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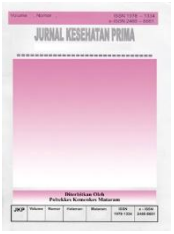

The Impact of High-Energy and High-Protein Bitsoya Snacks on Weight Changes in Underweight Adolescent Girls

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Abstract
Being overweight is a deficient nutritional status due to a lack of nutritional intake entering the body. It is said that a teenager is underweight if the results of the z-score measurement of Body Mass Index According to Age (BMI/U) are -3 SD to <-2 SD. Efforts to prevent nutritional problems related to energy consumption include consuming varied foods containing enough calories and protein. To determine the effect of high-energy and protein Bitsoya snacks on weight changes in South Merapi 1 State Junior High School underweight female adolescents. This type of research is quantitative research with a quasi-experimental design. The research design used a pre-test and post-test with one group. In this study, the average weight gain for respondents was 0.262 kg. The multiple linear regression test results obtained a significant value for the protein intake variable with a p-value of 0.048 (< 0.05). Giving bitsoya (soy stick biscuits) affects the weight gain of underweight adolescent girls.

Keywords: Adolescent Girls; Weight; Underweight; Biscuits

INTRODUCTION

Adolescents in Indonesia face nutritional problems, including malnutrition, overnutrition, and micronutrient deficiencies (UNICEF, 2021). Adolescents with poor nutritional status are at risk of infectious diseases, while overnourished and obese adolescents are at risk of various degenerative diseases. These nutritional problems can affect cognitive ability, productivity, and performance in adolescents (Muchtar et al., 2022).

Globally, the prevalence of underweight in adolescents is 8.4% for females and 12.4% for males (Christian & Smith, 2018). Data from the 2018 Riskesdas showed that the burden of undernutrition in Indonesia is still relatively significant. The prevalence of underweight in adolescents aged 13-15 years was 8.7% (6.8% thin and 1.9% very thin) and in 16-18 year olds, 8.1% (6.7% thin and 1.4% very thin). South Sumatra Province is one of the provinces with a prevalence of underweight above the national level, with 8.8% of adolescents aged 13-15 years and 8.3% of adolescents aged 16-18 years (Kemenkes RI, 2018).

Underweight is a state of malnutrition that occurs due to insufficient intake of nutrients into the body (Muna et al., 2015). The nutritional status indicators for the adolescent group were obtained from anthropometric measurements of body weight and height presented as Body Mass Index by Age (BMI/U). Adolescents were undernourished if the z-score was -3 SD to <-2 SD and malnourished if the z-score was less than -3 SD (Kemenkes RI, 2020).

The Health Screening activities carried out by officers at Junior High School 1 Merapi Selatan, Lahat

Regency, identified a large percentage of adolescents with malnutrition status (Perangai, 2023). The results of the Health Screening activities carried out on seventh-grade adolescent girls in July 2023 found that the prevalence of undernutrition in adolescent girls was 35.6% and increased to 37.3% in January 2024.

This study involved 32 adolescent girls aged 10–15 who were classified as underweight based on BMI-for-age and who met the eligibility criteria, including their willingness to participate as research subjects. The initial research phase involved developing Bitsoya snacks using soy flour, evaluating taste, color, aroma, and texture, and conducting proximate (chemical) analysis.

Data were gathered through interviews using a form documenting personal information, body weight, height, nutritional status, energy intake, and macronutrient intake (protein, fat, and carbohydrates) both before and after the intervention.

Efforts to prevent nutritional problems related to energy consumption include consuming a varied diet that contains enough calories and protein (Utami et al., 2017). Teenagers generally love snacks. One healthy snack product they favour is biscuits. Biscuits are dry food products obtained by baking dough from wheat flour with other foods and with or without the addition of permitted food additives (Standarisasi Nasional Indonesia, 2018).

Soybean is a legume that contains a high level of vegetable protein. The protein content in 100 grams of fresh soya beans is 30.2 grams, and in dried soya beans, it is 40.4 grams. Soybeans contain large amounts of protein, vitamins, lecithin, isoflavonoids, and micro and macro elements. Soy protein is also a source of bioactive peptides, which are used for the prevention of chronic diseases such as cardiovascular disease, diabetes, certain types of cancer, and impaired immune function (Dukariya et al., 2020).

