MINH
MALAHAYATI INTERNATIONAL JOURNAL OF NURSING AND HEALTH SCIENCE
ISSN 2620-9152 (Print)
ISSN 2621-4083 (Online)
DOI: 10.33024
Nomor: 79/E/KPT/2023

ARTICLE INFORMATION
Received: August, 21, 2026
Revised: October, 20, 2026
Available online: October, 23, 2026
at : https://e-jurnal.iphorr.com/index.php/minh

# Changes in hemoglobin (Hb), hematocrit (Hct), and random blood glucose (RBG) levels before and after the GEMPITA breakfast program

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**Abstract**

**Background:** The joint breakfast movement (*Gerakan Mangande Padondo Ante Kita)*, known as GEMPITA, is a program of the Central Sulawesi Provincial Health Office aimed at improving the nutritional status of school-aged children in Palu City.
**Purpose:** To examine changes in hemoglobin (Hb), hematocrit (Hct), and random blood glucose (RBG) levels following a 4 weeks breakfast intervention at Junior High School (SMP) 22 Pantoloan, Palu City.
**Method:** This was a pre-experimental study using a one-group pretest posttest design involving all students of SMP 22 Pantoloan. Hb, Hct, and RBG were measured using a Fora 6 Plus point of care testing (POCT) device. Of 111 enrolled students, only 35 paired blood samples met the inclusion criteria and were analyzed before and after the 4 weeks breakfast intervention.
**Results:** Paired t-test analysis of the 35 samples showed no statistically significant change in Hb or Hct levels before and after the 4 weeks intervention, whereas RBG levels changed significantly ($p<0.05$).
**Conclusion:** A significant change in RBG level was observed before and after the GEMPITA program, while no significant change was observed in Hb or Hct levels.

**Keywords: GEMPITA; Hematocrit; Hemoglobin; Random Blood Glucose.**

## INTRODUCTION

The joint breakfast movement or *Gerakan Mangande Padondo Ante Kita* (GEMPITA), is a program of the Health Office of Central Sulawesi Province designed to improve child nutrition and to promote the GEMPITA healthy-nutrition kiosk innovation in schools across Palu City. This activity is a pilot project providing free breakfast for 30 days to students of Junior High School (SMP) 22 Pantoloan. Breakfast provision is regarded as an important contributor to improving students' academic performance (Ariany et al., 2023; Health Office of Central Sulawesi Province, 2023).

The GEMPITA intervention was implemented over 4 weeks using a 5-day rotating menu cycle. Breakfast was served before 10:00 a.m., with an average energy content of approximately 500 kcal per serving. The day one menu consisted of steamed white rice, fish with green sambal, clear spinach soup, carrots, and fried tofu. The day two menu consisted of steamed white rice, meatball soup, sponge gourd, and corn fritters. The day three menu consisted of steamed white rice, battered fried chicken with tomato sauce, and stir-fried cauliflower with carrots. The day four menu consisted of steamed white rice, vegetable omelet, soy-braised tempeh, and stir-fried water spinach. The day five menu consisted of steamed white rice, minced chicken in sweet-and-sour sauce, mixed stir-fried vegetables, and fried tempeh (Ariany et al., 2023).

DOI: https://doi.org/10.33024/minh.v9i8.4393

Hemoglobin is a protein found in red blood cells that functions as the primary oxygen carrier throughout the body and gives blood its red color. The normal hemoglobin value in adolescents ranges from 12 to 16 g/dL. Hemoglobin level is frequently associated with a person's concentration ability; the lower an individual's hemoglobin level, the more difficult it becomes to concentrate (Aridya & Yuniarti, 2023; Hardiansyah et al., 2013; Rahmy et al., 2022; Sadiman et al., 2020; Sari et al., 2021). Hematocrit represents the percentage of red blood cell volume in whole blood. The hematocrit value is clinically important because it can be used to detect anemia and other conditions related to red blood cell counts, and it can also help verify the accuracy of hemoglobin measurements (Aridya & Yuniarti, 2023; Khalida et al., 2016; Purbasari et al., 2023; Kartika & Anggarini, 2020; Sadiman et al., 2020; Sari et al., 2021).

