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Correlation between Hemoglobin Level and Physical Fitness in Adolescent Women

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Abstract

Introduction

Physical fitness plays an important role in a person's life in carrying out daily activities and is assessed by VO2 max. Anemia interferes with the delivery of oxygen to tissues and causes a reduction in VO2 max. This study aims to analyze the relationship between hemoglobin levels and physical fitness in adolescent girls.

Methods

This research is an analytical observational study with a cross-sectional approach. A total of 102 young women who met the inclusion and exclusion criteria were recruited as subjects in this study. Physical fitness was assessed using the Multistage Fitness Test, and hemoglobin levels were measured using the Point of Care Testing method. Data analysis was carried out using the Spearman correlation test with a significance level of $p<0.05$.

Results

The average value of hemoglobin levels in adolescent girls is 12.97 g/dL, which is considered normal. The average physical fitness based on VO2 max prediction is 24.65 ml/kg/minute, which is included in the very poor category. The Spearman test results showed that there was a significant correlation between hemoglobin levels and physical fitness ($p=0.001$).

Conclusion.

There is a significant correlation between hemoglobin levels and physical fitness in adolescent girls as assessed based on VO2 max predictions.

Keyword: Hemoglobin; Physical fitness; VO2 max; Bleef test

Latar Belakang

Physical fitness can describe a person's physical condition to carry out daily activities. Unfit individuals tire quickly, if fitness increases, more work can be done with the same exertion (Sharkey, B.J. 2011). Physical fitness is defined as the body's ability to carry out daily physical work by adapting to the environment and physical loads efficiently without significant fatigue (Kokkinos P, 2015). Physical fitness functions to improve work abilities so that they can perform work optimally with better results. VO2 max as a basic indicator of physical fitness. VO2 max is defined as the highest amount of oxygen achieved during exhausting exercise and is measured in milliliters of oxygen used per kilogram of body mass per minute (ml/kg/minute) (Coulson M, et al, 2009). Cardiorespiratory fitness is a strong independent predictor of cardiovascular risk factors in adolescents (Barker AR et al, 2018).

Hemoglobin is very important for transporting oxygen from the respiratory system to the muscle system, therefore, a lack of hemoglobin will reduce oxygen transportation for normal daily function. Various researchers have indicated the importance of hemoglobin levels on cardiovascular endurance. Anemia interferes with oxygen delivery to tissues and causes reduced VO2 max. The decrease in VO2 max that occurs in anemic individuals causes a decrease in blood oxygen transport by the body when doing heavy work. (Suneeta Kalasuramath, et al, 2015).

Anemia is a condition where the number of red blood cells or the concentration of hemoglobin in them is lower than normal. Anemia is a global public health problem, especially affecting adolescent girls,

women aged 15–49 years, pregnant women, and children in low- and middle-income countries. (WHO, 2024). WHO estimates that in 2023 around 30.7% of women aged 15-49 years worldwide will suffer from anemia and in the Southeast Asia Region 46.4%. (WHO, 2025). In Indonesia, the prevalence of anemia in the 15-24 year age group is 32.0%. (Riskesdas 2018). As many as 62.5% of adolescent girls in Sanur Village, Denpasar City, Bali Province, Indonesia suffer from anemia (Sheila, et al, 2024). Adolescent girls are very susceptible to anemia due to lack of iron to support rapid growth, menarche, blood loss due to menstruation.

Anemia problems can reduce physical fitness due to lack of oxygen to muscle cells. Anemia, especially if it occurs in women of productive age (mothers-to-be), has long been thought to trigger many bad consequences, including babies born with a body weight below the reference standard, births that are not at full term, and academic abilities that cannot be restored as well as the potential for growth and development disorders resulting in children becoming stunted (Nadhiroh et al., 2023).

Research on hemoglobin and physical fitness has been carried out before, but the results are contradictory. A Prospective Study in First Year MBBS Students of Southern Odisha, India conducted by Minati Patnaik, et al (2021) shows that there is a significant positive correlation between hemoglobin concentration and VO2max in women ($r = 0.5112$, $P < 0.0001$. Research conducted by Wati proves that an athlete who has high hemoglobin levels has a good VO2 max. (Wati, et al, 2021). However, research conducted by Laurensia Mei Vrayanti Hutajulu showed that anemia status was not significantly related to physical fitness ($p>0.05$). This research aims to analyze the relationship between hemoglobin levels and physical fitness in adolescent girls.

