

RESEARCH STUDY

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The Relationship Between Chrononutrition with Nutritional Status, Mid Upper Arm Circumference and Anemia in Adolescent Girl

Hubungan Chrononutrition Terhadap Status Gizi, Lingkaran Lengan Atas, dan Anemia pada Remaja Putri

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ABSTRACT

Background: The Adolescents are currently facing the triple burden, which includes undernutrition, overnutrition or obesity, and micronutrient deficiencies. The nutritional status of adolescents was influenced by chrononutrition. Chrononutrition has a significant relationship with nutritional status. However, there are no studies in Indonesia that specifically examine the relationship between chrononutrition and nutritional status, Mid Upper Arm Circumference (MUAC), and anemia in adolescent girls.

Objectives: This study aimed to analyze the relationship between chrononutrition and nutritional status in adolescents.

Methods: This study was cross-sectional, that was conducted in Senior High School in Widodaren, Ngawi, in August until september 2024. The population in this study were teenager aged 14-19 years with a sampel size of 100 respondents calculated using the Lemeshow formula. The independent variable was chrononutrition namely breakfast skipping, evening eating and night eating. The chrononutrition was obtained using Chrononutrition Profile Questionnaire. Meanwhile the dependent variable was nutritional status using Body Mass Index/Age, anemia level using hemoglobin and chronic energy deficiency level which was obtained by mid upper arm circumference. The data was analyzed by chi square and fisher.

Results: There was a relationship between chrononutrition namely breakfast skip (p-value=0.046), night eating (p-value=0.016), and evening eating (p-value=0.01) with nutritional status. There was relationship between chrononutrition namely breakfast skipping (p-value=0.003), night eating (p-value=0.001) and evening eating (p-value=0.03) with Anemia in Adolescent Girl. There was no relationship between chrononutrition namely breakfast skipping, and evening eating with MUAC in Adolescent girl, but there was relationship between night eating with MUAC.

Conclusions: There was relationship between chrononutrition, namely breakfast skipping, night eating and evening eating with nutritional status and anemia. There was relationship between night eating with chronic energy deficiency. Meanwhile there was no relationship between chrononutrition, namely breakfast skipping and evening eating with chronic energy deficiency.

INTRODUCTION

The Adolescents in Indonesia are currently facing the triple burden of malnutrition, which includes undernutrition, overnutrition or obesity, and micronutrient deficiencies. Adolescents are part of a group vulnerable to nutrition problems because this period is marked by rapid growth and development, accompanied by changes in lifestyle and eating patterns¹. Around 25% of adolescents suffer from undernutrition or stunting, resulting in short stature, 9% of adolescents have a low body mass index and appear underweight,

while 16% are overweight or obese². The national prevalence based on the 2023 Indonesian Health Survey data showed that the prevalence of overweight adolescents aged 13-15 was 12.10%, and the prevalence of obesity was 4.10%. According to the 2023 Indonesian Health Survey (SKI) report 15.5% of adolescents aged 15-24 were recorded as anemia³. The prevalence of obesity among adolescents in East Java was 16.4% and 42% of adolescent girls in East Java experienced anemia⁴. Nutritional status assessment was important for adolescents as an early detection measure to prevent

metabolic syndrome diseases⁵. Nutritional status assessment was directly divided into anthropometric, clinical, and biochemical evaluations⁶.

The nutritional status of adolescents was influenced by various factors, including economic, cultural, eating habits, and physical activity levels⁷. Another factor that could affect nutritional status was chrononutrition⁸. Chrononutrition was related to eating patterns and the body's rhythms, showing that meal timing in alignment with the circadian rhythm could help regulate metabolism and support better nutritional status⁹. The circadian rhythm played an important role in physiological processes related to metabolism and energy balance. Changes in the circadian clock were related to changes in meal timing and an increase in body weight¹⁰. Chrononutrition behaviors that could negatively impact health included skipping breakfast, eating large portions, having late dinners, and irregular eating patterns throughout the night¹¹.

