

School-Based Balanced Nutrition Intervention Program in Preventing Obesity in Adolescents

Kurniati Dwi Utami^{1*}, Vina Novela², & Wijianto³

¹Poltekkes Kemenkes Kalimantan Timur, Indonesia, ²Universitas Fort De Kock, Indonesia,

³Poltekkes Kemenkes Palu, Indonesia

*Co e-mail: kurniati@poltekkes-kaltim.ac.id¹

Article Information

Received: April 23, 2026

Revised: June 01, 2026

Online: June 05, 2026

Keywords

Adolescent Obesity, Balanced Nutrition, School-Based Intervention, Health Behavior

ABSTRACT

Obesity among adolescents has become a significant public health concern, particularly in urban areas undergoing rapid nutritional transition. Purpose: This study aimed to evaluate the effectiveness of a school-based balanced nutrition intervention program in preventing obesity among adolescents by improving knowledge, attitudes, dietary behavior, and physical activity. Method: A quantitative quasi-experimental design with a non-equivalent control group was employed. The study involved 120 students aged 12–18 years in Padang City, divided into intervention and control groups. Data were collected through pre-test and post-test measurements using anthropometric assessment (BMI-for-age z-score), nutrition knowledge questionnaires, attitude and behavior scales, Food Frequency Questionnaire (FFQ), and International Physical Activity Questionnaire (IPAQ). Statistical analyses included descriptive, paired t-test, and independent t-test. Results: The intervention group showed a significant reduction in BMI z-score ($\Delta = -0.53$; $p < 0.001$) and obesity prevalence (35.0% to 18.4%), along with significant improvements in nutrition knowledge ($\Delta = +16.2$), attitudes ($\Delta = +13.6$), dietary behavior ($\Delta = +14.5$), and physical activity ($\Delta = +400$ MET) ($p < 0.001$). In contrast, the control group showed no significant changes ($p > 0.05$). Implications: The findings highlight the effectiveness of integrated school-based interventions combining nutrition education, environmental modification, and physical activity promotion in addressing adolescent obesity. Conclusion: The balanced nutrition intervention program is effective in improving health behavior and reducing obesity risk among adolescents, supporting its implementation as a sustainable school health strategy.

Keywords: Adolescent Obesity, Balanced Nutrition, School-Based Intervention, Health Behavior



INTRODUCTION

Obesity in adolescents is a growing public health problem both globally and nationally. By definition, obesity in adolescents is generally measured using anthropometric indicators such as Body Mass Index for Age (BMI/Age), expressed as a z-score based on WHO standards. This condition reflects excessive body fat accumulation, potentially leading to serious health impacts. During adolescence, biological, psychological, and social changes make this age group highly vulnerable to nutritional disorders, including obesity (Mursal et al., 2024).

Obesity among adolescents has emerged as a significant public health issue worldwide. The increasing prevalence of overweight and obesity in this age group has been associated with changes in dietary patterns, reduced physical activity, increased sedentary behavior, and the widespread availability of energy-dense foods. Adolescent obesity is characterized by excessive accumulation of body fat that may negatively affect physical health, psychological well-being, and social functioning. Furthermore, obesity during adolescence often persists into adulthood, increasing the risk of chronic diseases such as cardiovascular disease, type 2 diabetes mellitus, hypertension, and metabolic syndrome (World Health Organization, 2024).

The increasing prevalence of adolescent obesity is a serious concern in various countries, including Indonesia. Data shows that the prevalence of overweight and obesity among Indonesian adolescents reaches approximately 16%, which is considered high in the East Asia and Pacific region (Oddo et al., 2022). This condition indicates a shift in nutritional patterns from undernutrition to overnutrition, known as the double burden of malnutrition phenomenon, where obesity increases alongside persistently high levels of undernutrition (Kusumawardani et al., 2022).

The epidemiological transition occurring in Indonesia has contributed to the rise in adolescent obesity. Lifestyle changes due to urbanization and industrialization have led to dietary patterns that are higher in energy, fat, and sugar, and lower in fiber. Furthermore, physical activity tends to decline due to increased use of technology and a sedentary lifestyle (Oddo et al., 2022). These conditions increase the risk of obesity in adolescents.

