**The Exploration of Adolescent Girl’s Body Composition and its Relationship on Haemoglobin Levels in Semarang, Indonesia**

Eksplorasi Korelasi Komposisi Tubuh dengan Kadar Hemoglobin pada Remaja Putri di Kota Semarang, Indonesia

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| **Penerbit:**    © The Author(s). 2019 **Open Access**  Artikel ini telah didistribusikan berdasarkan atas ketentuan *Lisensi Internasional Creative Commons Attribution* *4.0*What if? Creative Commons Certification | **Abstract** Obesity and anemia prevalence in adolescents are rising. This study aims to explore the body composition profile of adolescent girls and its relationship to haemoglobin levels in Semarang City, Indonesia. This study is cross-sectional, with 110 adolescent girls aged 14-17 years who were purposively selected from State senior high school 2, 9, and 15 Semarang as subjects. Data were collected from September-October 2022. Waist circumferences (WC), height (H), and body fat percentage (%BF) were measured using a waist ruler, microtoise, and Bioelectrical Impedance Analyzer (BIA), respectively. Waist-to-height ratio (WHtR) is defined as waist measurement divided by height measurement in centimeters. Haemoglobin (Hb) levels were determined using point-of-care testing (POCT) methods. The Rank-Spearman test was used to analyze the relationship between body composition and Hb, and the difference between anaemic and non-anaemic subject’s body composition were analysed using Mann-Whitney test. The result showed that among all of the subjects, 8.2% are anemic, 21.8% considered abdominal obesity, and 40.9% were classified as overfat and obese. There is no relationship between WC (p=0.54), %BF (p=0.88), and WHtR (p=0.27) with Hb levels. Also, no difference in body composition between anaemic and non-anaemic adolescent girls (p>0.05). In conclusion, there are no associations between body composition and Hb levels in adolescent girls.  **Keywords: Anaemia, body composition, hemoglobin levels, adolescent girls** **Abstrak** Prevalensi obesitas dan anemia pada remaja meningkat. Penelitian ini bertujuan untuk mengeksplorasi hubungan antara komposisi tubuh dan kadar hemoglobin pada remaja putri di Kota Semarang, Indonesia. Penelitian ini merupakan studi cross-sectional dengan subjek sebanyak 110 orang remaja putri berusia 14-17 tahun dari SMA Negeri 2,9, dan 15 Semarang. Data diambil pada Bulan September-Oktober 2022. Pengukuran lingkar pinggang (LP), tinggi badan (TB), dan persen lemak tubuh (PLT) dilakukan menggunakan waist ruler, mikrotoise, dan Bioelectrical Impedance Analyzer (BIA). Rasio lingkar pinggang-tinggi badan (RLPTB) didefinisikan sebagai perbandingan lingkar pinggang dengan tinggi badan dalam sentimeter. Kadar Hemoglobin (Hb) diambil dengan metode point-of-care testing (POCT). Uji Rank-Spearman digunakan untuk menganalisis hubungan antara komposisi tubuh dan Hb, dan perbedaan antara komposisi tubuh subjek anemia dan tidak anemia dianalisis menggunakan uji Mann-Whitney. Hasil penelitian menunjukkan bahwa diantara semua subjek, 8,2% mengalami anemia, 21,8% mengalami obesitas sentral, dan 40,9% tergolong gemuk dan obesitas. Tidak ada hubungan antara LP (p=0,54), PLT (p=0,88), dan RLPTB (p=0,27) dengan kadar Hb. Selain itu, tidak ada perbedaan komposisi tubuh antara remaja putri anemia dan non-anemia (p>0,05). Sebagai kesimpulan, tidak ada hubungan antara komposisi tubuh dan kadar Hb pada remaja putri.  **Kata Kunci:** Anemia, kadar hemoglobin, komposisi tubuh, remaja putri |

# **Introduction**

Adolescent is a critical period of growth, which is characterized by fast physical growth and cognitive development and related to socioemotional factors like social environment, economy, and culture (Sparrow et al., 2021). Adolescents' nutritional status and health condition generally reflect nutrition needs during childhood and describe health conditions in adulthood. The problem of adolescent nutrition today is evolving from undernutrition and overnutrition (known as double-burden malnutrition) to triple-burden malnutrition, with increasing cases of micronutrient deficiencies in adolescents (Iriyani, 2022). Adolescent girls are prone to nutritional problems because of some conditions, such as menstruation, body image perception, and a complicated psychosocial development that may related to the body image perception and reduction of willingness to eat (Mulianingsih et al., 2021; Sistiarani et al., 2023).