According to a study by Borisenkov et al. (2023), multiple regression and logistic regression analyses showed a significant relationship between anthropometric indicators and two chrononutrition indices weekly average meals and dinner timing¹². Other studies also showed that children with high energy intake during the afternoon and evening meals had a 1.18 times higher risk of overweight compared to those who did not consume high energy at those times¹³. The meal timing that was not in accordance with the body's circadian rhythm could affect the regulation of energy metabolism, which potentially led to Chronic Energy Deficiency (CED). CED is a condition in which the body did not receive enough energy to perform basic functions, thereby impacting energy reserves¹⁴. One important indicator that could reflect nutritional status is Mid Upper Arm Circumference (MUAC), which is often used to assess energy and protein deficiencies in the body. Factors such as irregular meal timing, unbalanced food intake, and insufficient energy intake according to the body's needs could potentially affect the size of the mid upper arm circumference, which reflects the risk of CED¹⁵. Previous research showed a significant relationship between breakfast habits, meal frequency, and the incidence of CED in adolescent girls ($p\text{-value} < 0.05$). Adolescent girls skipping breakfast were 5.59 times more likely to experience CED compared to girls having breakfast. Additionally, adolescent girls eating three times a day had a 0.18 times lower risk of CED compared to girls eating

twice a day¹⁶. Chrononutrition related to the indicator of skipping breakfast was linked to hemoglobin levels. Skipping breakfast could cause an imbalance in eating patterns, leading to deficiencies in micronutrients essential for hemoglobin formation¹⁷. Low hemoglobin levels over an extended period could lead to anemia. According to a study by Andiarna, F (2018), adolescents who skipped breakfast had a 1.2 times higher risk of anemia compared to those who ate breakfast. Another chrononutrition indicator was the timing of dinner and dinner habits¹⁸. The average healthy dinner habit was <2-3 times per week, and the ideal dinner time was not later than 11 PM. Late-night eating syndrome could affect sleep quality¹¹. Poor sleep quality could affect hemoglobin levels¹⁹. According to the study by Ariani et al (2022), there was a relationship between sleep quality and low hemoglobin levels²⁰. Based on Franzago showed that the study of how meal timing affects health, has been shown to significantly influence nutritional status and overall well-being⁸. Currently, there are no studies in Indonesia that specifically examine the relationship between chrononutrition and nutritional status, Mid Upper Arm Circumference (MUAC), and anemia in adolescent girls. While several studies have explored the impact of dietary patterns, nutritional intake, and meal timing on overall health and anemia risk, research focusing on the specific concept of chrononutrition remains limited. Most existing studies emphasize the role of macronutrient and micronutrient intake, iron supplementation, and dietary habits in influencing nutritional status and anemia prevalence among adolescent girls^{21,22}. Based on the background, this study aimed to analyze the relationship between chrononutrition and nutritional status in adolescents.

METHODS

This study was an observational analytical study using cross-sectional approach that aimed to know the relationship between chrononutrition, namely breakfast skipping, evening eating and night eating with nutritional status, anemia level and mid upper arm circumference. This study was conducted in senior high school in Walikukun Disctric, Ngawi, East Java on August until september 2024. The population in the study were teenager aged 14-19 years with a sampel size of 100 respondent calculated using the Lameshow formula analytic correlative ordinal-ordinal²³.

$$n = \left[\frac{Z\alpha + Z\beta}{0.5 \ln \left(\frac{1+r}{1-r} \right)} \right]^2 = \left[\frac{1.96 + 1.645}{0.5 \ln \left(\frac{1+0.359}{1-0.359} \right)} \right]^2 = \left[\frac{3.61}{0.38} \right]^2 = 90.25$$

Annotation:

$Z\alpha$ = standard of alpha (5% = 1.96)

$Z\beta$ = standard of beta (5% = 1.645)

r = power value of previous research (based on Karim research, r value = 0.359)²⁴

To anticipate drop out 10% was added. The sample was $99.27 = 100$ respondent. The sampling was used purposive sampling with inclusion and exclusion criteria. The inclusion criteria in this study were teenagers aged 14-19 years and not dieting. The exclusion criteria were sick when research. This approach ensures that only

participants who meet the study's specific requirements are included. Data collection was conducted by gathering student information from the school, including a list of names and classes of students aged 14–19 years. Subsequently, collaboration with teachers was carried out to filter students who met the inclusion and exclusion

criteria. As an initial screening process, a brief interview was conducted to ensure that the selected students met the eligibility requirements for the study. The independent variable in this study was chrononutrition namely breakfast skipping, evening eating and night

eating. Meanwhile the dependent variable was nutritional status, anemia level and mid upper arm circumference. Chrononutrition data was obtained using Chrononutrition Profile Questionnaire (CPQ)²⁵. The cut of chrononutrition was shown in table 1.

