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Terima kasih

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Hemoglobin level related to physical fitness among female adolescents in rural area

Running title : Physical fitness among female adolescents

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Hemoglobin level related to physical fitness among female adolescents in rural area

Abstract

Background : Physical fitness is an indicator in assessing body's performance and it's influenced by various factors. This study aims to identify the factors related to physical fitness in female adolescents in rural areas.

Methods : This study was an observational study with a cross sectional design. 40 female adolescents in Pasawahan Sub-district, Purwakarta Regency were recruited as research subjects. Female adolescents which were recruited must be in a healthy status and not smoking. General characteristics of subjects were collected by structured questionnaire. Physical fitness was measured by Harvard Step Test, each subject had to step-up and step-down on harvard bench around 3 minutes. Hemoglobin level was measured by spectrophotometer using cyanmethemoglobin method, and food intake were also collected by interviewing subjects using 24 hours food recall form. Data were analyzed using Rank Spearman and Linear Regression.

Results : The results showed that the physical fitness of 75% subjects were classified as weak, even though their nutritional status were mostly (75%) were categorized as normal. All subjects had an iron deficiency level as well as 85% of subjects also had a vitamin C deficiency. This study also found that hemoglobin levels proved to be the main factor on affecting the physical fitness of subjects ($p = 0.044$).

Conclusions : In conclusion, the physical fitness of female adolescents in rural area was influenced by hemoglobin levels.

Keywords : physical fitness, hemoglobin level, female adolescents, rural area

Introduction

Physical Fitness is a person's ability to carry out daily activities with optimal performance, endurance and strength.¹ A person with good physical fitness will be able to do daily activities without causing excessive fatigue afterwards. Physical fitness is one of the important factors that allows people to lead healthy and active lives. When having good physical fitness, work performance will also get better. It is proven that a high cardiorespiratory fitness level is related with better firefighters' performance.² Other studies have also stated that the cardiorespiratory fitness level is related to the learning performance of school students. A study in Japan showed that there was a strong relationship between physical fitness and children's academic performance.³ This is in contrast to conditions that occur in society, where physical fitness is not considered an important thing that can affect work and learning performance. Research in Malang on high school adolescents showed that as many as 62% of subjects have poor physical fitness, and 38% of moderate physical fitness,⁴ while studies on high school adolescents in Subang showed that as many as 94.4% of subjects have less physical fitness.⁵

The level of physical fitness is influenced by several things, including nutritional intake, nutritional status, hemoglobin level, level of physical activity, age, sex, smoking habits, race and genetics.⁶ The level of physical fitness in women tends to be lower than in men, this is due to hemoglobin levels, body composition and activity levels are different between women and men. Hemoglobin levels have an important role in determining a person's physical fitness, especially in female adolescents. In addition, there was indication that area condition is one of the factors related to physical fitness. A study in Germany showed that adolescents living in rural areas, which are synonymous with low socio-demographic conditions, have less physical fitness than adolescents living in urban areas.⁷ However, another study in Portugal showed that adolescents living in rural areas have better physical fitness than adolescents who live in urban areas.⁸ Therefore, this study aims to identify factors related to the physical fitness of female adolescents in rural areas.

Subjects and Methods

This research is an observational study with a cross sectional study design. Subjects in this study were 40 female adolescents in Pasawahan District, Purwakarta Regency. Subjects must be in good health at the time of the study and did not smoke. Data regarding subject characteristics were collected through a structured questionnaire. The subject's physical fitness was measured by the Harvard Step Test, required the subject to do climb up and down on a Harvard stool for 3 minutes and their pulse recovery was measured for 3 times (1st, 2nd, and 3rd minutes). Hemoglobin levels were measured by a spectrophotometer using the cyanmethemoglobin method. Nutritional status was measured by calculating the z-score based on measurements of height and weight. In addition, data regarding the

subject's nutritional intake, including total energy, iron intake, and vitamin C intake, were measured using the food intake form for 2x24 hours.

Physical fitness was categorized as poor (score <66), moderate (score between 67 - 79), and good (score > 80). Nutritional status was categorized into 3 categories, namely underweight (z-score <-2 SD), normal (z-score between -2 SD to +2 SD), and overweight (z-score > +2 SD). Meanwhile, the nutritional adequacy level was calculated by comparing the intake for 2x24 hours with Recommended Dietary Allowances (RDA) according to the age group. Total energy was categorized as sufficient if it met 100% based on the RDA requirement. Meanwhile, the adequacy level of iron and vitamin C is said to be sufficient if the value is equal to or above the RDA. In this study, several variables that have been homogenized which included age, gender, level of physical activity, and no smoking habit. Meanwhile, race and genetics were not studied in this study so they fall into the limitations of the study.

