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Integrated School-Based Education for the Control of Overweight and Obesity among Adolescents in Bulukumba, Indonesia: A Quasi-Experimental Study

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Abstract

Background: Overweight and obesity among adolescents are public health problems that may persist into adulthood and increase the risk of non-communicable diseases. School-based health education can support behavioural change; however, the integration of the School Health Unit (UKS) with primary healthcare services has not been optimal. This study evaluated an educational approach integrating researchers, school UKS managers, and UKS programme coordinators at Puskesmas.

Methods: This study employed a quasi-experimental design with a pretest-posttest control group approach involving 210 adolescents with overweight or obesity from 21 junior secondary schools within the service areas of 21 Puskesmas in Bulukumba Regency. The participants comprised 105 adolescents in the intervention group and 105 in the control group. The intervention group received integrated education accompanied by an educational module, whereas the control group received the module for self-directed learning. Knowledge was measured using a 20-item questionnaire; physical activity using the Physical Activity Questionnaire for Adolescents (PAQ-A); dietary intake patterns using a Food Frequency Questionnaire (FFQ); self-efficacy using the 10-item General Self-Efficacy Scale (GSES); and anthropometric status using body weight and height. Within-group changes were analysed using the marginal homogeneity, McNemar, and Wilcoxon tests, as appropriate for the type of data.

Results: In the intervention group, the proportion with good knowledge increased from 20.00% to 60.00% ($p<0.001$), the proportion with high physical activity increased from 0.95% to 20.00% ($p<0.001$), and the proportion with high self-efficacy increased from 34.29% to 80.00% ($p<0.001$). The proportion in the high dietary intake category decreased from 65.71% to 30.48% ($p<0.001$), while mean BMI decreased from 27.14±3.35 to 26.19±3.37 kg/m² ($p<0.001$). In the control group, the proportion with good knowledge increased from 27.62% to 55.24% ($p<0.001$), the proportion with high self-efficacy increased from 15.24% to 43.81% ($p<0.001$), and the proportion in the high dietary intake category decreased from 66.67% to 50.48% ($p=0.001$). Physical activity did not change significantly ($p=0.260$), while mean BMI changed from 27.05±3.70 to 26.79±3.62 kg/m² ($p=0.104$).

Conclusions: Integrated school-based education was accompanied by positive changes across several outcomes in the intervention group. The control group, which received the module for self-directed learning, also experienced changes in several outcomes. These findings support the development of school-based educational approaches involving UKS and Puskesmas, with between-group differences interpreted cautiously because the baseline characteristics of the two groups were not fully balanced.

Trial registration: Indonesia Clinical Research Registry (INA-CRR), INA-180920261809F4B; retrospectively registered on 18 September 2026.

Background

Overweight and obesity among adolescents are increasingly important public health problems because they are associated with a range of short- and long-term health consequences.[1] Obesity is an abnormal

condition characterised by excessive accumulation of body fat, which may increase the risk of various health disorders.[2,3] In Indonesia, the prevalence of obesity has shown an increasing trend.[4] According to data from the Basic Health Research (Riset Kesehatan Dasar [Riskesdas]), the prevalence of obesity among adults increased from 10.5% in 2007 to 14.8% in 2013 and 21.8% in 2018, while the prevalence of obesity among adolescents aged 13–15 years reached 16% in 2018 (Kemenkes R.I., 2018). This condition is of concern because overweight and obesity during adolescence may persist into adulthood and increase the risk of non-communicable diseases, as well as adversely affecting physical and psychological health.[5–7]

The occurrence of overweight and obesity is multifactorial and is influenced by interactions among genetic, biological, psychosocial, behavioural, and sociocultural factors.[8–11] Among adolescents, unhealthy dietary patterns and low levels of physical activity are important behavioural factors contributing to energy imbalance.[12,13] Therefore, the management of overweight and obesity should not focus solely on weight reduction but should also promote sustained behavioural change through dietary regulation, increased physical activity, health education, and behavioural modification.[14–18] Such an approach is particularly important during adolescence because the formation of healthy habits during this period may influence behaviour and health status throughout subsequent stages of life.[19,20]

Schools provide a strategic setting for implementing health interventions among adolescents because they offer direct and sustained access to the adolescent population.[21–23] School-based health education has demonstrated benefits in improving knowledge and promoting behavioural changes related to physical activity, dietary patterns, and body mass index (BMI).[24–29] Systematic reviews and meta-analyses have also indicated that school-based interventions incorporating health education can improve dietary and physical activity behaviours and contribute to reductions in BMI among adolescents with overweight and obesity.[30–32] Previous research conducted by the researchers has likewise demonstrated that health education influences changes in physical activity patterns and BMI among adolescents.[16,33]

Although the effectiveness of school-based education has been widely reported, most approaches continue to focus primarily on delivering information to students and have not fully integrated health resources available within the school environment with primary healthcare services. However, changes in adolescent health behaviour require environmental support, sustained reinforcement, and the involvement of multiple stakeholders.[34,21] In the management of overweight and obesity, improvements in knowledge need to be accompanied by enhanced capacity among adolescents to adopt healthy behaviours, including increasing physical activity and controlling dietary intake patterns.[35,36]