Anemia is a condition in which hemoglobin levels fall below normal. Adolescence is a period of rapid physical, cognitive, and psychosocial change, during which sexual maturation occurs due to endocrine maturation. Physical maturation is also accompanied by changes in body composition. During this period, nutritional needs increase, which can predispose adolescents to anemia caused by nutrient deficiencies such as iron and folic acid (Aridya & Yuniarti, 2023; Hardiansyah et al., 2013; Purbasari et al., 2023; Rahmy et al., 2022; Sadiman et al., 2020).

Glucose is an essential nutrient that serves as the body's main energy source. It is derived from carbohydrates and proteins broken down by the digestive system before entering the bloodstream. Optimal blood glucose levels support learning achievement and cognitive function, and adequate nutrition can enhance cognitive performance and academic achievement. However, excessive blood glucose is also detrimental to health. Random blood glucose (RBG) testing measures blood sugar level in patients who are not fasting. This test can be performed at any time and is frequently used to detect diabetes and hypoglycemia in students (Warastuti, & Sudartik, 2023; Cholifah & Azizah, 2016; Primadiyanti et al., 2020; Hikmah et al., 2023).

Research evaluating changes in hemoglobin, hematocrit, and random blood glucose levels following 4 weeks of breakfast provision remains very limited. However, a study on the relationship between breakfast habits, hemoglobin levels, and learning concentration reported a significant association ($p<0.05$) (Mustofa & Rusmini, 2014). Similarly, a study on the effect of breakfast frequency on anemia status found a significant effect ($p<0.05$), with an odds ratio (OR) of 1.75, indicating that less frequent breakfast consumption was associated with a higher risk of anemia (Kartika & Anggarini, 2020). These findings motivated the present study, which aimed to evaluate changes in Hb, Hct, and RBG levels following 4 weeks of breakfast provision at SMP 22 Pantoloan, Palu City.

Globally, evidence regarding the impact of school feeding programs on hemoglobin levels remains mixed and inconsistent. A systematic review and meta-analysis of school feeding programs among children and adolescents in low and middle income countries found that, overall, such interventions did not produce a statistically significant effect on hemoglobin levels over observation periods of up to 12 months, although results varied across studies depending on intervention duration, menu energy density, and the baseline nutritional status of the study population (Wang et al., 2021). This finding provides important context, suggesting that the non-significant changes in Hb and Hct observed in the present study are consistent with the broader pattern reported for short- to medium-duration feeding interventions.

## RESEARCH METHOD

This study employed a pre-experimental, one-group pretest posttest design, with a target sample of capillary blood from 111 adolescent students at SMP 22 Pantoloan, Palu City, Central Sulawesi, before and after 4 weeks of breakfast provision. Breakfast menus were prepared by a nutritionist and were identical for all students on any given day, with the menu varying daily. Three laboratory parameters were assessed before and after the breakfast intervention: hemoglobin (Hb), hematocrit (Hct), and random blood glucose (RBG), using a Fora 6 Plus point of care testing (POCT) device. The study was conducted between September and October 2023.

Of the 111 students of SMP 22 Pantoloan enrolled, only 35 samples could ultimately be analyzed. This attrition occurred because (1) some students were absent during one or more of the 4

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weeks of breakfast provision, and (2) some students were absent at the time of blood sampling. These students were therefore excluded from the final analysis.

Data normality was assessed using the Shapiro-Wilk test (appropriate given a sample size <50). As the pre- and post-intervention data were obtained from the same (paired) subjects and were normally distributed, differences in Hb, Hct, and RBG levels before and after the intervention were analyzed using the paired t-test. A p-value <0.05 was considered statistically significant.

## RESEARCH RESULTS

Of the target sample of 111 students of SMP 22 Pantoloan who received the free breakfast intervention provided by a nutritionist, only 35 samples could be analyzed. This reduction occurred because a substantial number of participants did not meet the inclusion criteria at the time of post-intervention Hb, RBG, and hematocrit sampling. The descriptive analysis of these samples is presented in Table 1.