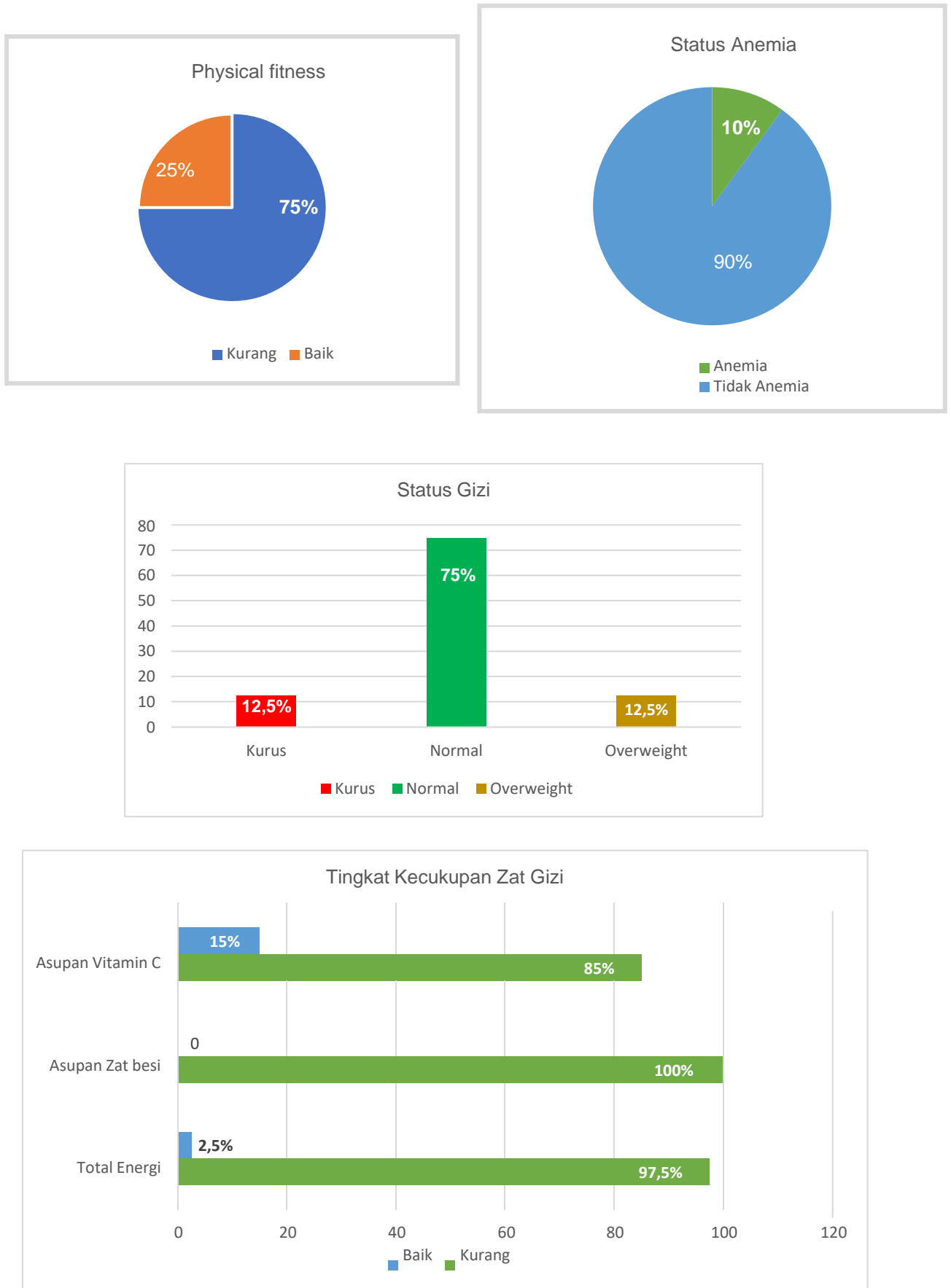
Data were analyzed using univariate, bivariate and bivariate analyzes. Univariate analysis was used to see the homogeneity of the data by testing the normality of the data using the Shapiro Wilk test. Bivariate analysis was used to see the relationship between variables of total energy, iron intake, vitamin C intake, nutritional status, and hemoglobin levels with physical fitness. Bivariate analysis was performed using the Rank-Spearman test. Meanwhile, to see the most influencing factors on the level of physical fitness of female adolescents in this study was tested by using the Linear Regression test. This research has passed the ethical test from the Health Research Ethics Commission of the Veterans National Development University Jakarta with the ethical clearance number: No. B/1634/X/2018/KEPK. All data and information obtained from research subjects in this study are strictly confidential.

Results

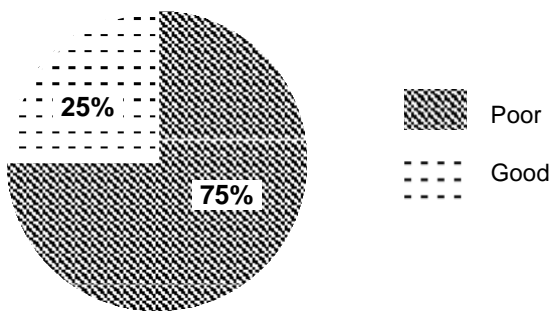
Subject Characteristics

The subjects in this study were female adolescents aged 15-16 years. The subject is a Sundanese tribe originating from the Pasawahan District, Purwakarta Regency. At the time of the study, the selected subjects were in good health and did not smoke, also had the same category of physical activity so that the data were homogeneous. The measurement results showed that most of the subjects had normal nutritional status (75%) and did not experience anemia (90%). However, when viewed from the level of physical fitness and the level of nutritional adequacy, most of the subjects were categorized as deficient (see table 1).