One important psychological aspect of behavioural change is self-efficacy. Successful long-term weight management is partly influenced by psychological and behavioural factors, including an individual's confidence in their ability to undertake and maintain healthy behaviours.[37] Self-efficacy is an important

factor in health promotion and education because it can influence motivation and an individual's ability to overcome barriers when undertaking behavioural change.[38,39] Therefore, educational interventions for adolescents with overweight and obesity should not only improve knowledge but also strengthen self-efficacy, promote physical activity, improve dietary intake patterns, and ultimately support improvements in nutritional status.[40]

Efforts to improve adolescent health also require cross-sectoral involvement, particularly from the health and education sectors.[41,42] Within the school context, the School Health Unit (Unit Kesehatan Sekolah [UKS]) provides a strategic platform for implementing promotive and preventive activities. However, the implementation of UKS has not yet been fully optimal or sustainable. Various challenges remain, including limited operational funding, inadequate facilities and infrastructure, and limitations in human resources and skills for UKS management. Responsibility for managing UKS is also frequently assigned as an additional duty to teachers or administrative staff, meaning that its implementation is not always integrated, well planned, or adequately directed.[39]

On the other hand, the UKS programme also forms part of the activities of Puskesmas as primary healthcare facilities. However, the relationship between the UKS programme at Puskesmas and UKS activities in schools has not been fully utilised to establish sustainable promotive and preventive activities. UKS guidance and monitoring activities in schools are still conducted on a limited and periodic basis, resulting in suboptimal synergy among healthcare personnel, school UKS managers, and students. This situation indicates the need to strengthen the linkage between schools and Puskesmas so that UKS functions not merely as a platform for specific health activities but also as a means of fostering a healthy lifestyle and preventing health problems on a sustained basis.[39]

Based on these conditions, integrating school-based education with the empowerment of school UKS and the involvement of UKS programme coordinators at Puskesmas represents an important approach for further development. An integrated approach allows education to extend beyond the provision of information or modules to students by reinforcing learning through mentoring, support from the school environment, and involvement of healthcare personnel. This integration is expected to enhance the sustainability of education and strengthen schools' capacity to support behavioural changes among adolescents in relation to physical activity, dietary intake patterns, self-efficacy, and nutritional status management.

The novelty of this study lies in the implementation of overweight and obesity education that integrates the empowerment of school UKS with the involvement of UKS programme coordinators at Puskesmas, supported by the use of an educational module. This model differs from educational approaches that merely provide materials or modules to adolescents without institutional support and mentoring from the school environment and primary healthcare services. Such integration is expected to create a more structured, contextual, sustainable, and implementable educational mechanism through the existing UKS system.

This study was conducted in 21 junior secondary schools, each located within the service area of one of 21 Puskesmas in Bulukumba Regency. This coverage provided an opportunity to involve schools and Puskesmas more evenly in the implementation of education across Bulukumba Regency. Therefore, this study aimed to analyse the effect of integrated school-based education on knowledge, physical activity, dietary intake patterns, self-efficacy, and body mass index (BMI) among adolescents with overweight and obesity in Bulukumba Regency, Indonesia.

Methods

Study Objective

This study aimed to analyse changes in knowledge, physical activity, dietary intake patterns, self-efficacy, and body mass index (BMI) before and after the provision of school-based education integrated with the school Health Unit (UKS) and the Puskesmas UKS programme among adolescents with overweight and obesity in Bulukumba Regency, Indonesia.

Study Design, Setting, and Study Period

The study employed a quantitative approach with a quasi-experimental pretest-posttest control group design. The study was conducted in 21 junior secondary schools located within the service areas of 21 Puskesmas in Bulukumba Regency, South Sulawesi, Indonesia. The first participant was recruited on 1 September 2025, the final participant was recruited on 30 November 2025, and all study activities were completed on 31 December 2025.

Participants, Eligibility Criteria, and Sampling

The study population comprised all adolescents with overweight or obesity attending the 21 junior secondary schools within the service areas of the 21 Puskesmas. Participants were selected using quota sampling, with 10 adolescents recruited from each school, resulting in a total of 210 participants. Overweight and obesity status was determined based on anthropometric measurements and BMI according to age and sex.

A total of 210 participants were divided into intervention and control groups, with 105 participants in each group.

Intervention and Comparator

The intervention group received integrated health education on the management of overweight and obesity through collaboration among the research team, the UKS programme coordinator at the Puskesmas, and the school UKS manager, with an educational module used as the educational medium. The intervention programme was implemented over a three-month period.

The control group received an educational module on the management of overweight and obesity for self-directed learning throughout the study period and did not receive the integrated educational support provided to the intervention group.

Data Collection Procedures

Data collection was conducted by the research team together with enumerators at the 21 schools. Measurements were conducted at two time points: before the intervention as the baseline assessment and after the intervention as the posttest assessment. The same measurement procedures were applied to both groups.

