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Enhancing nutritional literacy and improving dietary patterns in obese adolescents through e-booklets

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ABSTRAK

Latar Belakang: *Obesitas merupakan masalah kesehatan masyarakat dengan peningkatan prevalensi di semua kelompok usia di dunia. Salah satu faktor yang berkontribusi terhadap obesitas pada remaja adalah rendahnya literasi gizi dan pola makan yang tidak sehat.*
Tujuan: *untuk mengetahui dampak intervensi edukasi dengan media e-booklet terhadap pengetahuan dan asupan makanan.*
Metode: *single group pre-posttest intervention pada remaja di SMA di Kabupaten Kulon Progo, Yogyakarta, Indonesia. Sampel ditentukan dengan kriteria inklusi siswa SMAN 1 Sentolo, kelas X dan XI, bersedia menjadi responden, hadir saat pengumpulan data dan mempunyai skor IMT/U > 1 SD, sehingga berjumlah 46 orang. Intervensi edukasi diberikan dengan media e-booklet melalui grup WhatsApp sedangkan data pengetahuan dan asupan makanan diobservasi pada saat pre-test, posttest-1 dan posttest-2. Data pengetahuan dikumpulkan dengan kuesioner dan data asupan makanan dikumpulkan dengan food recall 2 x 24 jam lalu dianalisis dengan t-test dan Wilcoxon.*
Hasil: *Skor pengetahuan siswa pre, posttest-1 dan posttest-2 masing-masing adalah 56,3; 94,5; dan 98,5. Terdapat perbedaan pengetahuan yang signifikan baik pada posttest-1 maupun posttest-2. Tingkat asupan energi, protein, karbohidrat dan lemak pada pengukuran pre, posttest-1 dan posttest-2. Asupan energi menurun dari 126%, 110% dan 91%; asupan protein menurun dari 163%, 156% dan 106%; asupan lemak menurun dari 153%, 137% dan 106%; asupan karbohidrat menurun dari 100%, 91%, 76%. Hasil analisis menyatakan ada perbaikan asupan yang signifikan baik pada posttest-1 maupun posttest-2 kecuali asupan karbohidrat pada posttest-1.*
Kesimpulan: *Edukasi gizi dengan media e-booklet berdampak pada peningkatan pengetahuan tentang obesitas dan memperbaiki asupan makanan pada remaja yang mengalami overweight dan obesitas.*

KATA KUNCI*: asupan;edukasi; e-booklet; pengetahuan; protein; remaja*

ABSTRACT

Background: *Obesity is a public health problem with increasing prevalence in all age groups in the world. One of the factors that contribute to obesity in adolescents is low nutritional literacy and unhealthy diets.*

Objectives: *To determine the impact of educational interventions with e-booklet to knowledge and food intake.*

Methods: *A single group pre-posttest intervention study was conducted on adolescents in senior high school Sentolo 1 (SMAN 1 Sentolo), Kulon Progo, Yogyakarta, Indonesia. The sample was chosen by criteria for grades X and XI, willing to be responders, present during data collection, and had BMI-for-age-score >1 SD, as many as 46 participants included this study. Educational interventions were provided with e-booklet was shared through WhatsApp groups, while knowledge and food intake were observed during the pre-test, post-test 1, and post-test 2. Knowledge was collected by questionnaire, and food intake was collected by food recall 2x24 hours. We apply t-test and Wilcoxon to analyze the data.*

Results: *The knowledge scores significantly improved from 56.3 (pre-test) to 94.5 (post-test 1) and 98.5 (post-test 2) ($p< 0.05$). Significant reductions were observed in energy, protein, carbohydrate, and fat intake between pre-test, post-test 1, and post-test 2, demonstrating the intervention's effectiveness in improving dietary habits among adolescents.*

Conclusions: *Nutrition education using e-booklet has an impact on increasing knowledge about obesity and improving food intake in adolescents who are overweight and obese.*

KEYWORDS: *adolescent; education; e-booklet; intake; knowledge; protein*

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INTRODUCTION

Obesity is a condition in which a person accumulates fat above normal or excessively so that it poses a health risk. Obesity is one of the double nutrition problems in Indonesia and the world. Currently obesity is a global problem, obesity trends tend to rise in various parts of the world. In 2017 more than 4 million people died each year from obesity (1). Meanwhile, in Indonesia, obesity in the population aged ≥15 years has also increased by 4.4%, from 26.6% in 2013 to 31% in 2018 (2). The Special Region of Yogyakarta Province, 2018 is a province with a prevalence of obesity and overweight among adolescents aged 16-18 years at 14.43% (3), as well as the top 10 highest prevalence of obesity in Indonesia.