The impact of obesity on adolescents is not only short-term but also long-term. In the short term, obesity can lead to metabolic disorders, decreased physical fitness, and psychosocial problems such as low self-esteem and social stigma. Meanwhile, in the long term, obesity increases the risk of non-communicable diseases such as type 2 diabetes mellitus, hypertension, and cardiovascular disease (Colozza et al., 2025).

Obesity in adolescents is a condition influenced by a variety of interacting factors, including behavioural, environmental and social factors. A diet high in energy, saturated fat and added sugar, coupled with low consumption of fruit and vegetables, contributes to an energy imbalance that leads to weight gain. On the other hand, low levels of physical activity due to increased screen time and a sedentary lifestyle further increase the risk of obesity in adolescents. School environmental factors also play a significant role, as the availability of unhealthy food in canteens, easy access to high-calorie snacks, and limited facilities to support physical activity can influence students' health behaviours. The interaction of these various factors makes adolescent obesity a multidimensional



problem requiring a comprehensive and sustainable intervention approach (Colozza et al., 2025; Faraji et al., 2025; Oddo et al., 2022).

In this context, schools are a strategic setting for implementing health interventions. Schools have direct access to a large adolescent population and have the potential to influence behavior through education, policies, and the social environment. School-based interventions are considered effective because they can be implemented sustainably and involve various components such as teachers, peers, and school policies (Hassan et al., 2024).

Balanced nutrition intervention programs in schools generally include nutrition education, physical activity promotion, and improvements to the school food environment. The concept of balanced nutrition emphasizes a varied diet, adequate physical activity, and hygienic and healthy lifestyles. This integrated intervention has been shown to improve adolescents' health knowledge, attitudes, and behaviors (Oddo et al., 2022).

However, the implementation of nutrition intervention programs in schools still faces various challenges. Limited resources, lack of monitoring and evaluation, and low student compliance are major obstacles to program effectiveness. Furthermore, variations in social and cultural contexts also influence the success of interventions (Colozza et al., 2025).

Therefore, evaluating balanced nutrition intervention programs is crucial to ensure their effectiveness and sustainability. Evaluation is needed to assess the program's effectiveness in reducing obesity prevalence and changing students' eating and physical activity behaviors. Evaluation approaches can include process, outcome, and impact assessments, with indicators such as changes in BMI, nutritional knowledge, and health behaviors (Hassan et al., 2024).

Despite the various interventions implemented, comprehensive evaluative research in Indonesia remains limited. Most studies focus on educational aspects without integrating environmental and policy factors. Furthermore, few studies have used longitudinal or quasi-experimental designs to assess program effectiveness over the long term (Kusumawardani et al., 2022).

Although various school-based obesity prevention programmes have been reported to be effective in improving adolescents' health knowledge and behaviour, most studies in Indonesia still focus on nutrition education interventions as a single component. Research evaluating the effectiveness of multi-component interventions that simultaneously integrate nutrition education, school environment modification, and the promotion of physical activity remains relatively limited. Furthermore, empirical evidence using quasi-experimental designs with control groups to evaluate the impact of interventions on changes in adolescents' nutritional status, dietary behaviour, and physical activity simultaneously is still scarce, particularly in the context of urban schools in Indonesia.

The uniqueness of this study lies in the evaluation of a school-based balanced nutrition intervention programme that integrates three main components: nutrition education, healthy canteen environment modifications, and the promotion of structured physical activity. Not only does this study assess changes in knowledge and behaviour, but it also evaluates the programme's impact on changes in obesity status based on BMI/U indicators. Consequently, this study provides



more comprehensive evidence regarding the effectiveness of multi-component interventions in the prevention of adolescent obesity within a school setting.

METHODS

This study employs a quantitative approach with a quasi-experimental design, specifically a non-equivalent control group design, which aims to evaluate the effectiveness of a school-based balanced nutrition intervention programme in preventing obesity among adolescents. This design was chosen because it does not allow for full randomisation of subjects, yet still provides the ability to compare changes between the intervention group and the control group through pre-test and post-test measurements. Thus, changes occurring in the dependent variable can be attributed more rationally to the intervention provided.