Instruments and Measurements

Four questionnaire-based instruments were used to assess the behavioural and psychosocial outcomes, namely the obesity knowledge questionnaire, Physical Activity Questionnaire for Adolescents (PAQ-A), Food Frequency Questionnaire (FFQ), and General Self-Efficacy Scale (GSE). All instruments were administered at baseline and post-intervention using the same procedures in both the intervention and control groups.

Obesity Knowledge Questionnaire

Knowledge regarding overweight and obesity was assessed using a 20-item questionnaire with dichotomous *yes/no* response options. The questionnaire items covered the definition of obesity, risk factors, dietary patterns, physical activity, complications, prevention, and calculation of body mass index (BMI). Each item was scored according to a predetermined answer key, with 1 point assigned to a correct answer and 0 points to an incorrect answer. The total knowledge score was therefore calculated by summing the scores of the 20 items.

The questionnaire was adapted from the Ministry of Health of the Republic of Indonesia (2019) and modified by the researchers. [43] Knowledge was categorised into poor, moderate, and good based on the objective criteria proposed by Arikunto (2010), namely: good, 16–20 points (76–100%); moderate, 12–15 points (56–75%); and poor, <12 points (<56%).[44]

Physical Activity Questionnaire for Adolescents (PAQ-A)

Physical activity was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), a self-report questionnaire designed to assess adolescents' physical activity during the previous seven days. [45] The questionnaire used in this study consisted of 11 questions covering physical activity during leisure time, physical education classes, breaktime, lunchtime, after school, in the evening, and at weekends, as well as overall physical activity during the previous seven days and the frequency of physical activity on each day from Monday to Sunday. The questionnaire also included questions concerning illness or other barriers that might have affected the participants' usual physical activity.

The physical activity items used ordered response categories ranging from the lowest to the highest level of activity. Higher scores indicated higher levels of physical activity. The questions concerning illness or barriers were used to identify factors that might have affected physical activity and were not included in the physical activity score. Physical activity was assessed at baseline and post-intervention using the same procedures in both the intervention and control groups.

The questionnaire used in this study is available from the following source: Physical Activity Questionnaire for Adolescents (PAQ-A)

Food Frequency Questionnaire (FFQ)

Dietary intake patterns were assessed using a Food Frequency Questionnaire (FFQ) to describe the frequency with which respondents usually consumed various types of food.[46] The FFQ covered a range of food groups, including carbohydrate and starchy foods, animal protein, plant protein, dairy products and fats, vegetables, fruits, sweet and processed foods, beverages, and other foods.

Respondents were asked to report their usual food consumption during the previous year, taking seasonal consumption patterns into account where applicable. Consumption frequency was recorded using seven categories: never or less than once per month; 1–3 times per month; once per week; 2–4 times per week; once per day; 2–3 times per day; and four or more times per day. Each food item was accompanied by a standard serving size as specified in the questionnaire.

For the present study, food items were grouped according to food groups relevant to the study objectives, namely carbohydrate sources, animal protein, plant protein, fats and processed foods, vegetables, fruits, and dairy products. The frequency of consumption of each food group was used to describe respondents' dietary intake patterns. The scoring and categorisation procedures for dietary intake patterns followed the criteria specified in the study protocol.

The questionnaire used as the basis for the FFQ is available from the following source: Food Frequency Questionnaire

General Self-Efficacy Scale (GSE)

General self-efficacy was assessed using the 10-item General Self-Efficacy Scale (GSE) developed by Schwarzer and Jerusalem.[47] The instrument uses four response options ranging from 1 (*not at all true*) to 4 (*exactly true*). All 10 items are scored and summed to obtain a total score ranging from 10 to 40, with higher scores indicating higher levels of general self-efficacy.

The items assess respondents' perceived ability to solve difficult problems, achieve goals, cope effectively with unexpected events and difficulties, identify alternative solutions, and manage challenging situations. The 10-item structure and content of the instrument are presented in the original questionnaire.

The GSE was not specifically developed for the present study. The instrument documentation reports internal reliability coefficients, with Cronbach's alpha values ranging from 0.76 to 0.90, and describes associations between general self-efficacy and several psychological and health-related constructs. The Indonesian-language version used in the present study should be identified according to the version actually administered, together with the corresponding Indonesian adaptation or validation reference.

For the present study, the total GSE score was calculated by summing the scores for all 10 items, yielding a possible range of 10–40. The criterion used to classify participants into high and low general self-efficacy should be reported according to the cut-off specified in the study protocol or the relevant Indonesian validation study. The source questionnaire provided does not specify a high/low cut-off; therefore, a cut-off should not be introduced without documentary support.

The instrument source is available here: General Self-Efficacy Scale (GSE)

Anthropometric Measurements

Anthropometric measurements included body weight and height. Body weight was measured in kilograms (kg), whereas height was measured in metres (m). Body mass index (BMI) was calculated by dividing body weight in kilograms by the square of height in metres:

BMI = body weight (kg) / height² (m²)

Overweight and obesity status were determined according to age- and sex-specific BMI-for-age standards used in the study.

