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# Efficacy of cookies made from iron-fortified cassava composite flour in adolescent girls

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*Eficacia de las galletas elaboradas con harina compuesta de yuca fortificada con hierro en niñas adolescentes*

Sri Anna Marliyati[1], Slamet Budijanto[2], Feri Kusnandar[2], Rokhani Hasbullah[3], Azroo Alfaqih Rojuli[2], Mutiara Putri Abiyoga[1]

[1]Department of Community Nutrition, [2]Department of Food Science and Technology, and [3]Department of Mechanical Engineering and Biosystems. Faculty of Agricultural Technology. IPB University. Bogor, Indonesia

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**Correspondence:** Sri Anna Marliyati. Department of Community Nutrition. Faculty of Human Ecology. IPB University. Bogor, Indonesia
e-mail: marliyati@apps.ipb.ac.id; anna_marliyati@yahoo.com

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**ABSTRACT**

**Introduction:** anaemia among adolescent girls remains quite high. According to data from the WHO, the global prevalence of anaemia ranges from 40 % to 88 %. In Indonesia, the prevalence of anaemia among those aged 5-14 years is 26.8 %, and 32 % among those aged 15-24 years. Anaemia is a medical condition in which haemoglobin levels are below normal. This condition may be caused by low iron intake or impaired iron absorption. The purpose of this study is to evaluate the efficacy of an intervention using iron-fortified cassava composite flour cookies for adolescent girls with anaemia.

**Methods:** the research design used a single-blind pre-post study conducted on adolescent girls in an Islamic boarding school, divided into control and intervention groups. It was carried out randomly on subjects per group 28, with a total of 56 subjects in the study. Results were obtained in a total of 43 subjects, 27 in the intervention group and 16 in the control group. The intervention was carried out for three months, with cookies provided once a week for consumption over a week. Subject characteristics and dietary patterns were obtained through a questionnaire. Haemoglobin levels and anthropometric measurements were obtained through direct measurements. Cookie consumption compliance was assessed based on a compliance form.

**Results:** there was a significant increase in in Z-score in both groups. The average haemoglobin level increased from baseline to middle line, with a significant difference observed in both groups ($p < 0.05$), but no significant difference between the groups ($p < 0.05$). All the macronutrient adequacy levels for most subjects were classified as severely deficient. The frequency of food intake across all food groups was generally low for all subjects. Cookies consumption compliance at middle line was significantly higher in the control group.

**Conclusion:** the ANCOVA test for haemoglobin levels indicated no significant difference between the groups. Covariate variables that influenced changes in haemoglobin levels were the percentage of cookie consumption compliance and baseline haemoglobin levels.

**Keywords**: Anaemia. Adolescent girls. Composite flour. Cookies. Haemoglobin.

**RESUMEN**

**Introducción**: la anemia entre las adolescentes sigue siendo bastante alta. Según datos de la OMS, la prevalencia global de la anemia oscila entre el 40 % y el 88 %. En Indonesia, la prevalencia de la anemia entre las edades de 5 a 14 años es del 26,8 %, y del 32 % entre las edades de 15 a 24 años. La anemia es una afección médica en la que los niveles de hemoglobina están por debajo de lo normal. Esta afección puede estar causada por una ingesta baja de hierro o una absorción deficiente del hierro. Este estudio se realizó para determinar la eficacia de una intervención mediante galletas de harina compuesta de yuca, fortificadas con hierro, en niñas adolescentes.

**Métodos**: el diseño de la investigación utilizó un estudio pre-post simple ciego, realizado en niñas adolescentes de un internado islámico, divididas en grupos de control e intervención. Las características de los sujetos y los patrones dietéticos se obtuvieron mediante un cuestionario. Los niveles de hemoglobina y las mediciones antropométricas se obtuvieron mediante mediciones directas. El cumplimiento del consumo de galletas se evaluó mediante un formulario de cumplimiento.

**Resultados**: hubo un aumento significativo del peso corporal en ambos grupos. El nivel promedio de hemoglobina aumentó desde el inicio hasta el nivel medio, observándose una diferencia significativa en ambos grupos ($p < 0,05$). Todos los niveles de adecuación de macronutrientes para la mayoría de los sujetos se clasificaron como gravemente deficientes. La frecuencia de la ingesta de alimentos en todos los grupos de alimentos fue generalmente baja en todos los sujetos. El cumplimiento del consumo de galletas en la línea media fue significativamente mayor en el grupo de control.