Table 1. Chrononutrition cut off

Chrononutrition Category	Cut Off
Breakfast skipping	
Poor	≥4 days / week
Good	<4 days / week
Evening Eating	
Poor	≥ 23.00
Good	< 23.00
Nigh eating	
Poor	≥4 days / week
Good	<4 days/ week

The simplification of categories from three to two was carried out to facilitate data analysis, making the results easier to interpret and understand. Additionally, the "fair" category often lacks clear boundaries and can be subjective, potentially leading to bias in data classification. By merging the "fair" category into either "good" or "poor", the analysis becomes more consistent and objective. Nutritional status was measured by Body Mass Index for >18 years old and BMI/Age for ≤18 years old. Body weigh used a GEA brand digital scale and height measurement by a microtoice that have been calibration. Both instruments have been widely used in scientific research settings, meeting standard calibration requirements for anthropometric assessments. Nutritional status was categorized into two, namely normal nutritional status with a z-score value of BMI according to age is -2 sd to 1 sd and abnormal if the BMI according to age z-score value is <-2 sd and >1 sd. For >18 years old was analyzed by BMI with normal categorized if BMI was 18.5 - 22.9 kg/m^{2,26}. The hemoglobin level variable was carried out by taking blood from a vein by an expert which was measured using a hematology analyzer. Hemoglobin level was categorized into two namely anemia which was the hemoglobin level <12 mg/dl and non-anemia which was the hemoglobin level ≥12 mg/dl²⁷. Mid upper arm circumference was measured using metline. The method of measuring MUAC is by stretching the measuring tape around the midpoint between the acromion and olecranon bones of the left arm in a relaxed

state, the midpoint has been measured before the arm is bent 90 degrees. MUAC was categorized by Chronic Energy Deficiency (CED) with the value of MUAC was <23.5 cm and normal status if the value of MUAC was ≥23.5 cm²⁸. The data was analyzed by chi square if requirement was fulfilled, which in the context of the chi-square test, it is recommended that each cell in the contingency table has an expected frequency of at least 5. If more than 20% of the cells have expected frequencies less than 5, the validity of the chi-square test results may be compromised²⁹. Additionally, no cell should have an expected frequency of zero meanwhile the data was analyzed by fisher if the requirement hi square was not fulfill. A p-value < 0.05 was considered statistically significant, indicating a meaningful association between the variables analyzed. This study has received a code ethic number from RSUD dr. Soehadi Prijonegoro Sragen with the number 188/Etik-Crssp/VII/2024, at 7 August 2024.

RESULTS AND DISCUSSIONS

The characteristic responded include age, hemoglobin level, nutritional status, MUAC, and chrononutrition. In the category of age, divided into three categories, namely 14-15 years old, 16-17 years old and 18-20 years old. Hemoglobin level divided into two categories, namely anemia and non-anemia. Nutritional status divided into two category, namely abnormal and normal. The characteristic respondent showed in table 2.

Table 2. Characteristic respondent

Variable	n	%
Age (year)		
14 - 15	17	16.8
16 - 17	72	71.3
18 - 20	11	10.9
Hemoglobin level		
Anemia	16	15.8
Non-Anemia	84	83.2
Nutritional status		
Abnormal	23	22.8
Normal	77	76.2
MUAC		
CED	38	37.6

Variable	n	%
Normal	62	61.4
Brekafast Skip		
Poor	47	46.2
Good	53	52.5
Night Eating		
Poor	14	13.9
Good	86	85.1
Evening eating		
Poor	13	12.9
Good	87	86.1

The Majority age of respondents were 16-17 years old. A concerning finding was the relatively high prevalence of anemia among this group with 15.8% of respondent being anemic. The nutritional status of the respondent was generally normal. In terms of Mid Upper Arm Circumference (MUAC) 37.6% of respondents were classified as having Chronic Energy Deficiency (CED). The data chrononutrition showed that a majority of the

respondent had a good eating habit. However, 46.2% respondent have a skipping breakfast and 12.9% of respondents had poor night eating habits. The result from the research conclude that there was a relationship between chrononutrition namely breakfast skipping (p-value=0,046), night eating (p-value<0.01) and evening eating (p-value<0.01) with nutritional status.

