



Correlation Between Middle Upper Arm Circumference (MUAC), Body Mass Index (BMI, Daily Calories Intake And Hemoglobin Level Among Adolescent Girls In Benjor Village, Malang Regency, East Java

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Abstract. This study aims to determine the correlation between Middle Upper Arm Circumference (MUAC), Body Mass Index (BMI), daily calories intake and hemoglobin level among adolescent girls in Benjor Village, Malang Regency, East Java. This study is a cross sectional study conducted in Benjor Village, Tumpang District, Malang Regency. This study involved 41 female adolescents around 12-20 years old. Data was collected by measuring middle upper arm circumference using a metline, measuring height using a microtoise and weighing a stepping scale and then the data obtained are used to determine body mass index recording calorie intake with the 1 × 24 hour food recall method, and measuring blood hemoglobin with Point of Care Testing (POCT). After all data was obtained, it was statistically analysed using multiple regression test. From the results of the regression test, an adjusted R square value of 0.106 was obtained, Which means all independent variables have 10,6% influence to the dependent variable. from the results of the regression test, a significance value of 0.0158 was obtained, which means that the three independent variables have a simultaneous influence on the dependent variable. however, the results of partial influence show that calorie intake is 0.75, while BMI is 0.038, MUAC is 0.026, which means that the two independent variables have a partial influence. Based on the overall results of this study, it can be concluded that MUAC and BMI have a correlation with haemoglobin levels but no effect on calorie intake.

Keywords: MUAC, BMI, Daily Calorie Recall, Adolescent Girl, Hemoglobin Level, Stunting Prevention

1. Introduction

Adolescent health is one of the important factors in the development of quality human resources. Adolescence is an important period in preparing for adult life, especially for women, because during this period women must prepare themselves for the preconception period. Good health of adolescent girls can prevent problems with pregnancy, birth and problems with their babies in the future. Stunting is one of the problems that still cannot be resolved for the Indonesian people. Stunting is a problem of child growth and development caused by a lack of sustainable nutrition over a long period of time, which can begin in the womb, especially during the first 1000 days of life. According to the 2021 Indonesia Health Survey (SKI), data, the prevalence of stunting in Indonesia still reaches 21,5%, which means that almost a third of children under five in Indonesia experience non-ideal growth (Rokom, 2024). Intervention in the pre-pregnancy or preconception period in adolescent girls is the first and main step in the mission to reduce stunting rates in Indonesia.

Problems in adolescent girls are still a problem that has not been resolved. Based on data from the Malang Regency Government, the prevalence of stunting among toddlers in Malang Regency reached 19.5% in 2023 (Pemkab Malang, 2024). This means that the stunting condition in Malang District is still far from the national program “Zero Stunting”. In addition to stunting, anemia in adolescent girls is also a big problem in Indonesia, the anemia rate reaches 30%. Anemia in adolescent girls is very dangerous for health, especially if anemia during pregnancy is at risk of giving birth to babies with low birth weight (LBW) to disability (Rokom, 2021).

Anemia is a major factor in stunting. One of the causes of anemia is iron deficiency. Nutritional intake, especially iron, vitamin A, folic acid and protein greatly affect Hemoglobin (Hb) levels in the body, if the fulfillment of nutrition in the mother is poor, it will result in anemia and will ultimately affect the health of the fetus during pregnancy until birth. Therefore, the prevention of stunting must not only focus on fulfilling the nutrition of pregnant women, but must also start from the preconception period by improving the nutritional intake of adolescent girls.

Responding to the above problems, we conducted research in Benjor Village which aims to determine the relationship between Mid Upper Arm Circumference (MUAC) and Hb levels, the relationship between BMI and Hb levels and the relationship between calory intake to Hb. The results of this study are expected to be used for the development of other studies and the search for effective solutions to this problem.