Study Outcomes

The primary outcome of the study was the change in BMI from baseline to posttest. Secondary outcomes included changes in knowledge, physical activity, dietary intake patterns, and self-efficacy. Body weight and height were reported as supporting anthropometric outcomes.

Statistical Analysis

The data were analysed using SPSS. Descriptive analysis was used to describe participant characteristics and the distribution of each variable. The marginal homogeneity test was used to assess changes in paired categorical variables with more than two categories, McNemar's test was used to assess changes in paired categorical variables, and the Wilcoxon test was used to assess changes in paired numerical variables, including BMI. A p-value of <0.05 was considered statistically significant. Imbalances in baseline characteristics, particularly age and maternal education, were considered when interpreting the findings.

Ethical Considerations and Trial Registration

The study received ethical approval from the Health Research Ethics Committee of STIKes Panrita Husada Bulukumba under approval number 002797/KE-STIKES PHB/2025. Informed consent to participate was obtained from the parents or legal guardians of all adolescent participants. The adolescent participants were provided with clear and age-appropriate information about the study objectives, procedures, potential benefits, and their voluntary participation.

Results

Participant Characteristics

Table 1. Participant characteristics in the intervention and control groups (n=210)

Characteristic	Intervention n (%)	Control n (%)
Age		
12 years	16 (15.24)	22 (20.95)
13 years	89 (84.76)	37 (35.24)
14 years	0 (0.00)	32 (30.48)
15 years	0 (0.00)	14 (13.33)
Sex		
Male	46 (43.81)	44 (41.90)
Female	59 (56.19)	61 (58.10)
Father's employment status		
Employed	90 (85.71)	80 (76.19)
Unemployed	15 (14.29)	25 (23.81)
Father's educational level		
Higher	25 (23.81)	16 (15.24)
Lower	80 (76.19)	89 (84.76)
Mother's employment status		
Employed	36 (34.29)	29 (27.62)
Unemployed	69 (65.71)	76 (72.38)
Mother's educational level		
Higher	37 (35.24)	9 (8.57)
Lower	68 (64.76)	96 (91.43)
Parental history of overweight/obesity		
Yes	48 (45.71)	53 (50.48)
No	57 (54.29)	52 (49.52)
Family history of disease		
Diabetes mellitus	17 (16.19)	15 (14.29)
Hypertension	36 (34.29)	50 (47.62)
Rheumatism	6 (5.71)	9 (8.57)
Osteoporosis	0 (0.00)	1 (0.95)

Characteristic	Intervention n (%)	Control n (%)
Cardiovascular disease	0 (0.00)	1 (0.95)
No family history of disease	46 (43.81)	29 (27.62)
Family type		
Nuclear family	83 (79.05)	77 (73.33)
Extended family	22 (20.95)	28 (26.67)

Percentages were calculated within each group.

The intervention group was predominantly composed of participants aged 13 years (84.76%), whereas the control group had a more varied age distribution, ranging from 12 to 15 years. The sex distribution was relatively similar between the two groups. The most notable difference was observed in maternal educational level, with the proportion of participants whose mothers had a higher educational level being 35.24% in the intervention group and 8.57% in the control group. A parental history of overweight/obesity was relatively comparable between the groups. Differences in age and maternal educational level should be considered as potential confounding factors when interpreting changes in outcomes.

Changes in Knowledge, Physical Activity, Self-Efficacy, and Dietary Intake Patterns

Table 2. Changes in behavioural outcomes before and after the intervention

Variable	Group	Before n (%)	After n (%)	*p*
Knowledge				
Good knowledge	Intervention	21 (20.00)	63 (60.00)	<0.001
Good knowledge	Control	29 (27.62)	58 (55.24)	<0.001
Physical activity				
High physical activity	Intervention	1 (0.95)	21 (20.00)	<0.001
High physical activity	Control	16 (15.24)	10 (9.52)	0.260
Self-efficacy				
High self-efficacy	Intervention	36 (34.29)	84 (80.00)	<0.001
High self-efficacy	Control	16 (15.24)	46 (43.81)	<0.001
Dietary intake pattern				
High dietary intake	Intervention	69 (65.71)	32 (30.48)	<0.001
High dietary intake	Control	70 (66.67)	53 (50.48)	0.001

The *p*-values represent tests of within-group changes.

In the intervention group, the proportion of participants with good knowledge increased from 20.00% to 60.00%, high physical activity from 0.95% to 20.00%, and high self-efficacy from 34.29% to 80.00%. The proportion in the high dietary intake category decreased from 65.71% to 30.48%. In the control group, good knowledge increased from 27.62% to 55.24%, high self-efficacy from 15.24% to 43.81%, and the proportion in the high dietary intake category decreased from 66.67% to 50.48%. The proportion with high physical activity in the control group decreased from 15.24% to 9.52%.