Table 3. Relationship between chrononutrition and nutritional status in adolescent girl

Variable	Nutritional Status				P-value
	Abnormal		Normal		
	n	%	n	%	
Breakfast Skipping					
Poor	15	65.2	32	41.6	0.046 ^a
Good	8	34.8	45	58.4	
Night Eating					
Poor	7	30.4	7	9.1	0.016 ^b
Good	16	69.6	70	90.9	
Evening eating					
Poor	7	30.4	6	7.8	0.018 ^b
Good	16	69.6	71	92.2	

^aChi square test, significant if p-value<0.05

^bFisher test, significant if p-value<0.05

There was an effect of breakfast skipping with nutritional status. According to the guidelines, breakfast refers to the act of eating and drinking from the time of waking up until 9:00 a.m., and it should provide approximately 15 to 30% of the Recommended Dietary Allowance (RDA) to support a healthy, active, and productive lifestyle³⁰. The result said that as much as 65.2% respondent malnutrition was caused by breakfast skipping and 58.4 respondent who have normal nutritional status have a good breakfast habit. Breakfast the first meal of the day, marks the end of the overnight fasting period and plays a crucial role in chrononutrition. However, the prevalence of adolescents skipping breakfast is increasing. This study shows that there is a correlation between skipped of breakfast and nutritional status (p-value=0.046). The findings of this study are consistent with prior research, which showed that a significant prevalence of overweight/obesity and a poorer nutritional profile were consistently associated with skipping breakfast in randomized controlled trials and longitudinal intervention studies that included children and adolescents³¹. In previous studies, it was found that there was a significant correlation between skipping breakfast and nutritional status. In fact, 40% of students were underweight, and 7.7% were overweight³². Prior research additionally showed that

there was no significant association (p-value=0.491) between skipping breakfast and overweight/obesity in adolescents. However, the study demonstrated that adolescents who skipped breakfast had a significantly higher mean BMI than those who took breakfast (19.33 ± 3.27 kg/m²; 18.56 ± 3.05 kg/m²). The results were also in agreement with other studies conducted on adolescents in Greece, Malaysia, and New Delhi. Skipping breakfast can result in increased food consumption later in the day, which can ultimately contribute to obesity and weight gain³³.

Based on table 3, there was a relationship between night eating with nutritional status (p-value 0.016). Malnutrition was caused by night eating with the prevalence of 30.4% and 90.4% respondents who have a normal nutritional status was cause by a good habit night eating which is they eating at the nigh ≤ 3 days per week. The category showed the frequency of eating at night. The behavior of eating at night ≤ 3 times a week is good behaviour. While bad behavior is night eating ≥ 4 times or more a week at night. Night eating habits were defined as "dinner immediately before bed" (dinner within 2 hours of bedtime ≥ 3 times/week)³⁴. There was a relationship between evening eating with nutritional status. Based on the results, it showed that 30.4% malnutrition was caused by poor evening eating which

means having poor mealtime habits. Meanwhile 92.2% of respondents who have a normal status have good mealtime habits. Another study conducted by Putri S.A. et al, 2023, the night eating habits are related to the incidence of overnutrition³⁵.

Adolescence is a time of rapid growth and increased nutritional needs. Research shows that adolescent girls are underweight because of poor eating habits, despite knowledge of the importance of a balanced diet. Choosing nutrient-poor foods at night is thought to be a major contributor to malnutrition in adolescent girls³⁶. In a study conducted in Southern and Northern Nigeria, adolescent malnutrition was attributed to inadequate intake of nutrients such as iron, folate, zinc, calcium and vitamins³⁷. Other factors contributing to micronutrient deficiencies in adolescents include unhealthy eating habits, eating disorders, consumption of foods low in nutrients, extreme diets, irregular eating habits and lack of knowledge about nutrition³⁸.