2. Method

This study was conducted in Benjor Village, Tumpang District, Malang Regency involving 41 female adolescents with an age range of 12-20 years who were not yet married. In the study, several health checks were carried out which included, measurement of Mid Upper Arm Circumference (MUAC) which was carried out using a metline with a standard anthropometric position, namely the subject standing upright with the head facing forward. The acromion and radiale points are determined, then the

distance between the two points is measured and the midpoint is marked. The subject's arm is straightened and the measuring tape is wrapped around the center point with the same pressure on each measurement. Next, the Body Mass Index (BMI) was measured by measuring body weight using a step scale and measuring body height using a microtoise. The results of the weight and height measurements were then entered into the formula ($\text{Body weight} \div (\text{height}^2)$). Then recording calorie intake with the 1×24 hour food recall interview method, and measuring blood hemoglobin with Point of Care Testing (POCT). Before the examination the subject was given an informed consent sheet as a sign that the subject had given his willingness to do a health check.

After all data were obtained, the data were tabulated and descriptive analysis was carried out to determine the maximum value, minimum value, mean value, and standard deviation for further normality tests, Kolmogorov Smirnov test, and other prerequisite tests (multicollinearity, heteroscedasticity, and linearity). then testing with multiple regression obtained meaningful results if $P < 0.05$.

3. Result

Measurement results on 41 adolescent female respondents obtained Mid Upper Arm Circumference (MUAC) results revealed an imbalance in nutritional status. A total of 19 people (46.3%) had MUAC below the normal threshold (<22.6 cm), indicating underweight. The remaining 22 people (53.7%) had MUAC within the normal range (≥ 22.6 cm) indicating normal weight. The data is presented in the chart below.

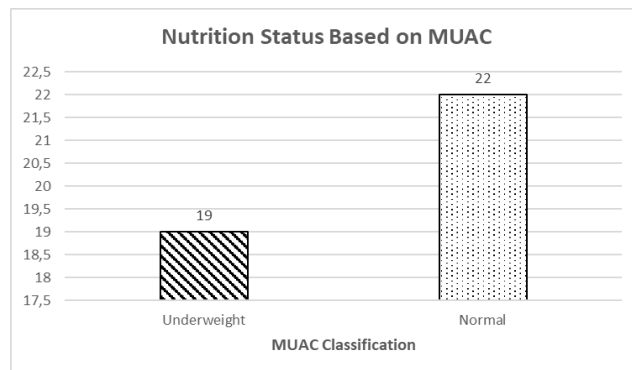


Fig 1. Nutrition Status Based on MUAC

The results of body mass index (BMI) measurements show a diverse distribution of nutritional status. A total of 11 people (26.8%) were categorized as underweight ($\text{BMI} < 18.5 \text{ kg/m}^2$), 20 people (48.8%) had normal weight ($\text{BMI} 18.5\text{--}22.9 \text{ kg/m}^2$), 7 people (17.1%) were overweight ($\text{BMI} 23\text{--}24.9 \text{ kg/m}^2$), 3 people (7.3%) were class I obese ($\text{BMI} 25\text{--}29.9 \text{ kg/m}^2$), and none (0%) were categorized as class II obese ($\text{BMI} \geq 30 \text{ kg/m}^2$). The data is presented in the chart below.

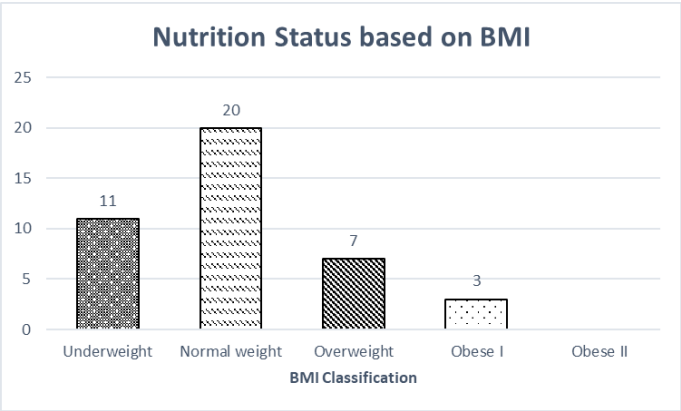


Fig 2. Nutrition Status based on BMI

Measurement of calorie intake showed significant variation. A total of 17 people (41.5%) had calorie intake below the normal threshold (<1600 kcal). The majority, 21 people (51.2%) had an adequate calorie intake (1600-2200 kcal). The remaining 3 people (7.3%) consumed excess calories. The data is presented in the chart below.