This study was conducted in several junior high schools (SMP) and/or senior high schools (SMA) in the city of Padang. The selection of locations was based on considerations of the characteristics of urban areas undergoing a nutritional transition and the rising prevalence of obesity among adolescents. The study was conducted over a three-month period, from October to December 2025, covering the preparation phase, the implementation of the intervention, and the evaluation of results.

The population for this study comprised all pupils aged 12–18 years enrolled at the schools in the study area. The study sample was selected using purposive cluster sampling. In the first stage, schools were selected purposively based on their willingness to participate, the presence of an active school health programme, and the characteristics of an urban area with a relatively high prevalence of adolescent obesity. Subsequently, classes were used as cluster units, and all students meeting the inclusion criteria within the selected classes were included as study participants. A total of 120 students were recruited and divided into an intervention group (n=60) and a control group (n=60). Meanwhile, exclusion criteria included students who did not complete the intervention or had specific medical conditions such as metabolic disorders.

The intervention was conducted over 12 weeks and consisted of three main components. The first component was education on balanced nutrition, delivered through six face-to-face sessions (once every two weeks) lasting 60 minutes per session, using presentation materials, booklets, posters, and interactive discussions. The material covered the concept of balanced nutrition, obesity prevention, healthy food choices, limiting the consumption of foods high in sugar, salt and fat, and the importance of physical activity.

The second component involved modifying the school environment through the implementation of a healthy canteen offering food and drink options in line with balanced nutrition guidelines, restrictions on the sale of ultra-processed foods, and the display of health promotion materials within the school grounds.

The third component is the promotion of physical activity through the implementation of structured exercise or sports three times a week, lasting 30–45 minutes per session, facilitated by physical education teachers. Compliance with the programme was monitored using weekly monitoring sheets completed by the research team and supervising teachers. The control group



received only the routine health education activities normally carried out by the school, without any additional specific interventions.

Data collection was carried out using several research instruments, namely a nutrition knowledge questionnaire, a Likert-scale-based attitude and behaviour questionnaire, a Food Frequency Questionnaire (FFQ) to measure dietary patterns, and the International Physical Activity Questionnaire (IPAQ) to assess physical activity levels. Nutritional status was measured using anthropometric tools, namely digital scales and a microtoise. All instruments underwent validity and reliability testing prior to their use in the study.

The research procedure began with a preparatory phase comprising obtaining permits, training enumerators, and pilot testing the instruments. This was followed by a pre-test, which involved measuring BMI and having respondents complete a questionnaire. The intervention was then delivered to the treatment group in the form of balanced nutrition education through counselling and educational media, modification of the school environment through the implementation of a healthy canteen, and the promotion of physical activity through regular sports activities. Once the intervention period was complete, a post-test was conducted to assess changes in all the variables under study.

Data analysis was carried out in stages using statistical software. Univariate analysis was used to describe the characteristics of the respondents and the distribution of the study variables. Bivariate analysis was performed using the paired t-test to examine changes within groups, and the independent t-test to compare differences between the intervention and control groups. If the data were not normally distributed, non-parametric alternative tests such as the Wilcoxon and Mann-Whitney tests were used. Furthermore, multivariate analysis was performed using linear or logistic regression to identify the effect of the intervention on obesity status whilst controlling for confounding variables.

The programme evaluation was conducted using three approaches: a process evaluation to assess the implementation of the intervention, an outcome evaluation to measure changes in knowledge, attitudes and behaviour, and an impact evaluation to examine changes in obesity status based on BMI. This study has obtained ethical approval from the Research Ethics Committee of the East Kalimantan Ministry of Health Polytechnic of Public Health, reference number: 123/PK-KT/IX/2025. All participants and parents/guardians provided informed consent prior to the study being conducted.

RESULTS

1. Respondent Characteristics

Table 1. Distribution of Respondent Characteristics (n=120)

Variables	Category	n	%
Age	12–14 years	52	43.3
	15–18 years	68	56.7
Gender	Men	58	48.3
	Women	62	51.7



Group	Intervention	60	50.0
	Control	60	50.0
Socioeconomic Status	Low	40	33.3
	Currently	55	45.8
	Tall	25	20.9

The distribution of respondents was relatively balanced between the intervention and control groups (50% each), thus supporting the validity of the comparison between the groups. The majority of respondents were in the 15–18 age group (56.7%), who are developmentally more vulnerable to lifestyle changes. The gender proportion was also relatively balanced, minimizing gender bias in the analysis.

