



**THE EFFECT OF E-CIGARETTE EDUCATIONAL GAMES TO INCREASE
KNOWLEDGE AND PREVENT THE DANGERS OF E-CIGARETTES PERSONAL
VAPORIZERS IN ADOLESCENTS**

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ABSTRACT

This study aimed to assess the impact of E-Cigarette Educational Games (ECG) on improving knowledge and promoting preventive behavior against the risks of e-cigarettes and personal vaporizers among adolescents. Conducted in Indonesia in 2024, the quasi-experimental study used a non-equivalent pretest and posttest control group design. A total of 158 senior high school students participated, divided into intervention and control groups based on the schools' locations. Participants were selected through random sampling, with stratified random sampling determining how many respondents came from each school. The intervention group received health education through ECG, while the control group was educated using leaflets. The educational session lasted three hours. Structured questionnaires collected data immediately after the intervention, measuring adolescents' knowledge of e-cigarette risks and their preventive behaviors. Data analysis used the Wilcoxon and Mann-Whitney tests, with a significance level set at 0.05. The results showed a significant increase in knowledge about e-cigarette dangers in the ECG group ($p = 0.000$), with a similar outcome in the leaflet group ($p = 0.000$). Preventive behavior concerning e-cigarette use significantly improved in the ECG group ($p = 0.000$), while no significant change occurred in the leaflet group ($p = 0.797$). ECG proved to be an effective tool for increasing knowledge and fostering preventive behavior regarding e-cigarettes, with interactive approaches being more successful in promoting behavioral change than traditional methods.

Keywords: adolescent; e-cigarette; knowledge; personal vaporizer

INTRODUCTION

Adolescence is a period in human development marked by significant psychological, biological, and social changes (National Academies of Sciences, 2019a). Changes that often occur in adolescents and adults include engaging in risky behaviours, such as consuming harmful substances (National Academies of Sciences, 2019a). The types of substances consumed have evolved, and methods and tools used to consume them have emerged. Some of these substances and devices include *electronic cigarettes (e-cigarettes)* and *personal vaporisers (PV)* (Sánchez-Sánchez et al., 2023). Electronic cigarettes (*e-cigarettes*) in adolescents are an important issue and require serious attention (Sánchez-Sánchez et al., 2023). The use of electronic cigarettes (*e-cigarettes*) in adolescents in Indonesia continues to increase. Various studies and health reports have highlighted some of the negative impacts that occur due to the use of electronic cigarettes (*e-cigarettes*) in this age group (Coke, 2020). Evidence of the increase in the number of e-cigarette users (*e-cigarettes*) aged 10-18 years, which reached 10.9 per cent in 2018. The results of the research conducted by Ladesvita found that the factors that affect adolescents using electronic cigarettes (*e-cigarettes*) in the North Jakarta Region include friends, the internet, parents, television, books, and other factors (Choi et al., 2021). The use of electronic cigarettes (*e-cigarettes*) is considered a trend today (Osibogun et al., 2020). Users of e-cigarettes claim that e-cigarettes have several advantages, such as reduced exposure to harmful substances produced by tobacco combustion, as well as improvements in nicotine control and flavour choices (Choi et al., 2021). The assumption that electronic cigarettes (*e-cigarettes*) are safer than conventional cigarettes and an alternative to quitting smoking is wrong because the content in electronic cigarettes is also as harmful as conventional cigarettes (tobacco) (Osibogun et al., 2020).

Electronic cigarettes (*e-cigarettes*) are electronic devices designed to convert liquids into aerosols (vapours) (Coke, 2020). Unlike conventional cigarettes, which produce smoke by burning tobacco, electronic cigarettes use a battery to heat a liquid that is converted into vapour; the user then inhales the vapour, similar to how they smoke conventional cigarettes (Short & Cole, 2021). *Aerosols* in electronic cigarettes (*e-cigarettes*) contain *propylene glycol*, *glycerin*, *aldehydes*, and other toxins (Short & Cole, 2021). *Aerosols* can also contain other compounds, such as small particles, heavy metals, and volatile organic compounds that may come from devices or liquids (Gorukanti et al., 2017). While some aerosol compounds may be considered safe, there are potential health risks, especially with long-term use (Merecz-Sadowska et al., 2020). Electronic cigarettes (*e-cigarettes*) are closely related to various health problems, such as lung diseases, heart disease, the immune system, cancer, and changes in *neurotransmitters* such as *dopamine* due to the content in e-liquid/aerosol (Gorukanti et al., 2017). *The nicotine* in e-cigarettes can alter a variety of physiological functions, including blood pressure, and can lead to adverse health events such as strokes and heart attacks (Coke, 2020). In addition, adolescents tend to be more susceptible to *nicotine* dependence, which can negatively impact their brain development (Ahyar Rosidi et al., 2023)(Abelia XA, n.d.). This dependence can create a smoking habit that continues into adulthood (Maciej Serda et al., 2021). Recent research suggests that e-cigarettes can also stimulate the onset of *tumorogenesis* (Merecz-Sadowska et al., 2020).