The proportion of adolescent girls in Indonesia who are overnourished has reached 31.9%. These proportions include overweight and obesity. The prevalence of obesity in rural areas was found to be higher than in urban areas, because of some factors, such as increased access to processed food, sedentary lifestyle, and economic development (LM et al., 2019). Thus, the global changes in diet and lifestyle are also important contributors to the rising prevalence of obesity and overweight in rural area (Bixby et al., 2019). On the other hand, the incidence of anaemia as a manifestation of micronutrient deficiency also reaches 32%, or, in other words, 3-4 out of 10 adolescent girls experience anemia (Kementerian Kesehatan Republik Indonesia, 2019). Iron Deficiency Anaemia is the most common problem that may result in bigger health consequences in the future (Sari et al., 2022)

Body fat distribution plays a role in iron metabolism. Adolescent girls with central obesity are more at risk of developing anemia due to high levels of hepcidin, inflammation, and low levels of iron in the body, even though they have received blood supplement tablets (Stoffel et al., 2020). Low-grade inflammation, in association with obesity, may increase the inflammatory cytokines and stimulate the liver production of hepcidin, thus disturbing cellular iron transport through ferroportin degradation (Alshwaiyat et al., 2021; Stoffel et al., 2020).

Several anthropometric indicators can be used to determine an individual's nutritional status, such as body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR). BMI is a common anthropometric index to interpret nutritional status. However, BMI has limitations as a predictive tool for degenerative diseases, such as diabetes and cardiovascular diseases, because BMI does not distinguish muscle mass and adipose tissue or fat mass. BMI also not able to consider micronutrient deficiencies (Khanna et al., 2022; Wu et al., 2024). Waist circumference and WHtR are anthropometric indicators that can be used to determine abdominal and visceral obesity. Waist circumference is known to be a more effective indicator of health than BMI and WHR, while WHtR is able to be a predictor of health problems such as hypertension, type 2 diabetes mellitus and cardiovascular disease (Mangla et al., 2020; Ross et al., 2020; Sweatt et al., 2024)

Semarang is an urban city experiencing disruptions in diet and lifestyle, as the study showed a low moderation score indicated that subjects tend to consume high fat high sodium, dan low quality diet (Dieny et al., 2020) Thus, it is interesting to explore the body composition profile of adolescent girls and its relationship to haemoglobin levels in Semarang City, Indonesia.

# **Method**

This is a cross-sectional study that conducted on SMA Negeri 2 Semarang, SMA Negeri 15 Semarang, and SMA Negeri 9 Semarang. The data was collected from September ~~2022~~ to November 2022. The samples are calculated using the Lemeshow formula, and got subjects are 110 adolescent girls a subjects. Subjects were taken using a purposive sampling technique. Sample inclusion criteria include (a) being 14-17 years old or sitting in class X and XI. The exclusion criteria are (a) Currently having period, (b) not present when collecting the study data data collection, (c) the subject refuses to continue the research.

Data taken in this study included percent body fat (%BF), waist circumference (WC), height, and hemoglobin levels (Hb Levels). Hemoglobin level data was taken using the point-of-care testing (POCT) method with the HemoCue device. According to World Health Organization (WHO), Samples are defined to be anaemic if the Hb level is < 12 g/dl and not anaemic if the Hb level is ≥ 12 g/dl. Nutritional status is defined using several indicators, namely percent body fat, WHtR, and waist circumference. Height was measured using a microtoise instrument with an accuracy of 0.1 cm. Waist circumference was measured using a waist ruler, with an accuracy of 0.1 cm. Body fat percentage was analyzed using a bioelectrical impedance analyzer (BIA). The waist circumference-height ratio (WHtR) is obtained by dividing the waist circumference (cm) by the body height (cm).