2. Descriptive Analysis of Research Variables (Pre-test and Post-test)

Table 2. Mean and Standard Deviation of Research Variables

Variables	Group	Pre-test Mean ± SD	Post-test Mean ± SD
BMI (z-score)	Intervention	1.85 ± 0.62	1.32 ± 0.55
	Control	1.79 ± 0.59	1.70 ± 0.57
Nutrition Knowledge	Intervention	62.4 ± 10.2	78.6 ± 8.5
	Control	63.1 ± 9.8	65.2 ± 9.5
Attitude	Intervention	58.7 ± 8.9	72.3 ± 7.6
	Control	59.2 ± 9.1	60.5 ± 8.7
Consumption Behavior	Intervention	55.6 ± 9.5	70.1 ± 8.2
	Control	56.2 ± 9.3	58.0 ± 9.0
Physical Activity (MET)	Intervention	1450 ± 320	1850 ± 410
	Control	1475 ± 300	150510

In the intervention group, there wasThe mean BMI z-score decreased from 1.85 to 1.32, indicating an improvement in nutritional status towards the normal category. In contrast, the control group experienced only minimal changes (1.79→1.70), indicating no significant change without intervention. Nutrition knowledge in the intervention group increased substantially (62.4→78.6), while the control group experienced only a small increase.

A similar pattern was seen in the attitudes and consumption behavior variables, indicating that the intervention had not only cognitive but also affective and behavioral impacts. Physical activity significantly increased in the intervention group, which is an important factor in energy balance.

3. Distribution of Obesity Status Categories

Table 3. Distribution of Nutritional Status Based on BMI/Age

Nutritional Status Category	Pre Intervention (%)	Post Intervention (%)	Pre Control (%)	Post Control (%)
Normal	25.0	48.3	26.7	30.0



Overweight	40.0	33.3	38.3	36.7
Obesity	35.0	18.4	35.0	33.3

The proportion of obesity in the intervention group experienced a significant decrease from 35.0% to 18.4%. There was a nearly twofold increase in the normal category in the intervention group. In the control group, the distribution changes were relatively small and did not show a significant pattern of improvement. This indicates that the intervention had a significant effect in reducing the prevalence of obesity.

BIVARIATE ANALYSIS

1. Paired t-test (Within Group)

Table 4. Paired t-test results for pre-test and post-test

Variables	Group	Mean Pre	Mean Post	Δ Mean	p-value
BMI (z-score)	Intervention	1.85	1.32	-0.53	0.000*
	Control	1.79	1.70	-0.09	0.082
Knowledge	Intervention	62.4	78.6	+16.2	0.000*
	Control	63.1	65.2	+2.1	0.094
Attitude	Intervention	58.7	72.3	+13.6	0.000*
	Control	59.2	60.5	+1.3	0.118
Consumption Behavior	Intervention	55.6	70.1	+14.5	0.000*
	Control	56.2	58.0	+1.8	0.102
Physical Activity	Intervention	1450	1850	+400	0.000*
	Control	1475	1505	+30	0.210

Information: * $p < 0.05$ (significant)

The results of the paired t-test showed that the intervention group experienced significant improvements across all indicators evaluated, including nutritional status, nutritional knowledge, attitudes towards healthy eating, dietary behaviour, and physical activity. In contrast, the control group showed no significant changes during the study period. These findings indicate that the intervention programme contributed to changes in health behaviour and improvements in the nutritional status of adolescents.

2. Independent t-test (Inter-Group Comparison)

Table 5. Results of the Independent t-test (Δ Change in Intervention vs. Control)

Variables	Δ Intervention	Δ Control	Mean Difference	p-value
BMI (z-score)	-0.53	-0.09	-0.44	0.000
Knowledge	+16.2	+2.1	+14.1	0.000
Attitude	+13.6	+1.3	+12.3	0.000
Consumption Behavior	+14.5	+1.8	+12.7	0.000
Physical Activity	+400	+30	+370	0.000

Information: * $p < 0.05$ (significant)



A comparative analysis between the groups showed that the changes observed in the intervention group were significantly better than those in the control group across all study variables. These results confirm that a school-based balanced nutrition intervention programme has a greater impact on improving health behaviours and preventing obesity than the routine approach applied to the control group.