**Conclusión**: la prueba ANCOVA para los niveles de hemoglobina no indicó ninguna diferencia significativa entre ambos grupos. Las variables y covariables que influyeron en los cambios de los niveles de hemoglobina fueron el porcentaje de cumplimiento del consumo de galletas y los niveles iniciales de hemoglobina.

**Palabras clave**: Anemia. Niñas adolescentes. Harina compuesta. Galletas. Hemoglobina.



## INTRODUCTION

Good health and well-being are the third indicator of the Sustainable Development Goals (SDGs) aimed at achieving a high-quality nation. Anaemia is a common issue, particularly among women. The Indonesian Basic Health Research (Riskesdas) in 2018 reported that the prevalence of anaemia among children aged 5-14 years was 26.8 %, and 32 % in the 15-24 age group (1). Adolescent girls are a high-risk group for anaemia (2). This is due to rapid growth during this period, which increases the need for micronutrients such as iron and folic acid. The iron requirement for adolescent girls is higher than for boys due to blood loss during menstruation (3).

Providing supplementation of Iron Supplement Tablets in the form of Iron (60 mg $FeSO_4$) and 48 folic acid (0.25 mg) for pregnant women and women of reproductive age is one of the Ministry of Health's efforts to address anaemia. Since 1997, early intervention has been implemented for adolescent girls, but no significant decrease in the prevalence of anaemia in this group has been observed. This is due to the low compliance of women of reproductive age and adolescent girls in taking the iron supplement tablets. One of the strategies that can be implemented to reduce anaemia in adolescent girls is by providing iron-rich supplementary foods. Fermented cassava flour (FCF) is cassava flour that has been modified through a fermentation process, involving soaking in water and adding lactic acid bacteria cultures. The fermentation process by lactic acid bacteria does not significantly alter its chemical composition but improves its functional properties and organoleptic quality (4). FCF has better characteristics, such as a whiter colour, a more neutral taste, and properties similar to wheat flour. With its affordable price, FCF has the potential to compete with wheat flour (5). FCF is highly suitable as a raw material for making cookies (6), however its nutritional content cannot be equated with wheat flour, especially its low protein content.

Cookies are one of the products that are popular with all groups. Cookies are a type of biscuit made from soft dough, with a high fat content, crispy texture, and a less dense cut surface when broken (7). Efforts to increase the nutritional value of cookies can be made by combining raw materials with other types of flour in the form of composite flour and fortifying them to increase their micronutrient content, which can then be used for making cookies. The purpose of this study is to evaluate the efficacy of an intervention using iron-fortified cassava composite flour cookies for adolescent girls.



## METHODOLOGY

### Research design

This study is classified as experimental research using a single-blind pre-post study design. The subjects were divided into two treatment groups, a control group (given cookies made from non-composite cassava flour) and an intervention group (given cookies made from cassava composite flour). The grouping of subjects to treatments was carried out randomly (random assignment). The study was conducted at several female Islamic boarding schools in Bogor City, which lasted for three months starting from June to August 2024. The subjects selected met the inclusion criteria, which were: 1) adolescent girls aged 13-18 years; 2) had experienced menarche; 3) diagnosed with anaemia with haemoglobin levels ranging from 8.0 to 11.5 g/dL; 4) not suffering from chronic diseases, liver diseases, or blood disorders such as thalassaemia and haemophilia; 5) and are willing to participate in the study by signing the informed ascent form. The exclusion criteria for this study included adolescents with allergies to eggs, nuts, and fish. Before data collection, subjects were provided with information about the study and an informed ascent form signed by subjects and teacher. This study has passed the ethical review process for health-related research involving human subjects, with the document number: 1154/IT3.KEPMSM-IPB/SK/2024.

**Number and method of subject selection**

The subject selection technique used in this study was purposive sampling. The study was conducted by comparing the control and intervention treatments, so the sample size calculation was performed using a hypothesis test for two population means (two-sided test) (8). Based on the calculation, the number of subjects for each treatment group was 25. To account for potential loss to follow-up, this number was increased by 20 %, making the final number of subjects per group 28, with a total of 56 subjects in the study. The subjects of this study were junior and senior high school students from three Islamic boarding schools: Pondok Pesantren Tarbiyyatun Nisa for the intervention group and Pondok Pesantren Mafaza 1 and 2 for the control group. During the intervention, one participant from the intervention group withdrew, and 12 participants from the control group transferred schools and could no longer continue as study subjects, resulting in a total of 43 subjects: 27 in the intervention group and 16 in the control group.

