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RESEARCH ARTICLE

The Benefits of Midmorning Snack to Combat Stunting: A Longitudinal Panel Study in the Riau Province of Indonesia

Aslis Wirda Hayati[1,*] and Hardinsyah Ridwan[2]

[1]*Department of Nutrition, Politeknik Kemenkes Riau, Jl. Melur 103 Pekanbaru, Riau 28122, Indonesia;* [2]*Department of Community Nutrition, Fakultas Ekologi Manusia, Institut Pertanian Bogor, Jl. Lingkar Kampus, Kampus IPB Dramaga Bogor 16680, Indonesia*

Abstract: ***Aim***: The aim of this research was to help stunted adolescents improve their nutritional status.

***Background*:** Stunting is a leading global nutritional problem, especially in developing countries such as Indonesia. This was a longitudinal panel study in the SMP Negeri 3 Pekanbaru Riau Province Junior High School in Indonesia.

***Objective*:** The objective of this study was to determine the impact of calcium and phosphorus supplementation via additional midmorning snacks for adolescents with stunting conditions.

***Methods*:** We included 36 participants, aged 12–15 years with a height-for-age Z-score of <-2 standard deviation. They underwent a one-month nutritional intervention during which selected snacks and high-calcium milk were given for midmorning snacks. The midmorning snack menu varied daily and included *gado-gado* (rice, boiled egg, potato, tempeh, tofu, long beans, cabbage & peanut sauce), fried vermicelli (vermicelli, omelet, cucumber & prawn crackers), *batagor* (tofu, cassava flour crackers, boiled egg & peanut sauce), *lontong medan* (rice, boiled egg, vermicelli, french fries, fried anchovy, green bean & carrots curry), sandwich (plain toast, omelet, cucumber, lettuce, tomato & chili sauce), chicken porridge (rice porridge, fried bread, shredded chicken & chicken broth), and fried rice *teri* (rice, anchovy, prawn crackers, cucumber, chili sauce & soy sauce). The total amount of energy from the meals and milk was 541.8 kcal (30 % of RDA-Recommended Dietary Allowance), 25 g of protein (50 % of RDA), 90 g of carbohydrate (30 % of RDA), and 600 mg of calcium (35 % of RDA). Meal and milk administration lasted 34 days in total. Data analysis and food intake consumption were conducted using the Pearson Product moments test.

***Results*:** The participants' mean height-for-age Z-score before and after the nutritional intervention was -2.5 ± 0.4 (-3.2 - 2.0) and -2.3 ± 0.4 (-3.2 - 1.2), respectively. After the intervention, the rate of stunting was reduced up to 19.4%; the rate of calcium intake before the nutritional intervention was 50% below the recommended dietary allowance 27.3 ± 27.8 (3.3:100.0) %; the rate of phosphorus intake among the participants was sufficient. The rate of calcium intake after the nutritional intervention was 59.1 ± 19.0 (15.5 - 100.0) % due to which the nutritional quality of food before the intervention was still lacking, namely 52.7 ± 15.5 (28.4 - 86.3) after the nutrition intervention increased to 84.8 ± 20.3 (30.9 - 100.0); (r-value = 0.43; p-value = 0.01).

***Conclusion*:** The nutritional intervention increased calcium intake. The outcome of the nutritional intervention led to the improvement of nutritional status from stunting to the normal category.

***Other*:** The midmorning snack given to teenagers is a snack meal available in the school canteen that they can buy with pocket money. It is necessary to create awareness about the importance of consuming high calcium midmorning snacks for teenagers. The activity of consuming high-calcium midmorning snacks by adolescents can be continued independently. So far, teenagers do not use pocket money to buy midmorning snacks that are high in calcium, but they buy other types of snacks that are low in calcium, consisting of pastel, noodles, tofu, fritters, pao, tempeh, rice cake, and eclairs. So far, no nutritional intervention has significantly increased the nutritional status of stunted children to normal levels; however, this type of intervention may become a viable option in the future.

Keywords: Adolescent, midmorning snack, calcium, egg, milk, the nutritional quality of food, stunting, phosphorus.

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*Address correspondence to this author at the Department of Nutrition, Politeknik Kemenkes Riau, Jl. Melur 103 Pekanbaru, Riau 28122, Indonesia; E-mail: aslis@pkr.ac.id

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1. INTRODUCTION

Stunting is a major nutritional issue worldwide, particularly in developing countries like Indonesia. Stunting in girls aged 15-19 is 52 % in Guatemala and 44% in Bangladesh [1]. The Ministry of Health, Republic of Indonesia (MOH RI) reported in 2007 that the prevalence of stunting among children aged 6-12 years and adolescents aged 13-15 years in Indonesia was 35.6 % and 35.2 %, respectively, based on data from the National Basic Health Research (RISK-ESDAS) [2]. The MOH RI found in 2010 that the prevalence of stunting among teenagers aged 13-15 in Indonesia was 35.2 % based on national statistics. In the province of Riau, the prevalence was 36.6 %. According to the WHO, these public health issues are considered extreme when the prevalence of stunting is between 30 and 39% and serious when the prevalence of stunting is greater than 40% [3]. Stunting is thus a consistent problem among the adolescent age group in the Riau province of Indonesia.