Method

The design of this research is observational analytic with a cross-sectional approach. The research was carried out in May-July 2025 at the Youth Posyandu in the Tampaksiring II Community Health Center Area, Tampaksiring District, Gianyar Regency, Bali Province. The implementation of this research has received ethical approval from the Health Research Ethics Commission of Politeknik Kesehatan Kemenkes Denpasar, with the issuance of Ethical Approval No. DP.04.02/F.XXXII.25/ 721/2025.

The population in this study were young women participating in the youth posyandu in the working area of the Tampaksiring II health center. In the Tampaksiring II Community Health Center working area, there are three youth posyandu spread across three villages, namely Pejeng Kangin Village, Pejeng Kelod Village and Pejeng Kawan Village. The sample in this study was all young women participating in the youth posyandu who met the inclusion criteria, namely 13-18 years of age, were willing to take part in the research by signing an informed consent, and did not have heart or lung disease. The exclusion criterion was that the subject withdrew during the research. A total of 102 samples met the inclusion and exclusion criteria.

The data used is primary data. Data collection was carried out by assessing physical fitness which was assessed by predicting VO2 max using the Multistage Fitness Test (MST) or Bleep Test method, as an indicator of adolescent cardiorespiratory endurance. The Multistage Fitness Test is a back and forth running test in stages on a 20 meter long track according to the level that can be done. Before the test begins, warm up for 10 minutes. The test participant runs according to the Bleep rhythm until he is unable to keep up with the rhythm's speed. Verbal encouragement is given to motivate participants to perform optimally. Physical fitness is categorized based on predicted VO2 max, namely very poor: <25.00 ml/kg/minute, poor: 25.00-30.90 ml/kg/minute, fair: 31.00-34.90 ml/kg/minute, good: 35.00-38.90 ml/kg/minute, excellent: 39.00-41.9 ml/kg/minute, and superior: > 41.9 ml/kg/minute (Fenanlampir, A et al, 2015). The sample's hemoglobin level was measured using the POCT (Point of Care Testing) method by a medical laboratory technologist. If the hemoglobin level is ≥12 it is classified as normal while the Hb level <12 is classified as anemia. (WHO, 2024).

Data is processed using a computer program. Data distribution was checked for normality using the Kolmogorov Smirnov test. Correlation between hemoglobin levels and physical fitness in non-normally distributed data using the Spearman Rank correlation test. The level of statistical significance was set at $p < 0.05$.

Results

The age range of research subjects was 13 to 18 years. The age distribution of research subjects is presented in table 1.

Table 1. Age Distribution of Research Subjects

Age (Years)	Frequency	Percentage
13-15	90	88,2
16-18	12	11,8
Total	102	100,0

Our research shows that the range of hemoglobin levels in research subjects is 9.8-15.7 g/dL, with an average of 12.97 g/dL. Physical fitness is based on predicted VO2 max with a range of 20.75 – 27.95 ml/kg/minute and an average of 24.65 ml/kg/minute which is included in the very poor category. For more details, the research variable data can be seen in table 2.

Table 2. Minimum Value, Maximum Value, and Mean Value of Research Variables

Variable	Minimum	Maximum	Mean
Hemoglobin (g/dL)	9,8	15,7	12,97
Predicted VO2 max (ml/kg/minute)	20,75	27,95	24,65

Research shows that 31.4% of research subjects experienced anemia and the subjects' physical fitness levels were classified as very poor (52.0%) and poor (48.0%). Complete data is presented in table 3.

Table 3. Anemia Status and Physical Fitness

Variable	Frequency	Percentage
Anemic Status		
Anemia	32	31,4
Normal	70	68,6
Physical Fitness		
Very poor	53	52,0
Poor	49	48,0

Our research shows that there is a significant correlation between hemoglobin levels and physical fitness as assessed by VO2 max prediction (p=0.000; r=0.724). This means that the higher the hemoglobin level, the higher the VO2 max, and vice versa, the lower the hemoglobin level, the lower the VO2 max.

Discussion

Maximum oxygen uptake (VO2 max) is the maximum amount of oxygen a person can obtain during exercise (Atiqa Ashfaq,.et al, 2022). Physical fitness assessment is carried out by measuring one of the fundamental components, namely VO2 max, which is the maximum capacity to breathe oxygen. Based on the results of our research from 102 research subjects, 52.0% had physical fitness in the very poor category and 48.0% were considered poor, with an average predicted VO2 max of 24.65 ml/kg/minute. This result is similar to that found by Jimmy Ch. Atty for Students of PJKR Study Program is 24.50 ml/kg/minute. However, the majority (95.51%) of students' physical fitness was very poor and 4.28% were poor (Jimmy Ch. Atty, 2024). Likewise, the estimated average VO2 max observed in Andries Monyeki's Makama study was 28.40 ml/kg/minute for girls which is far below the estimated average ˙VO2 max of 47.7 ml/kg/minute from international data for girls aged 12 to 14 years. (Andries Monyeki, et al, (2024).