Nutritional status is also influenced by sleep quality (sleeping before 11 pm) where lack of rest is associated with decreased leptin levels and increased ghrelin levels, thereby increasing appetite³⁹. Based on research conducted by Firmanurochim W, 2021, there is a relationship between night eating habits and the incidence of obesity in adolescent girls. Poor eating habits at night lead to the accumulation of fat in the subcutaneous tissue and other tissues because the body's metabolism is slower than in the morning or afternoon⁴⁰. There was a relationship between evening eating with

nutritional status. Modern lifestyle habits are characterized by more frequent postprandial states, exposure to unhealthy diets, sedentary lifestyle with prolonged sitting time, irregular meal times, skipping meals, chronic psychological stress, emotional eating, and consumption of food at night⁸. Body mass index is influenced by food consumption and health levels. Food consumption needs come from breakfast, lunch, dinner, and snacks. Dinner is consumed after an afternoon snack or starting at 5 pm⁴¹. Dinner is necessary to fulfil energy needs during sleep such as blood flow breathing, and heart^{41,39}. Dinner is best done at 3 or 4 hours before bedtime so that the digestive system has time to work and rest afterwards^{41,42,43}.

According to previous studies, overeating at night increases the risk of overweight and obesity^{34,44,45}. Late dinner is associated with an increase in ghrelin, a hormone that increases appetite at night^{41,43}. In this study, it was shown that late night diners who were on time would have normal nutritional status. These data support the idea that, with differences among chronotypes, a lower diet before bedtime and higher energy intake after waking up is associated with reduced BMI⁴⁶. However, other studies have shown no association between evening meals (number and timing of meals) and nutritional status⁴⁷. Body metabolism is regulated by circadian systems such as sleep and eating. The body's energy balance is associated with obesity, diabetes and heart disease⁴⁸.

Table 4. Relationship between chrononutrition and anemia in adolescent girl

Variable	Anemia Level				p-value
	Anemia		Non-Anemia		
	n	%	n	%	
Brekafast Skip					
Poor	13	81.2	34	40.5	0.003 ^a
Good	3	18.8	50	59.5	
Night Eating					
Poor	7	43.8	7	8.3	0.001 ^b
Good	9	56.2	77	91.7	
Evening eating					
Poor	5	31.2	8	9.5	0.033 ^b
Good	11	68.8	76	90.5	

^aChi square test, significant if p-value<0.05

^bFisher test, significant if p-value<0.05

The result from the research concludes that there was relationship between chrononutrition namely breakfast skip (p-value=0.003), night eating (p-value=0.001) and evening eating (p-value=0.03) with anemia in adolescent girl. Based on the result in table 4, conclude that 81.2% anemia was caused by breakfast skipping, meanwhile 59.5% who have normal haemoglobin level have a good habit of breakfast. The result showed that there was a relationship between breakfast skipping with anemia level. The habit of having breakfast has a significant impact on daily nutrient intake. Low hemoglobin levels can occur due to insufficient food intake that does not meet nutritional needs, resulting in low iron stores in the body. Iron deficiency is one of the main causes of nutritional deficiency anemia. One of the factors that influence low hemoglobin levels is eating

patterns. A lack of various nutrients such as carbohydrates, proteins, fats, vitamins, and minerals can reduce the amount of hemoglobin, which functions as an energy source. There is a significant relationship between energy and protein intake and the incidence of anemia. Inadequate energy intake carries a 3.3 times higher risk, and protein deficiency carries a 3.98 times higher risk of developing anemia⁴⁹. Micronutrient intake, including vitamin C, vitamin B6, vitamin B12, and iron, has been shown to be associated with the occurrence of anemia in adolescent girls⁵⁰. If the body continues to lack the energy supply needed for various physiological processes, protein damage involved in iron absorption, storage, and transport may occur. Iron deficiency does not directly cause a rapid decrease in hemoglobin levels, but it can contribute to that condition^{51,52}.

Based on the results of a questionnaire, there are several reasons why adolescent girls skip breakfast, including not being used to having breakfast, feeling lazy to eat in the morning, worrying about being late for school, and feeling stomach cramps after eating. Among these reasons, the most common is that adolescent girls feel lazy to have breakfast. This statement is consistent with the findings of Merlisia et al. (2024), which revealed several reasons why adolescent girls skip breakfast, such as fearing stomach cramps after eating, feeling drowsy, not having enough time, or rushing because of the fear of being late⁵³. Based on the previous research data distribution at SMP PGRI Semboro Jember, it was found that nearly half of the students never have breakfast in the morning. Having breakfast regularly and making it a habit is considered good behavior. A good breakfast should consist of nutritionally balanced food to meet nutritional needs until midday. A good breakfast menu should be high in protein and contain sufficient minerals to keep hunger at bay and fulfill nutritional needs until noon. Data on the incidence of anemia shows that nearly all students at SMP PGRI Semboro Jember suffer from anemia. Although some respondents regularly have breakfast, they still experience anemia. This could be caused by various factors, including gender, as females may be menstruating, which can affect Hb test results and lead to low hemoglobin levels or anemia⁵⁴.