Adolescence is the transition from childhood to adulthood, characterized by anatomical, physiological, and psychological changes. The three stages of adolescence are as follows: (a) physical preparation period, 11-15 years old; (b) preparatory period, 15-18 years old; and (c) adult preparatory period, 18-21 years old. [4]. Stunting is a common public health problem among adolescents around the world (up to 27-65 %) [5]. Stunting among adolescents is often disregarded as a nutritional deficiency problem [6]. Decreased cognitive learning ability, reduced productivity, and an increased risk of adolescent pregnancy, which leads to an unhealthy newborn, are all possible negative consequences. Compared to other postpartum times, the teenage years, along with the first year of life, have the second-fastest body and height development [6]. More than 20% of total height growth and up to 50% of body bone mass are attained during this period. As a result, adequate nutrition is essential during adolescence.

Calcium and phosphorus are required for body growth. Milk and dairy products are the main sources of these micronutrients. There is a link between milk consumption frequency and the amount and risk of stunting in children aged 24 months (OR =4.1, $p < 0.05$). The average amount of milk consumed by stunted children (17 times a week) is lower than healthy children's (24 times a week). Stunted children drink less milk (337.63 mL per day) than healthy children (468.13 mL per day) [7]. Milk contains calcium, necessary for bone and height growth [8]. In addition, fish and seafood have more calcium than beef or chicken [9]. Bone mineralization is extremely important during development. Low calcium intake can affect the function of osteoblasts by causing a lack of mineralization of the new bone deposit matrix. Bone growth during childhood can be hampered by calcium deficiency. Stunting is a side effect of losing weight [10,11].

Calcium forms complex bone-strengthening bonds with phosphates. Upon phosphorus deficiency, growth may be disrupted [12]. High-protein foods, such as meat, poultry, fish, eggs, and grains, are the primary sources of phosphorus. Phosphorus is abundant in foods rich in protein and calcium [13]. Phosphorus is also found in milk, so it is so important (93 mg milk). Furthermore, each 100 mg of milled rice contains 140 mg of phosphorus. During periods of growth, the body's need for calcium increases [14]. Calcium deficiency stifles growth [15]. Height can be utilized to indicate the quality of growth and bone formation [16, 17]. In this study, the rate of calcium intake before the nutritional intervention was 50% below the recommended dietary allowance (RDA)—27.3 ± 27.8 (3.3:100.0) % RDA, but the rate of phosphorus intake among the participants was sufficient.

In this study, the participants were provided a variety of locally available midmorning snacks and milk. As a result, the goal of the research was to see how additional midmorning snacks affected the potential improvement of stunting in adolescents.

2. MATERIALS AND METHODS

The study complied with the World Medical Association Declaration of Helsinki-Ethical Principles for Medical Research involving human subjects, and ethical approval was obtained from the Riau Polytechnic Ethics Committee (Reference Number: LB.02.03/6/04/2019). SMP Negeri 3 Pekanbaru, Riau Province, Indonesia, was the site of this longitudinal panel study. Students in their first, second, and third years took part in this study (Table **1**). By the middle of April 2019, the participants would be between the ages of 12 and 15, with a height-for-age Z-score (HAZ) of < -2 [18]. Parents' willingness to participate in the study was obtained, and they signed the informed consent form on behalf of their children. Diagnosed chronic illnesses, born twins, mental health disorders, a history of low birth weight, and concurrent participation in a similar study were all exclusion criteria [19].

The Lwanga and Lemeshow formula was used to calculate the number of samples [20]. A value of α =5% (1.964) and a value of β =20% (0.842) were utilized in the formula [21]. Previous research statistical parameters (*e.g.*, mean and standard deviation) were used to determine the number of samples representing population characteristics. The study showed that $\mu1-\mu2 = 0.4$ cm (the increase of study participant body length) and a standard deviation of $\sigma = 1.6$ cm, based on which the minimum sample of this research was 21 participants. 36 study participants were eligible for participating after the screening, as presented in (Table **1**).

On April 29th, 2019, records of the participants' height and food recall 1 x 24 hours were taken, which was the food consumed the day before. The measurement was retaken 10 months later (February 11th, 2020). No nutritional intervention was administered during the first ten months, and the count was implemented by Bhandari *et al.* in 2001 [22]. Between February 11th and March 11th, 2020, the study participants underwent a dietary intervention in the form of midmorning snacks [23] and high calcium milk. Records of the participants' height and 1 x 24 hours of food recalls were retaken on March 11th, 2020.

Table 1. Demographic Information of Study Participants.

Variable	Criteria	Values*
Number of Participants	Year I	30.6 (11)
-	Year II	41.7 (15)
-	Year III	27.8 (10)
Age (Year)	12	13.9 (5)
-	13	36.1 (13)
-	14	36.1 (13)
-	15	13.9 (5)
Sex	Male	50.0 (18)
-	Female	50.0 (18)
Birth weight (g)	< 2,500 (Low birth weight)	5.6 (2)
-	≥ 2,500 (No low birth weight)	94.4 (34)
Body length at birth (cm)	< 48 (Stunting)	19.4 (7)
-	48 — 55.6 (Normal)	75.0 (27)
-	≥ 55.6 (High)	5.6 (2)
Number of siblings (person)	1	8.3 (3)
-	2	22.2 (8)
-	3	44.4 (16)
-	4	13.9 (5)
-	5	5.6 (2)
-	6	5.6 (2)
Ethnicity	Malay	100.0 (36)
Place born	Jakarta, Jakarta Province	2.8 (1)
-	Pekanbaru, Riau Province	88.9 (32)
	Palembang, South Sumatra Province	2.8 (1)
	Medan, North Sumatera Province	2.8 (1)
	Jambi, Jambi Province	2.8 (1)
Mother's height (cm)	153.5 ± 8.7(120.0 — 175.0)	
-	< 150	16.7 (6)
-	≥ 150	83.3 (36)
Mother's education level	Elementary school	13.9 (5)
-	Junior high school	5.6 (2)
-	Senior high school	77.8 (28)
-	University	2.8 (1)
Mother's occupation	Housewife	77.8 (28)
-	Employee	13.9 (5)
-	Businessman	5.6 (2)
-	Entrepreneur	2.8 (1)