BPOM, or the Food and Drug Supervisory Agency, conducted a study on electronic cigarettes, which recommended that their harm outweighed their potential health benefits (Abelia XA, n.d.; Maciej Serda et al., 2021). This health problem is a special concern for adolescents whose brains are still developing, as consuming *nicotine* at this stage of development can make them more susceptible to addiction (Sapru et al., 2020). The development of the times and technology impacts the use of electronic cigarettes in adolescents (Sapru et al., 2020). Some factors in this relationship include technological advancements, changes in consumer behaviour, and social impact (Beutel et al., 2021). It is also important to note that technology can influence consumer preferences and product accessibility; the responsibilities of marketers, educators, and policymakers are crucial in regulating and guiding the use of e-cigarettes in adolescents to protect their health (Aaron, 2021). Without sufficient knowledge of the problems posed by e-cigarettes, the tobacco industry can create a new generation of customers (de Andrade et al., 2020). Good knowledge of the dangers of e-cigarettes is essential to protecting the health of adolescents. All parties, including adolescents, need to understand the risks associated with the use of *e-cigarettes* (Osibogun et al., 2020). Based on the problems described above, the purpose of this study is to find out whether there is an effect of the use of ECG (E-Cigarette Educational Games) on increasing knowledge and preventing the dangers of e-cigarettes/personal vaporisers in adolescents.

METHOD

This quasi-experimental study uses a non-equivalent (pretest and posttest) control group design. This research was conducted at Senior High Schools Aikmel and Lenek in East Lombok, West Nusa Tenggara Province, Indonesia, in 2024. The population in this study consists of all high school students in Aikmel District, including 7 Senior High Schools, 2 public schools, and 5 private schools. The sampling in this study followed 2 stages: the first, determining the research site; and the second, determining the samples. In the first stage, the research site was determined using random sampling; in the second stage, stratified random sampling was used (Sugiyono, 2019) (Neila Sulung & Abdi Iswahyudi Yasril, 2022). A total of 158 adolescents who met the inclusion and exclusion criteria were selected as research samples from the targeted population. The sample size in this investigation was determined using an unpaired numerical comparison of two groups. With one measurement, the determination of samples for the Eligible Population used random sampling, namely selecting 2 schools among 7 schools in Aikmel District. The schools were selected randomly, namely, senior high school Aikmel for the intervention group and senior high

school Lenek for the control group. The number of respondents in each school was determined using stratified random sampling, yielding 79 respondents in each school.

The researcher prepared the questionnaire based on the latest references; it was then tested first in a school with the same homogeneity as the research location, namely Senior High School Wanasaba. The validity test used Pearson Product Moment and reliability used Alpha Cronbach, The number of items in the Adolescent Knowledge Questionnaire about the Dangers of E-Cigarette/Personal Vaporizer was 31 items, and 20 valid items were found with a reliability level of 0.839 and the E-Cigarette/Personal Vaporizer Dangerous Prevention Questionnaire in Adolescents was 20 items, and 20 valid items were found with a reliability value of 0.981. Knowledge questionnaire: multiple-choice; prevention questionnaire: 5-point Likert scale (strongly disagree, disagree, neutral, agree, strongly agree). The knowledge questionnaire domain consists of 5 domains, namely Definition, Structure, ingredient, Types/Kinds, Impact/Effects, while the behaviour questionnaire consists of 3 domains, namely knowledge, attitude, and practice.