Various factors cause obesity, including technological advances, economy, transportation, communication (4) So that it has an impact on changes in movement patterns, consumption patterns, sleep patterns and increased stress (5) (6). In addition, the selection of food intake with high energy density, high fat, sugar, and salt content, passive lifestyle and lack of physical activity are the main contributors to obesity in adolescents (7). Research in Yogyakarta reported that the high intake of fried foods in productive age adults (8) and the use of passive transport is associated with an increased risk of obesity in adults (8) and adolescent (9). Another study reported that the problem of obesity in adolescents is related to inadequate knowledge (10), lack of access to healthy food in schools or school canteens, as well as the unavailability of nutrition education programs in schools (11).

Education is one of the effective interventions to increase knowledge in adolescents, hopefully they will have a good attitude and behavior as well (12–14). In fact, the adolescent age group is an age that has the potential to be active learners and become agents of healthy behavior change for themselves, their environment and their families later when they are adults (14,15). Several studies have succeeded in proving the success of nutrition education in adolescents, including anemia education in adolescents in Makassar, South Sulawesi (16), balanced nutrition education for elementary school children in Yogyakarta (17),

stunting and anemia education in adolescents in stunting locus areas in Yogyakarta (18), and sexual and reproductive health education in urban areas in Indonesia (19).

E-booklets combine the portability and cost-effectiveness of pocketbooks with the accessibility of digital platforms, making them an innovative and practical tool for delivering health education. Their ability to engage adolescents through visually appealing and interactive content has been proven effective in various educational interventions (20). This research aims to increase adolescents' knowledge and improve their consumption using e-booklets. This study is important as it addresses the growing issue of adolescent obesity, which is linked to poor nutritional literacy and unhealthy dietary habits. This research's novelty lies in using e-booklets as a digital intervention, which combines accessibility, interactivity, and engaging visual content to enhance nutritional education. The impact of this study extends beyond immediate knowledge improvement, as it provides evidence for integrating digital-based nutrition education into school curricula and public health programs, ultimately contributing to long-term obesity prevention among adolescents.

MATERIALS AND METHODS

Design

This study was a quasy experimental using a single group pre-posttest intervention. The intervention provided was education using e-booklets designed to improve adolescents knowledge of obesity, and has been tested for eligibility with an average score of 3.73 (good). This e-booklet contains information on the definition of obesity, causes, impacts, and recommended dietary portions, presented in an attractive format with a combination of text and images. Partisipant get an e-booklet sent through WhatsApp groups.

Education and interactive discussions through WhatsApp groups were given for 60 minutes for 4 consecutive days with different materials, namely day-1: definition, causes and effects of obesity, day-2 food intake, day-3 physical activity, day-4: review. The flow of the intervention is as shown in **Figure 1**.

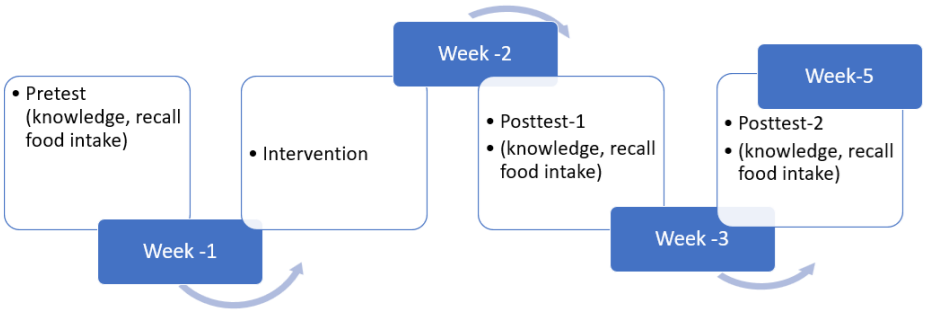


Figure 1. Intervention Flow

The study was conducted in Kulon Progo Regency, with the consideration that the prevalence of obesity is quite high, at 12.73%.(3) Data was collected in February-March 2023. The population is all students in high schools in Kulon Progo Regency. The school selection was carried out randomly, so that SMA Negeri 1 Sentolo was selected. The sample was taken as a total sample with inclusion criteria: students with a standard deviation of BMI-for-age z-score>1 standard deviation (SD), grades X and XI, age 14-18 years, and willing to be the subject of the study. The sample selection procedure is in detail in **Figure 2.**