Note: * % (n)

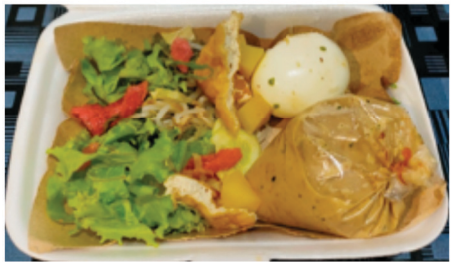
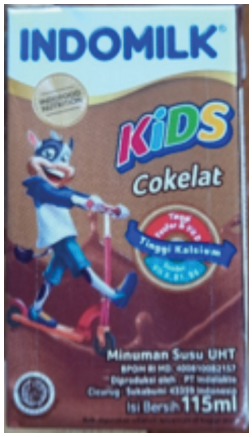
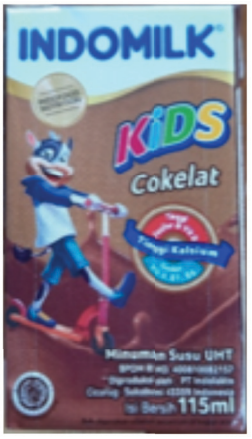
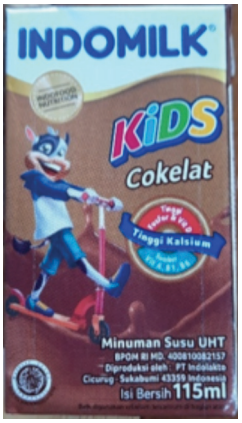
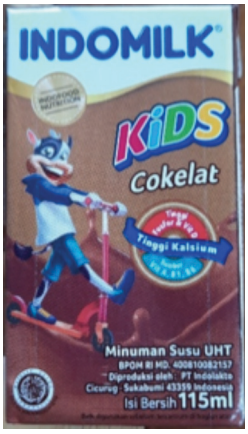
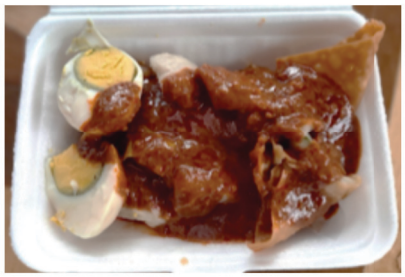
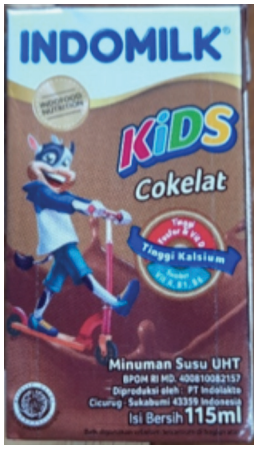
The midmorning snack menu varied daily and included *gado-gado* (rice, boiled egg, potato, tempeh, tofu, long beans, cabbage & peanut sauce), fried vermicelli (vermicelli, omelet, cucumber & prawn crackers), *batagor* (tofu, cassava flour crackers, boiled egg & peanut sauce), *lontong medan* (rice, boiled egg, vermicelli, french fries, fried anchovy, green bean & carrots curry), sandwich (plain toast, omelet, cucumber, lettuce, tomato & chili sauce), chicken porridge (rice porridge, fried bread, shredded chicken, shredded chicken & chicken broth), and fried rice *teri* (rice, anchovy, prawn crackers, cucumber, chili sauce & soy sauce) as displayed in Fig. (**1**) and Table **2**.

The midmorning snacks consist of 30% (recommended dietary allowance) RDA snacks with energy contents. The mid-morning snacks are foods sold by vendors near the school. Meals per day were divided into six; breakfast, midmorning snacks, lunch, afternoon snacks, dinner, and evening snacks. Energy provision during breakfast provided around 20% of RDA, lunch around 30%, and dinner around 20% of RDA; midmorning, afternoon, and evening snacks were approximately 10% of the RDA each [24]. The total amount of energy from the meals and milk was 541.8 kcal (30% of RDA), 25 g of protein (50% of RDA), 90 g of carbohydrate (30% of RDA), and 600 mg of calcium (35% of RDA). Meal and milk administration lasted 34 days in total.