Appropriate food intake in terms of quantity and portions, including regular breakfast habits, is crucial for meeting adolescents' nutritional needs. Breakfast contributes significantly to the total daily nutrient intake, accounting for about 25% of daily nutritional requirements. Government programs, such as the Balanced Nutrition Guidelines, encourage the importance of daily breakfast habits as part of a healthy lifestyle. Breakfast is a fundamental need for every individual as it provides various health benefits. A balanced and nutritious breakfast can support physical and mental growth and development, especially in adolescents. Adolescent girls who often skip breakfast are at higher risk of anemia due to nutrient deficiencies, particularly iron. Adolescent girls who skip a nutritious breakfast are 4 times more likely to develop anemia than those who have a nutritious breakfast habit. Adolescents who frequently skip breakfast may experience energy and nutrient deficiencies, which, if persistent, can hinder their growth and development⁵⁵.

Adolescents often have busy schedules, starting with school in the morning and continuing with extracurricular activities in the afternoon, plus additional tutoring or other activities. All these activities often make it difficult for them to find time to eat, let alone pay attention to the nutritional balance of the food they consume. As a result, many adolescents feel easily fatigued, sluggish, and low on energy. However, quick fatigue could also be caused by anemia or a blood deficiency⁵⁶. The findings of this study are consistent with those of Merlisia (2024), which showed a significant relationship between breakfast habits and the incidence of anemia in adolescent girls in the Rawasari Health Center area of Jambi City. This was evidenced by a chi-square test result with a $p\text{-value} < 0.05$ ($p\text{-value} = 0.016$)⁵³. Another study found similar results, indicating a

relationship between breakfast habits and anemia in adolescent girls at SMPN 13 Mataram with a $p\text{-value}$ of 0.010 of 36 adolescent girls with good breakfast habits, only 25% had anemia, whereas of 43 adolescent girls with poor breakfast habits, 23 (48.7%) had anemia. The impact of anemia in adolescents includes the potential disruption of growth, decreased concentration levels, and lower academic achievement. Therefore, special attention should be given to students by providing education on the importance of breakfast to prevent and avoid anemia. Additionally, there is a need for motivation from school authorities regarding nutrition and the importance of breakfast, as well as urging students to have breakfast or at least bring food to eat before 9 AM⁵².

As much as 91.7% of people who have normal haemoglobin level have a good habit of night eating, in the other hand 43,8% anemia was caused by a poor night eating habit. The result said that there was relationship between chrononutrition namely night eating with anemia level. Evening eating habits can increase the risk of night eating syndrome in adolescents, which is characterized by the habit of eating after 7 p.m. Adolescents who experience night eating syndrome are 6.5 times more likely to be overweight compared to those who do not experience it³⁵. Obesity is associated with various negative impacts, including anemia, which is a serious global public health issue. In addition to height and weight, anemia is a basic indicator reflecting an individual's nutritional well-being. Although it seems paradoxical, obesity is also related to malnutrition, where most people with long-term anemia appear thinner compared to others. This paradox regarding the coexistence of obesity and anemia is often overlooked. Women with a high body fat percentage show a much higher risk of iron deficiency compared to those with a lower body fat percentage⁵⁷.

Previous research showed similar findings, with a positive relationship between night eating syndrome and Body Mass Index. University students often study late at night, which leads to eating at night and skipping breakfast⁵⁸. A cohort study with data from health screenings conducted on respondents aged 47-74 years, who did not have pre-diabetes or diabetes, showed that 83 men (16.1%) and 70 women (7.5%) fell asleep within two hours after dinner. Observing the effect of a two-hour interval between dinner and sleep did not show a significant impact on increasing HbA1c levels. The regression coefficient for the two-hour interval and HbA1c levels over time was -0.02 ($p\text{-value} = 0.45$). Smoking ($p\text{-value} = 0.013$), alcohol consumption ($p\text{-value} = 0.010$), and higher BMI ($p\text{-value} < 0.001$) may have influenced HbA1c trends. A two-hour or shorter interval between dinner and sleep did not affect changes in HbA1c levels in middle-aged and older Japanese individuals⁵⁹.

