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ORIGINAL ARTICLE

EFFECT OF USING THE SICARE APPLICATION ON KNOWLEDGE ABOUT CHRONIC ENERGY DEFICIENCY AND THE DIETARY PATTERNS OF ADOLESCENT GIRLS

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ABSTRACT

The high prevalence of chronic energy deficiency (CED) among adolescent girls may be due to a lack of knowledge and unhealthy dietary practices. This study aimed to evaluate the effect of the SICARE application in improving healthy dietary knowledge among adolescent girls. This study employed a quasi-experimental design with a non-equivalent control group comprising 59 participants in each group. The study was conducted at a high school. The researchers used a knowledge questionnaire and the Food Frequency Questionnaire (FFQ) as measurement tools. The results showed a significant improvement in CED knowledge in the intervention group after using the application, from 12.68 ± 2.35 to 20.85 ± 1.37 ($p < 0.05$). The participants' eating habits also improved over the two weeks, with increased consumption of rice as a staple food, eggs as the primary source of animal protein, and tempeh and tofu as plant protein sources. Water spinach and papaya were the most frequently consumed vegetables and fruits. The findings suggest that the SICARE app is an effective educational tool for increasing knowledge about CED and promoting healthier eating habits among adolescent girls. Thus, the app can be used to address the high prevalence of CED in this population.

Keywords: *Adolescent, chronic energy deficiency, dietary patterns, knowledge, smartphone app*

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BACKGROUND

Chronic energy deficiency (CED) is a condition where an individual maintains energy balance, but at the expense of potential health risks or functional impairments. It can be identified using body mass index (BMI), with a threshold of less than 18.5 kg. This condition can also impair cognitive and mental development, lower educational attainment, and work efficiency (Dagne et al., 2021).

The World Health Organization (WHO) reports that up to 462 million people worldwide are underweight, with 45 million people categorized as underweight in 2020. The WHO estimated that chronic malnutrition contributes significantly to this condition (WHO, 2021). The Special Region of Yogyakarta has a relatively high prevalence of CED, at 17.2% (Balitbangkes RI, 2018). In 2022, the Kulon Progo district had the highest number of CED cases, at 13.80% (Dinas Kesehatan DIY, 2023). Moreover, the prevalence of CED among adolescent girls (aged 15-19 years) increased from 33.5% in 2018 to 36.3% in 2020 (Yulia et al., 2024).

The high prevalence of CED among adolescent girls is influenced by multiple factors, including concerns about physical appearance (body image), dietary patterns (meal frequency and food types), inadequate nutrient intake (such as energy, protein, fat, and iron), and low body mass index (Ardi, 2021). Although CED is a concern during adolescence, its persistence into adulthood has been linked to broader socioeconomic and demographic factors, including anemia, education level, place of residence, religion, wealth, marital and occupational status, age, alcohol consumption, and regional disparities (Dagne et al., 2021).

Poor dietary practices are a significant determinant of malnutrition, which can lead to weight loss, tissue damage, and CED. CED is characterized by prolonged energy and protein deficiency, resulting in various health complications (Rahman et al., 2024). Chronic energy deficiency (CED) results from prolonged periods of low food intake, leading to stunted growth and reduced physical activity (Dagne et al., 2021).

The health knowledge of adolescent girls affects various aspects of their dietary behavior, physical activity, and body image perception. Inadequate nutrition knowledge among adolescents is often associated with unhealthy dietary habits. This population often imposes dietary restrictions without understanding their actual nutritional needs, resulting in poor food choices that fail to meet their nutritional requirements (Hariyanti & Haryana, 2021).

In addition to inadequate nutritional intake, lack of awareness about the risks of CED also contributes to the prevalence of CED among adolescent girls. Knowledge plays a crucial role in shaping individual behavior, particularly in relation to health-related practices (WHO, 2021). Improved health knowledge can be achieved through health education interventions, where appropriate media can significantly affect how well information is received and retained (Lestari, 2021).