This is in line with research conducted Widodo et al. (2020) the results showed an increase in the nutritional value of the biscuit formula with soya bean flour substitution, namely calories increased by 17.86 kcal, protein increased by 1.335 grams, fat increased by 0.804 grams, and carbohydrates increased by 1.32 grams Research results Yulianto et al. (2022) showed that there was an effect of giving soya flour substitution biscuits on changes in body weight of undernourished toddlers.

Corn starch contains many benefits, including betaine. It has almost the same protein content as wheat starch, 9.2 grams, so corn starch can be used as a substitute for wheat starch in biscuits (Istinganah et al., 2017).

According to research conducted by Yudistira (2016), respondents preferred Biscuits with a high cornflour composition. This is because maize flour has a distinctive flavour that affects the taste of biscuits. The addition of corn flour aims to reduce the bitterness of soya beans caused by saponins found in the soya epidermis.

Research conducted by Arza et al. (2023) showed that providing biscuit snacks contributed to the intake of macronutrients and micronutrients in adolescents. Giving biscuits is also proven to be effective in increasing body weight and protein intake, which affects the increase in adolescent body mass index.

METHOD

The type of research used is quantitative research with a Quasi-Experiment design. The design in this research uses a one-group pre-test and post-test. The research was conducted at Junior High School 1 Merapi Selatan, which is situated in a rural area, approximately 1.5 hours from the city. Health screenings of seventh-grade girls revealed a malnutrition rate of 35.6% in 2023, which rose to 37.3% in 2024.

The research was conducted in April 2024. Samples were selected using simple random sampling, where participants meeting the inclusion criteria were randomly chosen during the study period. The study involved underweight adolescent girls aged 10–15 who met the inclusion criteria, including willingness to participate, complete the study, and sign a consent form. Exclusion criteria included allergies to soy, corn flour, or milk powder; intense physical activity; chronic illnesses; and non-participation in the intervention. The treatment was carried out for seven consecutive days as a snack to the respondents, given once daily with a weight of 75 grams. Statistical data analysis in this study was conducted using SPSS. Ethical approval number: 0442/KEPK/Adm2/III/2024

RESULT AND DISCUSSION

Bitsoya (soya stick biscuits) is a high-energy and protein snack used as a distraction food. Given once a day for seven consecutive days, one serving weighing 75 grams has a nutritional content of 406.29 kcal, 8.70 grams of protein, 25.68 grams of fat, and 35.07 grams of carbohydrates.

Table 1. Characteristics of respondents

Age	Treatment	
	n	%
10 – 12 years	12	37,5
13 – 15 years	20	62,5

The study's results based on respondents' characteristics consisted of age, which can be seen in Table 1. Based on Table 1, it was found that most respondents were 13-15 years old (62.5%) and 10-12 years old (37.5%). Adolescents are nutritionally vulnerable because they experience increased physical growth and rapid development. Adolescents tend to require greater nutrient intake but practice the wrong consumption pattern, i.e., the nutrients consumed do not match the needs of adolescent girls (Rohmah et al., 2023).

Table 2. Average Weight of Adolescent Girls

Body weight	Min	Max	Mean ± SD
Before	28,6	40,7	35,8 ± 2,8
After	28,8	41,0	36,1 ± 2,8

The mean body weight of respondents before the intervention was 35.8 kg, while it was 36.1 kg after the intervention.

Table 3. Frequency Distribution of Samples by Nutritional Status (IMT/U)

Nutritional status	Before		After	
	n	%	n	%
Normal	0	0	11	34,4
Underweight	32	100	21	65,6

Table 3 shows the nutritional status of respondents: 21 people (65.6%) are underweight adolescent girls, and 11 people (34.4%) are underweight adolescent girls.

Table 4. Category of Food Intake

Nutrients	Before		After	
	n	%	N	%
Energy				
Good	3	9,4	28	87,5
Not enough	29	90,6	4	12,5
Protein				
Good	8	25	30	93,7
Not enough	24	75	2	6,3
Fat				
Good	4	12,5	29	90,6
Not enough	28	87,5	3	9,4
Carbohydrate				
Good	4	12,5	15	46,9
Not enough	28	87,5	17	53,1

The results of a direct interview of respondents' food intake using a 1 x 24-hour food recall on the first, fourth, and seventh days. Before the intervention, three respondents (9.4%) had good energy intake, but after the intervention, 28 respondents (87.5%) had good energy intake.