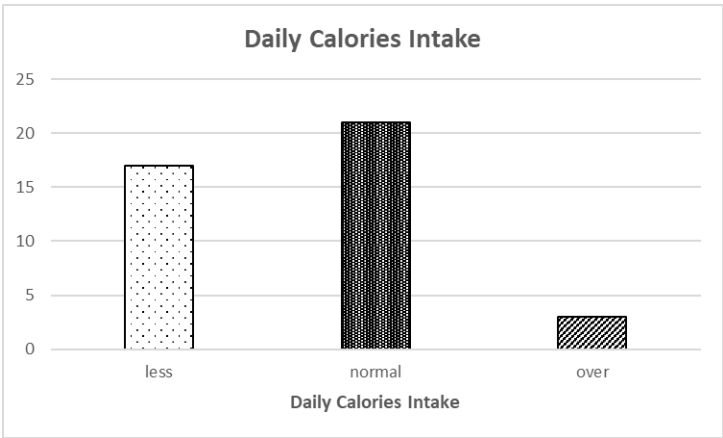


Fig 3. Daily Calories Intake

Hemoglobin measurement showed that 17 people (41.5%) were anemia (< 12 g/dL). The majority, 24 people (58.5%) had normal hemoglobin levels. The data is presented in the chart below.

To determine the correlation between Middle Upper Arm Circumference (MUAC), Body Mass Index (BMI), daily calories intake and hemoglobin level among adolescent girls in Benjor village, we performed multiple regression analysis. We also performed Classic assumption analysis prior to the multiple regression. The results of the classic assumption analysis included multicollenarity test, autocorrelation test and heteroscedasticitytest, will be showed below.

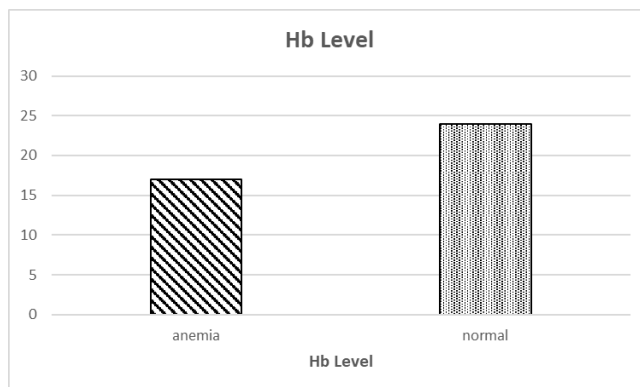


Fig 4. Hb level

From the multicollinearity result it showed MUAC tolerance is 0,150, BMI is 0.120 and Daily calories intake is 0.322. based on the result there was no multicollinearity (*tolerance* > 0,10). The result of autocorrelation test was performed using *Run Test* and showed Asymp. Sig (2 tailed) 0.015 or less than 0.05, which means there wasn't autocorrelation trend. Last test was heteroscedasticity result that performed with Glejser test, the result was significant value for MUAC is 0.99, BMI 0,513 and Calories intake 0.075, which shows $p > 0.05$, so all independent variables didn't show heteroscedasticity.

When all the classic assumption is clear so we performed multiple regression analysis. From the results of the regression test, R square value of 0.106 was obtained, which means that all the independent variables have only 10,6% influence on the dependent variable or we can call it as Determinant Coefficient (DC). From the results of the regression test (F test), a significance value of 0.0158 was obtained, which means that independent variables have a simultaneous influence on the dependent variable. however, the results of partial influence (t test) show that calorie intake significance value is 0.75, while significance value of BMI is 0.038, MUAC significance value is 0.026, which means that BMI and MUAC variables have partial influence ($p < 0.05$) while calories intake doesn't have influence to Hb level.