Adolescents nowadays are often immersed in advanced technology, driving the demand for engaging and accessible learning methods. Technology has facilitated access to health information and digital interventions, such as e-Health and m-Health, to manage various health conditions (Nutbeam, 2021). Health education media in the form of smartphone applications are underutilized, encouraging researchers to investigate the impact of using the SICARE application as a health education tool to prevent CED in adolescents. A similar study was published on the effectiveness of smartphone app-based interventions on adolescents' food intake. Gilliland et al. (2022) developed and evaluated the SmartAPPetite application designed to enhance food literacy and promote healthy eating behaviors in adolescents. The app provided users with personalized food tips, locally sourced recipes, and nutrition information reviewed by dietitians. Similarly, health education delivered through digital platforms, such as Instagram, has shown promising results in improving adolescent nutrition awareness and behaviour if the content is engaging and structured (Simatupang et al., 2024).

Previous studies have explored traditional methods for enhancing health education, including the use of booklets, scrapbooks, videos, and social media (Nadiya & Fazira, 2022; Waryana et al., 2019; Yulianasari et al., 2019; Zaki & Sari, 2019). However, the novelty of this study lies in the introduction and evaluation of the SICARE application as an innovative tool to enhance the CED-related knowledge and dietary behaviors of adolescent girls.

The SICARE app offers a personalized, interactive approach that is accessible and relevant to the digital habits of today's adolescents, which has not been thoroughly examined in previous studies utilizing mobile technology to educate adolescents about chronic energy deficiency and promote a healthy diet. This study aims to determine the impact of using the SICARE app on the knowledge about chronic energy deficiency and dietary patterns of adolescent girls.

METHOD

Study design

This study employed a quasi-experimental approach using a pre-test and post-test design with a control group. This research was conducted between November 2023 and January 2024.

Sample/ Respondents

The respondents in this study were adolescent girls with CED at Puskesmas Kalibawang, Kulon Progo, Daerah Istimewa Yogyakarta. The inclusion criteria for this study were adolescent girls in grades 10 and 11 who owned and used smartphones and were willing to participate as respondents. The exclusion criteria included adolescent girls who did not get permission from their parents and those who were sick. The drop-out criteria consisted of students who did not complete the study.

This study used the purposive sampling technique, targeting adolescent girls who were at risk of developing CED. The minimum number of respondents was determined using the Lemeshow formula. A total of 118 respondents participated. They were divided into an intervention group (59 respondents) and a control group (59 respondents).

Instrument

1. Questionnaire

Three experts validated the knowledge instrument to ensure accuracy and relevance. Construct validity was assessed in 30 adolescent girls with CED, yielding 25 valid items with correlation values ranging from 0.407 to 0.952. A reliability test using the Spearman-Brow method was also conducted and resulted in a value of 0.808.

The FFQ instrument was originally developed by a nutrition researcher and is recognized as a standard tool for evaluating dietary intake. The FFQ typically includes 20 to 50 food items, with scores determined by the frequency of consumption per day, week, or month. The total score can be converted into estimated daily or weekly nutrient intake using a food composition database. The validity of the FFQ instrument was further confirmed by Syauqy et al. (2021), who developed and validated a 137-item FFQ designed specifically for middle-aged and older adults in Semarang, Indonesia. In this study, the FFQ was evaluated against nine 24-hour dietary recalls (24HDRs) as the reference standard. The results showed de-attenuated Pearson correlation coefficients ranging from 0.54 to 0.82 for different nutrients, demonstrating the FFQ's moderate to strong validity.

2. The SICARE App

The SICARE app was developed by a team of professional technology developers in the healthcare field, in collaboration with an IT expert. The application's development process involved creating a project in the Android software development environment and selecting the appropriate project type. Next, the project configuration was performed, which involved combining programming and preparing server data, organizing the layout and interface, and, at the final stage, uploading the app to the target platform. The app was intended to be available for one year from its launch date.

After developing the prototype, the application and its material were tested by experts. The usability score was 74.45, which means the application is suitable for use. The measuring was conducted using an Alpha Testing Questionnaire and evaluated by three media experts (Menora et al., 2023).

