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Original Research

Effectiveness of Snakehead Fish (*Channa striata*) Snacks in Improving Protein Intake and Albumin Levels in Adolescent Girls at Risk of Chronic Energy Deficiency

Annasari Mustafa[1,*], Dwie Soelistyorini[2], Astutik Pudjirahaju[2] and Puput Dewi Safitri[3]

[1]Program Studi Pendidikan Profesi Dietisien, Jurusan Gizi, Politeknik Kesehatan Malang, Kota Malang, Indonesia
[2]Program Studi Diploma 3 Gizi, Jurusan Gizi, Politeknik Kesehatan Malang, Kota Malang, Indonesia
[3]Program Studi Sarjana Terapan Gizi dan Dietetika, Jurusan Gizi, Politeknik Kesehatan Malang, Kota Malang, Indonesia

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***Correspondence:**
Annasari Mustafa
Address: Program Studi Pendidikan Profesi Dietisien, Jurusan Gizi, Politeknik Kesehatan Malang, Kota Malang, Indonesia.
Email: annasary@yahoo.com

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ABSTRACT

Background: Chronic Energy Deficiency (CED) is a condition characterized by long-term inadequate intake of energy and protein, identified through Mid-Upper Arm Circumference (MUAC) measurements with a threshold of less than 23.5 cm. According to the 2013 Riskesdas data, the prevalence of CED among individuals aged 15-19 years in Indonesia was 46.6%, which decreased to 36.3% in 2018 for non-pregnant women. In East Java, the prevalence of CED among 15-19-year-olds was 52.5% in 2013 and 37.73% in 2018. Despite this decline, low albumin levels often signal poor nutritional status, typically resulting from prolonged nutrient deficiencies. Snakehead fish (*Channa striata*), known for its high protein content, particularly albumin, offers a potential solution for improving protein intake and blood albumin levels among adolescent girls at risk of CED. In this study, snacks made from snakehead fish provide significant protein, including 216.1 kcal and 8.01g of protein (Nugget), 214.88 kcal and 13.76g of protein (Siomay), and 216.4 kcal and 7.8g of protein (Ekado). When combined with vegetables, these snacks are expected to improve nutritional values, especially protein and albumin levels. This study aims to assess the impact of snakehead fish (*Channa striata*)-based snacks on protein intake and blood albumin levels in adolescent girls at risk of CED. **Methods:** The study used an experimental, quasi-experimental design with a one-group pretest-posttest approach. The intervention was provided twice a week for 2 months, with monitoring through 24-hour food recall forms and food records. **Results:** The results showed a significant improvement in protein intake ($p = 0.009$, paired sample T-test) and blood albumin levels ($p = 0.000$, Wilcoxon test) after the intervention. **Conclusion:** Snakehead fish (*Channa striata*)-based snacks effectively enhance protein intake and blood albumin levels in adolescent girls at risk of CED.

Keywords: Chronic energy deficiency; snakehead fish; *Channa striata*; snacks; protein intake; blood albumin levels

1. INTRODUCTION

Adolescence is a transition period from childhood to adulthood, characterized by rapid changes in physical, cognitive, and psychosocial development. These changes, often associated with inadequate intake of energy, protein,

and micronutrients, can lead to various nutritional problems, one of which is Chronic Energy Deficiency (CED).[1] CED is a condition in which an individual suffers from prolonged or chronic lack of energy and protein intake. CED can be identified by measuring upper arm circumference (LILA), with a cut-off point of less than 23.5 cm. Protein plays a crucial role as an alternative energy source, compensating for energy deficits when necessary. Therefore, meeting nutritional needs during adolescence is critical, as this period involves rapid growth and development, both physically and psychologically.[2]

According to data from the 2013 Basic Health Research, the prevalence of CED among non-pregnant women aged 15-19 years in Indonesia was 46.6%. Meanwhile, the 2018 Basic Health Research reported a prevalence of 36.3% for non-pregnant women in the same age group. In East Java Province, the prevalence of CED in adolescents aged 15-19 was 52.5% in 2013 and 37.73% in 2018 for non-pregnant women.[3,4] This indicates a decrease in the prevalence of CED in East Java from 2013 to 2018, though the rate remains higher than the national figure for CED.