Poor sleep quality due to insufficient sleep duration can have negative effects on the body, as biological processes during sleep are disrupted. One of the disruptions is in hemoglobin formation, which leads to a decrease in hemoglobin levels below normal. This happens because, during sleep, the body repairs damaged cells. If sleep duration is inadequate, the repair processes cannot function optimally, which in turn disrupts hemoglobin formation. As a result, the amount

of hemoglobin produced cannot meet the body's needs⁶⁰. Research on the hemoglobin levels of night-time food vendors in the Anduonohu area of Kendari shows that the majority of these vendors have low hemoglobin levels. This is due to their occupation, where they work late into the night, leaving them with insufficient rest time. Consequently, their red blood cell formation process does not occur normally, as red blood cells are produced between 9:00 p.m. and 12:00 a.m.⁶¹.

Adolescents need sufficient iron intake to prevent health issues, including anemia. This is due to the production of melatonin in adolescents, a hormone that naturally makes them tend to sleep later than children or adults. This condition causes them to often sleep later than they should. In fact, many adolescents struggle to sleep at the appropriate time because their brains are naturally active later in the evening. With reduced sleep time, the energy expended also increases. The ideal sleep duration for adolescents is between 7 to 9 hours per day. Other factors that contribute to sleep disturbances in adolescents include busy schedules, school pressures, stress, caffeine consumption, gadget use, medication, and mental health issues. Anemia in adolescents can be caused by iron deficiency in the diet, chronic diseases, unbalanced diets, and irregular lifestyles, such as eating late or insufficient sleep⁶². Adolescent girls with insufficient sleep duration are more likely to suffer from anemia compared to those with adequate sleep. For adolescents and young adults, the normal sleep duration is 8 hours. The sleep duration in the anemia group is around 6 hours, while the non-anemia group sleeps for 8 hours⁶³. Insufficient sleep duration can have adverse effects on the body, as biological processes that occur during sleep are disrupted, including hemoglobin formation, which results in lower-than-normal levels. Plasma iron decreases to one and a half times the normal

level when sleep deprivation reaches up to 120 hours. In the first 48 hours, the decrease is rapid, and then it slows down gradually. To return to normal levels, at least one week of recovery is needed⁶⁴.

Low hemoglobin levels in individuals with poor sleep quality can be caused by the body's homeostatic mechanisms. Poor sleep patterns can affect hemoglobin metabolism, which is closely related to red blood cell (erythrocyte) metabolism. Red blood cells function to remove free radicals formed during wakefulness. However, insufficient sleep can increase oxidative stress and lipid peroxidation in cell membranes, a process that involves free radical formation involving electrons in lipids. Peroxidation in erythrocyte membranes can cause damage to red blood cells, increasing the risk of hemolysis and significantly lowering hemoglobin levels in the blood. Although the body has mechanisms to maintain stability, a proper diet, such as the consumption of antioxidants can help combat oxidative stress. Additionally, maintaining good sleep hygiene is important to prevent oxidative stress, which can lead to anemia¹⁹. There was relationship between evening eating with anemia level. The result said that 90,5% of people who have normal haemoglobin were caused by a good behaviour in evening eating. Meanwhile 31.2% anemia was caused by a poor habit of evening eating. The frequency of nighttime feedings was inversely correlated with hemoglobin levels, indicating that increased nighttime feeding was associated with higher anemia prevalence. A study focusing on Turkish children found that those who were fed at night had significantly lower hemoglobin levels compared to non-nighttime feeders. Specifically, 31.0% of nighttime feeders were anemic, compared to 17.9% of those who did not receive nighttime feedings⁶⁵.

Table 5. Relationship between chrononutrition and MUAC in adolescent girl

Variable	Nutritional Status				p-value
	CED		Normal		
	n	%	n	%	
Brekfast Skip					
Poor	18	47.4	29	46.8	0.954 ^a
Good	20	52.6	33	53.2	
Night Eating					
Poor	11	28.9	3	4.8	0.001 ^a
Good	27	71.1	59	95.2	
Evening eating					
Poor	7	18.4	6	9.7	0.232 ^b
Good	31	81.6	56	90.3	