The SICARE application offers various information about nutrition, healthy lifestyles, and CED prevention for adolescent girls. The *Belajar Yuk* menu presents material on

CED, including its definition, signs and symptoms, causes, impacts, factors that influence it, prevention methods, and early detection methods. The *Cek status giziku* page can be used to determine the respondents' nutritional status by entering their weight, height, and upper arm circumference. Respondents can see whether their nutritional status indicates CED or not. The chat feature allows the researcher and the respondent to communicate with each other.

Intervention

The study employed a quasi-experimental design using a pre-test and post-test approach with a control group. The research was conducted from November 2023 to January 2024 in the working area of the Kalibawang Public Health Center.

The intervention group received the SICARE application, a digital health intervention tool designed to support the study objectives. Meanwhile, the control group was given the same educational content through traditional lecture-based sessions. The interventions were conducted over a period of two weeks. The respondents who used the SICARE application were guided by trained facilitators. Meanwhile, the lectures for the control group were delivered by health educators affiliated with the local public health center.

Data collection

The researchers distributed consent forms to the respondents before starting the study. They conducted a pre-test on the intervention group and the control group. The intervention group received health education through the SICARE app, while the control group initially did receive no intervention; however, they were given access to the SICARE app after the post-test. The respondents used the SICARE app for 2 weeks.

Data analysis

Bivariate analysis was used to examine differences in the respondents' knowledge and diet before and after the intervention. An independent t-test was used to analyze differences in pre-and post-intervention knowledge scores and dietary patterns between the intervention and control groups. The significance threshold for this study was set at $p < 0.05$.

Ethical consideration

This study was approved by the Ethics Committee of the Faculty of Medicine, Public Health, and Nursing, Gadjah Mada University, with reference number KE/FK/1198/EC/2023.