**Table 1. Descriptive Analysis of Study Variables (N=35)**

| Variable | Min-Max | Mean/Median | SD | p-value* |
|---|---|---|---|---|
| **Hemoglobin (Hb)** | | | | |
| **Pre** | 7.1-15.9 | 12.011/12.50 | 2.519 | p = 0.259 |
| **Post** | 7.8-15.3 | 11.014/11.90 | 1.775 | p = 0.808 |
| **Random Blood Glucose (RBG)** | | | | |
| **Pre** | 75-119 | 92.6/89.0 | 11.815 | p = 0.009 |
| **Post** | 72-138 | 101.314/98.0 | 14.171 | p = 0.408 |
| **Hematocrit (Hct)** | | | | |
| **Pre** | 21-47 | 35.49/37.0 | 7.418 | p = 0.275 |
| **Post** | 23-45 | 35.14/35.0 | 5.225 | p = 0.812 |

*Units: Hb in g/dL, RBG in mg/dL, Hct in %. Data normality tested using the Shapiro-Wilk test.

Based on the descriptive analysis of the 35 students' samples, the mean hemoglobin (Hb) level before breakfast provision was 12.011 g/dL (range 7.1-15.9 g/dL), and the mean Hb level after 4 weeks of breakfast provision was 11.014 g/dL (range 7.8-15.3 g/dL). The mean random blood glucose (RBG) level before breakfast provision was 92.6 mg/dL (range 75-119 mg/dL), and the mean RBG level after 4 weeks of breakfast provision was 101.3 mg/dL (range 72-138 mg/dL). The mean hematocrit (Hct) level before breakfast provision was 35.49% (range 21-47%), and the mean Hct level after 4 weeks of breakfast provision was 35.14% (range 23-45%).

**Table 2. Analysis of Changes in Hb, RBG, and Hct Levels**

| Variable | Before | | After | | Change | | p-value* |
|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | |
| **Hb** | 12.011 | 2.519 | 11.014 | 1.775 | 0.097 | 2.579 | 0.825 |
| **RBG** | 92.600 | 11.815 | 101.314 | 14.171 | -8.714 | 17.058 | 0.005 |
| **Hct** | 35.486 | 7.418 | 35.143 | 5.225 | 0.343 | 7.600 | 0.791 |

*Paired t-test.

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Based on the results shown above, the paired t-test analysis of the 35 samples showed no statistically significant change in hemoglobin (Hb) or hematocrit (Hct) levels before and after 4 weeks of breakfast provision. However, a statistically significant change in random blood glucose (RBG) level was observed before and after 4 weeks of breakfast provision ($p<0.05$).

## DISCUSSION

The present study found no significant change in hemoglobin and hematocrit levels before and after 30 days of breakfast provision ($p=0.825$ and $p=0.791$, respectively), whereas a significant change was observed in random blood glucose level ($p=0.004$).

The absence of a significant change in hemoglobin level before and after the 4 weeks breakfast intervention, together with the unchanged hematocrit level, contrasts with the theoretical expectation that breakfast provision increases hemoglobin and hematocrit levels. This finding also contrasts with the study on the effect of breakfast on hemoglobin level, which found a significant association between breakfast frequency and hemoglobin level ($p<0.05$, logistic regression), with an OR of 1.75, indicating that less frequent breakfast consumption was associated with a greater risk of anemia (Kartika & Anggarini, 2020). Consistent with this, a cross-sectional study among Indonesian elementary school children also reported an association between breakfast habits and both hemoglobin level and nutritional status, although the observational design of that study could not establish causality in the way the pre-post design of the present study can (Utama et al., 2018). The lack of significant change in Hb and Hct is likely related to the relatively short duration of the intervention. The average erythrocyte lifespan is approximately 100–120 days; therefore, a 4 weeks nutritional intervention may not have been sufficient to produce a measurable effect on erythrocyte-related parameters such as Hb and Hct, even with adequate daily iron intake. This estimated erythrocyte lifespan is consistent with hematological literature reporting a normal erythrocyte lifespan range of 70–140 days, averaging approximately 115 days, meaning that changes in erythrocyte composition resulting from short-term nutritional intervention may only become laboratory detectable after several turnover cycles have been completed (Franco, 2012). This is consistent with the findings of a meta-analysis of school feeding programs in developing countries, which found no significant effect on hemoglobin levels over evaluation periods of up to 12 months, as well as with an intervention study of breakfast and nutrition education among students at an Islamic boarding school in Indonesia, which only observed a significant increase in hemoglobin level after 9 months of intervention (Rimbawan et al., 2023). Taken together, the 4-week duration of the present study is likely the primary factor explaining the non-significant changes in Hb and Hct, rather than an indication that the GEMPITA program provides no benefit to students' hematological status. Another possible contributing factor is that not all students consumed the entire menu provided by the nutritionist over the 4 weeks; some may not have eaten the vegetables or side dishes served, which may explain why no significant change in hemoglobin or hematocrit level was observed in this study (Adelman, 2019; Appiah et al., 2023; Khalida et al., 2016; Sekiyama et al., 2017).

