



Research article

Intervention on Anemia prevention among adolescent girls: A quasi-experimental study on providing meatballs chips modified to increase hemoglobin levels

Indriati Andolita Tedju Hinga*, Christina Rony Nayoan, Afrona Elisabet Lelan Takaeb, Dominirsep Ovidius Dodo, Rut Rosina Riwu

Faculty of Public Health, Nusa Cendana University, East Nusa Tenggara, Indonesia

Corresponding author: Indriati Andolita Tedju Hinga, ✉ indriati.teddjuhinga@staf.undana.ac.id, **Orcid Id:** <https://orcid.org/0009-0006-5799-8053>
Faculty of Public Health, Nusa Cendana University, East Nusa Tenggara, Indonesia

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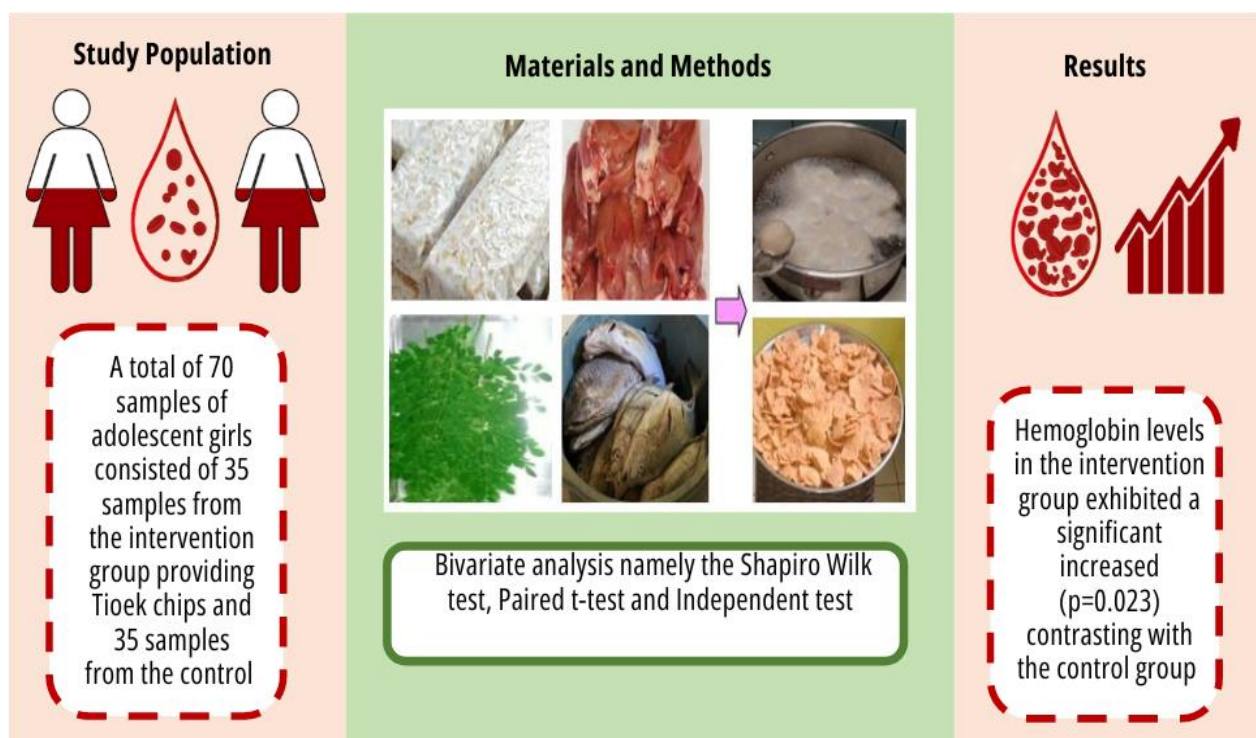
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ABSTRACT

Adolescent girls are at higher risk of anemia due to menstrual cycle, with iron deficiency from daily food intake being the most common cause. Therefore, this study aimed to determine the effect of fried meatballs modified with a combination of local ingredients, such as chicken liver flour, moringa oleifera leaves, soybean tempeh flour, and mackerel fish, abbreviated as Tioek chips, on changes in hemoglobin levels on adolescent girls in Kupang City and Kupang Regency. The results show that foods modified with nutritious local ingredients such as Tioek chips can be classified as an affordable and delicious alternative to healthy snacks to prevent anemia.



Keywords: Mackerel fish, Chicken liver, *Moringa oleifera*, Soybean tempeh.