**Research stages**

This study consisted of three stages: screening, baseline data collection, intervention, middleline data collection, and endline data collection. The screening stage involved recording the age and menarche status of potential subjects. The potential subjects were given an explanation about the study and asked for consent. Informed consent from their parents was not taken, but informed ascent was taken and signed by the subjects and their teacher as an application for permission. Those with haemoglobin levels ranging from 8.0 to 11.5 g/dL were included as research subjects. The baseline data collection stage included data collection on individual characteristics, dietary patterns, and nutritional status of the subjects. The intervention stage was conducted simultaneously in both control group and intervention group. The intervention was carried out for three months, with cookies provided once a week for consumption over the course of a week. Each subject received 16 pieces of cookies weighing 20 grams per piece to be consumed over 4 days in a week (4 pieces per day). One week before the intervention, the subjects in both groups were given Combantrin deworming tablets containing 250 mg of pyrantel pamoate. The deworming treatment aimed to eliminate confounding factors that could interfere with iron absorption (9). During the intervention stage, compliance with cookies consumption was also assessed weekly. The middleline data collection stage involved measuring the subjects' anthropometry and haemoglobin levels after 6 weeks of cookies consumption. The endline data collection stage included measuring haemoglobin levels, nutritional status, and food consumption to determine any changes after the intervention.

**Data collection**

Data collection was carried out through interviews using a questionnaire to determine the characteristics of the subjects (age and pocket money). Food consumption data were collected using a

2 x 24-hour food recall questionnaire. Dietary patterns were assessed using a Food Frequency Questionnaire (FFQ). The nutritional status of the subjects was analysed based on their body mass index (BMI) for age. Anthropometric data were obtained by directly measuring the subjects' height and weight using a portable stature meter Seca 213 (Hamburg, Germany) and digital scale Camry EB9003 (Tsuen Wan, N.T., Hongkong). Subjects' nutritional status was determined based on Body Mass Index for Age (BMI/A) using body weight, height, and age of subjects. The result of BMI calculation compared according to age by referring to BMI standard by age (BMI/A) with Z-score calculation. Haemoglobin data were collected using the cyanmethaemoglobin method with a HemoCue 201 device (Ängelholm, Sweden). Compliance with cookies consumption was obtained by subjects filling out a questionnaire consisting of the number of remaining cookies in a week independently and the questionnaire was collected every week.

**Statistical analysis**

Statistical analysis was conducted using IBM SPSS Statistics version 21.0 (IBM Corp, Armonk, New York, USA) software. The data are presented as mean ± standard deviation (SD). The differences in variables between the control and intervention groups were determined using an independent t-test, while the differences in variables before and after the intervention were analysed using a paired-dependent t-test. Statistical significance was tested at $p < 0.05$. The efficacy of providing cookies made from cassava composite flour fortified with iron on anaemia status and anthropometric measures in adolescent girls was analysed using ANCOVA.

## RESULTS

**Subject characteristics**

In this study, there were 43 subjects, consisting of 27 subjects in intervention group and 16 subjects in control group. The characteristics of the subjects, including age and pocket money, are presented in table I. There was a significant difference in age between control and intervention groups, which may be due to the different age ranges in each group. The control group was dominated by subjects aged 16-18 years (69.3 %), while intervention group mainly included those aged 13-15 years (70.4 %). There was no significant difference in pocket money between the two groups.

**Subject anthropometry**

The anthropometric measurements of subjects were taken at both the baseline and endline data collection. There was an average increase in body weight in both subject groups after the intervention. There was an average increase in Z-score in both subject groups after the intervention, but a significant increase was found only in the intervention group. After intervention (at endline), the intervention group's Z-score was significantly higher than the control group's ( -0.05 vs. -0.13). At baseline and endline, in all groups, Z-scores were classified into the normal nutrition category (Table II).