In contrast, the change in random blood glucose level before and after 4 weeks of breakfast provision was statistically significant. This finding is consistent with the study on the relationship between breakfast habits and blood glucose level in adolescent girls in Semarang, which found a strong association between breakfast habits and blood glucose level ($p<0.05$, $r=0.603$). This result indicates that blood glucose level is, among other factors, influenced by breakfast consumption, because breakfast helps meet nutrient requirements that are subsequently used as the primary substrate for blood glucose formation (Rizkyta & Mulyati, 2014). In addition, RBG reflects blood glucose level at a single point in time and is strongly influenced by the most recent food intake, which makes changes following a breakfast intervention more readily detectable in the short term (Khalida et al., 2016).

The increase in mean RBG following the intervention (from 92.6 to 101.3 mg/dL) remained within the normal random blood glucose range, and therefore does not clinically indicate a hyperglycemia risk in this population (Endocrinologists Indonesia, 2021).

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Skipping breakfast can leave the body without sufficient energy for daily activity. This occurs because metabolic processes continue overnight to generate the energy needed to sustain cardiac, pulmonary, and other muscular functions. As a result, blood glucose reaches its lowest level in the morning before an individual has eaten, so that a missed breakfast leads to insufficient glucose supply, as glucose reserves decline within approximately 18 hours in the absence of energy intake such as carbohydrates (Francis et al., 1983; Rizkyta & Mulyati, 2014).

This study has several limitations. First, the loss to follow-up rate was considerable: of the target 111 students, complete data were available for only 35 (31.5%), owing to absence during breakfast provision or blood sampling. This may introduce selection bias, as students who attended consistently throughout the intervention period may differ in adherence or baseline nutritional status from those who dropped out. Second, this study did not include a control group without the breakfast intervention; therefore, the observed changes particularly in RBG cannot be fully separated from other confounding factors such as dietary intake outside the program or daily physical activity. Third, the 4 weeks intervention duration is relatively short for assessing the long-term effect of the GEMPITA program on hematological status. Fourth, this study did not measure or control for other confounding factors known to influence hemoglobin levels in school aged children, such as intestinal helminth or parasitic infection status, which has been shown in some populations to contribute to variability in Hb levels and may mask the true effect of a nutritional intervention (Girum & Wasie, 2018). Fifth, the measurement of Hb, Hct, and RBG in this study used a Fora 6 Plus point of care testing (POCT) device; as with other POCT devices, glucose measurement may be influenced by the hematocrit value itself, and several studies have reported that both low and high hematocrit levels can introduce positive or negative bias into blood glucose measurements obtained with handheld glucometers (Tang et al., 2000). Accordingly, the observed changes in Hct and the RBG measurements in this study should be interpreted with caution and, ideally, confirmed with a reference laboratory method in future research.

## CONCLUSIONS AND RECOMMENDATIONS

This study concludes that a statistically significant change in random blood glucose level was observed before and after the free breakfast provided through the GEMPITA program. However, no statistically significant change was observed in hemoglobin or hematocrit levels before and after the GEMPITA breakfast intervention.

Future studies are recommended to extend the intervention duration beyond 4 weeks ideally to several months to allow sufficient time for erythrocyte turnover and to better capture potential effects on hemoglobin and hematocrit levels. The inclusion of a control group not receiving the breakfast intervention is also recommended to help isolate the effect of the GEMPITA program from other confounding factors, such as dietary intake outside the program, physical activity, and intestinal parasitic infection status. In addition, confirmation of point-of-care testing results using a reference laboratory method, along with monitoring of actual food consumption by students, is recommended to strengthen the validity of future findings.

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DOI: https://doi.org/10.33024/minh.v9i8.4393