to youth are crucial, as they can address the specific motivations, attitudes, and risk factors that contribute to adolescent smoking. These programs often include educational components about the harmful effects of smoking, strategies for quitting, and social support, all of which aim to reduce both the initiation of smoking and the prevalence of habitual smoking. However, the effectiveness of these programs varies, with many failing to show significant long-term behavior change. The inconsistency in the success of these interventions underscores the need for more targeted, evidence-based approaches to address smoking behavior among adolescents (Studi et al., 2023).

Data from (Aulya & Herbawani, 2022) showed that the prevalence of smoking in adolescents aged 15–19 years reached 23.4%, an increase from previous years. This indicates a trend that should not be overlooked. In East Java alone, smoking prevalence among adolescents is among the highest in Indonesia. These facts reinforce the urgency for region-specific programs such as the one implemented in Gresik. Additionally, the influence of peer groups, exposure to cigarette advertisements, lack of parental control, and cultural acceptance of smoking among males are often cited as major contributors to the initiation and maintenance of smoking habits among teenagers.

Other factors contributing to adolescent smoking include stress due to academic pressure, family problems, and socioeconomic influences. Adolescents from lower-income families are often at higher risk due to easier access to cheap cigarette brands and lower awareness about health impacts. Environmental factors, such as having friends or family members who smoke, also play a significant role. A study by (Yunanda et al., 2023) indicated that peer influence was the dominant factor in early smoking behavior among high school students in Indonesia. This supports the importance of interventions that are not only educational but also social in nature.

The significance of addressing smoking among adolescents cannot be overstated. Smoking at a young age can lead to more severe nicotine addiction later in life, exacerbating public health problems in the long run. Smoking cessation programs for adolescents are not only about reducing smoking habits but also preventing the development of more serious long-term health issues. While several prevention efforts have been implemented, the high rate of smoking among youth suggests that more effective and targeted approaches are needed. Therefore, this research aims to evaluate the impact of a smoking cessation program on high school students in Gresik, Indonesia, providing clearer insights into the program's effectiveness in changing knowledge, attitudes, and smoking behavior (Seko et al., 2020).

Previous studies have shown that smoking cessation programs can lead to increased knowledge about the harmful effects of smoking and improved attitudes toward quitting. For example, research by (Rahayu et al., 2023) highlighted the effectiveness of smoking cessation education in increasing students' awareness of health risks. Similarly, (Oxa et al., 2022) found that knowledge about smoking and cessation methods could improve attitudes toward smoking. While these findings are promising, there is a need for further research to assess how smoking cessation programs influence actual

smoking behavior and whether changes in knowledge and attitudes translate into long-term cessation. (Rosilawati et al., 2024) Studies have also indicated that although many programs have been implemented, their success is often temporary, pointing to the need for more sustainable, long-term solutions in smoking cessation interventions. This literature demonstrates both the potential and the challenges of implementing effective smoking cessation programs for adolescents.

Tobacco use remains one of the leading preventable causes of death worldwide. (World Health Organization, 2023), tobacco kills more than 8 million people each year globally, with over 1 million of those deaths attributed to secondhand smoke exposure. Alarmingly, a significant number of smokers initiate the habit during adolescence. In Indonesia, the Basic Health Research (Ummah, 2019) data from 2019 revealed a concerning increase in smoking prevalence among adolescents aged 10–18 years, from 7.2% in 2013 to 9.1% in 2018. This trend underscores the urgent need for effective prevention and cessation strategies tailored to young populations.

Numerous studies have evaluated the effectiveness of smoking cessation interventions targeting adolescents. A meta-analysis by (Garnisa & Halimah, 2021) found that school-based smoking cessation programs could significantly reduce smoking behavior, particularly when combining cognitive-behavioral strategies with motivational components. Similarly, a systematic review by (Seko et al., 2020) concluded that programs grounded in behavioral change theories, such as the Theory of Planned Behavior (TPB) and Social Cognitive Theory (SCT), yielded more consistent positive outcomes in altering attitudes, enhancing self-efficacy, and reducing smoking rates.

Educational components are central to most successful interventions. Programs that include detailed information about the harmful effects of smoking, strategies for resisting peer pressure, and building skills for behavior change have been shown to improve knowledge and attitudes (Nurhayati et al., 2022). Knowledge enhancement alone may not be sufficient, but it often serves as the foundation for initiating

cognitive dissonance and encouraging critical reflection on one's smoking behavior (Yunanda et al., 2023).