DISCUSSION

1. Effectiveness of Intervention on Obesity Status (BMI/U)

The results showed that the school-based balanced nutrition intervention program significantly reduced the mean BMI/Age z-score in the intervention group, from 1.85 to 1.32 ($\Delta = -0.53$; $p < 0.001$). Concurrently, the proportion of obese students decreased substantially from 35.0% to 18.4%, while the proportion with normal nutritional status almost doubled from 25.0% to 48.3%. In contrast, the control group experienced only a non-significant change in BMI ($\Delta = -0.09$; $p = 0.082$). These findings indicate that the integrated intervention—including nutrition education, modification of the school canteen environment, and promotion of physical activity—had a significant impact on improving adolescent nutritional status within a three-month period.

The magnitude of BMI reduction achieved in this study ($\Delta -0.53$ z-score) is consistent with the findings of Raut et al. (2024) in a quasi-experimental study conducted in Nepal, which reported an increase in nutritional knowledge scores accompanied by improvements in eating behavior and anthropometric indicators in the intervention group after 12 weeks of structured nutrition education. The study confirmed that school-based interventions using a participatory and interactive approach are more effective than conventional instructional methods in changing adolescents' nutritional behavior (Raut et al., 2024). Similarly, Marsigliante et al. (2022) in a six-month intervention study in Italy found that a school-based healthy lifestyle education program significantly improved children's knowledge, eating patterns, and weight status, with a visible effect on reducing the prevalence of overweight in the intervention group (Marsigliante et al., 2022).

These findings suggest that the success in reducing BMI is likely the result of a synergy between improved nutritional knowledge, improvements to the school food environment, and increased physical activity, all of which occurred simultaneously during the intervention period. Programmes that focus on just one aspect tend to have a more limited impact, as confirmed by the systematic review by Caron et al. (2023), which examined various obesity prevention intervention strategies among adolescents in school and clinical settings, and concluded that multi-component approaches targeting both behavioural and environmental changes consistently outperformed single interventions in producing meaningful changes in nutritional status (Caron et al., 2023). Furthermore, a duration of three months is considered sufficient to initiate biological changes, although long-term sustainability requires periodic reinforcement of the programme.

2. The Effect of Intervention on Nutritional Knowledge

Nutrition knowledge in the intervention group experienced a statistically significant increase from a mean of 62.4 to 78.6 ($\Delta = +16.2$; $p < 0.001$), while the control group only showed a minimal,



non-significant increase ($\Delta = +2.1$; $p = 0.094$). This increase reflects the success of the intervention in transferring balanced nutrition information to students through counseling methods, educational media, and interactive discussions designed to suit the cognitive developmental stage of adolescents.

These findings reinforce evidence previously reported by Kendel Jovanovic et al. (2023) in a school-based nutrition and lifestyle education program in Croatia, which found significant improvements in students' nutrition knowledge scores after the intervention, which correlated with improvements in diet quality and nutritional status in the medium term (Kendel Jovanovic et al., 2023). Furthermore, a narrative review by Alhelal et al. (2024) analyzing 14 school-based intervention studies from various countries concluded that interventions integrating nutrition education and physical activity consistently resulted in increased knowledge and improved body mass index in children and adolescents (Alhelal et al., 2024).

From a theoretical perspective, increased knowledge is a prerequisite for health behavior change according to the Health Belief Model (HBM). Increased knowledge strengthens the dimensions of perceived susceptibility and perceived benefits, which in turn encourages individuals to adopt protective behaviors against obesity. According to this framework, effective nutrition education not only increases awareness of the risks of obesity but also strengthens the belief that changes in diet and physical activity can provide tangible health benefits (Rosenstock, 1974 in NCBI, 2024).