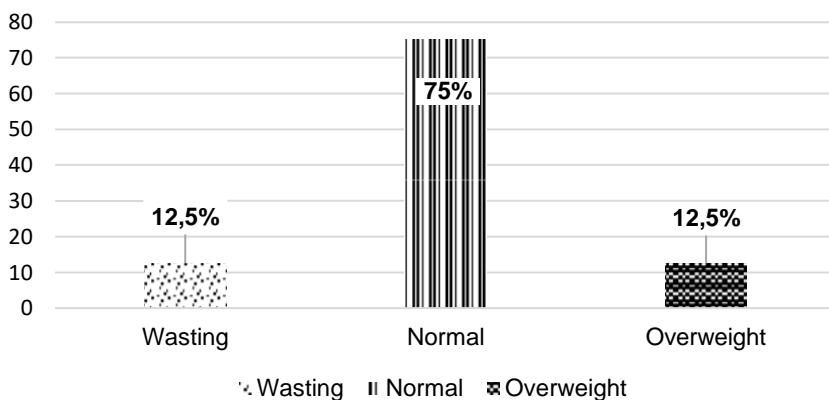
Picture 1 : Subject Characteristics



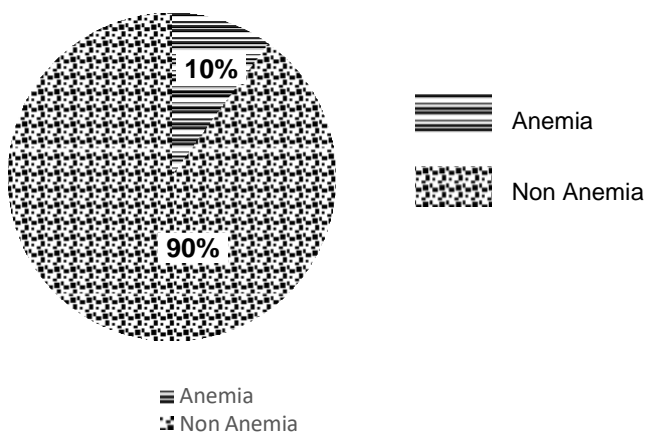
Physical fitness

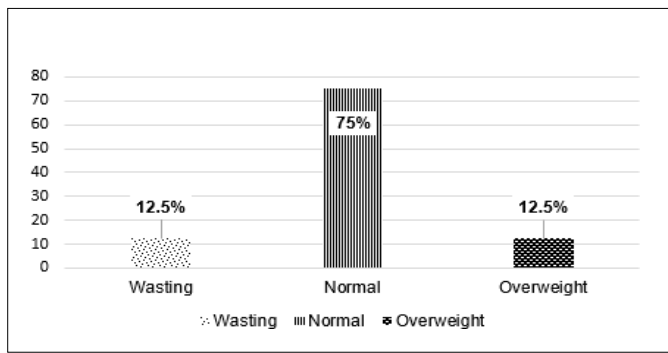
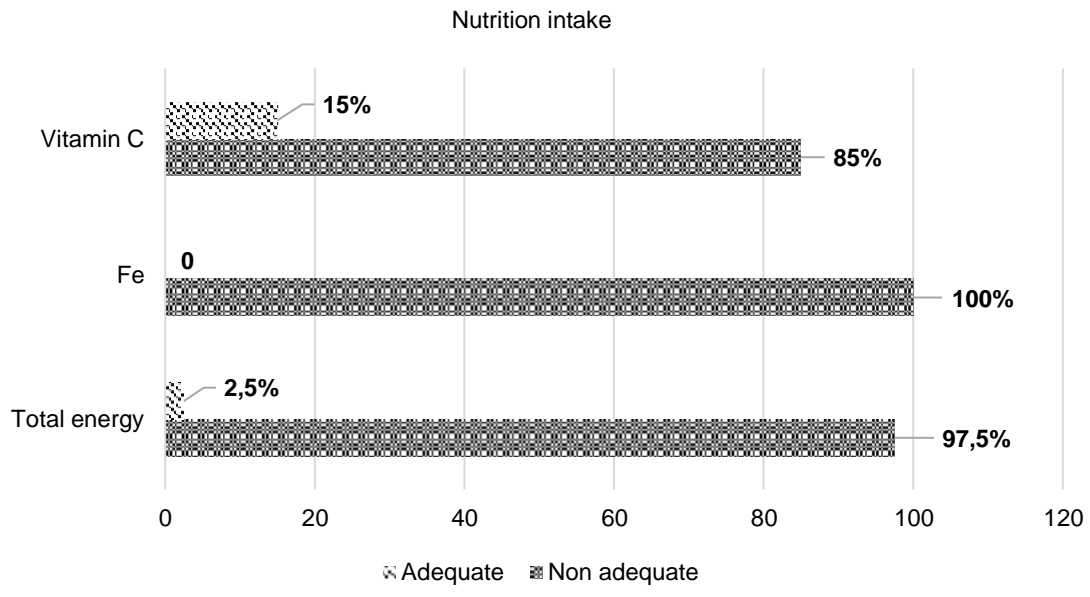


Nutritional Status



Anemia Status





Factors related to physical fitness of female adolescents

Table 1 : Factors related to physical fitness

Variables	Mean ± SD	p ^a
Nutritional Status	-0.0008 ± 0.87	0.330
Physical Fitness	62.77 ± 7.91	
Hemoglobin Levels	12.82 ± 0.63	0.031*
Physical Fitness	62.77 ± 7.91	
Energy Total	59.14 ± 0.23	0.318
Physical Fitness	62.77 ± 7.91	

Iron Intake	6.02 ± 3.94	0.182
Physical Fitness	62.77 ± 7.91	
Vitamin C Intake	36.08 ± 43.81	0.783
Physical Fitness	62.77 ± 7.91	

^a Rank Spearman test

The result of bivariate analysis showed that hemoglobin levels were related with female adolescent's physical fitness ($p=0.031$). However, to see which factors strongly affect physical fitness required further test with multivariate analysis. The eligible variables for the further multivariate test were hemoglobin levels and iron intake.