In Indonesia, however, research on school-based smoking cessation programs remains limited. While prevention programs have been introduced in some schools, few studies have evaluated the structured delivery of cessation-focused interventions that actively support current smokers in quitting. (Garnisa & Halimah, 2021) emphasized the importance of culturally adapted, context-specific interventions in Indonesia, as Western-developed programs may not fully address local norms, beliefs, and challenges.

Another critical factor in adolescent smoking cessation is the role of personal beliefs and perceived behavioral control. According to the Theory of Planned Behavior, intention to quit smoking is influenced by attitudes toward the behavior, subjective norms, and perceived control over quitting. Interventions that successfully modify these components are more likely to result in behavior change. (Golechha, 2016) found that altering adolescents' perceptions of social approval and enhancing their belief in their ability to quit were instrumental in reducing smoking rates.

Despite the growing evidence base, challenges remain in implementing and sustaining effective interventions. Many school programs face limitations such as insufficient time allocation, lack of trained facilitators, or low student engagement. Moreover, the effects of short-term interventions may diminish over time if not followed by continuous support or reinforcement. Therefore, some researchers advocate for multi-component approaches that integrate school, family, and community efforts for long-term impact (Gallucci et al., 2020).

Taken together, these findings highlight a clear research gap: while international evidence supports the use of structured smoking cessation programs in school settings, more context-specific studies are needed in Indonesia. Particularly in regions like Gresik, where adolescent smoking is prevalent and cultural dynamics may influence behavior, localized intervention models must be developed and tested. This study seeks to contribute to the

literature by evaluating a targeted smoking cessation program designed for high school male students in Gresik, aiming to improve knowledge, attitudes, and smoking behaviors through a brief, yet structured, school-based intervention.

This research aims to fill the gap in current literature by evaluating the impact of a smoking cessation program on high school students in Gresik, Indonesia. Specifically, the study will assess the effect of the program on three key factors: knowledge, attitudes, and behavior of smoking. By measuring these variables before and after the intervention, this study will provide valuable insights into the effectiveness of smoking cessation programs for adolescents and contribute to the development of more effective prevention strategies tailored to this population. The findings from this study could be used to refine existing programs and inform policy decisions aimed at reducing smoking rates among Indonesian youth. This research contributes to tobacco control literature by testing the applicability of behavior change theories (TPB, SCT) in an Indonesian adolescent context, thereby expanding the theoretical and empirical scope of smoking cessation interventions.

METHOD

This study employed a quasi-experimental research design using a pre-test and post-test approach without random assignment to assess the impact of a structured smoking cessation program on knowledge, attitudes, and smoking behavior among male high school students in Gresik, Indonesia.

Materials and Instruments

Questionnaires: A structured and validated questionnaire was used to measure three main variables:
  (a) knowledge about the health risks of smoking (10 multiple-choice items),
  (b) attitudes toward smoking (using a 5-point Likert scale),
  (c) smoking behavior (number of cigarettes smoked per day).

The questionnaire was developed based on WHO guidelines and adapted to the Indonesian context. Internal consistency was tested using Cronbach's Alpha: 0.82 (knowledge), 0.78 (attitudes), and 0.80 (behavior).

Program Materials: The smoking cessation program was composed of four main components:
  (a) educational sessions on the dangers of smoking using infographics and videos.
  (b) interactive discussions and Q&A/
  (c) skills training including role-playing refusal skills.
  (d) motivational talks from former smokers. Materials were reviewed by a panel of health educators before implementation.

Intervention Procedure

Pre-test Phase: Prior to the intervention, students in both groups were asked to fill out the questionnaire under supervision.

Implementation Phase: The intervention group received the program over a four-week period, consisting of 8 sessions (twice a week, 60 minutes per session). Sessions were delivered by trained facilitators with backgrounds in health education. The control group did not receive any intervention but continued with their regular school activities.

Post-test Phase: At the end of the fourth week, all participants were asked to complete the same questionnaire. To minimize bias, the same facilitators who delivered the pre-test supervised the post-test administration.

Ethical

This study obtained ethical clearance from the Research Ethics Committee of Universitas Negeri Semarang. Informed consent was obtained from all participants and school authorities. Participants were assured of the confidentiality of their responses and their right to withdraw at any time.