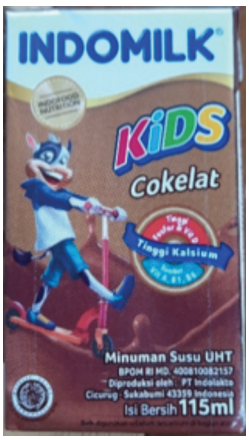
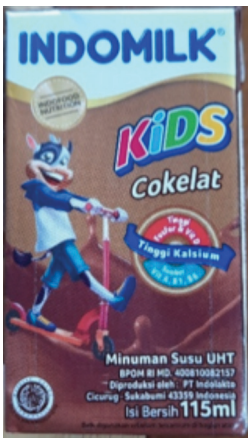
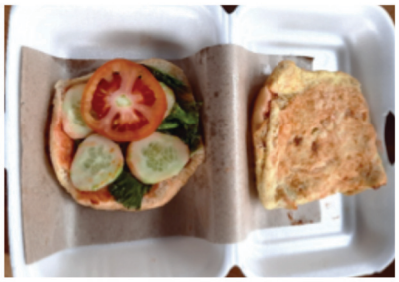
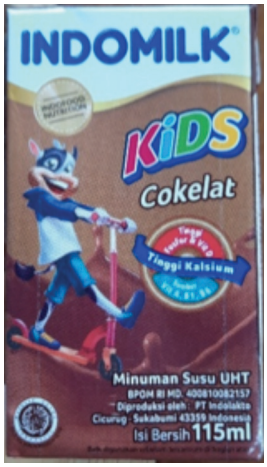
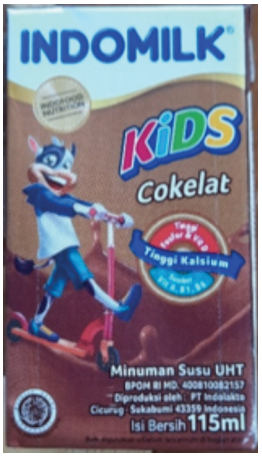
The participants entered the research area at around 7.00 a.m. The participants consumed three cartons of milk at 8:00 a.m., 10:00 a.m., and 12:00 p.m., given by the research team members. The midmorning snack was served at 10 a.m. and consumed right after. Both the meals and milk were consumed at school during school days. The researcher observed the participants both during meal and milk consumption. The research team and 2 members of the health school team members observed the meals consumed by the participants.

Once the milk was consumed, the participants left the research site. The amount consumed was recorded. The remaining unconsumed food was weighed and counted since it will affect the amount of nutritional intake consumed. A similar process was repeated between 10:00 a.m. and 12:00 p.m. On the other hand, during school breaks, the meals and milk were directly distributed to the students' residences by the research team member. The research team observed the consumption of the meals and recorded their intake in case there were any leftovers.

Requirement calculation (including energy, protein, fats, carbohydrates, vitamin A, vitamin E, vitamin B-1, vitamin B-2, vitamin B-6, vitamin C, sodium, calcium, magnesium, phosphorus, iron, and zinc) was based on the recommended dietary allowance (RDA) per age [25]. Analysis of the various nutrients was carried out using the Food-Beverage Nutrient Composition Database from the Indonesian Food Composition Table [26]. Based on nutritional intake data, the participants obtained nutritional adequacy. Nutritional adequacy (NA) is the level of nutrient intake that can meet the nutritional needs of almost all healthy people [27]. This means that a sufficient nutritional level is necessary to prevent diseases due to malnutrition, such as disorders due to

DAY	TIME		
	07:00 a.m.	10:00 a.m.	12:00 p.m.
MONDAY		 	
	Milk	Gado-Gado + Milk	Milk
TUESDAY		 	
	Milk	Fried Vermicelli + Milk	Milk
WEDNESDAY		 	
	Milk	Batagor + Milk	Milk

(Fig. 1) Contd….

THURSDAY		 	
	Milk	Lontong Medan + Milk	Milk
FRIDAY		 	
	Milk	Sandwich + Milk	Milk
SATURDAY		 	
	Milk	Chicken Porridge + Milk	Milk

(Fig. 1) Contd….

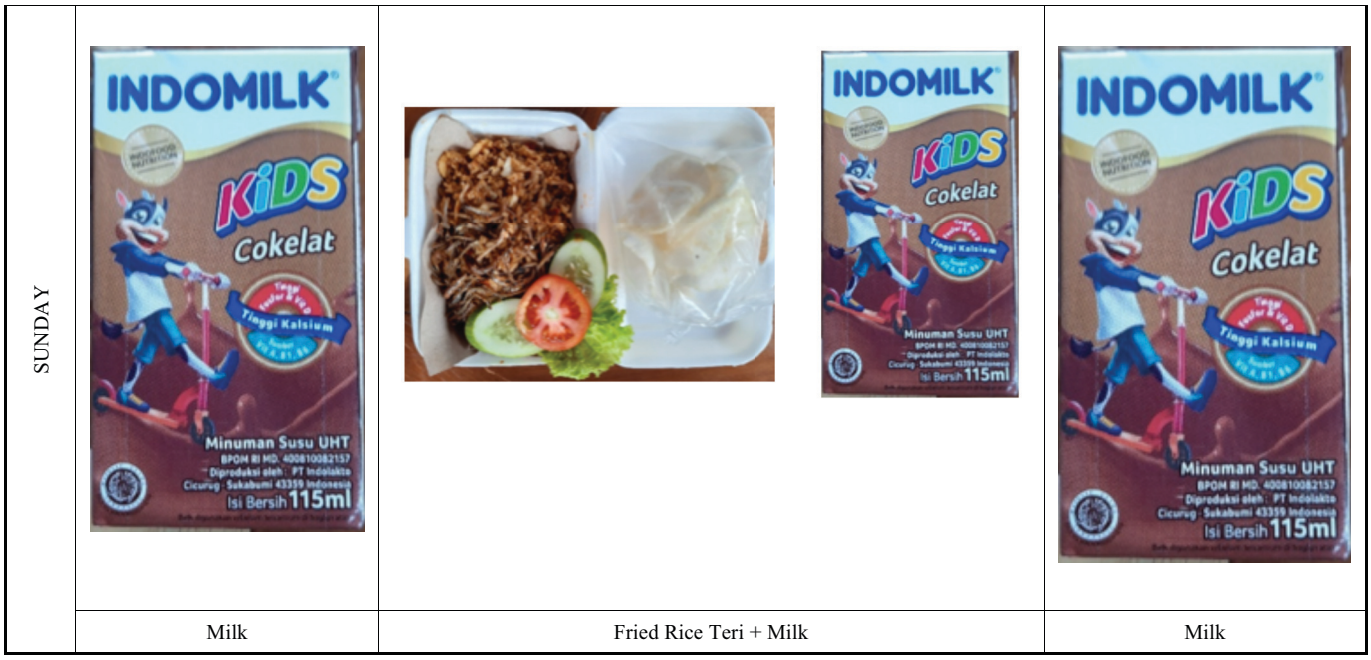


Fig. (1). The midmorning snack. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

Table 2. Nutritional content of midmorning snack meals per day.