4. Discussion

This study was conducted using 3 dependent variables and 1 independent variable, the relationship between MUAC and Hb, the relationship between BMI and Hb, the relationship between callory intakes. This study shows that Mid Upper Arm Circumference (MUAC) and hemoglobin levels in adolescents are highly correlated. In adolescent girls, the relationship between Upper Arm Circumference (LILA) and hemoglobin levels is strongly associated with their nutritional status. LILA is an indicator of nutritional status that is often used to assess the risk of protein energy malnutrition. When adolescent girls have a substandard LILA (<23.5 cm), it indicates the possibility of chronic undernutrition which may affect hemoglobin levels. An important protein in the blood called hemoglobin serves to carry oxygen throughout the body. Iron requirements increase during puberty, menstruation, and menopause in

adolescent girls, which increases the risk of anemia (Abeshi A, 2021). This is because hemoglobin synthesis is highly dependent on adequate nutrient intake, especially iron, folate and vitamin B12. Lack of intake of these nutrients can cause iron deficiency anemia in adolescent girls (K. Pibriyanti, NT Nufus, 2021).

In addition, the amount of hemoglobin (Hb) in the body can be significantly affected by poor nutritional conditions, especially if there are deficiencies in iron, protein and vitamin B12. Malnutrition can be seen from BMI (Body Mass Index). BMI is used to view nutritional status based on the ratio between body weight (in kilograms) and height (in meters squared), with a value of <18.5 meaning underweight. Hemoglobin is an important protein in red blood cells that is responsible for transporting oxygen throughout the body. As iron is essential for the manufacture of hemoglobin, iron deficiency due to malnutrition leads to decreased hemoglobin levels. Malnutrition can lead to decreased red blood cell production, which can lead to anemia. Iron and vitamin B12 deficiency can also interfere with erythropoiesis, which inhibits the formation of red blood cells (Mutumba R, 2023).

In general, calorie intake itself has no direct relationship with hemoglobin (Hb) levels, as Hb levels are influenced more by the quality of incoming nutrients rather than the quantity of calories. Calories measure the energy obtained from food, but hemoglobin production depends on specific components such as iron, vitamin B12, and folate, which are important in the formation of red blood cells. If calorie intake is high but not accompanied by essential nutrients such as iron, then Hb levels can still be low, as the body lacks the components needed for hemoglobin production. Research references also show that despite increased energy intake, anemia can still occur if micronutrient requirements such as iron are not met. In a study by Neufeld et al. (Neufeld LM, 2019), it was mentioned that increasing calorie intake without meeting iron needs did not improve the condition of anemia in children in developing countries.d

Hemoglobin (Hb) levels in adolescents are influenced by various factors, including nutritional intake, health, and environmental conditions. Inadequate iron intake is a major cause of anemia in adolescents, especially since iron is essential in the production of hemoglobin(Sari, P., 2022). In addition, deficiencies in other nutrients such as protein, vitamin B12, and folate can also interfere with red blood cell formation, which lowers Hb levels. Health conditions such as infections and chronic diseases also play a role, where inflammation can increase the production of hepcidin, a hormone that inhibits iron absorption. In adolescent girls, heavy or irregular menstruation increases the risk of anemia due to blood loss that is not matched by adequate iron intake (Pareek, P., Kuwari, S., & Thakur, 2022). Socioeconomic factors are also influential, as adolescents from families with low incomes tend to have more limited access to nutritious food and adequate health services (Gupta P, 2019). These factors are overall interconnected in determining the hemoglobin levels of adolescents, so ensuring adequate nutrition and proper medical attention is crucial to prevent anemia (Swamilaksita, P., 2022). Based on the overall results of this study, it can be concluded that MUAC and BMI have a correlation with haemoglobin levels but no effect on calorie intake.

5. Conflict of Interest

The author(s) declared no conflict of interest.

6. Acknowledgment

We, the Faculty of Medicine Student Research Team, would like to express our high appreciation for the good cooperation with the Faculty of Medicine, State University of Malang, which has provided funding and the partnership that has been established with Benjor Village as a research location. The support that has been provided, both in the form of funds and partnerships, has contributed greatly to the success of the research program. We hope that this synergy can continue.

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