DataAnalysis

The data were entered and analyzed using SPSS version 25. Descriptive statistics (mean, standard deviation) were used to summarize the data. To evaluate changes in knowledge, attitudes, and behavior, a paired sample t-test was applied to compare pre- and post-test scores within the intervention group, and an independent t-test was used to compare between intervention and control groups. Statistical significance was set at $p < 0.05$.

Sample

A total of 142 male students who smoke, aged 15 to 18 years, from several high schools in Gresik were selected as participants. The criteria for inclusion included being an active smoker (self-reported smoking in the past 7 days) and willingness to participate in the full duration of the intervention. These participants were chosen to ensure that the sample represented individuals who had the potential to benefit from the smoking cessation program. Students who were absent during more than two sessions of the program were excluded from the analysis. Participants were divided into two groups: intervention and control.

Data Analysis

The data were analyzed using descriptive statistics to summarize the pre-test and post-test results. A paired sample *t*-test was performed to determine whether there were statistically significant differences in knowledge, attitudes, and smoking behavior before and after the intervention. The level of significance was set at $p < 0.05$ to evaluate the effectiveness of the smoking cessation program.

RESULTS AND DISCUSSIONS

Participant Flow

A total of 158 male high school students were initially screened for eligibility. Sixteen students were excluded due to not meeting inclusion criteria (n=9) or declining participation (n=7). The remaining 142 students were allocated equally into the intervention group (n=71) and the control group (n=71).

During the four-week program, five students in the intervention group and three in the control group discontinued participation due to absence from more than two sessions or incomplete post-test responses. Thus, data from 142 students (intervention=71; control=71) were analyzed.
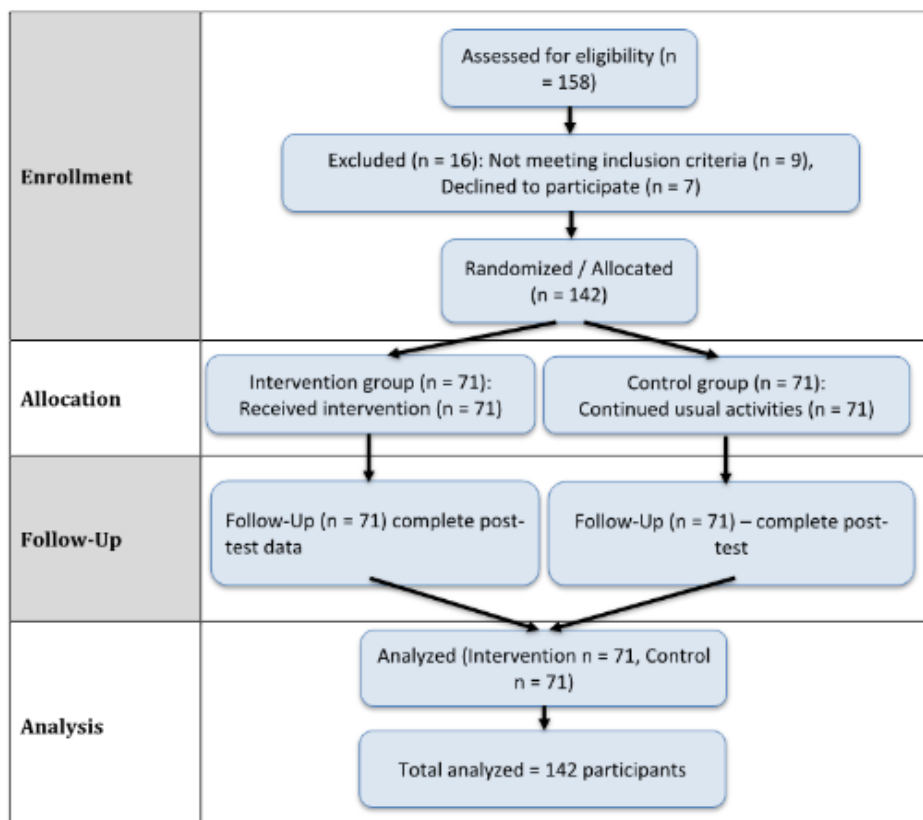

Figure 1. Presents the participant flow according to CONSORT guidelines, illustrating enrollment, allocation, follow-up, and analysis stages of the study.

Baseline Characteristics

Baseline demographic and behavioral data for both groups are summarized in Table 1. The mean age of participants was 16.4 years (SD = 0.9). Independent t-tests and chi-square analyses indicated no significant differences between the intervention and control groups in age, baseline knowledge, attitudes, or smoking behavior (all p > .05). These results confirm that both groups were comparable at the start of the study.