INTRODUCTION

Anemia is diagnosed based on blood haemoglobin concentrations falling below specified thresholds established based on age, sex and physiological status. It is considered a symptom of an underlying condition. The population groups most vulnerable to anemia include children under five years of age, children under two years of age and particularly infants, pregnant and postpartum women, as well as menstruating adolescent girls and women. Globally, anemia is estimated to affect half a billion women (30%) 15-49 years of age and 269 million (40%) children 6-59 months of age worldwide, 37% (32 million) of pregnant women and 30% (539 million) of non-pregnant women aged 15-49 years were affected by anemia. The most prominent causes were dietary iron deficiency, thalassemia and sickle cell trait, and malaria ^[1, 2].

High cases of anemia in an area indicate poor nutrition and other health problems. The problem of anemia in pregnant women is still a public health problem in Indonesia because its prevalence is more than 20%. The national prevalence of anemia for all age groups is 21.7%. Based on residence location, anemia prevalence in rural areas is higher (22.8%) than in urban areas (20.6%). The prevalence of anemia in women is relatively higher (23.9%) than in men (18.4%). Anemia among adolescent girls is higher than among adolescent boys because puberty in adolescent girls is the beginning of the menstrual cycle ^[3, 4]. Anemia reduction is included as one of six global nutrition targets of world health assembly, in its comprehensive implementation plan on maternal, infant and young child nutrition. Moreover, anemia in women aged 15-49 years is one of the targets for the United Nations' Sustainable Development 2030 Agenda ^[1, 5].

Low and lower-middle-income countries endure an enormous burden of anemia, particularly affecting populations living in rural settings, in poorer households and receiving no formal education. BISA Program Survey in February-March 2020 reported that the prevalence of anemia among adolescent girls in Kupang Regency, East Nusa Tenggara (NTT) Province, Indonesia, was 72.2%, meaning that 3 out of 4 senior high school students experience anemia. The prevalence of anemia is 72.2%, which is a combination of mild, moderate and severe anemia, thus the anemia problem in Kupang Regency is classified as a severe health problem because the prevalence is >40% ^[6]. Based on this classification, it is necessary to carry out interventions to treat anemic adolescents in a comprehensive and sustainable manner, in order to support the global anemia reduction program.

Poverty causes unmet needs for food, housing, accessible to health education and information. Nutritious food is considerably expensive, while food aid and supplements from the government aren't continuously provided. Malnutrition cases in East Nusa Tenggara

(NTT) Province are often found in low-income families. Therefore, it is necessary to utilize the potential local food of East Nusa Tenggara (NTT) Province which is known as dry land islands. Fish, poultry, *Moringa oleifera* and nuts are potential foods in this province that need to be managed optimally. Local food resources were slightly consumed due to a lack of socialization and training in local food processing, resulting in low community knowledge and skills.

Fried meatball chips are a food product that is popular among people nowadays. This dish need to be modified with nutritious local ingredients to increase their nutritional value. The innovation was carried out by substituting common ingredients with local NTT resources, namely chicken liver flour, *Moringa oleifera* leaf flour, soybean tempeh flour and mackerel meat, abbreviated as Tioek chips. Food modification made from local ingredients can be utilize as a feasible alternative food source of minerals and protein that is economical and delicious to prevent anemia. This study aims to determine the effect of the Tioek chips intervention in adolescent girls regarding changes in hemoglobin levels before and after consumption. Utilizing local food resources is a solution to overcome high number of health problems caused by low intake of nutritious food among nutritional risk groups in NTT Province.

MATERIALS AND METHODS

This research was conducted in two schools. Both schools are located in Kupang City and Kupang Regency, East Nusa Tenggara (NTT) Province, Indonesia. The experiments was carried out from July to September 2023, and there were 70 respondents selected using purposive sampling. The adolescent girls who participated as respondents were junior and senior high school students aged 15-18 years and not taking iron supplements. Exclusion criteria included having experienced an infection during the study, having a history of chronic disease, the respondent being pregnant, and being menstruating at the time of Hb examination. Ethical approval was obtained from the Health Research Ethics Committee (2023393-KEPK). All respondents gave their consent by signing informed consent.