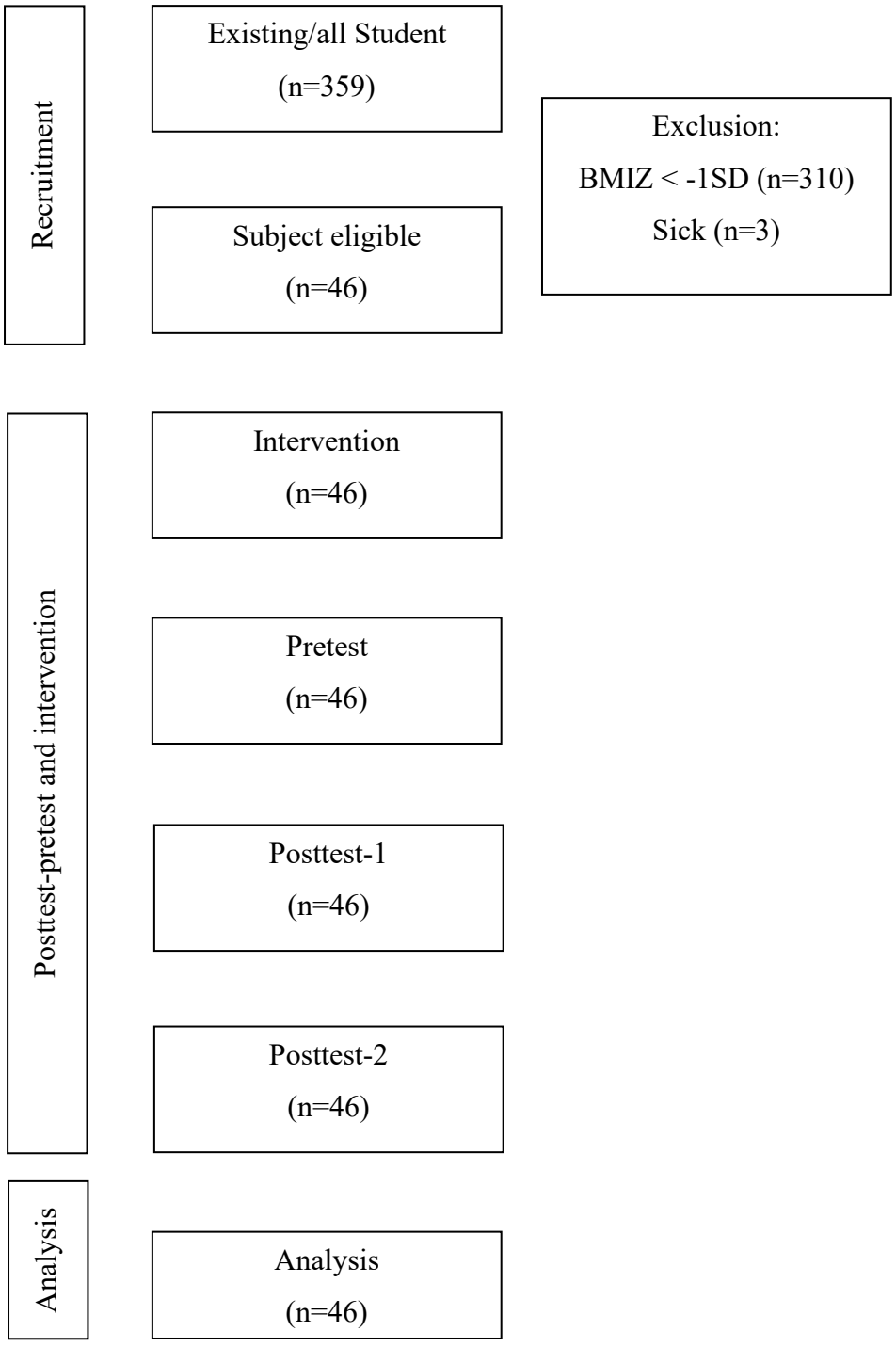


Figure 2. Research Consort Diagram

RESULTS AND DISCUSSIONS

Sample characteristics

Educational interventions for adolescents are one of the efforts to fulfill their literacy rights, including literacy in the health sector (13). Several studies state that adolescents are the potential age to gain new knowledge and experiences, this is in accordance with the characteristics of adolescents who have a high sense of curiosity, their role as agents of change, very wide implementation opportunities for themselves, the environment, and their families that are built later (22). As presented in **Table 1**, most of the samples were class X, 16 years old, and overweight. This finding highlights that overweight and obesity were already prevalent among adolescents. Facts in several countries around the world show that the phenomenon of overweight is a global threat with various accompanying risks (1). The results of the study stated that adolescent obesity tends to develop into obesity in adulthood, inhibits productivity, inhibits competitiveness in the field of work and academic ability (1,23–25), even related to a crisis of confidence (26,27) and being targeted by bullying (26,28).

Table 1. Subject Characteristics

Characteristics	n (46)	%
Grade/Level		
X	26	56.5
XI	20	43.5
Gender		
Male	23	50.0
Female	23	50.0
Age (years)		
15	2	4.3
16	30	65.2
17	13	28.2
18	1	2.2
Nutritional status		
Overweight	37	80.4
Obesity	9	19.6