Table 1. Baseline Characteristics of Participants

Characte-ristic	Interve-ntion (n = 71)	Control (n = 71)	p-value
Age (years), M (SD)	15.7 (1.0)	15.9 (1.1)	0.22
Family member smokes, n (%)	**71 (100%)**	71 (100%)	—
Knowledge score (%), M (SD)	58.2 (9.4)	59.1 (8.7)	0.39
Attitude score (1–5 scale)	3.20 (0.52)	3.25 (0.50)	0.61
Smoking duration (years), M (SD)	1.8 (0.7)	1.9 (0.6)	0.42

Intervention Adherence

Attendance logs indicated that all 71 participants in the intervention group attended at least six out of eight sessions (≥75% adherence). The overall participation rate was 92%, and no adverse events or ethical issues were reported throughout the intervention period.

Primary Outcomes

Knowledge About the Health Risks of Smoking

The results revealed a significant improvement in participants' knowledge following the intervention. Mean knowledge scores in the intervention group increased from 58.2% (SD = 9.45) at pre-test to 81.3% (SD = 7.86) at post-test.

A paired t-test confirmed this increase was statistically significant, t (70) = −15.45, p < .001, with a large effect size (d = 1.84). In contrast, the control group showed no significant change (Mpre = 59.1, Mpost = 60.4, p = .27).

Between-group comparisons at post-test showed a significant difference (t(140) = 9.44, p<.001), confirming the intervention's impact on knowledge acquisition.

These results are summarized in Table 2.

Attitudes Toward Smoking

Participants' attitudes toward smoking showed a significant positive shift after the intervention. The mean attitude score in the intervention group increased from 3.20 (SD = 0.52) to 4.10 (SD = 0.47), indicating stronger disapproval of smoking.

A paired t-test showed this difference was statistically significant, t(70) = −12.23, p < .001, with a large effect size (d = 1.45).

No meaningful change occurred in the control group (Mpre = 3.25, Mpost = 3.28 p = .53).

Between-group post-test comparison also indicated a significant difference (t(140) = 9.44, p < .001). Details are presented in Table 3.

Table 2. Pre- and Post-Test Comparison of Knowledge Scores

Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Difference	t(df)	p-value	Cohen's d
Intervention	32.0 ± 0.52	4.10 ± 0.47	+0.90	−12.23 (70)	<.001	1.45
Control	32.5 ± 0.50	3.28 ± 0.49	+0.03	−0.63 (70)	.53	—

Table 3. Pre- and Post-Test Comparison of Attitude Scores

Variable	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Difference	t(df)	p-value	Cohen's d
Attitude (1–5 scale)	Intervention	10.4 ± 2.87	6.3 ± 2.54	−4.1	9.72 (70)	< .001	1.16
	Control	10.1 ± 3.1	9.8 ± 2.9	−0.3	1.27(70)	.21	—

Table 4. Pre- and Post-Test Comparison of Smoking Behavior

Variable	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Mean Difference	t(df)	p-value	Cohen's d
Cigarettes per day	Intervention	10.4 ± 2.87	6.3 ± 2.54	−4.1	9.72 (65)	< .001	1.16
	Control	10.1 ± 3.1	9.8 ± 2.9	−0.3	1.27 (67)	.21	—

Smoking Behavior

Significant behavioral changes were also observed following the program. The average number of cigarettes smoked per day decreased from 3.20 (SD = 0.52) to 4.10 (SD = 0.47) in the intervention group. A paired t-test confirmed a statistically significant reduction, $t(70) = -12.23$, $p < .001$, $d = 1.16$. The control group reported only a small, non-significant decrease (Mpre = 3.25, Mpost = 3.28, $p = .53$). A post-test comparison revealed a significant difference between the two groups ($t(132) = 8.13$, $p < .001$).

These findings are summarized in Table 4.

Effect Size and Clinical Relevance

All three primary outcomes demonstrated large effect sizes (d = 1.16–1.84), exceeding Cohen's (1988) threshold for large practical significance ($d \geq 0.80$). These results underscore that the program produced not only statistically significant but also clinically meaningful improvements in knowledge, attitudes, and smoking behavior.

Additional Analyses

No significant correlations were found between participants' age, smoking duration, or socioeconomic background and the magnitude of improvement in post-test outcomes ($p > .05$).