A study conducted on 39 malnourished adolescent girls, randomly selected from a group of 273 girls across seven villages, found a significant relationship between protein intake and nutritional status.[5] Similarly, a strong correlation between energy and protein consumption and the incidence of CED has been observed in adolescent girls.[6,7] Adolescents consuming protein in excess (more than 120% of the Recommended Daily Allowance, RDA) exhibited a protective effect, with a 0.39 times lower risk of developing CED compared to those whose protein intake was below the recommended level (less than 80% of the RDA).[8] Albumin levels, which are indicative of poor nutritional status, are often low when energy and protein intake are insufficient over an extended period. Albumin level tests are more accurate than anthropometric measurements for assessing nutritional deficiencies. Studies have shown that albumin, the most abundant protein in blood plasma, can serve as a reliable indicator of health status and long-term protein deficiency.[9,10]

To increase albumin levels in adolescent girls with CED, a program offering snakehead fish-based foods could be implemented. Snakehead fish, which can be prepared at home as snacks combined with vegetables to improve texture, is an excellent source of protein and albumin. Snakehead fish contains 62.24 grams of albumin per kilogram (6.22%) and is known for its beneficial amino acids.[11] Consuming snakehead fish snacks may help raise blood albumin levels and improve nutritional status. Previous research on the effects of snakehead fish nuggets on breastfeeding mothers has shown a significant increase in blood albumin levels.[8] Therefore, the objective of this study is to assess the impact of snakehead fish-based snacks on protein intake and blood albumin levels in adolescent girls at risk of Chronic Energy Deficiency (CED).

2. METHODS

2.1 Study Design and Subjects

This study used a Quasi-Experimental design with a One Group Pretest-Posttest approach. In this design, the researcher measured variables from a single group of subjects (pretest), then provided snakehead fish-based snacks twice per week for 2 months (8 weeks). After the intervention, a second measurement (posttest) was carried out, and the pretest and posttest results were compared. The aim of this study was to analyze the effect of snakehead fish-based food on protein intake and blood albumin levels in adolescents (female adolescents at risk of Chronic Energy Deficiency, CED).

The research was conducted at SMA Negeri 1 Singosari, Malang Regency, and included activities such as location surveys, data collection, and intervention delivery. Research activities began in August, with data collection and treatment occurring from August to October 2022. Product preparation took place at the COE Laboratory – Center for Excellence in Science and Technology, Malang Health Polytechnic.

2.2 Inclusion-Exclusion Criteria

The target respondents for this study were 33 female adolescents from SMA Negeri 1 Singosari, Malang Regency, selected based on inclusion criteria. The inclusion criteria for this study were as follows: the participants had to be female adolescents in grade X at SMA Negeri 1 Singosari, Malang Regency, and must be willing to participate by signing the informed consent form. Additionally, the respondents had to be at risk of Chronic Energy Deficiency (CED), as indicated by an upper arm circumference (LiLA) of less than 23.5 cm and/or a body mass index (BMI) of less than 18.5 kg/m². Participants also had to be free from illness and not

allergic to snakehead fish. The exclusion criteria included respondents who became ill during the study or those who did not participate in all research activities.

2.3 Data Collection and Measurement

Data collection was conducted directly by the researchers, with assistance from nutrition cadres who had been trained by the researchers. Data was collected during the pre-intervention (week 0) and post-intervention (week 8) periods.

Data collection began with a meeting with the school to explain the study and obtain approval. Following this, observations and population data collection were conducted, which included obtaining personal information, measuring height, weight (BMI), LiLA, and selecting samples according to the inclusion criteria. Food consumption data was gathered using the 24-hour food recall method and food records, which were administered twice: once before the intervention and once after the intervention. This allowed for the determination of average protein intake before and after the intervention and monitoring of protein intake during the intervention period. Blood albumin levels were measured twice: before and after the intervention. Blood samples were taken by analysts from Marsudi Waluyo Hospital, in collaboration with the researchers, using the EBRA XL-200 tool and the reagent method.

The intervention consisted of snakehead fish-based snacks, including nuggets, dumplings, and ekado. Snakehead fish nuggets are fried snacks made primarily from snakehead fish and carrots. The dumplings are made with snakehead fish and green spinach, while the ekado contains snakehead fish and carrots. The preparation, processing, storage, and cooking were carried out at the COE Laboratory, Department of Nutrition, Malang Health Polytechnic (Jalan Besar Ijen No. 77 C). The snakehead fish-based snacks were provided to respondents twice per week for 2 months (alternating Tuesdays and Fridays or Wednesdays and Fridays), with one serving per day during break time. Each serving consisted of 3-5 pieces (60-80 grams).