Table 2 : Linear Regression Analysis

Factor	B	SE	p	CI
Constant	9.607	23.834	0.689	-38.703 - 57.917
Hemoglobin Levels	3.906	1.873	0.044	0.112 - 7.700
Iron Intake	0.512	0.301	0.097	-0.097 - 1.121

The multivariate test results showed that hemoglobin levels were the only factor affecting female adolescent's physical fitness levels ($p<0.05$).

Discussion

Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, what this study adds to the available evidence, effects on patient care and health policy, possible mechanisms); Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research).

Acknowledgement

I would like express my gratitude to my institution, Diponegoro University and my research team partner institution, STIKes Holistik Purwakarta, for their support so that researchers can complete this research

well. I also want to deliver my appreciation to the research subjects who have participated and helped carry out the data collection well.

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Tue, Dec 22, 2020 at 1:45 PM

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Berikut kami kirimkan hasil review naskah artikel yang sudah Bapak/Ibu Submit ke Annals of Tropical Medicine and Public Health (ATMPH). **Mohon Penulisan Nama Author tidak dibalik**, dan di cek kembali untuk keseluruhan galley proof naskahnya. **Jika ada beberapa poin yang harus diperbaiki, reviewer sudah menandai dengan highlight warna kuning** inggih. Untuk penulisan nama author mengikuti kaidah berikut :

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Dian Permana
Sunarto Sunarto

Mohon naskah dapat diperbaiki dan dikirim kembali kepada kami maksimal **Rabu, 23 Desember 2020 pukul 13.00 WIB**.

Terima kasih.

Salam,
Panitia The 3rd ICOPH-TCD

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Hemoglobin level in relation with physical fitness among female adolescents in rural area

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Abstract

Background :Physical fitness is an indicator in assessing body's performance and it is influenced by various factors including gender. Previous research has shown that physical fitness among male is higher than female. **Aims**: This study aims to identify the factors related to physical fitness in female adolescents in rural area. **Settings and Design**: This study is an observational study with a cross-sectional design. **Methods and Material**: 40 female adolescents in Pasawahan Sub-district, Purwakarta Regency were recruited as research subjects. Female adolescents who were recruited must be in a healthy status and did not smoke. General characteristics of subjects were collected using structured questionnaire. Physical fitness was measured using Harvard Step Test. Each subject had to step-up and step-down on Harvard bench for around 3 minutes. Hemoglobin level was measured by spectrophotometer using cyanmethemoglobin method, and food intake was also collected by interviewing subjects using 24 hours food recall form. **Statistical analysis used**: Data were analyzed using Rank Spearman and Linear Regression. **Results**: The results showed that the physical fitness of 75% of subjects were classified as poor, even though their nutritional status mostly were categorized as normal (75%). All subjects had an iron deficiency level while 85% of subjects also had a vitamin C deficiency. This study also found that hemoglobin levels proved to be the main factor

which affected the physical fitness of subjects ($p = 0.044$). **Conclusions:** In conclusion, the physical fitness of female adolescents in rural area was influenced by hemoglobin level.

Keywords: physical fitness, hemoglobin level, female adolescent, rural area

Key Messages:

Hemoglobin plays an important role in the transportation of oxygen through the body. Therefore, it is very needed on the muscular and cardiorespiratory endurance activities.

Introduction

Physical Fitness is a person's ability to carry out daily activities with optimal performance, endurance, and strength.¹A person with good physical fitness will be able to do daily activities without causing excessive fatigue afterwards. Physical fitness is one of the important factors that allow people to lead healthy and active lives. Having good physical fitness will also improve work performance. It has been proven that a high cardiorespiratory fitness level is related to better fire fighters' performance.²Other studies have also stated that the cardiorespiratory fitness level is related to the learning performance of school students. A study in Japan showed that there was a strong relationship between physical fitness and children's academic performance.³This is in contrast with the conditions that occur in society, where physical fitness is not considered an important thing that can affect work and learning performance. A research in Malang conducted on high school adolescents showed that as many as 62% of subjects had poor physical fitness, and 38% had moderate physical fitness,⁴while studies on high school adolescents in Subang showed that as many as 94.4% of subjects had poor physical fitness.⁵

The level of physical fitness is influenced by several factors including nutrition intake, nutritional status, hemoglobin level, level of physical activity, age, sex, smoking habit, race, and genetics.⁶The level of physical fitness in women tends to be lower than in men. This is due to hemoglobin level, body composition, and activity levels which are different between women and men. Hemoglobin levels have an important role in determining a person's physical fitness, especially in female adolescents. In addition, there is an indication that area condition is one of the factors related to physical fitness. A study in Germany showed that adolescents who lived in rural areas, which are synonymous with low socio-demographic conditions, had less physical fitness than adolescents who lived in urban areas.⁷However, another study in Portugal showed that adolescents who lived in rural areas has better physical fitness than adolescents who lived in urban areas.⁸As the correlation between physical fitness

and rural areas is unclear, this study aims to identify factors related to the physical fitness of female adolescents in rural area.