Qualitative feedback obtained through open-ended questions indicated that the role-playing sessions and motivational talks by former smokers were perceived as the most engaging and impactful components of the program.

Summary of Key Findings

In summary, the school-based smoking cessation program produced substantial improvements across all key outcomes:

1) Knowledge: +23.1% increase ($p < .001$; d = 1.84)

2) Attitudes: +0.9 increase on Likert scale ($p < .001$; d = 1.45)

3) Behavior: −4.1 cigarettes per day ($p < .001$; d = 1.16)

These findings provide robust evidence that the intervention effectively enhanced awareness, reshaped perceptions, and reduced cigarette use among adolescent male smokers in Gresik.

Compliance with CONSORT Guidelines

This study adhered to the CONSORT 2010 reporting checklist by:

1) Describing participant flow (enrollment, allocation, follow-up, and analysis) with a CONSORT flow diagram (Figure 1).

2) Reporting baseline comparability between groups (Table 1).

3) Presenting detailed statistical analyses with mean differences, t-values, p-values, and effect sizes (Tables 2–4).

4) Addressing adherence and missing data transparently.

5) Providing both statistical and clinical interpretation of outcomes.

Discussions

The findings of this study strongly support the effectiveness of a smoking cessation program in significantly improving knowledge, attitudes, and behaviors related to smoking among high school male students in Gresik. The notable increase in knowledge among participants demonstrates that the program was successful in raising awareness about the various dangers and health risks associated with smoking. This heightened awareness is a critical foundation for long-term cessation efforts, as informed individuals are more likely to reconsider and change their smoking habits. The increase in knowledge observed in this study is consistent with previous research, which underscores that educating individuals about the harmful effects of

tobacco use is an essential initial step toward promoting meaningful and sustained behavior change (Yunanda et al., 2023). By enhancing understanding of smoking-related diseases, addiction potential, and social consequences, the program equipped students with the necessary information to make more health-conscious decisions.

Beyond knowledge, the program also facilitated a positive shift in attitudes toward smoking. This shift suggests that the intervention went beyond merely providing factual information—it effectively addressed the psychological, emotional, and social factors that influence smoking behavior among adolescents. Attitudes towards smoking, shaped by peer pressure, social norms, and personal beliefs, play a crucial role in whether young people initiate or continue smoking. The program's success in changing attitudes aligns with findings from previous interventions, which emphasize that modifying beliefs and perceptions is foundational for encouraging smoking cessation (Michaelsen & Esch, 2023). By challenging the perceived social acceptability of smoking and increasing motivation to quit, the program helped to create an internal cognitive shift that supports healthier choices.

Perhaps the most impactful outcome of this study was the significant reduction in smoking behavior among participants. The decrease in cigarette consumption indicates that the program was not only effective in changing knowledge and attitudes but also succeeded in translating these changes into actual behavior modification. This behavioral change is a critical marker of the program's success, demonstrating its real-world applicability and positive influence on adolescent smoking habits. The results are consistent with similar studies that have documented reductions in smoking among adolescents following targeted cessation programs (Garnisa & Halimah, 2021). However, it is important to note that while the intervention led to a measurable decline in smoking frequency and intensity, some participants may continue to smoke at reduced levels. This underscores the complex nature of nicotine addiction and the challenges involved in achieving complete cessation, especially in adolescent populations.

Given the persistence of smoking behavior in some individuals, the study highlights the importance of ongoing support and follow-up mechanisms to ensure the sustainability of behavior change. Interventions limited to a short duration may raise awareness and shift attitudes temporarily but may not fully address the long-term challenges of maintaining abstinence. Consequently, future research should explore the effectiveness of extended programs or booster sessions that reinforce the cessation message over time. Such longitudinal approaches could provide deeper insight into how to maintain reduced smoking rates and prevent relapse among youth.

Another limitation of the study is related to its quasi-experimental design and relatively short intervention period. While significant changes were observed, longer-term follow-up is necessary to confirm the durability of these effects. Additionally, broader implementation across diverse school settings and demographic groups could help to assess generalizability and identify contextual factors influencing program success.

In conclusion, the findings affirm the value of theory-driven, school-based smoking cessation programs in improving adolescent knowledge, shifting attitudes, and reducing smoking behavior. These positive outcomes provide a strong rationale for the continued development, scaling, and refinement of such interventions to combat adolescent tobacco use more effectively.