Table 1. Nutritional content of each portion of the snakehead fish-based snacks

No.	Nutrient	Nugget (3 pcs, 60g)	Siomay (5 pcs, 80g)	Ekado (3 pcs, 60g)
1	Albumin	1.94 g	3.7 g	1.4 g
2	Energy	216.1 kcal	214.9 kcal	216.4 kcal
3	Protein	8.01 g	13.8 g	7.8 g
4	Fat	14.1 g	4.3 g	13.3 g
5	Carbohydrates	14.95 g	29.3 g	17.1 g
6	Vitamin C	0.9 mg	1.55 mg	3.3 mg
7	Iron (Fe)	1.8 IU	0.18 IU	1.2 IU
8	Zinc	0.5 mcg	0.2 mcg	0.3 mcg

2.4 Data Analysis

Data analysis was performed using the SPSS program, with a 95% confidence interval. Normality tests were conducted using the Kolmogorov-Smirnov test. Differences in pre- and post-intervention data were analyzed using the paired sample T-test (for normally distributed data) and the Wilcoxon test (for non-normally distributed data).

2.5 Ethical Clearance

This study followed the ethical guidelines set by the ethical committee. Ethical approval for the study was obtained from the Health Research Ethics Commission (KEPK) of Malang Health Polytechnic (Reg. No. 717/KEPK-POLKESMA/2022). In addition, privacy for respondents data was maintained properly.

3. RESULTS

3.1 General Overview of Respondents

The characteristics of the sample in this study include age group, gender, and nutritional status. The distribution of sample characteristics can be seen in Table 2.

Table 2. Distribution of respondent characteristics

Characteristics	Category	Frequency (n)	Percentage (%)
Age	16 years	33	100.0
	Total	33	100.0
Gender	Female	33	100.0
	Total	33	100.0
Nutritional Status	Underweight – Very Underweight & LiLA < normal	25	75.8
	Underweight – Very Underweight	2	6.1
	LiLA < normal	6	18.2
	Total	33	100.0

3.2 Protein Intake of Respondents Before and After Intervention

Based on the normality test (Kolmogorov-Smirnov), the p-value was >0.05 (data normally distributed), and continued with the Paired Sample T-Test (Table 3).

Protein intake of respondents was measured based on the results of a 24-hour food recall before and after the intervention. The details of protein intake before and after the intervention can be seen in Table 4.

Table 3. Results of Kolmogorov-Smirnov statistical test for protein intake before and after intervention

Variable	N	Mean ± SD	Min	Max	p-value
Protein Intake Before Intervention	33	48.3788 ± 17.23051	17.00	83.52	0.200
Protein Intake After Intervention	33	57.9279 ± 20.32707	23.97	107.65	

Table 4. Protein intake of respondents before and after intervention

Variable	N	Mean	Std. Error Mean	95% Confidence Interval	p-value
Protein Intake Before Intervention	33	9.54909	3.43103	-16.53787	-2.56031
Protein Intake After Intervention	33	19.70978			

Significant at $\alpha = 0.05$; Paired Sample T-Test

From Table 4, the p-value of 0.009 < 0.05 indicates that there is a significant difference before and after the intervention. This suggests that the provision of snakehead fish-based snacks and vegetables has an impact on protein intake in adolescent girls at risk of CED. This intervention contributed to an increase in protein intake, as snakehead fish-based snacks are a rich source of protein.

3.3 Albumin Levels of Respondents Before and After Intervention

Based on the normality test (Kolmogorov-Smirnov), the p-value was <0.05 (data not normally distributed), and continued with the Wilcoxon test (Table 5).

Table 5. Results of Kolmogorov-Smirnov statistical test for albumin levels of respondents before and after intervention

Variable	N	Mean ± SD	Min	Max	p-value
Albumin Level Before Intervention	33	4.2045 ± 0.32356	3.70	5.31	0.000
Albumin Level After Intervention	33	4.6245 ± 0.32421	4.29	5.92	

Albumin levels are used as an indicator of biochemical changes related to body protein stores and changes in nutritional status. The following (Table 6) are the results of the Wilcoxon test for blood albumin levels.