Data were collected in three main parts: The first part was to collect female students' BMI and hemoglobin levels of all the participants in both groups; secondly, the intervention consisted of continuously providing the adolescent girls (in the treatment group) with Tioek chips as much as 240 grams per day for 14 days; The third part was carried out by checking hemoglobin levels after the intervention in both groups. Anthropometric measurements were taken using instruments, namely digital scale for measuring body weight measurement and stature meter for height measurement. Hemoglobin (Hb) level was measured using a portable Hb test, namely the digital Hb test. Hb examination was carried out at the beginning and end of

the study on adolescent girls aged 15-18 years. Hemoglobin (Hb) levels of 12-16g/dl are considered normal or not anemia, Hb levels of 11.0-11.9g/dl are considered mild anemia, Hb levels of 8.0-10.9g/dl are considered moderate anemia and Hb levels <8.0g/dl are considered severe anemia.

The initial step was a trial of producing Tioek chips by making chicken liver flour, *Moringa oleifera* leaf flour and soybean tempeh flour first. The next step was to make Tioek chips using the following ingredients: mackerel 300g, soybean tempeh flour 75g, chicken liver flour 75g, *Moringa oleifera* flour 30g, sago flour 350g, cornstarch 35g, wheat flour 50g, tapioca flour 50g, garlic 40g, fried shallots 20g, salt 10g, powdered stock 10g, pepper powder 10g, ginger powder 3g, baking powder 5g, two eggs, margarine 30g, ice water 240ml. All these ingredients are mixed and mashed using a blender/chopper. Once it becomes dough, rolled it into small balls and boiled into meatballs. The meatballs are cooled, sliced thinly, and fried into chips. Tioek chips made from chicken liver flour, *Moringa oleifera* leaves flour, soybean tempeh flour and mackerel, were divided into small portions weighing 80g per pack. Each girl in the treatment group consecutively received as many as three packs (240g) per day for 14 days, so in total each respondent received 42 packs of Tioek chips.

This was a quasi-experimental study with a pretest-posttest comparison group design. Data was checked for normality using Shapiro Wilk test due to small number of respondents which was only 70 respondents (35 for each group). The results showed that the data was normally distribution. Then the data was analysed using parametric test with paired and independent t-test, to find out the difference within and between groups, before and after consumption of Tioek chips. Data is considered significantly different if the p-value was less than 0.05.

RESULTS AND DISCUSSION

The majority of adolescent girl respondents aged 15-17 years are short in stature (54%), compared to normal height standards for adolescent girls, which are 15 years (147.9 cm), 16 years (148.9 cm), 17 years (149.5 cm) and 18 years (149.8 cm). In line with the results of the Body Mass Index (BMI) of respondents, the majority of whom were underweight (60%), compared to BMI standards for underweight (<18.5 kg/m²), normal (18.5-22.9 kg/m²), overweight (23-24.9 kg/m²) and obesity (>25 kg/m²). The majority respondents are also at risk of experiencing Chronic Energy Deficiency (CED), amounting to 66%, compared to the standard measurement of Middle Upper Arm Circumference (MUAC), which is less than (<23.5 cm) and normal (23.5-28.5 cm) [7]. Based on anthropometric measurements data to assess nutritional status, it shows that the nutritional status of majority respondents is still low (Table.1).

Table 1: Characteristics, Nutritional Status and Health of the Respondents (N= 70)

Characteristics	N	%	Mean
Height (cm)			145.30
Normal	32	46	
Short Stature	38	54	
Body Mass Index (BMI) (kg/m ²)			18.10
Normal	28	40	
Underweight	42	60	
Obese	0	0	
Mid Upper Arm Circumference (MUAC) (cm)			22.20
Non Chronic Energy Deficiency (CED)	24	34	
Risk of Chronic Energy Deficiency (CED)	46	66	
Hemoglobin (Hb) Levels (g/dl)			10.10
Normal (Non Anemia)	27	38	
Mild Anemia	35	50	
Moderate Anemia	8	12	
Severe Anemia	0	0	

Source: Primary data, 2023

The results of respondents' nutritional status based on anthropometric measurements were consistent with the following examination of hemoglobin levels. In Table 1, the majority of respondents aged 15-18 years suffer from anemia (62%) consisting of mild anemia (50%) and moderate anemia (12%). It is based on standard categories of hemoglobin levels, namely moderate anemia (8.0-10.9 g/dl), mild anemia (11.0-11.9 g/dl) and non-Anemic or normal (12-16 g/dl) [8]. Therefore, it can be concluded that the nutritional and health status of the respondents still needs to be improved.