Changes in Body Weight, Height, and BMI

Table 3. Anthropometric changes before and after the intervention

Variable	Group	Before, mean±SD	After, mean±SD	Difference	*p*
Body weight					
Body weight (kg)	Intervention	62.80±8.59	61.68±9.26	−1.12	—
Body weight (kg)	Control	64.22±10.64	63.60±10.99	−0.62	—
Height					
Height (cm)	Intervention	151.97±7.15	152.97±6.79	+1.00	—
Height (cm)	Control	153.91±7.67	154.61±7.62	+0.70	—
BMI					
BMI (kg/m²)	Intervention	27.14±3.35	26.19±3.37	−0.95	<0.001
BMI (kg/m²)	Control	27.05±3.70	26.79±3.62	−0.26	0.104

The symbol '—' indicates that a *p*-value was not reported for changes in body weight and height.

Mean body weight decreased by 1.12 kg in the intervention group and 0.62 kg in the control group. Height increased by 1.00 cm and 0.70 cm, respectively. Mean BMI decreased by 0.95 kg/m² in the intervention group ($p<0.001$) and by 0.26 kg/m² in the control group ($p=0.104$).

Changes in Nutritional Status Based on BMI

Table 4. Distribution of nutritional status before and after the intervention

Nutritional status	Intervention before n (%)	Intervention after n (%)	Control before n (%)	Control after n (%)
Underweight	0 (0.00)	1 (0.95)	0 (0.00)	0 (0.00)
Normal	0 (0.00)	10 (9.52)	0 (0.00)	3 (2.86)
Overweight	26 (24.76)	26 (24.76)	39 (37.14)	38 (36.19)
Obesity	79 (75.24)	68 (64.76)	66 (62.86)	64 (60.95)

Note: Nutritional status classification followed the BMI-for-age and sex-specific standards used in the study.

In the intervention group, the proportion of participants with obesity decreased from 75.24% to 64.76%, while the proportion classified as normal increased to 9.52% and that classified as underweight to 0.95%. In the control group, the proportion with obesity decreased from 62.86% to 60.95%, while the proportion classified as normal increased to 2.86%. These changes are descriptive and cannot be considered evidence of differences in effects between the groups without direct between-group testing.

Discussion

Participant Characteristics

The characteristics of the participants in this study showed that the intervention group was predominantly composed of 13-year-old adolescents (84.76%), whereas the control group had a more diverse age distribution, ranging from 12 to 15 years, with the largest proportion also aged 13 years (35.24%). In terms of sex, both groups had relatively comparable compositions, with females predominating, accounting for 56.19% of the intervention group and 58.10% of the control group. These findings indicate that the sex composition of the two groups was relatively similar, although the differences in age distribution indicate a degree of heterogeneity that should be considered when interpreting the results.

The more homogeneous age distribution in the intervention group provided a relatively more consistent developmental context. Adolescence is an important period for the formation of dietary habits, physical activity, and health behaviours. Differences in age may be associated with levels of independence, the ability to understand health information, peer influence, and patterns of daily activity. Therefore, differences in age distribution between the groups should be considered as one of the contextual factors when assessing changes in behaviour following the intervention.

The predominance of female participants in both groups should also be considered, as biological and social characteristics may be associated with nutritional status and health behaviours. Differences in body fat composition and metabolic regulation between males and females may contribute to differences in the risk of overweight and obesity. The literature underpinning this study also identifies

sex differences as one aspect associated with metabolic regulation and susceptibility to metabolic disorders.[48],[49]

Family characteristics showed that most fathers of the participants were employed, whereas most mothers were not employed. Most parents had educational attainment at primary to senior secondary school level. However, a notable difference was observed in maternal education, with 35.24% of mothers in the intervention group having a higher level of education compared with only 8.57% in the control group. This finding is important because the family environment plays a role in shaping dietary habits, food choices, daily activities, and support for behavioural change among adolescents.[50] Thus, parental education, particularly maternal education, may represent a contextual factor that influences the family's capacity to receive and apply health information.[51]

A parental history of overweight or obesity was reported for 45.71% of participants in the intervention group and 50.48% in the control group. This finding indicates that family-related factors are important for understanding overweight and obesity among adolescents. Obesity is not solely associated with individual behaviour but is a multifactorial condition involving interactions among genetic, biological, environmental, and behavioural factors.[52],[53],[54] Therefore, educational interventions for adolescents should continue to be situated within the context of both the family and school environments, as individual behavioural changes may be influenced by the environments in which adolescents live their daily lives.[55]

Effect of Integrated School-Based Education on Knowledge

The findings showed a substantial increase in the proportion of participants with good knowledge in the intervention group, from 20.00% before the intervention to 60.00% after the intervention ($p<0.001$). In the control group, the proportion with good knowledge also increased, from 27.62% to 55.24% ($p<0.001$). These findings indicate that both module-based information and integrated education were associated with improvements in knowledge, although the descriptive increase was greater in the group receiving integrated education.

The increase in knowledge in the intervention group may be explained by the characteristics of the intervention, which relied not only on the educational module but also involved researchers, school UKS managers, and the UKS programme coordinator at the Puskesmas. This integration enabled information to be delivered in a more structured manner and reinforced through direct communication, explanation, support, and the school environment. Thus, students not only received written materials but also had opportunities to understand the content through interaction with those involved in the school health programme.