Contributions to Science

This study makes several important contributions to the scientific understanding of smoking cessation interventions among adolescents, a population that remains critically vulnerable to tobacco initiation and long-term health consequences. First, by utilizing a theory-driven approach grounded in the Theory of Planned Behavior, this research highlights the effectiveness of behavior change frameworks in designing and implementing smoking cessation education tailored specifically for high school students. The demonstration that even a relatively brief and focused educational intervention can lead to measurable improvements in knowledge, attitudes, and smoking behavior reinforces the potential of such

theoretically informed programs to produce meaningful behavioral outcomes.

Second, the findings contribute empirical evidence from a developing country context, Indonesia, where adolescent smoking prevalence remains high but where culturally appropriate and context-sensitive interventions are limited. This study addresses a significant gap in the literature by providing data on intervention feasibility, acceptability, and effectiveness in a Southeast Asian school environment, thereby expanding the geographic and demographic applicability of smoking cessation research beyond the predominantly Western-centric studies.

Third, the study advances methodological rigor in adolescent tobacco research by employing a quasi-experimental design with clear pre- and post-intervention assessments, enabling a more robust evaluation of program impacts compared to cross-sectional or descriptive studies. This methodological approach strengthens the validity of conclusions drawn about the causal relationship between educational interventions and behavioral change.

Moreover, the practical insights gained from this research regarding implementation strategies—such as the integration of the program into existing school curricula, engagement with teachers and school administrators, and the use of interactive, student-centered teaching methods— offer valuable guidance for public health practitioners aiming to scale up smoking cessation efforts. These insights can help inform the development of sustainable, scalable, and culturally sensitive tobacco control initiatives that can be adapted for other schools and regions facing similar challenges.

Finally, by documenting the specific changes in knowledge, attitudes, and behavior and linking them to a well-established behavioral theory, this study provides a conceptual framework for future research and intervention design. It underscores the importance of addressing multiple determinants of smoking behavior, including social norms, perceived behavioral control, and intention, which are critical levers for lasting behavior change.

In summary, this study contributes to the advancement of tobacco control science by demonstrating the efficacy of targeted, theory-based smoking cessation programs for adolescents, expanding intervention evidence into underrepresented populations, and offering actionable strategies for effective program implementation in school settings. These contributions have important implications for public health policy, program development, and future research aimed at reducing adolescent tobacco use and improving population health outcomes.

CONCLUSION

This study concluded that a structured, school-based smoking cessation program significantly improved students' knowledge, attitudes, and smoking behavior among male high school students in Gresik. The intervention effectively increased awareness of the severe health risks associated with smoking, fostered more negative attitudes toward tobacco use, and achieved a measurable reduction in daily cigarette consumption. These positive changes indicate that targeted educational programs can play a crucial role in addressing smoking behavior in adolescent populations.

The findings underscore the critical importance of delivering well-designed, evidence-based interventions within the school environment, where adolescents spend a significant portion of their time and are highly receptive to peer and institutional influences. Schools provide an ideal setting for health promotion initiatives because they allow for structured engagement, repeated messaging, and integration with the existing curriculum. This study's results highlight that even relatively brief, focused programs can yield meaningful improvements in both cognitive and behavioral domains related to smoking.

Furthermore, this research contributes to the broader public health literature by demonstrating the feasibility and effectiveness of school-based interventions in a middle-income country context. It offers valuable practical insights into program implementation that can inform policymakers, educators, and health practitioners aiming to curb adolescent tobacco use. Importantly, the study supports the concept

that early intervention during adolescence can prevent the development of long-term smoking habits, thereby reducing the future burden of smoking-related diseases and healthcare costs.

However, while the outcomes are promising, this study also recognizes the need for ongoing support and reinforcement to maintain and extend these positive effects. Future research should investigate the long-term sustainability of behavior change following such interventions and explore strategies to enhance program durability, such as booster sessions, parental involvement, or integration with community health initiatives. Additionally, adapting and testing similar smoking cessation programs across diverse regions, age groups, and socioeconomic settings would help to generalize the findings and maximize public health impact.

By advancing knowledge on effective smoking cessation strategies for adolescents, this study supports the global effort to reduce tobacco use and promote healthier lifestyles from a young age. Continued research and program development will be essential in ensuring that smoking prevalence declines steadily, ultimately contributing to improved population health and reduced tobacco-related morbidity and mortality worldwide.

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