Table 2: Hemoglobin levels before and after Tioek chips given in the Intervention group and control group

Hemoglobin Levels (gr/dL)	Groups		p-value
	Intervention	Control	
Before Treatment			
Mean ± SD	10.10 ± 0.56	10.15 ± 0.62	0.682
Min ± max	9.00 ± 11.00	9.00 ± 11.15	
After Treatment			
Mean ± SD	11.78 ± 0.93	10.18 ± 0.65	0.023
Min ± max	11.12 ± 13.42	9.10 ± 11.18	
Deviation Average			
Mean ± SD	1.68 ± 0.36	0.03 ± 0.05	0.000
Min ± max	0.70 ± 2.42	0.00 ± 2.24	
p-value (Paired t-test)	0.000	0.000	

Source: Primary data, 2023

Table 2 shows that the average hemoglobin level of respondents increased after consumed Tioek chips as a snack for 14 days. The average hemoglobin level in the control group was 10.18 g/dl and the experimental group after being given the intervention increased to 11.78 g/dl. The average increase in hemoglobin levels between the experimental group before the intervention and after the

intervention with Tioek chips increased by 1.60 g/dl. The results of the paired t-test between before and after the intervention was given, the p-value was (0.023), which means there was a difference in hemoglobin levels before and after consumed Tioek chips. Based on these results, it can be concluded that there is an influence of giving Tioek chips on the hemoglobin levels of adolescent girls.

Deficiency of nutritional and health status in adolescent girls can increase the risk of problems occurring now and in the future. The majority of adolescent girl respondents are at risk of Chronic Energy Deficiency (CED) of 66%, underweight Body Mass Index (BMI) of 60%, short stature (54%) and diagnosed with anemia (62%). Nutritional status has a significant relationship with academic achievement. Underweight students are 1.96 times more likely to achieve mediocre grades (C, D) than normal-weight students [8, 9]. Anemia is one of the indirect causes of maternal and newborn mortality. During pregnancy, anemia has been associated with poor maternal and birth outcomes. The impact of anemia on pregnant women is maternal mortality, miscarriage, implantation bleeding, premature birth, stillbirth or Intrauterine Fetal Death (IUFD), Intrauterine Growth Restriction (IUGR), Low Birth Weight (LBW), impaired development of all fetal organs (learning ability, cognitive ability, even the child is at risk of experiencing disabilities) [1].

Indirectly, anemia has become a common illness among adolescent girls in Indonesia because the causes and symptoms are often not realized by them. Iron and protein intake is still below adequate based on the Nutritional Adequacy Rate (NAR) standards for Indonesian people (iron 11 mg/day and protein 65 mg/day). Adolescents with bad eating behaviors have a greater risk of experiencing nutritional disorders [10, 11]. Insufficient food sources of iron and protein intake in adolescent girls can be caused by a lack of variety in the food consumed. A similar study conducted by Sayrani and Tedju Hinga et al (2019), found that daily consumption patterns that do not vary are the main factor causing anemia in adolescents in Kupang Regency, NTT Province [12].

Adolescent nutritional intake needs to be carefully considered because it can trigger anemia, due to the high nutritional needs during adolescence. Therefore, nutrient-dense food interventions based on local food are needed to prevent adolescent nutritional problems, especially anemia. The study's paired T-test results showed an increase in hemoglobin levels in adolescent girl respondents after being given the intervention. The intervention consisted of Tioek chips made from chicken liver flour, Moringa oleifera leaves flour, soybean tempeh flour and mackerel at a dose of 240 g/day for 14 days consecutively. The analysis results indicating a significant difference in hemoglobin levels before and after being given the intervention of Tioek chips in adolescent girls.

Poultry is a source of animal food that contains heme iron and is easily found among the public. The results of Tioek snack intervention, which used chicken liver flour as one of the ingredients, were similar to research conducted by Nurlidan et al (2022), that there was a difference in the hemoglobin levels of adolescent girls after giving chicken liver, namely the average pre-test value was 11.15 g/dl. The average post-test value increased to 12.99 g/dl with a p-value (0.000) [13], meaning that giving chicken liver significantly increased hemoglobin levels in adolescent girls. The iron contained in chicken liver is a type of heme iron. The body absorbs heme iron more easily and quickly than the non-heme iron found in vegetables and fruits. Chicken liver is an internal organ that allows it to be reprocessed into nutritious products with economic value [14].

Tempeh is a native Indonesian food that is often underestimated and considered cheap, but has many benefits. Tempeh was prepared by fermenting cooked peeled soybeans. The protein content in tempeh can be compared to the content in meat. It contains a significant amount of proteins. The content of tempeh is proven to have better quality than soybeans because the water-soluble protein content will increase proteolytic enzymes [15]. One of the main ingredients for making Tioek chips is soybean tempeh flour. The results of Tioek snack intervention research are similar to the results of research conducted by Indrasari and Agustina (2021), which showed that the average hemoglobin level in the intervention group before being given soybean tempeh flour was 9.4278 g/dl and after being given was increased to 10.7111 g/dl with a p-value (of 0.000), which means that the consumption of tempeh and iron influences anemic condition.