The low level of physical fitness in our study may be due to low physical activity among adolescent girls. The test is carried out by running 20 meters, starting with a slow rhythmic run and continuing as the level increases, causing the young women to be unable to keep up with the increase in rhythmic speed to reach the maximum limit. Another influencing factor is the low motivation of test participants to perform optimally, even though verbal encouragement is given to motivate participants. The link between physical activity and physical fitness refers to the capacity of the circulatory and respiratory systems to supply oxygen to skeletal muscle mitochondria for the production of energy required during physical activity. (Robert Ross, et al, 2016). This is also in accordance with Laurensia Mei Vrayanti Hutajulu's research on 129 samples showing female students' physical activity has a positive correlation with physical fitness where

increasing physical activity can increase the VO2 max value ($p<0.001$; $r=0.32$). (Laurensia Mei Vrayanti Hutajulu, et al, 2021). Physiological factors that influence VO2 max are the quality of the cardiovascular system in supplying the necessary oxygen to the muscles and the ability of the muscles to extract and utilize the oxygen that has been provided. Beneficial effects of exercise for fitness-related metabolic and cardiorespiratory improvements. Regular exercise is undoubtedly important for overall health (Yan Qiu, et al, 2023). The anemia status factor also influences physical fitness in young women.

Our study found a significant correlation between hemoglobin levels and fitness as assessed by VO2 max prediction ($p=0.000$; $r=0.724$). This means that the higher the hemoglobin level, the higher the VO2 max, and vice versa, the lower the hemoglobin level in the body, the lower the oxygen transport into the blood, the lower the VO2 max. These results are in line with previous research conducted by Sheila on young women at the youth posyandu in Sanur Tourism Village, Denpasar, Bali, showing that there was a significant relationship between anemia status and physical fitness with p-value = 0.000. (Sheila, et al, 2024). The decrease in VO2 max that occurs in anemia sufferers is likely caused by low hemoglobin levels and as a result reduced blood oxygen transport. Likewise, other studies found a strong relationship between hemoglobin levels and VO2 max in young women in India. (Suneeta Kalasuramath, 2025). A Prospective Study in First Year MBBS Students of Southern Odisha, India showed that there was a significant positive correlation between hemoglobin levels and VO2 max in women ($r = 0.5112$, $p < 0.0001$). (Minati Patnaik et al, 2021).

Anemia is a condition when the number of red blood cells or hemoglobin concentration in the blood is below the required normal limit. In fact, anemia is not a disease, but rather a collection of symptoms that occur as a result of decreased hemoglobin concentration in the blood (Turner et al., 2023). In our study, we found that 31.4% of adolescent girls were anemic, with the lowest hemoglobin level being 9.8 mg/dl. Our research results are in line with Salvatheana Patrisia which shows that 33% of junior high school students in Kupang City suffer from anemia (Salvatheana Patrisia, 2025). This result is lower than Sheila's research on Adolescent Girls at the Adolescent Posyandu of Sanur Tourism Village which found that around 62.5% of teenage girls suffered from anemia (Sheila, 2024). In another study, 27% of adolescent girls in South Africa had low hemoglobin levels and 21% had iron deficiency without anemia. (Makama Andries Monyeki, 2024).

Most cases of anemia that occur in Indonesia occur due to inadequate iron intake from food and this applies to all groups prone to anemia, including young women (Zulfa, 2023). Severe iron deficiency can reduce hemoglobin levels, reduce erythropoiesis, and result in iron deficiency anemia. In general, iron deficiency anemia is caused by gastrointestinal bleeding and menstrual bleeding, but it can also be caused by a lack of iron intake from food and other things that make it difficult to absorb iron. Therefore, the main goal of preventing iron deficiency anemia is to improve diet in an effort to replenish iron reserves in the body and return hemoglobin to normal levels (Moisidis-Tesch & Shulman, 2022).

Conclusions

Our research concluded that the average hemoglobin level in adolescent girls was 12.97 g/dL. As many as 31.4% of adolescent girls experience anemia. The physical fitness of young women is classified as very poor (52.0%) and poor (48.0%), with an average predicted VO2 max of 24.65 ml/kg/minute. There is a significant relationship between hemoglobin levels and physical fitness with p value = 0.000 and correlation coefficient (r) = 0.724.

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