The increase in knowledge gained demonstrates the effectiveness of the educational component in improving adolescents' nutritional literacy, although changes in knowledge alone do not necessarily guarantee sustained behavioural change without adequate environmental support. This finding is reinforced by the umbrella review by Samad et al. (2024), which examined 17 systematic reviews and concluded that school-based interventions relying solely on individual education without support from changes to the school environment tend to result in short-lived increases in knowledge; conversely, multi-component interventions combining education, environmental changes, and community engagement have been shown to produce more sustainable changes in eating behaviour among adolescents (Samad et al., 2024). Therefore, comprehensive interventions need to be continuously strengthened through parallel approaches to motivational enhancement and environmental modification.

3. The Influence of Intervention on Attitudes and Consumption Behavior

The intervention group showed a significant increase in attitudes toward healthy eating ($\Delta = +13.6$; $p < 0.001$) and better consumption behavior ($\Delta = +14.5$; $p < 0.001$), while the control group did not experience significant changes in either variable. Changes in the affective dimension (attitude) that were simultaneously accompanied by changes in behavior indicate that the intervention was able to go beyond the cognitive level and successfully influence students' dispositions and actual actions in choosing food.

These changes in attitudes and consumption behavior can be explained through the Social Cognitive Theory (SCT) framework developed by Bandura. SCT emphasizes the role of self-efficacy



and observational learning in shaping health behaviors. When students receive balanced nutrition education accompanied by demonstrations of healthy food choices through a modified school cafeteria, they not only gain information but also have behavioral models to emulate and an environment that supports the implementation of those behaviors. A systematic study by Hassan et al. (2024) showed that school-based interventions that combined components of nutrition education, environmental changes, and physical activity promotion were consistently more effective than single interventions in changing adolescent eating behaviors and weight (Hassan et al., 2024).

Modifying the school cafeteria environment as one component of the intervention plays a crucial role in supporting changes in consumption behavior. A school food environment that provides healthy food options and limits the availability of ultra-processed foods creates a choice architecture that allows students to make healthier choices without having to rely entirely on their own willpower. This aligns with the ecological model approach, which emphasizes the role of environmental factors as determinants of individual behavior, often stronger than knowledge alone (Colozza et al., 2025).

These findings suggest that the observed changes in consumption behaviour are likely still influenced by the presence of intervention programmes and the school environment; therefore, a long-term evaluation is required to assess their sustainability. These findings are consistent with the conclusions of Araujo et al. (2022) in their systematic review and meta-analysis of school-based food education intervention studies among adolescents, which showed that sustainable changes in consumption behaviour can only be achieved if interventions are implemented over a longer period and accompanied by structured post-intervention behaviour reinforcement strategies; without such sustainability components, changes in dietary patterns achieved during the programme tend to weaken over time (Araujo et al., 2022). Further studies with a longitudinal design are required to confirm the sustainability of behavioural changes following the intervention.

4. Effect of Intervention on Physical Activity

Physical activity in the intervention group increased significantly from a mean of 1,450 METs to 1,850 METs ($\Delta = +400$ METs; $p < 0.001$), while the control group experienced only a non-significant increase ($\Delta = +30$ METs; $p = 0.210$). This increase reflects the success of the physical activity promotion component of the intervention program, which included structured exercise activities and awareness raising about the importance of daily physical activity for adolescent health.

Increasing physical activity is a key factor in creating an energy balance that supports weight loss and BMI. Previous research consistently shows that low levels of physical activity are a strong predictor of obesity in adolescents. Bektiningrum et al. (2025) confirmed that interventions that integrated physical activity enhancement with nutrition education resulted in greater changes in nutritional status than interventions that focused solely on dietary aspects. Furthermore, structured and enjoyable school-based physical activity programs have been shown to increase students' self-efficacy in maintaining an active lifestyle, as described by the SCT framework.

The increase in physical activity observed during the intervention is thought to have contributed to the improvement in nutritional status seen in the intervention group, although the



influence of physical activity factors outside the school environment cannot be entirely ruled out. Support for this assumption is provided by the systematic review by Xie et al. (2025), which examined the effectiveness of various types of physical activity behaviour change interventions in children and adolescents, and concluded that all measurable behavioural change benefits—including improvements in cardiorespiratory fitness and reductions in fat mass—were exclusively found in studies implementing structured physical activity programmes, whilst interventions without a structured physical activity programme component did not demonstrate similar benefits; this reinforces the central role of structured physical activity programmes in the success of school-based interventions (Xie et al., 2025). However, the researchers also acknowledge that there is a possibility of confounding factors in the form of differences in out-of-school physical activity among respondents that were not fully controlled for in this study's design, given that IPAQ measurements are self-reported and susceptible to reporting bias.