Before collecting data, the researcher explained the research objectives and procedures to prospective respondents. Adolescents who were willing to participate in the study then signed *informed consent*. The research was divided into two, namely, the implementation of research in the intervention group and the implementation of research in the control group. The implementation of the research in the intervention group was (a) Adolescents who were willing to be the subject of the research, divided into several groups (b) Each group was accompanied by a research team and research assistant (c) Respondents then filled out a *pretest questionnaire*, namely the Adolescent Knowledge questionnaire about the Dangers of E-Cigarettes/Personal Vaporizers and the questionnaire on the prevention of the dangers of E-Cigarettes/Personal Vaporizers in adolescents (d) Respondents then explained the rules and methods using *ECG (E-Cigarette Educational Games)*; (e) Respondents are then given the opportunity to play *ECG (E-Cigarette Educational Games)* (f) After respondents finish using *ECG (E-Cigarette Educational Games)* as an educational medium to prevent the dangers of E-Cigarette/Vape, respondents then fill out a *post-test* questionnaire, namely a knowledge questionnaire about Adolescent Knowledge about the Dangers of E-Cigarettes/Personal Vaporizers and a questionnaire on the prevention of the dangers of E-Cigarettes/Personal Vaporizers in adolescents. Meanwhile, the implementation of the research in the control group was: (a) Respondents filled out a *pre-test questionnaire*, namely the Adolescent Knowledge questionnaire about the Dangers of E-Cigarettes/Personal Vaporizers and the questionnaire on the prevention of the dangers of E-Cigarettes/Personal Vaporizers in adolescents (b) Then the respondents learned about the dangers of E-Cigarettes/Personal Vaporizers in adolescents by using the Leaflet (c) Following their completion of the leaflet, the respondents *completed the* leaflet questionnaires, *which served as the post-test*. Goodie bags were given to the *respondents* as a thank-you for their willingness to participate in the research after the post-test. The data were analysed using descriptive statistics to describe age, gender, father's education, mother's education, father's occupation, mother's occupation, living together, and smoking history. Because the data are not normally distributed (Kolmogorov-Smirnov test, $p < .05$), the Wilcoxon test was used to determine differences in ECG dangerous prevention knowledge and behaviour, and the Mann-Whitney test was used to determine differences in ECG dangerous prevention knowledge and behaviour between the intervention and control groups. The collected data were analysed.

RESULT

Respondent Characteristics

Based on Table 1, it was shown that the characteristics of respondents based on age, gender, father's education, mother's education, father's work, mother's work, and living together were homogeneous in both groups ($p > 0.05$). Most respondents were 16 years old; fathers and mothers had mostly secondary education; fathers' occupations were mostly labourers; mothers were mostly not working; most students lived with their parents; and most had no smoking history.

Table 1.
 Frequency Distribution of Respondent Characteristics in the Intervention Group and Control Group

Characteristics Respondent	Intervention (n=79)		Control (n=79)		P value	
	f	%	f	%		
Age	15	8	5,1	5	3,2	0,422 ^a
	16	47	29,7	47	29,7	
	17	24	15,2	26	16,5	
	18	0	0	1	0,6	
Gender	Man	30	19,0	33	20,9	0,745 ^b
	Woman	49	31,0	46	29,1	
Father's Education						
Maternal Education	Primary school	13	8,2	7	4,4	0,108 ^b
	Secondary school	56	35,4	67	42,4	
	University	10	6,3	5	3,2	
Maternal Education	Primary school	7	4,4	6	3,8	0,401 ^b
	Secondary school	61	38,6	67	42,4	
	University	11	7,0	6	3,8	
Father's Work						
Mother's Work	Self-employed	17	10,8	15	9,5	0,324 ^a
	Farmer	26	16,5	16	10,1	
	Labourer	21	13,3	35	22,2	
	Teachers	1	0,6	3	1,9	
	Etc	14	8,9	10	6,3	
Mother's Work	Self-employed	13	8,2	12	7,6	0,245 ^a
	Farmer	19	12,0	14	8,9	
	Labourer	2	1,3	3	1,9	
	Teachers	8	5,1	4	2,5	
	Etc	37	23,4	46	29,1	
Living Together	Parents	75	47,5	74	46,8	1,000 ^c
	Not parents	4	2,5	5	3,2	
Smoking History						
Living Together	Yes	5	3,2	9	5,7	0,401 ^b
	No	74	46,8	70	44,3	

^a Mann-Whitney test; ^b Chi-Square test; ^c Fisher test

A comparison of adolescents' knowledge and behaviour about the prevention of E-cigarette dangers before and after education was given to the intervention group and the control group.

Table 2 shows that there is a significant difference in adolescents' knowledge about the prevention of E-Cigarette dangerous before and after being educated using *E-Cigarette Educational Games* (p=0.0001), there is a significant difference in adolescents' knowledge about the prevention of E-Cigarette dangerous between before and after being given education using leaflets (p=0.0001), there is a significant difference in adolescents' behaviour about E-Cigarette hazard prevention between before and after being given education using E-Cigarette Educational Games after being educated using *E-Cigarette Educational Games* (p=0.0001), and there was no significant difference in adolescent behaviour regarding the prevention of E-Cigarette dangerous between before and after being given education using leaflets (p=0.797).

Table 2.