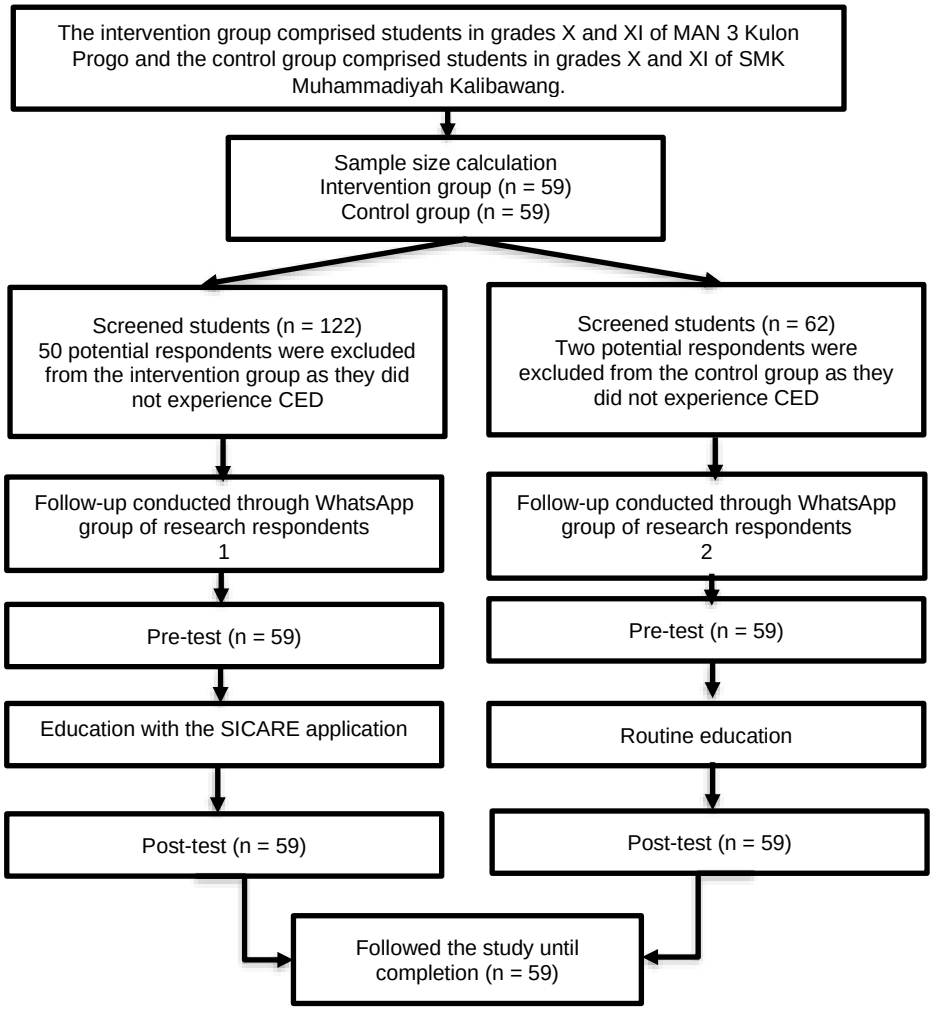

Figure 5. Research Process

RESULT

1. Respondents' Characteristics

Table 1 shows that there are no significant differences between the two groups (homogeneous).

Table 1. Frequency distribution of the respondents' characteristics

Variable		Group				p-value
		Intervention		Control		
		n	%	n	%	
Age	11 – 14 years	0	0.0%	1	1.7%	0.149[b]
	15 – 17 years old	59	100%	45	76.3%	
	18 – 21 years old	0	0.0%	13	22.0%	
Father's education	Elementary school	13	22.0%	24	40.7%	0.140[b]
	Junior High School	20	33.9%	16	27.1%	
	Senior High School	23	39.0%	19	32.2%	
	College tall	3	5.1%	0	0.0%	
Mother's education	Elementary school	18	30.5%	17	28.8%	0.335[b]
	Junior High School	22	37.3%	16	27.1%	
	Senior High School	18	30.5%	24	40.7%	
	College tall	1	1.7%	2	3.4%	
Parent's income	Less than 1,900,000	41	69.5%	38	64.4%	0.557[a]
	More from 1,900,000	18	30.5%	21	35.6%	
Information exposure	Yes	12	20.3%	5	8.5%	0.066[a]
	No	47	79.7%	54	91.5%	
Sources of information	Never exposed	47	79.7%	54	91.5%	0.068[b]
	Print media	0	0.0%	0	0.0%	
	Internet	8	13.6%	0	0.0%	
	Officer health	4	6.8%	4	6.8%	
	Other	0	0.0%	1	1.7%	

[a]Chi-Square, [b]Mann Whitney Test

2. Knowledge about CED among adolescent girls

Table 2 illustrates the difference in knowledge scores on CED between the two groups. This study demonstrated that both the SICARE application in the intervention group and the lecture in the control group led to a significant increase in the respondents' CED knowledge.

Table 2. Differences in the CED knowledge of adolescent girls (n = 118)

Variable	Intervention	CI 95%		p	Control	Δ	p	CI 95%		Effect size
	Mean ± SD	Lower	Upper		Mean ± SD			Lower	Upper	
Pre-test knowledge	12.68 ± 2.35	-8.77	-7.56	0.000	11.51 ± 3.39		0.000	-7.86	-5.83	
Post-test knowledge	20.85±1.37				18.36 ± 2.41					
Difference in knowledge	8.16 ± 2.33				6.84 ± 3.89	1.13	0.018			0.41

Table 3 presents the relationship between external variables and knowledge and diet. The results showed that the selected external variables were not associated with adolescent girls' knowledge and diet (p > 0.05).

Table 3. Bivariate test results between external variables and CED

Variable		Knowledge		p
		Mean	Standard deviation	
Age	15 years	20.65	1.45	0.159 [f]
	16 years	21.30	1.17	
	17 years	20.00	0.00	
Father's education	Elementary school	21.00	1.22	0.614 [f]
	Junior High School	21.10	1.29	
	Senior High School	20.57	1.56	
	College tall	20.67	1.15	
Mother's education	Elementary school	20.89	1.18	0.998 [f]
	Junior High School	20.82	1.43	
	Senior High School	20.83	1.58	
	Desert tall	21.00	0.00	
Parent's income	≤1,900,000	20.66	1.35	0.112 [g]
	≥1,900,000	21.28	1.36	
Information exposure	Once follow	20.92	1.31	0.847 [g]
	Never follow	20.83	1.40	
Sources of information	Never exposed	20.83	1.40	0.492 [f]
	Internet	21.25	1.28	
	Officer health	20.25	1.25	