The distribution of marungga (*Moringa oleifera*) is extensive in various types of dry land habitats in NTT Province, which has a tropical climate. The quality of marungga plant, which grows on the mainland of Timor Island, NTT Province, is claimed to have the best quality in the world based on research results from several Spanish institutions. Local *Moringa oleifera* is a nutrient-rich alternative plant that has the potential to be a source of nutrition to overcome nutritional problems cheaply, easily and naturally. The use and innovation of *Moringa* products in NTT is still insufficient to overcome nutritional problems. Several recent studies Hastuty et al (2022) and Kustiani (2024), have suggested that there is a significant difference between hemoglobin levels in adolescent girls, before and after consuming *Moringa* leaf extract ($p < 0.05$).

The nutrients in moringa leaves include protein, carotene, vitamin C, minerals, especially iron and calcium. Several recent studies Najib (2020) and Wahyurin (2021), have suggested that vitamin C in moringa leaf powder is 17.3 mg/100 gram and there was a significant relationship between vitamin C intake and Hb levels

young girls ^[21, 22]. According to the theory of iron absorption can be enhanced by consuming vitamin C simultaneously because it reduces ferric to ferrous iron. Iron levels in the body can influence the formation of hemoglobin levels. Therefore, the difference in absorption of iron consumed in the control and intervention groups is also influenced by the daily consumption of vitamin C. However, the level of vegetables and fruit consumption as the main source of vitamin C among people in Indonesia is still relatively low.

Fish is one of local commodities in NTT, which has the advantage of containing high nutritional value as a source of animal protein, vitamins and minerals as well as rich in omega-3 essential fats, higher than chicken and beef. Indonesia, especially NTT Province, is islands with abundant marine resources. However, the utilization of fishery products to prevent nutritional problems in NTT Province still needs to be improved. The Tioek snack intervention research uses fresh mackerel as one of the main ingredients. The results of Tioek snack intervention research are similar to the results of research conducted by Febriyanti et al (2022) that the intervention group of anchovy nuggets and blood supplement tablets was more effective in increasing the Hb levels of pregnant women compared to the control group which only consumed blood supplement tablets. A similar study conducted by Inayah and Pratikwo (2022), showed that the salmon-stuffed steamed buns intervention influenced the increase in hemoglobin levels significantly, and there were differences of hemoglobin levels in anemic pregnant women between the intervention group and the control group ^[15].

Adolescent girls who experience nutritional problems, if become pregnant in the future, will have long-term health impacts for themselves and their children. Sayrani and Tedju Hinga et al (2019), suggest that anemia in adolescent girls is the most significant contributor to the birth of a stunted generation in the future, so preventing anemia in adolescents must be a priority. Preventing anemia in teenagers from an early age is the best choice, compared to the long-term impacts caused by anemia in the future. Interventions regarding nutrition and positive body image have an effect on increasing knowledge and practices in adolescent's girls. The involvement of the formal sector, such as schools, is very vital in reducing the incidence of anemia. It is necessary to increase community production skills in processing potential local food as a sources of protein, minerals and vitamins in the daily food menu that is affordable, nutritious and delicious, so that it is liked by adolescents.

Limitations of the study

This study did not test the nutritional value of meatball chips modified with a combination of local ingredients, such as chicken liver flour, Moringa oleifera leaves flour, soybean tempeh flour and mackerel fish (Tioek chips), which was considered a research limitation. In addition, the study period and daily dietary factors that

could influence adolescent girls' hemoglobin levels were not assessed. Further study is needed to address these issues.

CONCLUSION

Foods modified with nutritious local ingredients such as Tioek chips can be classified as an affordable and delicious alternative to healthy snacks to prevent anemia. The intervention of providing Tioek chips combination of local ingredients such as chicken liver flour, moringa leaf flour, soybean tempeh flour, and mackerel fish increased hemoglobin levels. Foods modified with nutritious local ingredients such as Tioek chips can be classified as an affordable and delicious alternative to healthy snacks to prevent anemia. Community knowledge and skills was improved to modify nutritious local foods by adapting to popular trends. This facilitated the production of economically viable, highly nutritious, delicious, and favored products among adolescent girls. Therefore, further studies were needed to explore processing and utilization of potential local foods in addressing nutritional problems, specifically in groups at risk of nutritional challenges.

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