A comparison of knowledge and prevention of e-cigarette dangers before and after education was provided for the intervention and control groups

Variable	Group	Before the Intervention	After the Intervention	P-value (Wilcoxon Test)
		Median (Min-Max)	Median (Min-Max)	
Knowledge	Intervention (n=79)	9 (3-14)	15 (4-18)	0,0001*
	Control (n=79)	9 (3-13)	11 (3-17)	
Behaviour	Intervention (n=79)	84 (35-92)	92 (62-100)	0,0001*
	Control (n=79)	83 (61-95)	84 (55-95)	

*Significant at p< 0.05

Comparison of adolescents' knowledge and behaviour about the prevention of e-cigarette dangers after being educated in the interview control group.

Table 3 shows a significant difference in adolescents' knowledge about the prevention of e-cigarette dangers after education in both groups ($p = 0.0001$), as well as in adolescents' behaviour regarding the prevention of e-cigarette dangers after education in both groups ($p = 0.0001$).

Table 3.

Comparison of Adolescent Knowledge and Behaviour Gaps in the Prevention of E-Cigarette Danger in the Intervention Group and the Control Group After Education

Variable	Group	Median (Min-Max)	P-value (Mann-Whitney Test)
Knowledge	Intervention (n=79)	5 (19-12)	0,0001
	Control (n=79)	2 (10-7)	
Behaviour	Intervention (n=79)	8 (-12-45)	0,0001
	Control (n=79)	0 (-26-23)	

*Significant at $p < 0.05$

DISCUSSION

Characteristics Respondent

Based on Table 1, it was shown that the characteristics of respondents based on age, gender, father's education, mother's education, father's work, mother's work, and living together were homogeneous in both groups ($p > 0.05$). Most respondents were 16 years old; fathers and mothers had mostly secondary education; fathers' occupations were mostly labourers; mothers were mostly not working; most students lived with their parents; and most had no smoking history. The respondents in this study are grade XI students, whose average age of adolescents in grade XI of high school is 16–17 years; adolescents are a potential group that needs serious attention because they are characterized by a strong sense of curiosity and a desire to try new things (Beal et al., 2016). Adolescence is a period of rapid growth and development, both physical, psychological, and intellectual. Adolescents typically have a strong sense of curiosity, love adventure and challenges, and tend to take risks without careful consideration (National Academies of Sciences, 2019b). This curiosity also applies to the use of e-cigarettes; based on a study conducted in Australia, it was reported that in 2018, about 14% of children aged 12 to 17 had tried e-cigarettes at least once (Wakefield et al., 2018).

Knowledge of the dangers of e-cigarettes

There was a significant increase in knowledge after receiving education through *E-Cigarette Educational Games*. This research is in line with Wilandika's research (Wilandika et al., 2022), which stated that the Kasaba Quartet card game was effective in increasing adolescents' knowledge about HIV/AIDS. This research is also in line with Zusanti's research (Zusanty et al., 2022), which states that puzzle games can improve preschool children's cognitive development. In addition, research conducted by Surapaneni (Surapaneni, 2024) states that CARBGAME can improve knowledge. Students find CARBGAME to be a fun and engaging learning experience. Most students feel that education through games fuels their interest and motivation to learn about vitamins in biochemistry because it taps into their intrinsic desire to engage, compete, and achieve, creating a more in-depth, fun, and effective learning ecosystem. CARBGAME has similarities with ECG (*E-Cigarette Education Game*), where this game uses cards designed to increase adolescents' knowledge of E-Cigarettes (Scalise et al., 2020). Other research also shows that adolescents significantly prefer game-based learning methods over conventional ones (Katonai et al., 2023). Increased knowledge among adolescents can affect the level of awareness about the potential side effects of e-cigarette use, so it is necessary to prevent it early (R. Singh et al., 2024).

There was a significant increase in knowledge after being educated using leaflets. These results align with the research by Kamriana (Kamriana et al., 2024), who found that educational media using leaflets can increase knowledge of health protocols during the COVID-19 pandemic. This result also aligns with the research by Ernawati (Ernawati et al., 2020), who found that providing

education through leaflets increases patients' knowledge of hypertension. Likewise, Saragih's research (Saragih et al., 2020) found that leaflet media effectively increases cadre knowledge in making overtraps. The same is true of Astiza's (Astiza et al., 2023) research, which showed differences in average knowledge levels before and after nutrition education delivered through leaflet media. Leaflet media is also effective in increasing elementary school students' knowledge of maintaining dental and oral health in elementary school students (Emini et al., 2023). Research by Kregtin (Kregting et al., 2020) found that women who received information through leaflets reported greater knowledge about breast cancer screening. Leaflet media can be obtained easily and effectively as an information medium; the image is selected based on the set achievements. The presence of an attractive image will foster a sense of enthusiasm and a desire to remember the message associated with it; the leaflet can be easily carried and read by anyone in a relaxed state when there is no activity.