These findings are consistent with the rationale underlying the intervention, which positioned health education as an important component of behavioural change in relation to overweight and obesity among children and adolescents. Davison et al. (2023) identified behavioural interventions as an important component of overweight and obesity management among children and adolescents.

Meanwhile, Habibie et al. (2022) reported benefits of school-based nutrition education in the management of adolescent obesity. Nally et al. (2021) also demonstrated the benefits of school-based interventions for obesity-related behaviours.[14],[24],[25]

The increase in knowledge is important because knowledge can provide a basis for developing awareness of the consequences of unhealthy eating behaviours and insufficient physical activity. In this study, knowledge was not considered an endpoint in itself, but rather as one component expected to support changes in physical activity, dietary intake patterns, and adolescents' self-efficacy. Thus, the greater increase in knowledge in the intervention group provides an indication that integrating education with the school environment and primary healthcare services may strengthen health learning compared with self-directed module-based education.

Effect of Integrated School-Based Education on Physical Activity

Changes in physical activity were among the most prominent findings of this study. In the intervention group, the proportion of participants with high physical activity increased from 0.95% to 20.00%, and this change was statistically significant ($p<0.001$). Conversely, in the control group, the proportion with high physical activity decreased from 15.24% to 9.52%, with no statistically significant change ($p=0.260$).

These findings suggest that providing an educational module for self-directed learning alone may not be sufficient to produce consistent changes in physical activity. Physical activity is a behaviour strongly influenced by the environment and requires opportunities, support, motivation, and sustained reinforcement.[12] Therefore, the change in physical activity in the intervention group may be associated with the involvement of the school environment through UKS and support from Puskesmas personnel, who reinforced the educational messages.

School-based interventions have the advantage of being delivered within an environment that adolescents access routinely.[56] Education delivered in this setting can be accompanied by support from teachers and UKS managers, allowing health messages to extend beyond knowledge acquisition. This is consistent with Nally et al. (2021), who demonstrated the benefits of school-based interventions for obesity-related behaviours, and Santos et al. (2023), who highlighted the importance of family- and environment-oriented approaches in promoting physical activity among children and adolescents.[25], [26]

The findings of this study are also consistent with those of Asnidar et al. (2023), which provided an empirical basis for this study concerning the relationship between health education and changes in physical activity patterns and BMI.[16] Thus, the findings strengthen the argument that health education may have greater potential to produce changes in physical activity when accompanied by a supportive environment and mechanisms for ongoing support.

Nevertheless, the increase in physical activity in the intervention group from 0.95% to 20.00% also indicates that behavioural change did not occur among all participants. A large proportion of

participants had not reached the high physical activity category after the intervention. This finding indicates that changes in physical activity are more complex than changes in knowledge. Information about the benefits of physical activity needs to be translated into routinely practised habits, requiring further strategies such as monitoring, reinforcement, group activities, and sustained school support.[57], [58]

Effect of Integrated School-Based Education on Self-Efficacy

Self-efficacy showed the largest proportional change in the intervention group. The proportion of participants with high self-efficacy increased from 34.29% before the intervention to 80.00% after the intervention ($p<0.001$). In the control group, the proportion with high self-efficacy also increased, from 15.24% to 43.81% ($p<0.001$).

The increase in self-efficacy in the intervention group indicates that integrated education not only provided knowledge but may also have strengthened adolescents' confidence in their ability to undertake behavioural changes. In the management of overweight and obesity, this aspect is important because adolescents may understand healthy behaviours without necessarily feeling capable of implementing them consistently. Belief in one's ability is an important link between knowledge and action.[59]

These findings are consistent with Oikarinen et al. (2023), who demonstrated an association between self-efficacy in eating management and tendencies towards unfavourable eating behaviours among individuals with overweight and obesity.[37] In addition, Jalali et al. (2024) provided supporting evidence through a systematic review and meta-analysis concerning the effects of training on self-efficacy.[38]

In the context of this study, the involvement of school UKS and Puskesmas may have provided stronger sources of social support for adolescents. Ongoing support enabled students to receive feedback, motivation, and reinforcement when experiencing difficulties in changing their dietary patterns or physical activity.[60],[61] Therefore, the substantial increase in self-efficacy may be understood as one mechanism that may help explain the more consistent behavioural changes observed in the intervention group.

These findings also support the results of Suswani (2022), which were used as an empirical basis for the study and indicated that health education may be associated with changes in knowledge, self-efficacy, and BMI among adolescents with overweight and obesity.[33]

Effect of Integrated School-Based Education on Dietary Intake Patterns

Dietary intake patterns changed in both groups, although the greater change was observed in the intervention group. The proportion of participants with a high dietary intake pattern in the intervention group decreased from 65.71% to 30.48% ($p<0.001$), whereas in the control group it decreased from 66.67% to 50.48% ($p=0.001$).