Data were analyzed for normality using the Kolmogorov-Smirnov test and bivariate analysis using the Spearman rank correlation test. This research has been ethically approved under number 002/KEPK-FKM/UNIMUS/2023.

# **Result and Discussion**

The subjects in this study were female students from class X and XI, with an age range of 14-17 years. Most subjects had normal nutritional status, based on WC and WHtR anthropometric indicators (Table 1). Based on the body fat percentage indicator, overfat and obesity rates were found to be quite high, namely 23.6% and 17.3% respectively. The majority of subjects in this study did not experience anemia (Hb≥ 12 g/dl). However, there were 8.2% of subjects who experienced anemia.

**Table 1.** Subject’s Characteristics

|  |  |  |
| --- | --- | --- |
| Variable | n | % |
| Age |  |  |
| 14-15 y.o. | 36 | 32.7 |
| 16-17 y.o. | 74 | 67.3 |
| Waist Circumference |  |  |
| Normal | 86 | 78.2 |
| Obesity | 24 | 21.8 |
| Percent Body Fat |  |  |
| Under-fat | 6 | 5.5 |
| Normal | 59 | 53.6 |
| Overfat | 26 | 23.6 |
| Obesity | 19 | 17.3 |
| Hemoglobin Level |  |  |
| Normal | 101 | 91.8 |
| Anemia | 9 | 8.2 |

**Table 2.** Relationship between Waist Circumference, Percent Body Fat, and WHtR with Hemoglobin Levels

|  |  |  |
| --- | --- | --- |
| Variable | p-value | r |
| Waist circumference | 0.54 | 0.058 |
| Percent body fat | 0.88 | -0.015 |
| WHtR | 0.27 | 0.106 |

The results of correlation analysis using the Spearman rank test showed that there was no relationship between hemoglobin levels and waist circumference, percent body fat, and WHtR (p > 0.05) (Table 2). This study is contrary to (Kerkadi et al., 2021) study that indicated Subjects with the higher waist circumference had lower serum Hb, serum iron, and transferrin saturation compared to those with normal waist circumference. This study also found that the women with a higher waist circumference showed a significant increase of CRP, indicated an inflammation in the subject with central obesity.

According to the theory, women tend to have a higher body fat percentage than men. Adipose tissue in women is found more in the thighs and calves, so women have a higher risk of experiencing obesity, especially gynoid obesity (Karastergiou et al., 2012). Categorization of nutritional status can be done through anthropometric measurements. Measurements of the human body are influenced by genetic, environmental, social, cultural, lifestyle, functional, and health factors. Anthropometric measurements can be utilized to evaluate the likelihood of malnutrition, obesity, muscle loss, excessive fat, and uneven distribution of fat. Circumferences, skinfold thickness, and body weight are potential factors that can be changed, while height and bone diameters cannot be altered (Padilla et al., 2021). Measurements of waist circumference and waist circumference-height ratio are known to be more sensitive measurements for determining obesity status in adolescents than body mass index according to age, with sensitivity and specificity >0.8 (Mulyasari & Pontang, 2018).

Adolescent girls, in general, have a higher risk of experiencing anemia than adolescent boys. This is caused by various factors, such as menstruation which causes loss of blood and the iron contained in it in large volumes (Puspitasari et al., 2022). Dietary patterns also play an important role in the development of anemia in adolescent girls. A study found that unhealthy dietary patterns increased the possibility of anemia four times higher than healthy eating practices (Vaira et al., 2022). A Study found that low consumption of animal foods, fruits, peanuts, and vegetables are some factors that related to iron-deficiency anemia. Lack of awareness of consuming iron-rich food, supported by increasing habits of iron-inhibiting food consumption, such as coffee and tea after eating, may worsen the condition, increasing the risk of having iron deficiency anemia (IDA) (Belali, 2022; Riskika et al., 2023). Adolescent girls with low iron intake are eleven times higher of protein-energy-malnutrion (Telisa & Eliza, 2020). Adolescent girls also display a unique characteristic in striving for an ideal body weight. They tend to limit their intake, and, for a long term, it affects the dietary habit (Gandhi, 2022)

Obesity is also known to be one of the factors that can play a role in causing anemia in adolescent girls. A high percentage of body fat which is positively correlated with the incidence of obesity can cause low-grade inflammation. This mechanism causes an increase in serum hepcidin and serum interleukin-6. As a response to inflammation and infection that occurs, an important component of the immune system called toll-like receptors (TLR) will cause the erythropoiesis process to become ineffective, thus causing anemia caused by inflammation (Alshwaiyat et al., 2021).