Midmorning Snack	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Calcium (mg)
Gado-gado & milk	552.0	21.5	20.5	76.4	462.3
Fried vermicelli & milk	594.5	18.1	30.5	65.8	428.0
Batagor & milk	419.5	23.4	20.4	40.5	474.8
Lontong medan & milk	646.9	27.4	23.9	84.3	668.9
Sandwich & milk	366.8	14.3	11.5	55.9	413.0
Chicken porridge & milk	580.7	21.4	11.8	100.7	405.6
Fried rice teri & milk	632.1	19.4	33.1	68.4	559.1
Average	541.8	20.8	21.7	70.3	487.4

iodium deficiency for iodium, xeroftalmia and night blindness for vitamin A, and beriberi for thiamin. NA is the daily adequacy of nutrients according to age group, gender, body size, and activity to prevent the occurrence of malnutrition or excess nutrition.

Internationally, various terms are used such as in the United States and Canada, NA is also known as Dietary Reference Intakes (DRIs), and in the European Union called Population Reference Intakes, in Japan called Nutrients-Based Dietary Reference Intakes (NBDRIs), WHO uses the term Recommended Intake (RNI), in the Philippines, the term Recommended Energy and Nutrient Intake (RENI) is used and in Australia and New Zealand the term Nutrient Reference Values (NRVs). Moreover, the energy adequacy was categorized as low when recorded at <70 and sufficient if ≥70% of RDA; the protein adequacy was categorized as low when recorded at <80 and sufficient if ≥ 80% of RDA; the vitamin and mineral adequacy was categorized as low when recorded at <50% and sufficient if ≥ 50% of RDA.

$$\text{Nutritional Adequacy Rate (NAR)} = \frac{\text{Nutritional Intake}}{\text{Recommended dietary allowance (RDA)}} \times 100\%$$

The nutritional quality of the food intake was calculated based on Hardinsyah's formula [28]. It was categorized low if at <70% and sufficient at ≥70% of RDA.

$$\text{Nutritional quality of food (\%)} = \frac{(\text{NARi})}{n}$$

NARi = Nutritional Adequacy Rate (truncated at 100)

n = The number of nutritions and the nutritional quality of food (energy: i=1; protein: i=2; fats: i=3; carbohydrates: i=4; vitamin A: i=5; vitamin E: i=6; vitamin B1: i=7; vitamin B2: i=8; vitamin B6: i=9; vitamin C: i=10, sodium: i=11; calcium: i=12; magnesium: i=13; phosphorus: i=14; iron: i=15; zinc: i=16).

The study also involved teacher's and parent's questionnaires regarding details of participants' eligibility. This instrument also explored information regarding both the parental and socio-economic status of the study participants, such as household income per month. Data analysis and food intake consumption were conducted using the Pearson Product moments test with the SPSS version 16 for Windows.

3. RESULTS AND DISCUSSION

3.1. Height and Calcium Intake

Before the intervention, all participants experienced stunting. The mean height of the participants was 141.0 ± 5.2 (128.8 - 152.2) cm, their age was 13.5 ± 0.9 (12.0 - 15.0) years, and the HAZ was -2.5 ± 0.4 (-3.2 -2.0) (Table **1**).

At the beginning of the study, calcium and phosphorus adequacy rates positively correlated with the study participant's height (r calcium =0.433**, r phosphorus =0.406**) (Table **3**). The level of calcium adequacy rate among all participants was low (27.3 ± 27.8, 3.3 - 100.0%). The sufficient adequacy rate of calcium is about ≥50% of the Nutritional Adequacy Rate (NAR) and is considered inadequate if <50% of the NAR [29].

Moreover, at the same time, the calcium intake of participants aged 10-12 years, both male and female, was 244.5 mg and 223.5 mg, respectively. For those aged 13-15 years, the calcium intake of boys and girls was 315.2 and 362.9 mg, respectively.

Calcium intake among adolescent girls-based on a Bangladeshi study- was 248.80 ± 212 mg, in line with our study's findings [29].

3.2. Calcium Intake from Milk

No study participants had dairy allergies. A total of 89% of the study participants liked cold milk, while 11% liked it at room temperature.

A total of 16.4% of the participants had been accustomed to buying milk even before this research was conducted. The types of consumed milk were UHT Kids Chocolate (5.5%), ultra-milk (5.5%), REAL GOOD milk brand (2.7%), and Milo (2.7%). A portion of 100 g of milk contains about 143

Table 3. Correlation Height and Nutritional Adequacy Rate of Participants and Nutritional of Adequacy Rate No Intervention and After Intervention Group.