5. Relationship with the Theoretical Framework

Overall, the results of this study can be explained holistically through three main theoretical frameworks. First, the Health Belief Model (HBM) explains how increased knowledge about the risks and impacts of obesity increases students' perceived susceptibility and perceived severity to obesity-related diseases, ultimately motivating changes in eating behavior and physical activity. Second, Social Cognitive Theory (SCT) explains the mechanism of change through increased self-efficacy resulting from positive experiences in choosing healthy foods in the modified cafeteria, as well as observational learning reinforced by the role of teachers and peers throughout the program. Third, the Ecological Model emphasizes the importance of changes at multiple levels of the ecosystem—individual, group, and institutional environments—for interventions to produce comprehensive and sustainable impacts.

The integration of these three theories into the intervention design is a key strength of the program evaluated in this study. Unlike interventions that focus solely on one level of change, the school-based balanced nutrition program studied simultaneously targeted cognitive (knowledge), affective (attitudes), behavioral (consumption and physical activity), and environmental (school cafeteria) dimensions, resulting in a greater and more meaningful impact on all variables studied.

6. Research Limitations

Although this study yielded significant findings, several limitations warrant consideration. First, the quasi-experimental non-equivalent control group design did not allow for full randomization, thus precluding the possibility of differences in baseline characteristics between groups that could influence the results. Second, the three-month intervention duration was relatively short for assessing the sustainability of behavior change and its long-term impact on nutritional status. Third, the self-reported measurement of physical activity using the IPAQ potentially contains reporting bias. Fourth, the study's limited scope in one city (Padang) limits the generalizability of the findings to other regional contexts. Further research with a randomized



controlled trial design, longer duration, and more geographically diverse samples is highly recommended to strengthen the evidence for the effectiveness of this intervention.

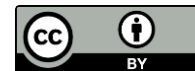
CONCLUSIONS

School-based balanced nutrition intervention programmes have been shown to be effective in improving adolescents' nutritional status and health behaviours. Interventions that integrate nutrition education, modifications to the school canteen environment, and the promotion of physical activity result in significant improvements in nutritional knowledge, attitudes, dietary behaviour and physical activity, as well as a reduced risk of obesity compared to the control group.

These findings suggest that a school-based, multi-component approach is a promising strategy for the prevention of adolescent obesity. Therefore, the integration of balanced nutrition programmes into school health policies and activities should be considered as a sustainable promotive and preventive measure. Further research with a longer observation period and wider geographical coverage is required to evaluate the sustainability of the intervention's impact.

REFERENCES

- Alhelal, A., AlSalem, M. S., Alasmari, F. M. A., Alqarni, S. A., Alamri, R. M. A., Alshahrani, R. A. A., Hassan M., A. A., Almalki, A., Alenezi, W. H. D., Abdulrahim, N. M. F., & Aiyed B., A. O. (2024). Effectiveness of School-Based Interventions for Preventing Obesity in Children: A Narrative Review. *Cureus*, 16(12). <https://doi.org/10.7759/cureus.75104>
- Colozza, D., Padmita, A. C., Ndiaye, M., Tarmizi, S. N., Widiastuti, E., Kekalih, A., Pramesthi, I. L., & Wiradnyani, L. A. (2025). Barriers to childhood obesity prevention in the school food environment: a qualitative study from Indonesia. *BMJ Paediatrics Open*, 9(1), e003980–e003980. <https://doi.org/10.1136/bmjpo-2025-003980>
- Faraji, M., Wiradnyani, L. A. A., Chandra, D. N., Februhartanty, J., Wangsa, A., & Widyahening, I. S. (2025). Targeted Educational Materials for Sugar-Sweetened Beverage Intervention among Urban Adolescents in Jakarta: A Mixed-Methods Study. *Jurnal Gizi Dan Pangan*, 20(1), 21–30. <https://doi.org/10.25182/jgp.2025.20.1.21-30>
- Hassan, M. A., McDonough, D. J., Ryu, S., Zhou, W., Oginni, J., & Gao, Z. (2024). Comparative effectiveness of school-based obesity prevention programs for children and adolescents: a systematic review and network meta-analysis. *Frontiers in Public Health*, 12. <https://doi.org/10.3389/fpubh.2024.1504279>
- Kendel Jovanovic, G., Jankovic, S., & Pavicic ZeZelj, S. (2023). The effect of nutritional and lifestyle education intervention program on nutrition knowledge, diet quality, lifestyle, and nutritional status of Croatian school children. *Frontiers in Sustainable Food Systems*, 7. <https://doi.org/10.3389/fsufs.2023.1019849>
- Kusumawardani, N., Rizkianti, A. R., Mubasyiroh, R., Mubasyiroh, R., Arfines, P. P., & Puspita, T. (2019). Adolescents school students in Java and Sumatra are in greater risk of obesity. *Health Science Journal of Indonesia*, 10(2), 119–127. <https://doi.org/10.22435/hsji.v12i2.2448>