[f]One-way ANOVA, [g]Independent t-test

3. Overview of the Diet of Adolescent Girls

The study also assessed the diet of adolescent girls in both groups for 2 weeks. The respondents in both groups consumed rice as their staple food three times a day (see Table 4). They also frequently consumed animal protein, especially eggs (see Table 5). The vegetable protein intake among the respondents was mostly in the form of tempeh and tofu (see Table 6). Vegetables, such as water spinach, and fruits, such as papaya, were also frequently consumed by the respondents (see Table 7).

Table 4. Dietary distribution of foods consumed

Food	Pre-test					Post-test				
	Never (%)	Daily		Weekly		Never (%)	Daily		Weekly	
		1-3x (%)	>3x (%)	1-2x (%)	3-6x (%)		1-3x (%)	>3x (%)	1-2x (%)	3-6x (%)
Intervention group										
Rice	0	88.1	11.9	0	0	0	86.8	13.1	0	0
Cake	39	1.7	8.5	44	6.8	3.3	19.7	8.2	50.8	18.0
Sweet potato	50.8	1.7	5.1	37.3	5	9.8	9.8	3.3	31.1	45.9
Cassava	64.4	1.7	0	30.5	3.4	8.2	9.8	9.8	37.7	34.4
Potato	50.8	3.4	8.5	32.2	5.1	5.8	11.5	8.2	31.1	44.3
Control group										
Rice	0	88.5	11.5	0	0	0	89.8	10.2	0	0
Cake	73.8	1.6	0	24.6	0	52.5	0	0	47.5	0
Sweet potato	85.2	0	0	9.8	4.9	78.0	0	0	22.0	0
Cassava	63.9	0	0	36	0	71.2	0	0	28.8	0
Potato	65.6	0	0	34.2	0	66.1	0	0	33.9	0

Table 5. Dietary distribution of animal protein consumed

Food	Pre-test			Post-test		
	Never (%)	Weekly		Never (%)	Weekly	
		1-2x (%)	3-6x (%)		1-2x (%)	3-6x (%)
Intervention group						
Meat	79.6	11.9	8.5	26.3	65.6	8.1
Chicken	28.8	50.8	20.4	0	47.6	52.4
Chicken's liver	44.1	45.1	10.8	18.0	55.7	26.2
Fish	52.5	30.5	8.5	21.3	37.7	41.0
Squid	94.9	3.4	1.7	72.1	27.9	0
Shrimp	93.2	1.7	3.4	4.9	83.6	11.5
Shell	93.2	1.7	3.4	78.7	18.0	3.3
Egg	30.5	33.9	35.6	10	29.8	59.2
Control group						
Meat	78.7	21.3	0	65.6	34.4	0
Chicken	9.8	85.2	4.9	5.1	93.2	1.7
Chicken's liver	59.0	40.8	0	49.2	50.8	0
Fish	37.7	62.3	0	50.8	49.2	0
Squid	95.1	4.9	0	100.0	0	0
Shrimp	90.2	4.9	4.9	100.0	0	0
Shell	95.1	4.9	0	98.3	1.7	0
Egg	13.1	50.8	36.1	10.2	76.3	13.1

Table 6. Dietary distribution of vegetable protein consumed

Food	Pre-test			Post-test		
	Never (%)	Weekly		Never (%)	Weekly	
		1-2x (%)	3-6x (%)		1-2x (%)	3-6x (%)
Intervention group						
Tofu	11.9	39.0	49.1	0	18.0	82.0
Tempeh	10.2	35.6	54.2		16.4	83.6
Peanut red	89.8	8.5	1.7	54.5	29.1	16.4
Peanut green	74.6	15.3	10	24.6	44.3	27.8
Peanut soya bean	74.6	15.3	9.2	34.3	37.7	27.9
Oncom	94.9	3,4	1.7	55.1	27.9	21.3
Cashew nut	94.9	5.1	0	73.8	21.3	4.9
Control group						
Tofu	9.8	27.9	62.3	6.8	39.0	54.2
Tempeh	11.5	34.4	54.1	5.1	37.3	57.6
Peanut red	91.8	8.0	1.6	100.0	0	0
Peanut green	88.5	11.4	3.3	98.3	1.7	0
Peanut soya bean	96.7	3.3	0	100	0	0
Oncom	100	0	0	100	0	0