The decrease in the proportion with a high dietary intake pattern in both groups indicates that the educational module provided for self-directed learning may also have contributed to changes in dietary behaviour. However, the greater reduction in the intervention group suggests a possible additional benefit from ongoing support and integration with the school environment and Puskesmas. Direct education provided opportunities for adolescents to relate nutritional information to the food choices they made in everyday life.[62]

Changes in dietary intake patterns may also be understood as the result of interactions among knowledge, self-efficacy, and the environment.[63] Increased knowledge provides a cognitive basis for understanding healthier foods, whereas increased self-efficacy may strengthen adolescents' confidence in their ability to control their food choices.[64] At the same time, support from the school and family environments may help sustain these behaviours.

Wang et al. (2022), as cited in the study references, demonstrated an association between dietary knowledge and overweight/obesity among children and adolescents.[65] This finding provides context indicating that increased knowledge about dietary patterns may represent an important component of strategies for controlling overweight and obesity, although knowledge alone may not always be sufficient to produce sustained behavioural change.

The findings of this study are also consistent with Deswita et al. (2021), who identified eating behaviour, knowledge, physical activity, and parental support as factors associated with obesity among adolescents.[66] Thus, the findings indicate that changes in dietary behaviour should be understood as a process involving both individual and environmental factors.

Effect of Integrated School-Based Education on Body Mass Index

Changes in BMI showed a more pronounced pattern in the intervention group than in the control group. The mean BMI in the intervention group decreased from 27.14 ± 3.35 kg/m² to 26.19 ± 3.37 kg/m², representing a reduction of 0.95 kg/m² ($p<0.001$). Meanwhile, the control group experienced a smaller reduction, from 27.05 ± 3.70 kg/m² to 26.79 ± 3.62 kg/m², corresponding to a reduction of 0.26 kg/m², and this change was not statistically significant ($p=0.104$).

The reduction in BMI in the intervention group is an important finding because BMI is a more distal outcome than knowledge and self-efficacy. Changes in BMI require not only changes in knowledge but also changes in dietary behaviour and physical activity that are maintained with sufficient consistency. In this study, the change in BMI occurred alongside increased knowledge, physical activity, and self-efficacy, as well as a reduction in dietary intake patterns. This pattern of change suggests that the intervention may have operated through several behavioural pathways simultaneously.

These findings support Jacob et al. (2021), who showed that school-based interventions incorporating health education have the potential to reduce BMI among adolescents aged 10–19 years.[30] Habibie et

al. (2022) and Nally et al. (2021) also provide a basis for considering schools as an important setting for interventions to control overweight and obesity.[24],[25]

The study by Asnidar et al. (2023), which provided one of the foundations for this research, also supports the use of health education to promote changes in physical activity and BMI.[16] Meanwhile, Suswani (2022) provides supporting evidence for the use of health education to promote changes in knowledge, self-efficacy, and BMI among adolescents with overweight and obesity.[33]

Nevertheless, the reduction in BMI in the intervention group should be interpreted cautiously. Adolescents are still undergoing growth, and changes in height may also affect BMI values.[67] In this study, height increased in both groups, whereas body weight decreased. In the intervention group, body weight decreased by 1.12 kg and height increased by 1.00 cm, whereas in the control group body weight decreased by 0.62 kg and height increased by 0.70 cm.

Thus, changes in BMI should not be understood solely as a consequence of weight loss but as the result of changes in both body weight and height during the study period.[68] Nevertheless, the greater reduction in BMI in the intervention group provides an indication that the integrated educational approach has potential for improving the anthropometric status of adolescents with overweight and obesity.[69]

Changes in Nutritional Status as the Final Intervention Outcome

Changes in the distribution of nutritional status provide additional information regarding the effects of the intervention. In the intervention group, the proportion of participants with obesity decreased from 75.24% to 64.76%. After the intervention, 10 participants (9.52%) were classified as having normal nutritional status and 1 participant (0.95%) as underweight. In the control group, the proportion with obesity decreased to a lesser extent, from 62.86% to 60.95%, while 2.86% were classified as having normal nutritional status after the intervention.

These changes indicate a greater shift in the distribution of nutritional status in the intervention group. However, this does not mean that all participants achieved normal nutritional status. Most participants in the intervention group remained in the obesity category after the intervention. This finding indicates that educational intervention during the study period should be understood primarily as an initial strategy for initiating changes in behaviour and anthropometric status, rather than as a standalone intervention capable of resolving obesity within a short period.[70]

This condition is important because the control of overweight and obesity among adolescents requires a long-term approach. (Al-Khudairy et al., 1996) Behavioural interventions need to be implemented continuously and involve the environments in which adolescents grow and develop.[66] Lister et al. (2023) and Hargreaves et al. (2022), as cited in the study references, emphasise the importance of strategies that support the growth, nutrition, and development of children and adolescents.[41],[42]

Integration of UKS and Puskesmas as a Mechanism for Strengthening the Intervention

The main finding of this study lies not only in the changes in outcomes but also in the institutional integration approach used. The intervention group received education through the involvement of the researchers, school UKS managers, and the UKS programme coordinator at the Puskesmas, whereas the control group received the educational module for self-directed learning.