From Table 6, the p-value of 0.000 < 0.05 indicates that there is a significant difference before and after the intervention. This means that the provision of snakehead fish-based snacks and vegetables affects the blood albumin levels in adolescent girls at risk of CED. Therefore, this intervention contributed to the increase in blood albumin levels. This is consistent with research showing that albumin levels increased after intervention with snakehead fish nuggets, where the average albumin level rose from 3.03 g/dL to 4.38 g/dL, representing an increase of 1.34 g/dL.

Table 6. Blood albumin levels of respondents before and after intervention

Variable	N	Negative ranks (N)	Positive ranks (N)	Mean ± SD	p-value
Albumin Level Before Intervention	33	2	31	4.2045 ± 0.32356	0.000*
Albumin Level After Intervention	33			4.6245 ± 0.32421	

Significant at α = 0.05; Wilcoxon test

4. DISCUSSION

Protein is known as one of the macronutrients, alongside fat and carbohydrates, that supports the overall performance and function of the human body. Protein is an essential substance involved in the formation of muscle tissue. Without protein, the body's hormones, particularly those related to digestion, would not function properly. The results of the 1x24 hour food recall study, conducted before and after the intervention, showed that the average protein intake before the intervention was 48.3788 g. After the intervention, it increased to 57.9279 g, reflecting an increase of 9.55 g. This intervention successfully increased protein intake over the course of 2 months. The Paired Sample T-Test results indicated a significant increase, with a p-value of 0.009 < 0.05, proving that there was a real difference before and after the intervention. This suggests that providing snakehead fish and vegetable snacks can significantly increase protein intake in female adolescents at risk of CED (Chronic Energy Deficiency). Snakehead fish, known for its high nutritional value, is rich in albumin protein, essential amino acids, and minerals such as zinc and iron, which can stimulate appetite, repair damaged tissue cells, improve nutritional status, and boost immunity.[14] This intervention study contributed to an increase in protein intake, as snakehead fish-based snacks are a rich source of protein.[13] This finding aligns with research showing that high protein intake can increase albumin levels after continuous administration over 5 weeks.[14]

Adequate protein intake helps reduce the risk factors for CED related to Upper Arm Circumference. Regarding protein adequacy, it functions as an alternative energy source, providing compensation in cases of energy deficits.[17]

Albumin, a vital component of protein in the body, is found in the blood and helps regulate water balance in cells and provide nutrition to them. Albumin has a long half-life (20 days), and a decrease in albumin levels typically indicates prolonged and severe protein deficiency.[15] Blood albumin levels serve as an important indicator of a person's nutritional status. Normal blood albumin levels are between 3.5–4.5 g/dL, and levels below this range can indicate nutritional problems, as the nutrients carried in the blood are insufficient to nourish the cells, leading to malnutrition. A deficiency in albumin can also weaken the immune system, making the body more susceptible to illness.

The results of the study showed that the average blood albumin level before the intervention was 4.2045 g/dL. After the intervention, it increased to 4.6245 g/dL, representing an increase of 0.42 g/dL. This intervention was able to increase blood albumin levels over the course of 2 months. The Wilcoxon Test results indicated a significant increase, with a p-value of 0.000 < 0.05, leading to the rejection of H0 and the acceptance of H1, confirming a significant difference before and after the intervention. This suggests that providing snakehead fish snacks positively affects blood albumin levels in female adolescents at risk of CED.

The snakehead fish snack contains a complete profile of amino acids and albumin derived from snakehead fish meat. Protein is the primary component in forming essential amino acids in the body, including albumin. When protein intake is sufficient, blood albumin levels will also be adequate. This finding is consistent with research that demonstrates a relationship between protein intake and albumin levels, with a p-value of $0.030 < 0.05$.[14]

5. CONCLUSION

The average protein intake and blood albumin levels increased significantly after consuming snakehead fish-based snacks. which contain high albumin as a snack for 2 months. Providing snakehead fish-based snacks as a snack 2 times a week for 2 months is effective in improving protein intake and blood albumin levels in female adolescents at risk of KEK with LiLA classified as KEK and/or low BMI. For institutions, it is recommended that schools use snakehead fish snacks as an alternative additional food to overcome KEK problems in female adolescents, considering that many female adolescents are included in the nutritional status of being undernourished. For female adolescents, it is hoped that in the future they can increase the consumption of snakehead fish snacks as an alternative additional food or snack to prevent KEK. Further research is expected to develop this research by conducting it in other areas with a larger number of samples to strengthen the research results.

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Conflict of Interest

The authors declare no conflict of interest.

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