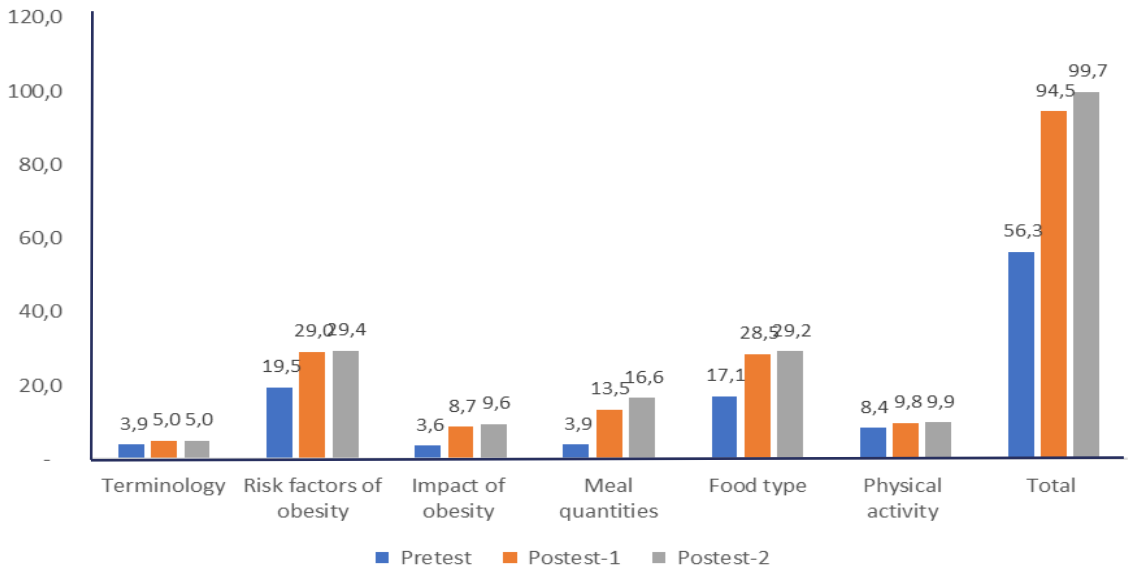


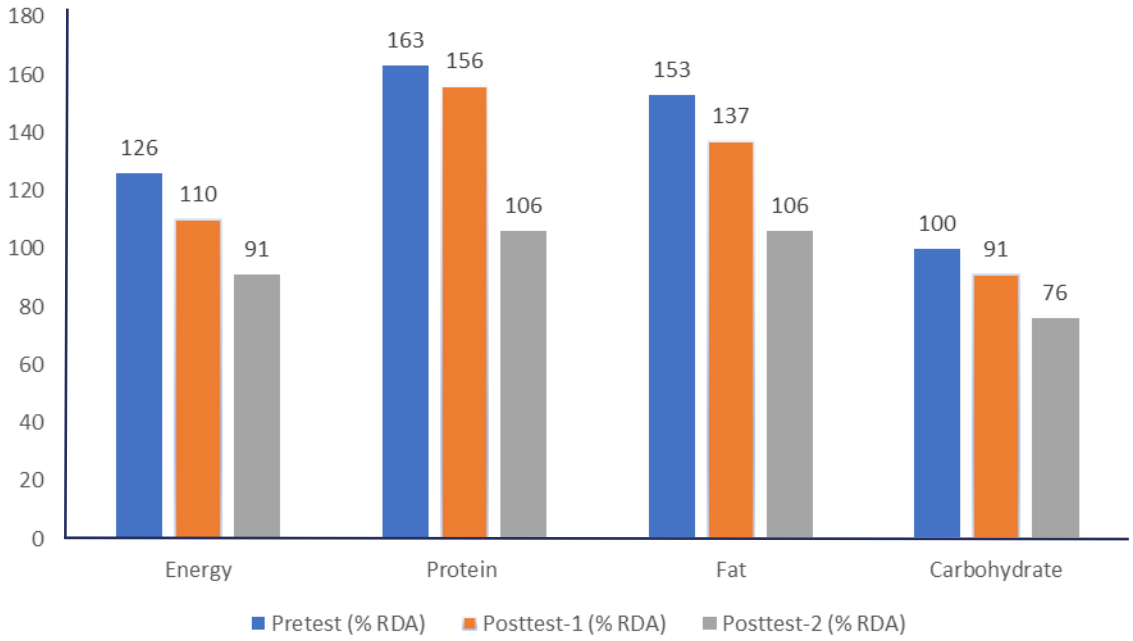
Figure 3. Knowledge improvement based on question aspects and total scores pre and post intervention

Adolescent knowledge before and after the intervention

As illustrated in **Figure 3**, adolescents' knowledge improved significantly and consistently at posttest-1 and postetest-2 compared to pretest. The results of this study support previous research on short course interventions to increase the capacity of cadres about the growth and development of toddlers (29) and educational interventions through home visits to increase maternal knowledge about growth, and infant young children feeding (IYCF) (30). This finding reinforces the potential of short-term, digitally mediated intervention in achieving knowledge among adolescents.

Food intake

As shown in **Figure 4**, the level of adequacy, represented by the % RDA of food intake, decreased consistently in energy, protein, fat, and carbohydrates after the intervention in both posttest-1 and posttest-2. The statistical analysis confirmed that this reduction was significant across most nutrients.



This consistent decrease indicates that the intervention not only improved knowledge but also successfully influenced dietary behavior. The expected effect of reducing total consumption is to prevent further weight gain and eventually lower the prevalence of overweight and obesity. However, a noteworthy finding is the considerable decrease in protein intake after education. While this may be considered as part of the intervention's success in reducing excessive intake, it is important to note that if the decrease in protein intake persists for a long period, it could negatively affect adolescent health outcomes. Prolonged protein deficits may interfere with growth and development of adolescents (31), interfere with learning performance (32), inhibits the maturation process of the reproductive organs and increases the risk of abnormalities in the pubertal period (31), anemia (33), less of fitness level and other risks of malnutrition (34).

Reducing calorie intake needs to be assisted so that adolescents are still satisfied with their nutritional needs. Improvements in food consumption after education have also been reported by previous researchers, for example nutrition education on the eating behavior of adolescent runners in California (35), nutrition education for elementary school children in Mexico (36), and elementary school students in Indonesia (17), While the reduction in protein intake aligns with the intervention's goal of reducing excessive calorie consumption, a

prolonged deficit could have adverse effects on adolescent growth and development (37). Future interventions should aim to balance calorie reduction with adequate intake of essential nutrients to support optimal health outcomes.

The school-based nutrition education program is an educational strategy with the potential to achieve optimal results, as school children are generally a well-literate population. According to Social Learning Theory- Bandura, adolescents learn effectively through observation, modeling, and reinforcement from their social environment, including school settings. Previous finding showed that educational materials about obesity, when presented engagingly and interactively, can attract adolescent interest and facilitate better retention of knowledge (25,38).

Implications of education on adolescent food knowledge and intake

Education increases knowledge and significantly decreases all types of food intake in both posttest-1 and posttest-2, except for the posttest-2 value in carbohydrate intake. As detailed in **Table 2**.