Subjects and Methods

This research is an observational study with a cross-sectional study design. Subjects in this study were 40 female adolescents in Pasawahan District, Purwakarta Regency. Subjects must be in good health at the time of the study and did not have smoking habit. Data regarding subject characteristics were collected through a structured questionnaire. The subjects' physical fitness was measured by the Harvard Step Test, which required them to do step-up and step-down on a Harvard stool for 3 minutes. Their pulse recovery was measured 3 times (1st, 2nd, and 3rd minutes). Hemoglobin levels were measured by a spectrophotometer using the cyanmethemoglobin method. Nutritional status was measured by calculating the z-score based on measurements of height and weight. In addition, data regarding the subjects' nutrition intake, including total energy, iron intake, and vitamin C intake, was measured using 2x24 hours food recall form.

Physical fitness was categorized as poor (score <66), moderate (score between 67 - 79), and good (score > 80). Nutritional status was categorized into 3 categories, namely underweight (z-score < -2 SD), normal (z-score between -2 SD to +2 SD), and overweight (z-score > +2 SD). Meanwhile, the nutrition adequacy level was calculated by comparing the intake in 2x24 hours with Recommended Dietary Allowances (RDA) according to the age group. Total energy was categorized as adequate if it reached 100% based on the RDA requirement. Meanwhile, the adequacy level of iron and vitamin C was classified to be adequate if the value was equal to or above the RDA. In this study, several variables that were homogenized included age, gender, level of physical activity, and no smoking habit. Meanwhile, race and genetics were not measured in this study, therefore those variables are included in the limitations of the study.

Data were analyzed using univariate, bivariate, and multivariate analysis. Univariate analysis was used to see the homogeneity of the data by testing the normality of the data using the Shapiro Wilk Test. Bivariate analysis was used to see the relationship between the variables of total energy, iron intake, vitamin C intake, nutritional status, and hemoglobin level with physical fitness. Bivariate analysis was analyzed using Rank-Spearman Test. Meanwhile, to see the most influential factors of the level of physical fitness of female adolescents, this study used the Linear Regression Test.

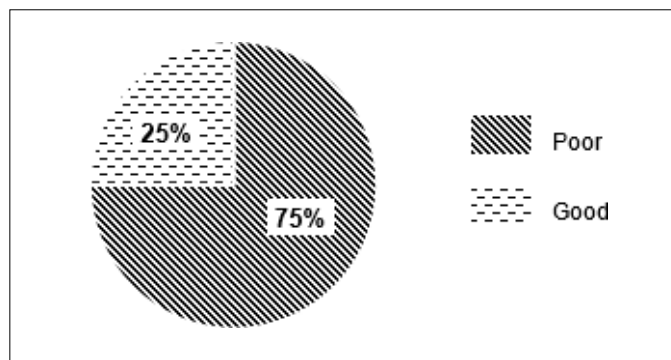
This study has passed the ethical review from the Health Research Ethics Commission of the Universitas Pembangunan Nasional Veteran Jakarta with the ethical clearance number: No. B/1634/X/2018/KEPK. All data and information obtained from research subjects in this study are strictly confidential.

Results

Subject Characteristics

The subjects in this study were female adolescents aged 15-16 years. The subjects were Sudanese tribe originating from the Pasawahan District, Purwakarta Regency. At the time of the study, the selected subjects were in good health and did not smoke. Subjects also had the same category of physical activity so that the data were homogeneous. Physical fitness has various components, i.e. muscular and cardiorespiratory endurance. Those components also become indicators of the general physical fitness of people. In this study, physical fitness was measured using Harvard Step Test. Classification of physical fitness was based on the calculation of pulse recovery in the 1st, 2nd, and 3rd minute closely after the measurement. The physical fitness of subjects in this study were categorized as poor (75%) and good (25%).

Figure 1 : Physical fitness of subjects



The data showed that most of subjects had poor physical fitness. Some previous studies have stated that poor physical fitness has an influence in people’s daily activities, therefore it is also related to their nutritional status. This study found that most of the subjects had normal nutritional status (75%) and did not have risk of anemia (90%).