The absence of a relationship between nutritional status based on waist circumference, waist circumference-height ratio, and body fat percentage in this study could be due to the majority of subjects in this study, according to hemoglobin levels, being considered as not anemic. . Another reason that may support the result is that anemia is the late stage of iron deficiency. There are several phases prior to iron deficiency anemia. The first phase of iron depletion is characterized by low ferritin levels. The second phase, iron deficiency without anemia, are observed as low in ferritin, serum iron, transferrin, but still normal in haemoglobin levels. Furthermore, Iron deficiency with anemia represents extreme iron depletion and shows noticeable signs and symptoms. As this events occurs, there is a decrease in erythropoiesis in the bone marrow which leads to low hemoglobin concentrations and the development of IDA (Yang et al., 2023).

This research is interesting to develop. This is because the prevalence of obesity and anemia in adolescent girls shows an increasing trend. Several factors can be added as determinants of the risk of obesity and anemia in adolescent girls.

# **Conclusion**

There is no correlation between hemoglobin levels and waist circumference, waist circumference-height ratio, and percent body fat in adolescent girls in Semarang City. Further research may be done on larger subjects to determine the factors that influence hemoglobin levels in adolescent girls.

# **Acknowledgement**

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|  | How do you get this number of respondents? | 1 | 1 | Using the Lemeshow formula. We aren’t adding the formula in abstract, but we mentioned it on the method |
|  | Senior High School | 1 | 1 | As already mentioned in the paper |
|  | How do you carry out sampling techniques? | 1 | 1 | It is already mentioned in the abstract as purposive sampling |
|  | The research results were not related, please analyze the relationship between two variables using numerical data | 1 | - | The author has analyzed all the data using numerical values. However, the result showed no relationship. |
|  | Describe the findings of Hemoglobin levels | 1 | 1 | It is already mentioned as anemic |
|  | Grammar? | 1 | 1 | It is already revised |
|  | Why causes all these body composition variables to be unrelated to hemoglobin levels among adolescent girls? Explain it! | 1 | 4-6 | The authors have tried to explain the reason on the discussion part |
|  | girls | 1 | 1 | The keywords have been updated and arranged alphabetically |
|  | body composition, hemoglobin levels | 1 | 1 | The keywords have been updated and arranged alphabetically |
|  | Komposisi tubuh | 1 | 1 | The keywords have been updated and arranged alphabetically |
|  | Socioemotional factors | 2 | 2 | The keywords have been updated and arranged alphabetically |
|  | Put the data as evidence based | 2 | 2 | It is already revised |
|  | How big is the population?  Do you used sampling size formula?  How to select them as respondent? | 2 | 2 | Already mentioned in the method. We are using Lemeshow formula and purposive sampling techniques |
|  | Were they grouped on “currently having periods/not currently having periods”? As it can affect Hb level. | 2 | 2 | The students who were in periods are excluded, so that we add more exclusion criteria. Already revised |
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|  | Who took the data?  How did you use Ethical Clearance in this study? | 3 | 3 | Already mentioned in the paper. We as the authors took the data ourselves |
|  | According to? Please mention the body regulating this criteria. | 3 | 3 | WHO. Already mentioned in the paper |
|  | There were no association among variables.  Change your analysis by use numeric data between two variables | 3 | 3 | The data has been analyzed in numeric. We’ve tried to re-analyze it and found the same result |
|  | Please cluster these groups in the next submission | 3 | 3 | We have already mention it on the Table 1 |
|  | What is this? | 4 | 4 | Already mentioned in the paper |
|  | Use the up to date reference, at least the last 5 years.  Use references sourced from the AcTion Journal | 4 | 4 | We’ve add 2 paper from action and revised the old citation |