**Haemoglobin levels**

Haemoglobin levels were measured at baseline, middleline, and endline. Table II presents the changes in haemoglobin levels for both subject groups. There was no significant difference in haemoglobin levels between the control and intervention groups at baseline and endline. From baseline to middleline, the average haemoglobin increased by 0.8 g/dL in the control group and by 0.4 g/dL in the intervention group, with a significant difference between the two groups. By endline data collection, there were no significant changes in haemoglobin levels in either the control or intervention groups (Table II).

**Cookies consumption compliance**

Cookies consumption compliance was assessed based on the total number of cookies consumed during the intervention period. The total number of cookies that should have been consumed during the intervention period was 192 cookies. The average number of cookies consumed by the control group was higher than the intervention group. There was a decrease in the percentage of compliance in cookies consumption in the control group at the middleline (the decrease was 4.1 %) and endline (the decrease was 4.6 %). Meanwhile, for the intervention group, there was an increase in the percentage of compliance in cookies consumption at the middleline (2.7 %), but decreased at the endline (1.3 %). There was a significant difference in the level of compliance in cookies consumption at the middleline between the two groups (Table III).

**Nutritional intake and adequacy levels**

The energy and nutrient adequacy levels of most subjects were classified as severely deficient (< 80 %) at both baseline and endline. There was no significant difference in nutrient intake and adequacy levels between the two groups of subjects in the baseline except for Iron adequacy level. The iron adequacy level of intervention group was higher than the control group. There was a tendency for higher energy and macronutrient intake in the intervention group compared to the control group. Energy intake and adequacy level at endline in both groups tend to increase compared to baseline as well as macronutrient intake for fat and carbohydrate, but decreased for protein. There was a significant difference in fibre and vitamin C intake between the control and intervention groups at endline. The intake of fibre and vitamin C in control group was higher than in the intervention group, but both were still classified as deficits (Table IV).

**Frequency of food consumption**

The frequency of food consumption of subjects was assessed based on the frequency of various food groups consumed. There was a significant difference in the frequency of food consumption at baseline for the animal protein, plant-based protein, vegetable, fruit, and supplement food groups between control and intervention groups. At the endline, there was no significant difference in the frequency of food consumption for all food groups between the two groups (Table V). The frequency of food consumption of subjects for all food groups was mostly classified as rare. In the control group, there was a tendency to decrease in the average frequency of consumption for the animal protein, plant-based protein, vegetable, fruit, beverage, and supplement food groups between baseline and endline, while there was a tendency to increase for the grain and snack groups, but not significantly. In the intervention group, there was a tendency to increase in the average frequency of food consumption for plant-based protein, grains, fruit and snack group between baseline and endline, while there was a tendency to decrease for animal protein, vegetables, snacks, beverages, and supplements.

## DISCUSSION

Efficacy of cookies made from iron-fortified cassava composite flour can be evaluated based on several parameters, such as nutritional status (Z-score), and haemoglobin levels. Table II shows an average increase in Z-score in both subject groups after the intervention, but a significant increase was found only in the intervention group. Z-score in all groups was classified into the normal nutrition category. The intervention group's Z-score was significantly higher than the control group's (-0.05 vs. -0.05). Covariate variables included at baseline were body weight, cookies consumption, nutritional status (BMI-for-age), and nutrient intake. The only covariate variable that had a significant effect at baseline was body weight. Adjusted ANCOVA for body weight showed no significant difference between the control and intervention group, indicating that the difference in Z-score was due to the intervention applied.