Food	Pre-test			Post-test		
	Never (%)	Weekly		Never (%)	Weekly	
		1-2x (%)	3-6x (%)		1-2x (%)	3-6x (%)
Cashew nut	100	0	0	100	0	0

Tofu, tempeh; Oncom: fermented soybean

Table 7. Dietary distribution of vegetables consumed

Food	Pre-test			Post-test		
	Never (%)	Weekly		Never (%)	Weekly	
		1-2x (%)	3-6x (%)		1-2x (%)	3-6x (%)
Intervention group						
Long beans	33.2	33.9	32.9	24.6	39.3	36.1
Carrot	16.9	45.8	37.3	19.7	21.3	59.0
Broccoli	20.3	45.8	33.9	14.7	24.6	60.7
Spinach	13.5	49.2	37.5	13.1	21.4	65.5
Water spinach	13.6	45.8	40.7	0	26.3	68.9
Mustard	20.3	55.9	23.1	6.5	26.2	59.0
Cassava leaves	35.6	45.8	18.6	14.7	39.3	41.0
Beans	39.0	45.8	15.3	14.8	31.1	54.1
Chayote/ Japan	50.8	37.1	11.9	22.2	29.5	48.3
Eggplant	42.4	40.7	16.9	19.7	36.1	44.2
Control group						
Long beans	36	57.4	6.6	30.5	69.5	0
Carrot	31.1	62.3	6.6	20.3	78.0	1.7
Broccoli	42.6	54.1	3.3	32.2	66.1	1.7
Spinach	37.7	57.4	4.9	27.1	71.2	1.7
Water spinach	31.1	63.3	5,6	15.3	83	1.7
Mustard	43.3	54.1	2.5	30.5	67.8	1.7
Cassava leaves	57.4	39.2	3,2	62.7	37.3	0
Beans	78.7	21.3	0	86.4	13.6	0
Chayote/ Japan	63.9	36.1	0	52.5	47.5	0
Eggplant	70.5	29.5	0	72.9	27.1	0

Table 8. Dietary distribution of fruits consumed

Food	Pre-test			Post-test		
	Never (%)	Weekly		Never (%)	Weekly	
		1-2x (%)	3-6x (%)		1-2x (%)	3-6x (%)
Intervention group						
Avocado	78.0	11.9	10.2	26.3	42.6	27.9
Apple	69.5	16.3	13.6	19.6	47.5	32.6
Orange	50.8	35.6	13.6	21.3	24.6	54.1
Mango	69.5	16.0	13.5	27.9	23.0	49.2
Papaya	47.5	42.4	10.2	13	36.1	50.8
Rambutans	72.9	18.7	8.5	19.6	45.9	34.4
Wine	62.7	24.4	11.9	16.3	3.9	44.3
Banana	72.9	18.6	8.5	19.6	42.6	37.7
Dragon fruit	45.8	33.8	20.4	24.6	21.3	54.1
Soursop	79.7	11.9	8.5	44.2	37.7	14.8
Durian	81.4	15.3	3.4	22.9	47.5	29.5
Melon	89.8	5.1	5.1	39.3	42.6	18.0
Guava	76.3	13.6	10.2	26.3	54.1	19.7
Control group						
Avocado	90.2	9.8	0	89.8	10.2	0
Apple	82.0	17.2	0	78.0	22.0	0
Orange	60.7	39.4	0	52.5	47.5	0
Mango	78.7	22.3	0	59.3	40.7	0
Papaya	49.2	39.3	12.5	45.8	54.2	0
Rambutans	75.4	24.6	0	83.1	16.9	0
Wine	49.2	50.8	0	50.8	49.2	0
Banana	95.1	4.9	0	98.3	1.7	0
Dragon fruit	59.0	32.8	7.2	40.7	59.3	0
Soursop	93.4	6.6	0	93.2	6.8	0
Durian	90.2	9.9	0	91.5	8.5	0
Melon	95.1	4.9	0	98.1	0	1.7
Guava	85.2	14.8	0	91.5	8.5	0