S. No.	Nutrients	Correlation Height with Nutritional Adequacy Rate					
		Nutritional Adequacy Rate (%)	Correlation height with Nutritional Adequacy Rate		Nutritional Adequacy Rate (%)	Correlation height with Nutritional Adequacy Rate	
		No Intervention (April 29th, 2019)	(*r* value)	(*p* value)	After Intervention (March 11th, 2020)	(*r* value)	(*p* value)
1	Energy	70.7±18.5 (39.6 — 100.0)	0.118	0.495	66.9±20.3 (30.2 — 86.6)	-0.037	0.832
2	Protein	77.3±20.0 (44.5 — 100.0)	0.078	0.650	87.3±18.0 (50.9 — 100.0)	0.069	0.687
3	Fats	73.2±25.9 (20.8 — 100.0)	0.048	0.781	76.6±24.5 (42.3 — 100.0)	0.051	0.769
4	Carbohydrates	61.2±18.0 (24.5 — 100.0)	0.104	0.547	49.5±19.8 (18.4 — 100.0)	0.009	0.959
5	Vitamin A	75.1±35.4 (5.0 — 100.0)	0.202	0.238	77.9±20.6 (35.4 — 100.0)	0.028	0.873
6	Vitamin E	21.3±13.4 (0.0 — 58.2)	0.142	0.408	54.6±26.8 (7.3 — 100.0)	0.000	0.999
7	Vitamin B-1	35.6±21.2 (9.1 — 100.0)	0.277	0.101	63.0±21.4 (25.0 — 100.0)	-0.048	0.781
8	Vitamin B-2	62.2±24.6 (20.0 — 100.0)	0.209	0.222	97.9±5.8 (76.9 — 100.0)	-0.025	0.884
9	Vitamin B-6	61.9±22.7 (25.0 — 100.0)	0.166	0.333	78.2±20.5 (38.5 — 100.0)	0.145	0.400
10	Vitamin C	17.2±24.2 (0.0 — 85.8)	0.169	0.324	30.4±33.4 (5.4 — 100.0)	0.029	0.866
11	Sodium	17.0±11.9 (2.0 — 55.7)	0.291	0.086	76.0±26.2 (18.6 — 100.0)	0.058	0.738
12	Calcium	27.3±27.8 (3.3 — 100.0)**	0.433	0.008	59.1±19.0 (15.5 —100.0)	0.071	0.680
13	Magnesium	73.1±21.1 (35.7 — 100.0)	0.100	0.561	92.8±14.3 (42.8 — 100.0)	0.133	0.440
14	Phosphorus	55.9±21.2 (25.4 — 100.0)**	0.406	0.014	87.8±17.0 (45.4 — 100.0)	0.123	0.476
15	Iron	52.8±29.0 (14.0 — 100.0)	0.110	0.524	75.5±24.3 (26.4 — 100.0)	0.093	0.590
16	Zinc	61.2±22.0 (33.3 — 100.0)	0.208	0.233	84.8±20.3 (30.9 — 100.0)	0.062	0.719
Nutritional quality of food		52.7±15.5 (28.4 — 86.3)*	0.281	0.027	84.8±20.3 (30.9 — 100.0)	0.062	0.720

Note: ** = *P* VALUE <0.01; * = *P* VALUE <0.05

mg of calcium that was digestible in the body. Apart from milk, ice cream also contains calcium and was consumed by 2.5% of the participants. The content of calcium in 100 g of ice cream is 123 mg.

The prevalence of stunting is lower in children who consume milk. Both the amount and frequency of milk consumption in adolescents aged 16-17 years are related to height [8, 16]. Children aged 1-12 years who consume at least two cups of milk per day will have a reduced risk of stunting (p <0.05) [30].

The 2nd grade students of *SMP Negeri* 2 in Bulagi Banggai Regency of the Central Sulawesi Province of Indonesia usually drink two glasses of milk per day (equivalent to 480 ml), which could decrease stunting events within 2 months (p =0.01) [29]. Milk-derived calcium intake of children with stunting aged 24-59 months is lower than 276.17 mg/day and 628.41 mg/day, which is the amount for non-stunting children (p <0.05) [9].

Milk calcium is absorbed by the body during the growth period at about 50-70%, with one glass of milk (equivalent to 240 ml) containing more than 270 mg of calcium— almost one-third of the daily calcium needs; therefore, milk consumption is very beneficial for school-aged children [31].

Regularly consuming milk is highly recommended to meet calcium needs [32]. Milk consumption can improve bone growth, which ultimately influences height and helps reduce the risk of bone mass loss [33].

Milk is considered a good source of calcium, energy, protein, and minerals; it contains nutrients necessary for bone and height growth [8]. Moreover, milk is the best source of calcium and is the largest contributor to daily calcium consumption [34].

Proteins in cow milk—such as casein, whey, and amino acids, can stimulate the formation of IGF-1, which plays a role in the proliferation of chondrocytes and osteoblasts, as well as the formation of bone tissue matrix [33]. Low calcium intake can lead to low mineralization of the new bone mineralization matrix and affect osteoblast function. Calcium enriches the peak of bone mass and can form new bone tissue 30. Peak bone density occurs at the age of 17 years in males and 11-14 years in females. Optimal bone mass in girls and boys occurs at the age of 11–14 and 14–16 years, respectively. The process of bone formation begins by forming a strong but still soft and flexible matrix. The matrix consists of fibers made of collagen enclosed by gelatin. The matrix begins to become strong and harden through the calcification process, namely the formation of mineral crystals containing calcium compounds. This crystal consists of calcium phosphate or calcium phosphate combination and calcium hydroxide called hydroxyapatite {(3Ca3(PO4)2 Ca(OH)2}. Since calcium is the main mineral in this bond, it must be in sufficient quantities in the fluid surrounding the bone matrix [35].

Calcium forms a complex bond with phosphate that can provide strength to bones [30]. Poor calcium intake in adolescents can disrupt growth and peak bone mass [36]. A total of 51% of peak bone mass accumulates during puberty and reaches 37% of the adult bone mineral density [37]. In adolescence, the increase in bone mass occurs between 40–60% of the total bone mass [38].