Results of the ANCOVA test of haemoglobin levels showed no significant difference between control and intervention groups at baseline and endline. Covariate variables affecting haemoglobin level changes included the percentage of compliance of cookies consumption and baseline haemoglobin levels. Previous experimental studies on iron supplementation have shown that initial haemoglobin levels affect Hb changes, considering confounding variables such as BMI, compliance, percentage of daily energy and protein requirements, and iron intake (10). Other studies have also indicated that initial haemoglobin levels have a significant impact on changes in haemoglobin levels after intervention (11). In this study, cookies fortification did not have a significant effect on Hb changes in subjects. This may be due to the low retention of fortificants during the cookies making process, resulting in a final dosage that did not match the initial design. Additionally, the short intervention period may have prevented of haemoglobin levels changes. According to Nestel and Davidson (2004), the lack of efficacy in iron supplementation studies may be influenced by insufficient iron dosage, compliance levels, intervention duration, periods of high nutrient demand, and nutrient deficits (12). Table II shows that control group also have an increase in haemoglobin levels. This may be due to the control (placebo) cookies provided to control group, which were made from wheat flour containing iron fortificants. Indonesia enforces a mandatory standard for wheat flour fortification, as specified in SNI 3751-2009, with minimum additions of 50 mg/kg iron, 30 mg/kg zinc, 2.5 mg/kg vitamin B1, 4 mg/kg vitamin B2, and 2 mg/kg folic acid. Research by Rachmalia, Kusumawardani and Mubasyiroh (13) indicated that the highest change in haemoglobin levels occurred in groups consuming wheat flour products three or more times per week. Compliance of cookies consumption during the intervention period was higher in the control group (91.3 ± 8.3) compared to the intervention group (86.9 ± 8.5). Low compliance in the intervention group may be due to taste differences between control and intervention cookies. Intervention group cookies had a cassava aroma and have sour aftertaste. These flavour and aroma characteristics may have resulted from the fermentation process that produces lactic acid in the mocaf (modified cassava flour) used as one of the main ingredients in the intervention cookies (14). This different with control cookies, which were made from wheat flour and had a more similar taste to commercially cookies, so the consumption compliance was higher.

Adolescents have high nutritional needs because they are still in a growth phase. Additionally, their physical activity level is higher compared to other age groups, which requires increased nutrient intake. The energy and nutrient adequacy levels for most of the subjects were categorized as deficient (< 80 %) compared to the National adequacy Rates for Adolescents in Indonesia. There was no significant difference in energy intake between control and intervention groups at baseline and endline. The low nutrient intake was attributed to portion sizes that did not meet their needs or low nutritional quality. Most subjects were common to eat less than three times a day with portions that did not meet nutritional requirements. Additionally, subjects sometimes skipped meals, especially breakfast and dinner, due to busy schedules or boredom with the available food options. High activity levels may also contribute, as subjects tend to pay less attention to the food that they consumed (15). Protein intake in control and intervention group was classified as deficient and decreased in endline. There was a trend of higher protein intake in the intervention group compared to the control group, though it was not significant. Most subjects rarely consumed animal and plant-based proteins (1-2 times per week). Low levels of protein intake can obstruct iron transport, which can increase the risk of anaemia in adolescents (16).

Fat intake in control and intervention group was classified as deficient in baseline but increased in endline. The increase in fat intake tended to be higher in the intervention group, reaching a level that generally met daily fat requirements by endline. This may be due to subjects consuming more fried snacks. There was no significant difference in fat intake between two groups at baseline and endline. Low-fat intake among most subjects was due to meals that rarely contained fat-rich ingredients. Additionally, cooking methods can influence fat intake, with foods more often stir-fried or prepared in broth. These findings are consistent with Nurlabibah et al. (15), who reported that most subjects' fat intake was low due to meals that prepared by stir-frying method.

Carbohydrate intake in both groups was classified as low but increased in endline. There was a trend of higher carbohydrate intake in the intervention group compared to the control group, but it was not significant. Most subjects consumed carbohydrate-rich foods, primarily rice, less than three times per day and frequently skipped meals, especially breakfast. The portion of rice consumed by subjects was also generally small, as the portion standards set by the boarding school did not meet students' daily nutritional needs, contributing to a deficit in carbohydrate adequacy (17).

Fibre and vitamin C intake in both subject groups were classified as low. This low intake of fibre and vitamin C was due to subjects' general dislike of vegetables and fruits, resulting in infrequent consumption. Subjects tended to prefer meals combining rice with side dishes rather than including vegetables. Additionally, the infrequent availability of fruit may also contribute to the fibre and vitamin deficiencies observed in both groups. This aligns with research by Camila et al. (18), which found that adolescent fibre intake tends to be deficient due to low vegetable and fruit consumption. Adolescents are also inclined to prefer snacks that are flavourful, high in sugar and salt, and low in nutrients. There was a significant difference in fibre and vitamin C intake between the two groups. The control group tended to consume vegetables and fruits more frequently than the intervention group. This was influenced by differences in vegetable and fruit availability across boarding schools. A lack of vitamin C intake can impact the incidence of anaemia in adolescents, as vitamin C can increase the absorption of non-heme iron by up to four times (16).