- Marsigliante, S., Ciardo, V., Di Maglie, A., My, G., & Muscella, A. (2022). Efficacy of school-based intervention programs in reducing overweight: A randomized trial. *Frontiers in Nutrition*, 9. <https://doi.org/10.3389/fnut.2022.1001934>
- Mursal, Akbar, Y., Ardianti, R. D., & Ananda, R. (2024). Effects of Balanced Nutrition Education on Knowledge About Overweight Among Adolescents – International Journal of Research and Innovation in Applied Science (IJRIAS). *Internasional Journal of Research and Innovation Applied Science*, IX(VII). <https://doi.org/10.51584/IJRIAS.2024.907058>
- Oddo, V. M., Roshita, A., Khan, M. T., Ariawan, I., Wiradnyani, L. A. A., Chakrabarti, S., Izwardy, D., & Rah, J. H. (2022). Evidence-Based Nutrition Interventions Improved Adolescents' Knowledge and Behaviors in Indonesia. *Nutrients*, 14(9), 1717. <https://doi.org/10.3390/nu14091717>
- Raut, S., KC, D., Singh, D. R., Dhungana, R. R., Singh, M., & Sunuwar, D. R. (2024). Effect of nutrition education intervention on nutrition knowledge, attitude, and diet quality among school-going adolescents: a quasi-experimental study. *BMC Nutrition*, 10(1). <https://doi.org/10.1186/s40795-024-00850-0>
- Francis, L., Peterson, J. K., Peary, A., Estrada-Ibarra, E., Russell, N. G., & Schroeder, K. (2025). Nurse-involved policy, systems, and environmental school-based interventions for supporting healthy nutrition and obesity prevention among children and adolescents: A systematic review. *Journal of School Nursing*, 41(1), 5–35. <https://doi.org/10.1177/10598405241288538>
- Mancone, S., Corrado, S., Tosti, B., Spica, G., Di Siena, F., Misiti, F., & Diotaiuti, P. (2024). Enhancing nutritional knowledge and self-regulation among adolescents: Efficacy of a multifaceted food literacy intervention. *Frontiers in Psychology*, 15, 1405414. <https://doi.org/10.3389/fpsyg.2024.1405414>
- Rahmani, A., & Nadhiroh, S. R. (2024). Efforts undertaken by several ASEAN countries to address childhood and adolescent obesity in school-based programs: A systematic review. *Amerta Nutrition*, 8(1), 151–160. <https://doi.org/10.20473/amnt.v8i1.2024.151-160>
- Selamat, R., Aziz, N. A. A., Raib, J., Zulkafly, N., Mohamad, W. N. A. W., Ismail, A. N., Jalaludin, M. Y., Md. Zain, F., Ishak, Z., Yahya, A., & Mokhtar, A. H. (2025). Effects of a nutrition education intervention on nutrition knowledge and attitude among overweight and obese primary schoolchildren: A cluster randomized controlled trial. *BMC Public Health*, 24(Suppl 1), 3629. <https://doi.org/10.1186/s12889-025-21671-1>
- World Health Organization (WHO), 2024. Obesity and Overweight. <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>