The need for calcium and phosphorus increases in adolescence as height growth and bone mass formation rapidly occur [14]. Intake of calcium and phosphorus helps calcium absorption. Deposits of calcium and phosphorus inside the organic matrix are in the form of hydroxyapatite crystals during the mineralization process and give strength to the bones. The deficiency of both minerals and inappropriate ratios can affect bone growth [39].

During growth, calcium deficiency can lead to a reduction both in bone mass and hardness, which is in the period of formation. Calcium deficiency not only affects both bone and tooth growth but affects the immune system, nervous system resistance and impairs heart muscle contraction power as well [35]. Long-term calcium consumption deficiency will negatively affect bone structure; moreover, during growth, it can induce growth disorders [36]. Calcium is 99% in skeletal bones and 1% in other tissues, as well as bodily fluids that can be distributed throughout the body [40]. During adolescence, enough calcium intake helps produce better bone mass. Adequate calcium intake can help protect bones and daily calcium loss through excretion (urine and feces), sweat, and breath. A sufficient daily calcium intake can restore lost calcium [41].

3.3. Non-dairy Calcium Intake for Stunting Prevention

Before this study was conducted, participants had consumed non-dairy calcium sources. The amount of that food they consume is very small. So it is not sufficient as the recommended dietary adequacy. Tofu, tempeh, beans, and green vegetables, contain fiber and oxalate—which form insoluble salts—thus inhibiting calcium absorption. This condition will cause low calcium content bioavailability from the consumed foods [42].

3.4. The Price of Milk

The daily allowance received by the study participants on average was IDR 14,417 ± 6,429 (USD$ 1.03 ± 0.46). Calcium content in ultra-high temperature (UHT) Kids Chocolate 115 mL milk pack was 30% with the suggestion of serving two packages per day. The price of milk per box was IDR 2,200 (USD$ 0.15). The lowest price of milk in the canteen around the school is IDR 1,000 (USD$ 0.07) and the highest is IDR 3,200 (USD$ 0.22) per box. However, the brands of milks are different from the intervention milk.

Family income was related to the incidence of stunting in infants (p = 0.048). Low family income is at risk of getting stunting [43]. The type of purchased food depends on the family's income level [44]. The grocery purchasing capability of the family correlates with its income level; a high family income allows the fulfillment of the nutritional needs of the whole family; however, low family income relates with a low purchasing power for household food and potentially affects stunting events in children.

Table 4. Body Height and Z-Score of Participants Based on Age.

	Before Treatment (Control Class)			-	After Treatment (Experiment Class)		
Age	**Measurement Date**	**Body Height**	**Z-score**	**Measurement Date**	**Body Height**	**Z-score**
12	11/02/2020	135.3±2.3 (133.6 — 137.9)	-2.6±0.3 (-2.90 — -2.65)	11/03/2020	136.4±2.5 (134.7 — 139.3)	-2.6±0.3 (-2.90 — -2.25)
13	11/02/2020	141.5±4.8 (135.4 — 151.7)	-2.5±0.6 (-3.24 — -1.36)	11/03/2020	143.2±5.0 (135.8 — 153.5)	-2.3±0.6 (-3.15 — -1.19)
14	11/02/2020	144.9±3.8 (138.1 — 150.9)	-2.4±0.5 (-3.34 — -1.97)	11/03/2020	146.4±3.7 (140.4 — 153.6)	-2.3±0.5 (-3.10 — -1.68)
15	11/02/2020	147.5±3.8 (143.5 — 154.9)	-2.4±0.3 (-2.87 — -1.91)	11/03/2020	148.1±3.7 (144.2 — 155.2)	-2.3±0.3 (-2.75 — -1.85)
-	Average	143.6±5.2 (133.6 — 154.9)	-2.5±0.4 (-3.30 — -1.40)	Average	144.9±5.1 (134.7 — 155.2)	-2.3±0.4 (-3.15 — -1.19)

3.5. Egg Consumption

A total of 2.8% of the participants preferred boiled eggs, while 5.5% liked fried eggs, and 33.3% liked omelets. Except for chicken porridge and fried rice, the midmorning snacks contain eggs. Egg consumption provides nutrition that facilitates increased growth and contributes to reducing stunting (p <0.05) [14]. Younger children aged 6–9 months who consumed one medium-sized egg per day for six months could increase height and reduce stunting by 47% [13]. The toddlers' frequency of egg consumption who fall into the category has 1.813 times added risk of stunting, compared to those who consume eggs that fall into the frequent category [45].

Egg consumption was 27.8 grams/day by children aged 10-13 years. The frequency of consuming eggs by these children aged 10-13 years was 5 times/week [46].

3.6. The Midmorning Snacks

Within the first ten months, participants had not received the midmorning snacks. When participants had not received the midmorning snacks, some participants consumed snacks themselves. The types of snacks that participants consumed were pastel, noodles, tofu, fritters, *pao*, tempeh, rice cake, and eclairs. However, the consumption of these snacks did not improve the participant's nutritional status. On the 11th month (for 34 consecutive days), the participants were given a variety of meals—during midmorning snack— along with high calcium milk. The meals were purchased from shops near the participants' area. The price of one meal was approximately IDR 8,000 (USD$ 0.56), which is considered very affordable. The lowest price of one meal is IDR 5,000 (USD$ 0.35), and the highest price is IDR 10,000 (USD$ 0.70). Therefore, the participants will be able to purchase the meals even after the completion of the study.