Iron intake in both subject groups was classified as low. There was a significant difference in iron intake between the two groups at baseline, with the intervention group have a higher level of iron adequacy than the control group. The iron adequacy level in the control group increased at endline, whereas it decreased in the intervention group. This low iron intake may be attributed to subjects' low protein intake. Subjects tended to consume plant-based protein sources (tofu and tempeh) more often than animal protein. The absorption rate of iron from plant-based protein sources is typically lower (1-2 %), which can lead to reduced haemoglobin levels and anaemia (16). The frequency of food intake in both groups was generally low. The average frequency of animal protein consumption in both groups was also low. Based on FFQ interview results, the animal proteins that most frequently consumed by subjects were eggs and chicken. Animal protein such as beef was only provided on special events such as Eid Al-Adha. There was a significant difference in the frequency of animal protein consumption between two groups at baseline, with the control group consuming animal protein more frequently than the intervention group. Based on recall results, animal protein in the control group’s meals was more often included as part of mixed dishes or as a side addition. Protein plays a role in transporting iron to the bone marrow for haemoglobin formation (19). The study by Yanti et al. (2024) found that protein intake among adolescent girls, particularly from red meat and liver was insufficient, potentially increasing the risk of anaemia. The frequency of plant-based protein intake was higher than animal protein intake in both groups. Tofu and tempeh were the most frequently consumed plant-based proteins. Research by Camilia et al. (2023) indicated that tempeh and tofu are the most used plant-based protein sources in boarding school meal menu. There was a significant difference in the frequency of plant-based protein consumption between two groups at baseline, with the control group showing a higher frequency of plant-based protein intake than the intervention group.

The frequency of vegetable and fruit consumption in both groups was generally low. The most frequently consumed vegetables and fruits were carrots, tomatoes, and oranges. The low frequency of vegetable and fruit intake among subjects may be due to the majority's dislike of vegetables and the infrequent availability of fruits in the students' meal menu. According to Nurwanti et al. 20), adolescent girls tend to consume fruits and vegetables less than five times a week. Vitamin C in green vegetables and fruits can aid in preventing anaemia by altering the form of iron to enhance iron absorption in the body (16). There was a significant difference in the frequency of vegetable and fruit consumption between control and intervention groups at baseline, with the control group consuming vegetables and fruits more frequently than the intervention group. According to recall results, the control group's fruit intake was often supplemented by fruits brought by families during visiting times, outside of the boarding school menu.



## CONCLUSION

The results of the ANCOVA test showed that providing cookies made from iron-fortified cassava composite flour affected nutritional status in adolescent girls. The intervention group's nutritional status (Z-score) was significantly higher than the control group. Meanwhile, this intervention had no significant effect on haemoglobin levels. The haemoglobin levels in the control group were not significantly different from those in the intervention group at both baseline and endline. The covariate variables that influenced changes in haemoglobin levels were the percentage of cookie consumption compliance and baseline haemoglobin levels.

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Table I. Subject characteristics

| **Characteristics** | **Control group** | **Intervention group** | ***p*-value** |
|---|---|---|---|
| | ***n* ( %)** | ***n* ( %)** | |
| Age | | | |
| 13-15 | 4 (30.7) | 19 (70.4) | 0.001* |
| 16-18 | 9 (69.3) | 8 (29.6) | |
| Mean ± SD | 16.2 ± 1.6 | 14.3 ± 1.4 | |
| Pocket money (Rp) | | | |
| Mean ± SD | 297058.8 ± 109645.1 | 302777.8 ± 9017.6 | 0.859 |