There was a significant difference in knowledge about the dangers of e-cigarettes in both groups after being educated using *E-Cigarette Educational Games* and the group that was educated using leaflets. The results of this study are in line with the research conducted by Bintang (Bintang et al., 2019), who stated that there was a significant difference between the intervention group (gastritis card game) and the control group (leaflet) in adolescents' knowledge after education about gastritis. The results of this study are also in line with Hsieh's research (Hsieh et al., 2023), which stated that safety knowledge was significantly higher in the game-based group than in the exercise-based group. Likewise, the results of research conducted by Hartati (Hartati & Putri, 2021) concluded that there was an effect of providing health education on adolescents' knowledge about the dangers of smoking. Changes in the level of knowledge and behaviour of adolescents are a necessary start in dealing with the use of e-cigarettes among adolescents in tobacco prevention and control programs, which can affect the health of adolescents (Chun et al., 2020).

Behaviour about the dangers of e-cigarettes

This study showed a significant increase in behaviour after being educated using *e-cigarette educational games*. This research is in line with the research conducted by Chow (Chow et al., 2020), who stated that the game-based approach effectively changes children's behaviour by increasing their intake of fruit and vegetables and educating them about healthy eating. Educational media using games can positively affect intentions and desire to quit smoking, and students can receive such media well (Guo et al., 2020). Education provided through ECG (*E-Cigarette Educational Games*) can serve as a forum for developing prevention programs (Seitz et al., 2022) and interventions to improve health in adolescents (Bold et al., 2018). Behavioural changes in adolescents suggest that individual factors (perception of danger) play an important role in e-cigarette cessation behaviour (Ahuja et al., 2022). The use of *e-cigarettes* and the nicotine content in them can interfere with brain function and cause mental health disorders, especially in adolescents, because the impact is common in the habit of smoking conventional tobacco and e-cigarettes (Grant et al., 2019).

There was no significant improvement in behaviour after being educated using leaflets. This research is in line with research conducted by Natalie Gold (Gold et al., 2019). It was found that there was no significant difference in the provision of health information through leaflets and the improvement of patient behaviour in conducting health checks; this happened because it took a long time for behaviour to be seen to change. Stopping the use of e-cigarettes is not an easy or short thing to do, but it takes a long time to be said to have stopped using them. According to the Transtheoretical Model by Prochaska and DiClemente, the stages of behaviour change include pre-contemplation, contemplation, action, maintenance, and termination (Emadzadeh & Vakili, 2020). There were significant differences in adolescent behaviour regarding the dangers of e-cigarettes in both groups after being given education. This research aligns with Wardoyo's (Wardoyo et al., 2020), which found a significant difference in effectiveness between game-based and conventional

learning methods in improving student learning outcomes. When using games in the classroom, students are more likely to be attentive and willing to dedicate much time to improving their game skills. Compared to traditional teaching methods, students who use guided play achieve better results in pedagogical practice. Card games can increase learners' cognitive interest and enhance learning when appropriately scaffolded (P. Singh et al., 2021). The game-based approach enhances learners' decision-making skills within the game and advances their motor skill performance in motor skill assessments (Manninen et al., 2024). According to Bai (Bai et al., 2020), education through games has many advantages: gamification can foster enthusiasm, provide performance feedback, meet students' needs for recognition, and encourage goal setting.

CONCLUSION

In conclusion, the use of ECG (E-Cigarette Educational Games) can be used as one of the interventions in educational media to increase knowledge and change behaviour to prevent the use of e-cigarettes in adolescents. From the results of the research, there is a relationship between the level of adolescent knowledge about the prevention of E-Cigarette dangerous before and after being educated using E-Cigarette Educational Games, there is a relationship between adolescents' knowledge about the prevention of E-Cigarette dangerous between before and after being educated using leaflets, there is a relationship between adolescents' behaviour about the prevention of E-Cigarette dangerous before and after being educated using E-Cigarettes Educational Games, and there was no relationship between adolescent behaviour about the prevention of E-Cigarette dangerous between before and after being given education using leaflets. The results of ECGs (E-Cigarette Educational Games) indicate the potential to efficiently educate young people about the risks and repercussions of vaping. These games have been shown to raise knowledge of vaping-related health risks, refute myths, and minimise the likelihood of commencing vaping. ECGs can effectively reach and resonate with young audiences by presenting information in an engaging, interactive way, potentially leading to beneficial changes in their attitudes and behaviours towards e-cigarettes.

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