Researchers expect that in the future (after the period of nutrition intervention in the form of midmorning snacks has been completed by researchers), stunting teenagers can provide for their own. The first reason is that mid-morning snacks are sold around them. The second reason is the price of the midmorning snacks. The students can use snack money to buy mid-morning snacks. Researchers have informed stunting teens during midmorning snacks that they need to increase their food intake as much as the midmorning snack the researchers provided. The addition of food intake is to optimize the linear growth of stunting adolescents during the growing chase.

3.7. The Height after Nutrition Intervention

After the intervention, the height of the participants increased (Table **4**). The control group was formed before being given a midmorning snack. In the first ten months of the study, all participants were not given midmorning snacks. The nutritional status of all participants in the first ten months is still stunting. The treatment group, which had been given the midmorning snacks for 34 days, began in the eleventh month. A total of 19.4% of participants increased their nutritional status from stunting to normal after consuming the midmorning snacks for 34 days. The height of the participants in the control group was 143.6 ± 5.2 while of the treatment group was 144.9 ± 5.1 cm (p < 0.00). The average increase tendency (mean) in participant height after treatment is 1.3 cm (Table **4**).

As a result, the dietary intervention used in this study successfully improved the nutritional status of the participants from stunting to normal. Not only did consuming midmorning snacks and drinking milk increase calcium intake, but it also increased the intake of other nutrients. The intervention improved the nutritional food quality from 52.7 ± 15.5 (28.4 — 86.3) to 84.8 ± 20.3 (30.9 — 100.0) (Table **3**). Calcium was one of the essential nutrients that normalized the nutritional status of the participants.

3.8. The habit of Consuming Snacks

Consuming snacks maintains energy levels before main meal time [47]. The habit of school-snacking occurs because 3-4 hours after breakfast, the individual feels hungry again [48]. Consumed snacks and energy contribution to the recommended adequacy are positively correlated [49]. Hawker food constitutes beverages, snacks, and full meals—defined as either ready-to-eat or pre-cooked meals at the point of sale—and sold either on the road or in public places [50].

Three-day estimated dietary records were kept for 194 white 3- and 4-year-old children to determine and evaluate the extent, nature, and quality of their snacking. Between-meal eating contributed more than one-third of the average day's energy and approximately one-quarter of most vitamins and minerals to the children's diets. Foods eaten between meals were, however, significantly less nutrient-dense than mealtime foods. Snacks purchased by children are generally fulfilling and rich both in energy and fat; however, these children are highly malnourished [51]. The nutritional value of hawker meals does not always satisfy the body's nutritional requirements [52].

3.9. Benefits of Midmorning Snacks and Milk to Height

During the 10-month non-intervention period, 8.3% (n =36) of the participants had their nutritional status changed from stunting to normal, meaning that without any intervention, about 90% of the participants would still be stunting. This could be due to different growth spurs. Furthermore, as seen here, a 1-month intervention was able to change 19.4% of participant statuses from stunting to normal.

Therefore, it is predicted that if the intervention is continued for up to 6 months, all participants could be able to improve their status from stunting to normal. This prediction was made based on the calculation that for one month, the intervention could reduce by 19.4%, so if the intervention was extended to 6 months, 19.4 x 6 = 116.4% (≈ 100%) became normal, meaning that all participants would have normal nutritional status.

The strength of this study is that the nutrition intervention activities provided to participants are relatively easy to be implemented because midmorning snacks and milk are sold around them, and the price is affordable and can be purchased with the pocket money given by their parents. Time before this research was conducted, they did not know about the types of food they should consume, how much, and when to consume them. Time after the research was conducted, they became aware of this and were able to meet their nutritional needs.

The nutrition intervention underwent only one month and did not continue for up to 6 months because the coronavirus that causes Covid-19 has infected Indonesia since March 2, 2020 as was conveyed by the President of the Republic of Indonesia; furthermore, the Ministry of Education and Culture of the Republic of Indonesia issued circular letter number 2 of 2020 regarding the prevention and handling of COVID-19, starting March 12, 2020, due to which learning activities in schools were stopped and online learning was administered.

This research should be conducted simultaneously between the group that was given the nutrition intervention and the group that was not given the nutrition intervention. However, due to limited research funding, the design became pre-nutrition intervention and post-nutrition intervention was given in the same school. As a suggestion, future research could be undertaken by having a control group of age-appropriate individuals with similar stunting for six months.

CONCLUSION

Calcium intake is crucial in avoiding adolescent stunting. The primary sources of calcium from snacks purchased by stunted adolescents were pastel, noodles, tofu, fritters, *pao*, tempeh, rice cake, and eclairs. These snacks, however, did not increase their nutritional status. As a result, midmorning snacks and calcium-fortified milk were supplied. The midmorning snack menu, which included *gado-gado*, fried vermicelli, *batagor*, *lontong medan*, sandwich, chicken porridge, and fried rice *teri* changed every day. The midmorning snack and a high-calcium milk intake increased the nutritional status of the participants. In order to prevent stunting, basic calcium sources such as midmorning snacks and high calcium milk must be eaten.

Providing intervention, such as midmorning snacks and milk, may be an alternative for the Indonesian government to reduce stunting rates. So far, no nutritional intervention has significantly increased the nutritional status of stunted children to normal levels; however, this type of intervention may become a viable option in the future.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Riau Polytechnic Ethics Committee Indonesia (Reference Number: LB.02.03/6/04/2019).

HUMAN AND ANIMAL RIGHTS

No animals were used in this study. All human procedures were followed in accordance with th World Medical Association Declaration of Helsinki-Ethical Principles for Medical Research.

CONSENT FOR PUBLICATION

The participants' parents signed informed consent before the research data was taken by the enumerator.

AVAILABILITY OF DATA AND MATERIALS

The data used in this research will not be shared as it contains personal information.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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