Table 2. **Educational implications on adolescent knowledge and food intake between measurement times**

Variables	Pretest	Posttest-1	Posttest-2	Posttest-1 vs Pretest Mean±SD, p- value	Posttest-2 vs Pretest Mean±SD, p- value
Knowledge	56.3 ± 10.8	94.5 ± 6.5	99.7 ± 6.8	38.2 ± 3.3 0.000*	43.4 ± 3.4 0.000*
Energy intake (%RDA)	126 ± 28.2	110 ± 26.3	91 ± 9.3	-17 ± -2 0.000*	-36 ± - 32 0.000*
Protein intake (%RDA)	163 ± 52.6	156 ± 17.8	106 ± 17.7	-22 ± -11 0.001*	-56 ± - 28 0.000*
Fat intake (%RDA)	153 ± 61.7	137 ±n53.3	106 ± 24.6	-17 ± -8 0.032*	-47 ± - 44 0.000*
Carbohydrate intake (%RDA)	100 ± 84	91 ± 20.8	76 ± 9.9	-6 ± -3 0.609	-21 ± -12 0.001*

Noted : a. t-test; b. *Wilcoxon*; *p<0.05

The decrease in food intake as a result of educational interventions is not only related to reducing portion sizes but also involves behavior modification strategies, such as replacing high-calorie fried foods with healthier alternatives, reducing the consumption of sugary drinks, and increasing fruit intake. This aligns with the Health Belief Model-Rosenstock, which explains that individuals are more likely to change dietary behaviors when they perceive health risks, understand the benefits of adopting healthier habits, and feel confident in their ability to change. Adolescents who recognize the link between excessive fried food consumption and obesity risks are more motivated to alter their eating habits.

Furthermore, fried foods and sugary beverages are widely popular among adolescents because of their convenience, taste, and sensory appeal (39–41). Despite this, research consistently shows that these food choices contribute substantially to overweight and obesity(8,40,41). This finding aligns with the Transtheoretical Model by Prochaska & DiClemente), where adolescents may move from the contemplation stage (realizing unhealthy food habits) to the action stage (actively modifying diet) through education-based interventions

Finally, to ensure the sustainability of the program, maintain consistent results, integrating nutrition education into the school curriculum is a crucial step. According to the Diffusion of Innovation Theory by Rogers), new interventions are more likely to be adopted if they are compatible with existing systems and perceived as beneficial. Embedding nutrition education into formal learning structures can support both academic performance and long-term health outcomes. Moreover, collaboration with school-based initiatives such as healthy canteen programs and adolescent counseling centers can strengthen implementation and ensure a comprehensive approach to promoting healthy eating habits.

LIMITATION

The limitations of this study include the relatively short duration of the intervention, which was conducted over a period of just one week. As a result, the impact of the intervention on key outcomes, such as weight loss, could not be measured effectively. Additionally, the educational intervention was only implemented in a single treatment group among individuals with overweight in an urban population. The other several technical obstacles also related to the use of e-booklets distributed through WhatsApp. Some participants experienced stable internet connection accessibility issues, which could affect their ability to receive and open e-booklets. Additionally, participants' technical literacy levels vary, so some may be less comfortable using WhatsApp and PDF files, which can hinder their engagement. File compatibility issues also arise, where the e-booklet format may not appear the same across devices.

In addition, we have difficulty ensuring that participants actually read or understand the educational content we provide. However, the narrow scope limits the generalizability of the findings, as the results may differ in other settings, such as rural areas or among populations with different demographic or socioeconomic characteristics. To address the limitation of a short intervention period, future studies should extend the duration to capture long-term outcomes, such as sustained changes in weight or behavior. Additionally, incorporating a control group and expanding the study to rural populations would enhance the generalizability and robustness of the finding.

CONCLUSION AND RECOMMENDATION

The study highlights the effectiveness of school-based e-booklet interventions as a scalable solution to combat adolescent obesity. Policymakers and educators are encouraged to integrate these programs into the national curriculum, leveraging digital platforms for wider reach and greater impact. The intervention demonstrated consistent improvements in adolescents' knowledge and significant reductions in food intake. To sustain these positive outcomes, schools should incorporate nutrition education into formal curricula, embedding topics like healthy eating and physical activity into subjects such as biology or physical education. Extracurricular activities promoting healthy lifestyles can further reinforce these efforts. Additionally, community health centers (Puskesmas) can adopt the e-booklet as an effective tool to improve adolescent knowledge and dietary habits. By distributing this resource via digital platforms, such as health apps or social media, accessibility and engagement can be further enhanced, ensuring broader adoption and impact.

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