Figure 2 : Anemia status of subjects

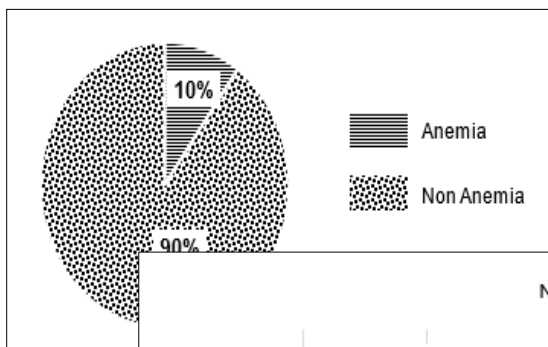
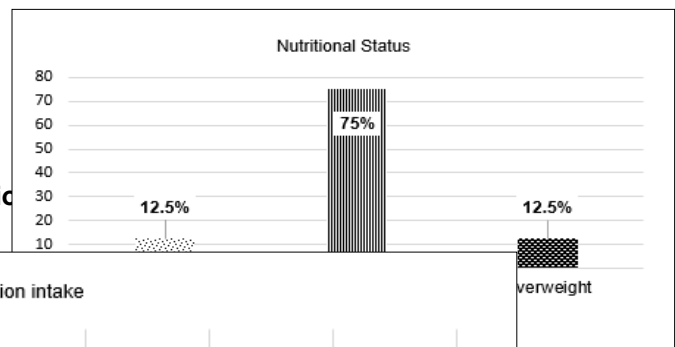


Figure 3 : Nutritional status of subjects



Based on Figure 4, subjects who had adequate total energy were only 2.5% and the rest were classified as non-adequate (97.5%). Another nutrition intake such as vitamin C and Fe intake of the subjects were also classified as non-adequate, i.e. 85% and 100%, respectively. The dietary habit of Sudanese tribe may be one of the aspects that influence the subjects' nutrition intake. The description of the kind and culture of dietary habit will be presented on the discussion.

Factors related to physical fitness

Physical fitness is influenced by many factors, such as nutritional status, hemoglobin level, total energy, iron (Fe) intake, and vitamin C intake. In the bivariate analysis, this study found that hemoglobin level was related to physical fitness of the subjects (Table 1).

Table 1 : Factors related to physical fitness

Variables	Mean ± SD	<i>p</i>^a
Nutritional status Physical fitness	-0.0008 ± 0.87 62.77 ± 7.91	0.330
Hemoglobin level Physical fitness	12.82 ± 0.63 62.77 ± 7.91	0.031*
Total energy Physical fitness	59.14 ± 0.23 62.77 ± 7.91	0.318
Iron (Fe) intake Physical fitness	6.02 ± 3.94 62.77 ± 7.91	0.182
Vitamin C intake Physical fitness	36.08 ± 43.81 62.77 ± 7.91	0.783

^a Rank Spearman Test

The average hemoglobin level of the subjects in this study was 12.82 ± 0.63 g/dL, so it was categorized as normal. Even though the data showed that hemoglobin level was the only factor related to physical fitness as its significance level was less than 0.05 ($p=0.031$) and eligible for multivariate analysis, iron intake was also eligible for multivariate analysis as its significance level was less than 0.25 ($p=0.182$).

Table 2 : Linear Regression Analysis

Factor	B	SE	<i>p</i>	CI
Constant	9.607	23.834	0.689	-38.703 - 57.917
Hemoglobin level	3.906	1.873	0.044	0.112 - 7.700
Iron intake	0.512	0.301	0.097	-0.097 - 1.121

The multivariate analysis found that hemoglobin level was the only factor that was strongly related to physical fitness of the subjects ($p<0.05$). The determination coefficient (R^2) of this analysis was 14.2%, meaning that 14.2% of the subjects' physical fitness was affected by hemoglobin level while 85.8% was affected by other factors. This study also showed that every 1 g/dL increase in hemoglobin levels would increase 3.906 of the subjects' physical fitness scores.

Discussion

The definition of being healthy according to World Health Organization (WHO) is not always related to the presence of disease, but also a condition of being well physically, mentally, and socially. People with healthy status could do various activities comfortably; therefore having a good physical fitness is quite important. The level of physical fitness is one of the factors that affect adolescent's health. Adolescents with an average age of 19 years need good physical fitness. A good level of physical fitness is expected to improve the quality of physical activity both academically, practically and in everyday situations.⁹This study found that 75% of the subjects had poor level of physical fitness, although most of the subjects had normal nutritional status. Several studies have linked the relationship between high body mass index (BMI) with poor performance in weight-bearing activities. However, the relationship between children's weight and muscle strength has not been consistent.¹⁰⁻
¹³A study reported that the status of obesity and overweight had a negative impact on aerobic capacity, agility, lower limb strength, and body balance. However, several studies have reported that overweight children do better than obese children in weight-bearing activities. This condition can be caused by the fact that the quantity of fat mass as an inert load is higher in obese children than

overweight children, therefore it limits the physical movement, physical activity, and the development of motor skills of obese children.^{14,15}

This study also found that physical fitness among female adolescents were not related to nutrition intake. The iron intake of all of subjects were classified as non-adequate. Based on RDA, the recommended intake of iron for female adolescents aged 16-18 years is 26 mg, while the average intake of the subjects in this study was 6.02 ± 3.94 mg. The low level of iron adequacy may be due to low knowledge of iron sources and a lack of diversity in food consumption. Dietary habit in rural area is usually still related to the cultural aspect. The Sudanese tribe often provides tea in their daily consumption. Tea (*Camellia sinensis*) is one of the plant species which contain stanin. If the subjects had high consumption of tea, it would make the iron intake became poorly absorbed by the body a stanin could impair iron absorption. Insufficient consumption of iron in the daily diet increases the risk of anemia in female adolescents. Iron (Fe) is an important trace element for humans which acts as an activator and cofactor of energy metabolism, hemoglobin synthesis, and oxygen transport of muscle tissue.¹⁶