*$p < 0.05$

Table II. Subject's Z-score and haemoglobin changes

| **Parameter** | **Control group Mean ± SD** | **Intervention group Mean ± SD** | ***p*-value[a]** |
|---|---|---|---|
| *Z-Score (IMT/U)* | | | |
| Baseline | 0.45±1.19 | 0.57±1.14 | 0.053 |
| Endline | -0.13±1.1 | -0.05±1.1 | <0.001* |
| Δ | -0.58±0.7 | -0.62±0.15 | 0.606 |
| *p-value*[b] | 0.05 | 0.00* | |
| Adjusted ANCOVA[c] | | | 0.283 |
| *Height (cm)* | | | |
| Baseline | 154.4 ± 4.2 | 154.4 ± 4.4 | 0.697 |
| Endline | 154.4 ± 4.3 | 153.9 ± 4.6 | 0.725 |
| Δ | 0.0 ± 0.8 | -0.5 ± 0.6 | 0.306 |
| *p*-value[b] | 0.846 | 0.490 | |
| *Haemoglobin (g/dL)* | | | |
| Baseline | 11.6 ± 1.2 | 11.6 ± 0.9 | 0.722 |
| Middleline | 12.4 ± 1.3 | 12.0 ± 1.3 | 0.663 |
| Endline | 11.9 ± 0.9 | 11.6 ± 1.2 | 0.581 |
| Δ (Middle-Base) | 0.8 ± 1.2 | 0.4 ± 1.1 | 0.615 |
| Δ (End-Middle) | -0.5 ± 0.8 | -0.4 ± 1.2 | 0.821 |
| Δ (End-Base) | 0.3 ± 1.2 | 0.0 ± 1.2 | 0.537 |
| *p*-value[b] (Middle-Base) | 0.017* | 0.049* | |
| *p*-value[b] (End-Middle) | < 0.001* | 0.077 | |
| *p*-value[b] (End-Base) | 0.406 | 0.987 | |
| Adjusted ANCOVA[c] | | | 0.430 |

[a]Mann Whitney; [b]Paired *t*-test; [c]ANCOVA; *$p < 0.05$.

Table III. Compliance cookies consumption

| **Cookies consumption** | **Control group** | **Intervention group** | ***p*-value [a]** |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| Consumption amount (pcs) | 175.2 ± 15.7 | 166.7 ± 16.2 | 0.083 |
| Compliance cookies consumption in middle-base ( %) | 95.9 ± 7.9 | 85.5 ± 9.4 | < 0.001* |
| Compliance cookies consumption in end-middle ( %) | 91.8 ± 8.5 | 88.2 ± 7.5 | 0.301 |
| Compliance cookies consumption in end-base ( %) | 91.3 ± 8.3 | 86.9 ± 8.5 | 0.083 |

[a]Independent sample *t*-test. *$p < 0.05$.

Table IV. Intake and nutrition adequacy level of subjects

| **Nutrients** | **Food consumption** | **Baseline** | | | **Endline** | | |
|---|---|---|---|---|---|---|---|
| | | **Control** | **Intervention** | ***p*-value**[a] | **Control** | **Intervention** | ***p*-value**[a] |
| | | *Mean ± SD* | | | *Mean ± SD* | | |
| Energy | Intake (kkal) | 891 ± 309 | 967 ± 356 | 0.615 | 1061 ± 271 | 1111 ± 425 | 0.841 |
| | Adequacy level ( %) | 52.8 ± 18.4 | 61.6 ± 23.5 | 0.366 | 63 ± 15.2 | 69.6 ± 23.9 | 0.505 |
| Protein | Intake (g) | 34.9 ± 13.9 | 34.0 ± 12.8 | 0.624 | 33.2 ± 9.8 | 34.3 ± 12.3 | 0.890 |
| | Adequacy level ( %) | 54.9 ± 20.9 | 57.7 ± 22.1 | 0.990 | 52.2 ± 15.1 | 57.3 ± 18.1 | 0.530 |
| Fat | Intake (g) | 33.5 ± 16.0 | 34.3 ± 22.3 | 0.870 | 37.5 ± 12.2 | 43.8 ± 21.5 | 0.580 |
| | Adequacy level ( %) | 59.6 ± 28.8 | 65.3 ± 43.7 | 0.850 | 66.3 ± 20.8 | 82.2 ± 37.2 | 0.263 |
| Carbohydrate | Intake (g) | 112.9 ± 48.9 | 128.5 ± 60.0 | 0.498 | 144.7 ± 42 | 148.2 ± 64.1 | 0.821 |
| | Adequacy level ( %) | 48.7 ± 21.5 | 59.6 ± 28.9 | 0.280 | 62.1 ± 17.4 | 67.6 ± 26.9 | 0.615 |
| Fibre | Intake (g) | 4.3 ± 2.3 | 3.2 ± 2.1 | 0.074 | 5.0 ± 2.4 | 3.5 ± 2.4 | < 0.001* |
| | Adequacy level ( %) | 12.0 ± 6.1 | 10.6 ± 7.3 | 0.358 | 13.6 ± 6.7 | 11 ± 7.1 | 0.124 |
| Vit C | Intake (g) | 8.3 ± 6.5 | 14.9 ± 20.7 | 0.538 | 19.2 ± 12.3 | 10.8 ± 9.1 | 0.022* |
| | Adequacy level ( %) | 9.0 ± 7.0 | 20.3 ± 29.9 | 0.178 | 21.1 ± 13.4 | 14.3 ± 11.3 | 0.092 |
| Iron | Intake (g) | 3.5 ± 1.6 | 4.3 ± 2.0 | 0.171 | 4.7 ± 2.1 | 4.0 ± 1.9 | 0.243 |
| | Adequacy level ( %) | 18.6 ± 8.2 | 27.7 ± 14.4 | < 0.001* | 25.1 ± 10.6 | 24.9 ± 11.0 | 0.811 |