^aChi Square test, significant if p-value<0.05

^bFisher test, significant if p-value<0.05

The result from the research concludes that there was no relationship between chrononutrition namely breakfast skip, and evening eating with MUAC in adolescent girl, but there was relationship between night eating with MUAC. The result research showed that there was no relationship between breakfast skip with upper arm circumference level (p-value 0.95). Despite the fact from the result showed that 47% chronic energy deficiency was caused by a poor habit of breakfast. This is in line with the study by Matsumoto, et al in 2020

which showed that skipping breakfast was related to vitamin, mineral deficiencies, and poor diet in junior high school students in Japan⁶⁶. Skipping breakfast causes an increase in consumption of 193 kJ at lunch and 783 kJ at dinner. Skipping one meal reduces daily energy intake by 1464 kJ and decreases the daily nutritional adequacy rate. Although skipping meals improves scores for some components, poor food quality, especially at breakfast, can have a negative impact on long-term health, especially the nutritional status of chronic energy

deficiency⁶⁷. The absence of a relationship between skipping breakfast and upper arm circumference can be caused by many factors, one of which is the determination of the standard size of the LILA used. Based on recent research, the standard size of the LILA 24.5 cm as the optimal limit for identifying underweight is equivalent to a BMI <18.5 kg/m². LILA measurement requires low cost and easy measurement, LILA can be an alternative to BMI to detect underweight if BMI measurement is not possible. LILA has a strong correlation with BMI in healthy and chronically ill people⁶⁸. While in this study, the standard LILA size used was 23.5 cm in accordance with the reference standard used for Indonesians.

Based on the result said that there was relationship between night eating with upper arm circumference level (p- value 0.001). 92,5% respondent who have a normal upper arm circumference was affect by a good habit of night eating, meanwhile 28.9% chronic energy deficiency was caused by a poor habit of night eating. This study showed that there is a relationship between eating at night and upper arm circumference. Adolescent girls with Chronic Energy Deficiency (CED) experience persistent or long-term protein and energy deficiencies, with an upper arm circumference of less than 23.5 cm⁶⁹. The causative factors of CED in adolescents include a lack of nutritional intake or a history of infectious disease. Adolescent girls who rarely eat at night affect their nutritional status. Adolescent girls are now very concerned about body image and reduce food for the ideal body. Adolescents who are not satisfied with their body shape will go on a diet by reducing their portion of food or not eating dinner at all^{69,70}.

There was no relationship between evening eating with upper arm circumference level (p-value 0.23). Despite the fact showed that 90.3% a normal upper arm circumference was determined by a good habit of evening eating. The varying portion sizes during evening eating habits indirectly affected the size of the upper arm circumference. The study by Afiska showed a significant relationship between energy intake, protein, fat, iron, zinc, and upper arm circumference⁷¹. However, other studies showed that energy intake, carbohydrates, and protein were not significantly related to the occurrence of chronic energy deficiency (CED), while fat intake was significantly associated with the occurrence of chronic energy deficiency⁷². Upper arm circumference was often used as a measure of nutritional status, particularly to evaluate body fat reserves and muscle mass, as well as to identify malnutrition in individual⁷³. Physiologically, upper arm circumference reflected the amount of adipose tissue (body fat) contained in the body, particularly in the arm area. In individuals with overweight or obesity, the amount of adipose tissue in the arm area could increase, while in individuals with malnutrition, adipose tissue could decrease. In addition to fat, muscle mass also contributed to the size of the upper arm circumference, and changes in body composition could affect an individual's nutritional status²⁸.

CONCLUSIONS

The conclusion from the research were chrononutrition, namely breakfast skipping have an effect with nutritional status and anemia. There was relationship between chrononutrition, namely night eating with nutritional status, anemia and chronic energy deficiency. There was relationship between chrononutrition, namely evening eating with nutritional status and anemia. Meanwhile chrononutrition, namely breakfast skipping and evening eating there was no effect with chronic energy deficiency.

The conclusion of this study showed that chrononutrition, specifically the habit of skipping breakfast, affected nutritional status and anemia, while the habit of eating dinner impacted nutritional status, anemia, and chronic energy deficiency. However, the habits of skipping breakfast and eating dinner did not affect chronic energy deficiency.

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AUTHOR CONTRIBUTIONS

KP: Conceptualization, Supervision and writing original draft; IM: writing original draft background and discussion; LL: Methodology, writing-review and editing and analysis data; QFR: project administration and writing-original draft; LM, NA, IC: roles/writing-original draft; SN : As part of the English language review.

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