This difference in approach provides an important explanation for why changes in the intervention group appeared more consistent. The school provided an environment close to adolescents, UKS provided a platform for promotive and preventive activities, while the Puskesmas provided technical support and primary healthcare services.[23] The integration of these three elements created a mechanism through which education functioned not merely as information transfer but also as a process of ongoing support and behavioural reinforcement.[72]

This is consistent with the background of the study, which indicated that the relationship between school UKS and the UKS programme at the Puskesmas had not been fully utilised to develop sustainable promotive and preventive activities. This study sought to address this gap by integrating education, school UKS, and Puskesmas within a single intervention approach.

From a behavioural change perspective, this integration can be understood through the interaction between individual and environmental factors. Knowledge and self-efficacy operate at the individual level, whereas teachers, UKS managers, Puskesmas personnel, and the school environment represent environmental factors that can provide support and reinforcement. Changes in physical activity and dietary intake patterns then represent behavioural manifestations, while BMI constitutes a more distal health outcome. Thus, the changes observed in this study demonstrate a pattern progressing from improvements in cognitive and psychological factors towards behavioural changes and, ultimately, changes in anthropometric indicators.[73]

Conclusion

Integrated school-based education involving researchers, school UKS managers, the UKS programme coordinator at the Puskesmas, and an educational module was associated with increased knowledge, physical activity, and self-efficacy, as well as reductions in high dietary intake patterns and BMI in the intervention group. The control group, which received the module for self-directed learning, also experienced changes in several outcomes. These findings support the development of a school-based educational model through collaboration between schools and Puskesmas. However, differences between the groups should be interpreted cautiously because their baseline characteristics were not fully balanced.

Study Limitations

This study has several limitations that should be considered. First, the use of quota sampling and the group allocation mechanism limits causal inference and generalisability. Second, there were imbalances in the distribution of age and maternal education between the intervention and control groups, leaving

the possibility of residual confounding. Third, several behavioural outcomes were assessed using questionnaires and may therefore have been affected by recall or reporting bias. Fourth, the participants were adolescents who were still undergoing growth, meaning that changes in height may have influenced changes in BMI. Fifth, changes between the groups should be interpreted cautiously because the primary analyses focused on within-group changes.

Abbreviations

BMI: body mass index;

UKS: School Health Unit;

SMP: junior secondary school;

PAQ-A: Physical Activity Questionnaire for Adolescents;

FFQ: Food Frequency Questionnaire;

GSES: General Self-Efficacy Scale;

SPSS: Statistical Package for the Social Sciences.

Declarations

Ethics Approval and Consent to Participate

All procedures involving human participants were conducted in accordance with the ethical principles and applicable regulations governing research involving human participants, including the principles of the Declaration of Helsinki. The study received ethical approval from the Health Research Ethics Committee of STIKes Panrita Husada Bulukumba under approval number 002797/KE-STIKES PHB/2025. Informed consent to participate was obtained from the parents or legal guardians of all adolescent participants. The adolescent participants were provided with clear and age-appropriate information about the study objectives, procedures, potential benefits, and their voluntary participation. Participants were informed that participation was voluntary and that they could decline or withdraw from participation without penalty. All procedures involving human participants were conducted in accordance with the approved research protocol and applicable ethical requirements.

The study was retrospectively registered with the Indonesia Clinical Research Registry (INA-CRR), registration number INA-180920261809F4B, on 18 September 2026. As the first participant was recruited in September 2025, registration took place after participant recruitment had commenced and is therefore reported as retrospective registration.

Consent for Publication

Not applicable. This article does not contain identifiable information, images, or individual-level data relating to any participant. All findings are presented in aggregate form.

Data Availability

The research data supporting the findings of this article are available from the corresponding author upon reasonable request and in accordance with applicable research ethics and confidentiality requirements. Access to individual participant-level data may be restricted to protect participants' privacy and confidentiality. The data include participant characteristics, knowledge, physical activity, dietary intake patterns, self-efficacy, body weight, height, and BMI.

Competing Interests

The authors declare that they have no competing interests related to the research, authorship, or publication of this article.

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Authors' Contributions

AAsn designed and developed the study, prepared the methodology, coordinated the implementation of the research, conducted the statistical analysis, and prepared the manuscript, particularly the Discussion section. MM contributed to the preparation of the Introduction and assisted with the implementation of the study. FF contributed to the development of the methodology and assisted with data collection and study implementation. AAsd contributed to the statistical analysis. AAg and HH assisted with data collection and study implementation. AAl contributed to the development of the scientific content and conceptual framework, interpretation of the findings, critical editing, and refinement of the final version of the manuscript. All authors reviewed and approved the final version of the manuscript and accepted responsibility for the aspects of the study corresponding to their respective contributions.

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Trial Registration

Indonesia Clinical Research Registry (INA-CRR), registration number INA-180920261809F4B; retrospectively registered on 18 September 2026.

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