[a] Mann-Whitney test.

Table V. Food frequency of subjects

| Food group | Food frequency | Baseline | | | Endline | | |
|---|---|---|---|---|---|---|---|
| | | Control | Intervention | p-value[a] | Control | Intervention | p-value[a] |
| | | n ( %) | n ( %) | | n ( %) | n ( %) | |
| Animal protein | Rarely | 16 (100) | 26 (96.3) | < 0.001* | 16.0 (100) | 27.0 (100) | |
| | Sometimes | 0 (0) | 1 (6.3) | | 0.0 (0) | 0.0 (0) | |
| | Often | 0 (0) | 0 (0) | | 0.0 (0) | 0.0 (0) | |
| | Mean ± SD | 1.13 ± 0.33 | 0.65 ± 0.33 | | 0.79 ± 0.38 | 0.63 ± 0.28 | 0.221 |
| Plant-based protein | Rarely | 11 (68.8) | 26 (96.3) | < 0.001* | 13.0 (81.3) | 23.0 (85.2) | |
| | Sometimes | 5 (31.3) | 1 (3.7) | | 3.0 (18.8) | 4.0 (14.8) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 1.77 ± 0.78 | 1.12 ± 0.75 | | 1.5 ± 0.82 | 1.39 ± 0.75 | 0.789 |
| Vegetable | Rarely | 16 (100) | 27 (100) | < 0.001* | 16 (100) | 27 (100) | |
| | Sometimes | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 1.15 ± 0.49 | 0.81 ± 0.54 | | 0.80 ± 0.33 | 0.59 ± 0.43 | 0.112 |
| Fruit | Rarely | 16 (100) | 27 (100) | < 0.001* | 16 (100) | 27 (100) | 0.380 |
| | Sometimes | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 0.44 ± 0.33 | 0.19 ± 0.32 | | 0.41 ± 0.37 | 0.29 ± 0.21 | |
| Grains | Rarely | 13 (81.3) | 25 (92.6) | 0.005 | 11.0 (68.8) | 26.0 (96.3) | 0.197 |
| | Sometimes | 3 (18.8) | 2 (7.4) | | 5.0 (31.3) | 1.0 (3.7) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 1.81 ± 0.42 | 1.44 ± 0.38 | | 2.03 ± 0.85 | 1.65 ± 0.45 | |
| Snack | Rarely | 16 (100) | 26 (96.3) | 0.473 | 16 (100) | 27 (100) | 0.051 |
| | Sometimes | 0 (0) | 1 (3.7) | | 0 (0) | 0 (0) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 0.71 ± 0.67 | 0.57 ± 0.65 | | 0.78 ± 0.65 | 0.41 ± 0.48 | |
| Beverage | Rarely | 12 (75.0) | 21 (77.8) | 0.350 | 15.0 (93.8) | 26.0 (96.3) | 0.518 |
| | Sometimes | 4 (25) | 6 (22.2) | | 1.0 (6.3) | 1.0 (3.7) | |
| | Often | 0 (0) | 0 (0) | | 0 (0) | 0 (0) | |
| | Mean ± SD | 1.59 ± 0.78 | 1.38 ± 0.94 | | 1.03 ± 0.77 | 0.88 ± 0.65 | |
| Supplement | Rarely | 9 (56.3) | 26 (96.3) | < 0.001* | 15.0 (93.8) | 26.0 (96.3) | 0.089 |
| | Sometime | | | | | | |

*$p < 0.05$. [a]Mann-Whitney test.