4. Dietary Patterns Among Adolescent Girls

Table 9 illustrates the difference in dietary scores between the two groups. A significant difference was observed between the pre- and post-intervention dietary scores in both groups. This study demonstrated that providing the SICARE

application to the intervention group and lectures to the control group resulted in significant dietary improvements.

Table 9. Eating pattern differences in adolescent girls (n = 118)

Variable	Intervention	CI 95%		p	Control	Δ	CI 95%		p	Effect size
	Mean ±SD	Lower	Upper		Mean ± SD		Lower	Upper		
Dietary patterns		-2.66	-0.68	0.001			0.22	1.89	0.013	
Pre-test	9.85±2.07				10.68±2.57					
Post-test	11.52±4.08				9.62±2.17					
Eating pattern differences	1.67±3.79				-1.05±3.19	2.73	1.45 – 4.01		0.000	0.17

DISCUSSION

1. The CED knowledge of adolescent girls

Both the intervention and control groups initially had low mean knowledge scores on CED before receiving health education. A lack of information on CED and its prevention contributed to the low level of knowledge about CED and a healthy diet. A person's level of knowledge will influence their health behaviors, which are shaped by prior health education. Thus, effective health education interventions can increase knowledge and promote positive behaviour change, leading to improvements in public health indicators. For example, Singh et al. (2023) highlighted that health education interventions can lead to significant behavior modifications, emphasizing the role of knowledge acquisition in health behaviour change.

People obtain information through various media channels, which disseminate news, treatment information, prevention strategies, and nutritional guidelines. These media can influence health behavior change. Mass media campaigns have been shown to produce positive changes or prevent negative changes in health-related behaviors across populations (Singh et al., 2023). Similarly, social media platforms have become an integral part of health communication, offering opportunities for health promotion and behaviour change interventions (Wakefield et al., 2010). Health education using the SICARE application, as well as in the control group, significantly increased the average knowledge score about CED in adolescent girls. This finding supports Dinengsih and Hakim's (2020) study, which found that Android applications used for health education can increase knowledge levels. Additionally, a high intensity of information and education provided to adolescent girls is more effective in enhancing their knowledge (Patimah et al., 2023).

The effect size value of 0.41 in the test of the difference in scores between the two groups showed that the SICARE application was more effective in increasing the respondents' knowledge about CED. These results align with Lestari's (2021) statement that Android-based health education applications can increase knowledge about CED. Additionally, research on the Android Studio application has demonstrated a significant increase in adolescent nutritional knowledge (Sulistiani et al., 2021).

2. Overview of adolescent girls' diets

The results showed that the SICARE application had a significant influence on the diet of adolescent girls. Post-intervention, there was a significant increase in the consumption of staple foods, including rice, as well as animal proteins such as eggs and vegetable proteins like tempeh and tofu. In addition, water spinach was the most frequently consumed vegetable, while papaya was the most preferred fruit. Adolescents often consume rice as a staple food three times a day, making it their primary source of carbohydrates (in the morning, afternoon, and evening). Indonesian culture traditionally favors rice as a staple food, as it is readily accessible and has long been a staple of the community (Prisylvia et al., 2022).

Adolescents often include eggs and fish in their diets as accessible sources of animal protein. This finding supports Mahmudiono et al.'s (2020) study, which found fish and eggs as popular choices among adolescents. Nevertheless, it is important to note that factors such as demographic and economic conditions often limit access to animal protein.

Economic constraints often lead families to prioritize staple foods over more expensive protein sources, impacting the nutritional quality of adolescents' diets. A study conducted in Ethiopia highlighted that a combination of individual, familial, and community-level factors influences adolescents' dietary habits. Limited accessibility and availability of diverse food items at home, along with cultural practices and economic limitations, were identified as barriers to the consumption of animal-source foods among adolescents (Agedew et al., 2022).