The protein intake of respondents before the intervention was eight (25%) with good protein intake,

and after the intervention, there were 30 respondents (93.7%) with good intake.

The fat intake of respondents before the intervention was four respondents (12.5%) with good intake, while after the intervention, there were 29 respondents (90.6%) with good intake.

The carbohydrate intake of respondents before the intervention was 4 respondents (12.5%) with good intake, and after the intervention, there were 15 respondents (46.9%) with good intake. Respondents' intake data can be seen in Table 4.

Table 5. Mean Macronutrient Intake

Nutrients	Min	Max	Mean ± SD
Energy			
Before	1043,8	1697,4	1253,3 ± 146,83
After	1518,3	2067,5	1812,0 ± 121,47
Protein			
Before	26,2	65,8	42,7 ± 9,38
After	48,6	73,1	62,2 ± 6,52
Fat			
Before	24,9	56,4	39,3 ± 9,39
After	50,7	82,8	69,3 ± 7,49
Carbohydrate			
Before	132,7	247,4	177,2 ± 29,18
After	195,2	268,3	234,3 ± 18,52

Based on Table 5. The average macronutrient intake of respondents increased after the intervention.

Table 6. Difference in Mean Body Weight

Initial average ± SD	Final average ± SD	t	*p value*
35,875 ± 2,8137	36,137 ± 2,8401	-6,673	0,000

It can be seen in Table 6 that there was an increase in body weight for respondents with an average weight gain of 0.262 kg. The results of the t-dependent test obtained a p value <0.05, meaning there is a significant difference in average body weight in underweight adolescent girls before and after being given bitsoya snacks (soya stick biscuits).

This is in line with research conducted by Widodo et al. (2020), which shows an increase in nutritional value in biscuit formulas with soya bean flour substitution.

Table 7. Multiple Linear Regression Test

Intake Nutrients	*Unstandardized Coefficients* B	Sig.	*R Squ*
Energy	0,012	0,598	0,377
Protein	0,010	0,048	
Fat	0,015	0,081	
Carbohydrate	0,013	0,397	

The results of multiple linear regression tests found that protein influenced adolescent weight gain by 37.7%. The results of the significance value of the protein intake variable <0.05, namely 0.048. Therefore, it can be concluded that protein intake influences changes in body weight in underweight adolescents.

This is also in line with the research of Irwan et al. (2020), which found an increase in average body weight caused by the contribution of energy and protein intake from additional food modifications and support for increased main food intake.

In this study, evidence from recent international research further supports the observed improvement in body weight and nutritional status of underweight adolescent girls following the Bitsoya snack

intervention. A study by Jannati et al. (2024) in Iran demonstrated that the intake of quality protein and fat, including those from plant-based sources such as vegetable oils and soy protein, was positively associated with anthropometric growth indicators in school-aged girls. Plant-based protein was found to contribute significantly to height-for-age (HAZ). At the same time, plant-derived omega-3 fatty acids correlated positively with improvements in mid-upper arm circumference (MUAC) and body mass index (BMI).

In addition, a review by Garcia-Iborra et al. (2023) found that higher protein intake in children and adolescents contributes to increased fat-free mass index (FFMI) and may improve overall body composition. They emphasized that current protein intake recommendations may underestimate the actual needs of physically active children and adolescents, particularly in the teenage age group.

A recent narrative review by Escobedo-Monge et al. (2025) also supports using plant-based proteins, particularly soy, to promote healthy growth. They highlighted that soy protein has a high biological value, with a Protein Digestibility-Corrected Amino Acid Score (PDCAAS) close to that of animal proteins. Although animal proteins generally offer a more complete amino acid profile, soy and other plant-based proteins can still support optimal growth in children and adolescents when consumed in sufficient quantities and as part of a balanced diet.

CONCLUSION

The results of the independent t-test showed that there was an effect of giving Bitsoya (soya stick biscuits) a high-energy and protein snack in adolescents (p-value <0.05, namely 0.000). Multivariate analysis showed that the nutrient that most influenced the increase in body weight was protein, where the statistical result was p-value = 0.048. For adolescents, it is recommended to consume foods that are high in energy and protein.

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