Hemoglobin level was the only variable related to physical fitness among female adolescents. One study reported that there was a significant relationship between hemoglobin level and physical fitness in students. The higher the hemoglobin level, the better the student's physical fitness level, where the hemoglobin level contributed 9.72% to the student's physical fitness.¹⁷The relationship between hemoglobin level and physical fitness was strengthened by another research conducted on students of Muhammadiyah 1 Ponorogo high school which found that hemoglobin levels were associated with physical fitness. Students with anemia had 9.3 times greater risk of having less physical fitness than students who did not suffer from anemia. Hemoglobin is a medium for transporting oxygen from the lungs to all body tissues and bringing back carbon dioxide from the body's cells to the lungs to be excreted from the body. Decreased oxygen supply due to a lack of hemoglobin in the blood results in fatigue, drowsiness, and difficulty concentrating while studying or working, so that the work and study performance would also decrease as well.¹⁸

Lack of hemoglobin in the blood will cause a decrease in oxygen that is being transported to the body and brain cells, and it will also cause symptoms of fatigue. A person who has hemoglobin deficiency or abnormal red blood cells experiences abnormality in the exchange process of oxygen and carbon dioxide in the blood vessels, which will result in decreasing physical fitness.¹⁹During muscular endurance and cardiorespiratory endurance activities, the diffusion of oxygen and carbon dioxide throughout the capillaries and alveolar membrane capillary tissue increases. Oxygen and carbon dioxide are transported by the blood, mainly in chemical combination by diffusing and dissolving in the plasma. Oxygen that diffuses into red blood cells combines chemically with hemoglobin (Hb) to form

oxyhemoglobin (HbO₂). This process increases the oxygen attraction carrying capacity of the blood by about 65 times. An increase in the amount of hemoglobin will increase the oxygen carrying capacity as well as muscle endurance and cardiorespiratory endurance.²⁰

Conclusion

Physical fitness is one of the indicators of human health and it is influenced by many factors including hemoglobin level. The hemoglobin level among female adolescents in rural area depended on the dietary habit of the area itself. In this situation, culture's belief also became a main factor that determined the dietary habit. Execution of a strategic intervention is very needed to solve this case. Therefore, nutrition education regarding dietary habit that can fight against anemia should be provided in rural area.

Acknowledgement

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Hemoglobin level in relation with physical fitness among female adolescents in rural area

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Abstract

Background : Physical fitness is an indicator in assessing body's performance and it is influenced by various factors including gender. Previous research has shown that physical fitness among male is higher than female. **Aims**: This study aims to identify the factors related to physical fitness in female adolescents in rural area. **Settings and Design**: This study is an observational study with a cross-sectional design. **Methods and Material**: 40 female adolescents in Pasawahan Sub-district, Purwakarta Regency were recruited as research subjects. Female adolescents who were recruited must be in a healthy status and did not smoke. General characteristics of subjects were collected using structured questionnaire. Physical fitness was measured using Harvard Step Test. Each subject had to step-up and step-down on Harvard bench for around 3 minutes. Hemoglobin level was measured by spectrophotometer using cyanmethemoglobin method, and food intake was also collected by interviewing subjects using 24 hours food recall form. **Statistical analysis used**: Data were analyzed using Rank Spearman and Linear Regression. **Results**: The results showed that the physical fitness of 75% of subjects were classified as poor, even though their nutritional status mostly were categorized as normal (75%). All subjects had an iron deficiency level while 85% of subjects also had a vitamin C deficiency. This study also found that hemoglobin levels proved to be the main factor which affected the physical fitness of subjects ($p = 0.044$). **Conclusions**: In conclusion, the physical fitness of female adolescents in rural area was influenced by hemoglobin level.

Keywords: physical fitness, hemoglobin level, female adolescent, rural area

Key Messages:

Hemoglobin plays an important role in the transportation of oxygen through the body. Therefore, it is very needed on the muscular and cardiorespiratory endurance activities.

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Introduction

Physical Fitness is a person's ability to carry out daily activities with optimal performance, endurance, and strength.¹ A person with good physical fitness will be able to do daily activities without causing excessive fatigue afterwards. Physical fitness is one of the important factors that allow people to lead healthy and active lives. Having good physical fitness will also improve work performance. It has been proven that a high cardiorespiratory fitness level is related to better firefighters' performance.² Other studies have also stated that the cardiorespiratory fitness level is related to the learning performance of school students. A study in Japan showed that there was a strong relationship between physical fitness and children's academic performance.³ This is in contrast with the conditions that occur in society, where physical fitness is not considered an important thing that can affect work and learning performance. A research in Malang conducted on high school adolescents showed that as many as 62% of subjects had poor physical fitness, and 38% had moderate physical fitness,⁴ while studies on high school adolescents in Subang showed that as many as 94.4% of subjects had poor physical fitness.⁵

The level of physical fitness is influenced by several factors including nutrition intake, nutritional status, hemoglobin level, level of physical activity, age, sex, smoking habit, race, and genetics.⁶ The level of physical fitness in women tends to be lower than in men. This is due to hemoglobin level, body composition, and activity levels which are different between women and men. Hemoglobin levels have an important role in determining a person's physical fitness, especially in female adolescents. In addition, there is an indication that area condition is one of the factors related to physical fitness. A study in Germany showed that adolescents who lived in rural areas, which are synonymous with low socio-demographic conditions, had less physical fitness than adolescents who lived in urban areas.⁷ However, another study in Portugal showed that adolescents who lived in rural areas has better physical fitness than adolescents who lived in urban areas.⁸ As the correlation between physical fitness

and rural areas is unclear, this study aims to identify factors related to the physical fitness of female adolescents in rural area.