Moreover, the study was conducted in a mountainous area, far from the city centre. Therefore, the respondents had difficulty accessing protein sources, such as seafood (including squid, shrimp, and shellfish). Additionally, the parents of this study's participants have incomes below the regional minimum wage, making it difficult for them to afford meat or other animal proteins. This finding is consistent with previous research, which found that adolescents in rural areas tend to consume less fat compared to other nutrients. Adolescents typically consume only 10% of the recommended fat intake (Yulia et al., 2024).

In this study, the respondents consumed tofu and tempeh as vegetable protein sources three to six times a week. This consumption pattern shows regular consumption. Prisylvia et al. (2022) also found that adolescents usually consume tofu and tempeh as sources of plant-based protein three to six times a week. These foods are popular due to their affordability and availability, with soybeans being locally cultivated for production.

This study also revealed that adolescent girls often consume kale, broccoli, and spinach three to six times a week. Additionally, they consumed smaller amounts of spinach, mustard greens, and carrots on one or two occassions a week. These varying frequencies reflect occasional consumption rather than daily intake. Nurholihah et al. (2019) also observed that adolescents preferred kale, followed by mustard greens (Nurholilah et al., 2019). In the Kalibawang Health Centre area, which is surrounded by many rice fields,

kale is readily available and affordable, as it thrives well in local rice fields.

For fruits, the respondents generally consume papaya, oranges, and salak three to six times a week, with the occasional guava once or twice a week. This pattern reflects regular but not daily consumption. This fruit consumption pattern reflects a broader trend observed in Southeast Asian adolescents, who reported inadequate intake of fruits and vegetables. 28% of adolescents consume fruits less than once a day, with an overall average of only 1.3 servings per day, which is well below the WHO recommendation of at least two servings per day. This statistic suggests that even in populations where fruits are locally accessible and culturally integrated into diets, daily consumption remains a challenge (Peltzer & Pengpid, 2012).

Adolescent girls undergo various physical changes, including an increase in muscle mass, a rise in body fat, and hormonal fluctuations. These changes significantly impact their nutritional needs. Thus, inadequate consumption of essential nutrients, particularly energy and protein, can increase the risk of CED in adolescents (Yulia et al., 2024). By providing easily accessible information and interactive features, the app empowers users to make informed food choices, addressing issues such as CED.

3. The SICARE application

The SICARE application intervention was more effective in improving the knowledge and diet of adolescent girls regarding CED than traditional lecture methods. The improvement in the diet of the intervention group was also more significant compared to the control group. These findings align with Dinengsih and Hakim's (2020) research, which revealed that Android applications were more effective in improving knowledge compared to lectures. Turnip and Arisman (2022) also confirmed that Android apps increased adolescent girls' knowledge more effectively than lectures.

Android applications have been proven effective as a medium for nutrition education, improving knowledge and healthy eating habits (Perdana et al., 2017). Such applications enable their users to access information and knowledge easily (Fitriami & Galaresa, 2021). Moreover, Muliana et al. (2023) found that Android-based applications can drive changes in education and knowledge, with adolescents preferring to use digital technology in their daily lives to obtain information.
The positive outcomes observed with the SICARE app underscore the importance of integrating digital health tools into nursing practices. Nurses can utilize the app to educate patients, monitor progress, and provide personalized support, thereby increasing the effectiveness of nutrition education interventions.

A limitation of this study is that it could not be confirmed whether the respondents in the intervention group exclusively accessed material from the SICARE application or whether those in the control group received information solely from lectures. However, we included questions to identify any additional sources of information accessed by the respondents during the two weeks following the installation of the SICARE application for the intervention group and after the lecture for the control group.

CONCLUSION AND RECOMMENDATION

The SICARE app improved the respondents' knowledge about CED. The app has shown promising results in improving adolescents' knowledge of nutrition and promoting healthier food choices. Its ability to provide customized information, give dietary advice, and monitor progress empowers adolescents to make better food choices. Thus, digital-based interventions can be effective for reaching adolescents who may have limited access to traditional nutrition education resources.

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