Subjects and Methods

This research is an observational study with a cross-sectional study design. Subjects in this study were 40 female adolescents in Pasawahan District, Purwakarta Regency. Subjects must be in good health at the time of the study and did not have smoking habit. Data regarding subject characteristics were collected through a structured questionnaire. The subjects' physical fitness was measured by the Harvard Step Test, which required them to do step-up and step-down on a Harvard stool for 3 minutes. Their pulse recovery was measured 3 times (1st, 2nd, and 3rd minutes). Hemoglobin levels were measured by a spectrophotometer using the cyanmethemoglobin method. Nutritional status was measured by calculating the z-score based on measurements of height and weight. In addition, data regarding the subjects' nutrition intake, including total energy, iron intake, and vitamin C intake, was measured using 2x24 hours food recall form.

Physical fitness was categorized as poor (score <66), moderate (score between 67 - 79), and good (score > 80). Nutritional status was categorized into 3 categories, namely underweight (z-score < -2 SD), normal (z-score between -2 SD to +2 SD), and overweight (z-score > +2 SD). Meanwhile, the nutrition adequacy level was calculated by comparing the intake in 2x24 hours with Recommended Dietary Allowances (RDA) according to the age group. Total energy was categorized as adequate if it reached 100% based on the RDA requirement. Meanwhile, the adequacy level of iron and vitamin C was classified to be adequate if the value was equal to or above the RDA. In this study, several variables that were homogenized included age, gender, level of physical activity, and no smoking habit. Meanwhile, race and genetics were not measured in this study, therefore those variables are included in the limitations of the study.

Data were analyzed using univariate, bivariate, and multivariate analysis. Univariate analysis was used to see the homogeneity of the data by testing the normality of the data using the Shapiro Wilk Test. Bivariate analysis was used to see the relationship between the variables of total energy, iron intake, vitamin C intake, nutritional status, and hemoglobin level with physical fitness. Bivariate analysis was analyzed using Rank-Spearman Test. Meanwhile, to see the most influential factors of the level of physical fitness of female adolescents, this study used the Linear Regression Test.

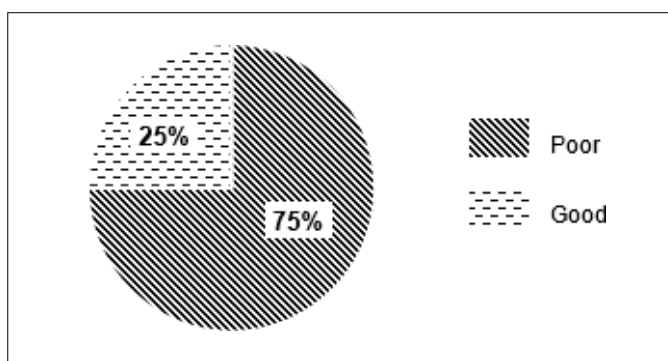
This study has passed the ethical review from the Health Research Ethics Commission of the Universitas Pembangunan Nasional Veteran Jakarta with the ethical clearance number: No. B/1634/X/2018/KEPK. All data and information obtained from research subjects in this study are strictly confidential.

Results

Subject Characteristics

The subjects in this study were female adolescents aged 15-16 years. The subjects were Sudanese tribe originating from the Pasawahan District, Purwakarta Regency. At the time of the study, the selected subjects were in good health and did not smoke. Subjects also had the same category of physical activity so that the data were homogeneous. Physical fitness has various components, i.e. muscular and cardiorespiratory endurance. Those components also become indicators of the general physical fitness of people. In this study, physical fitness was measured using Harvard Step Test. Classification of physical fitness was based on the calculation of pulse recovery in the 1st, 2nd, and 3rd minute closely after the measurement. The physical fitness of subjects in this study were categorized as poor (75%) and good (25%).

Figure1 : Physical fitness of subjects



The data showed that most of subjects had poor physical fitness. Some previous studies have stated that poor physical fitness has an influence in people's daily activities, therefore it is also related to their nutritional status. This study found that most of the subjects had normal nutritional status (75%) and did not have risk of anemia (90%).

Figure 2 : Anemia status of subjects

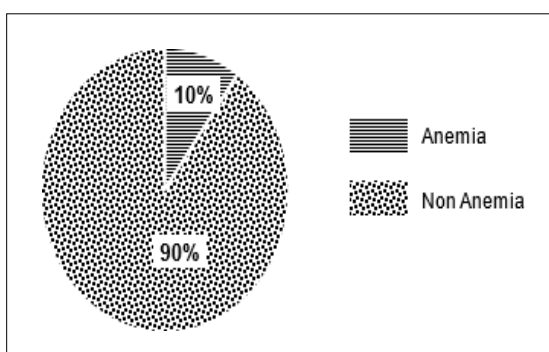


Figure 3 : Nutritional status of subjects

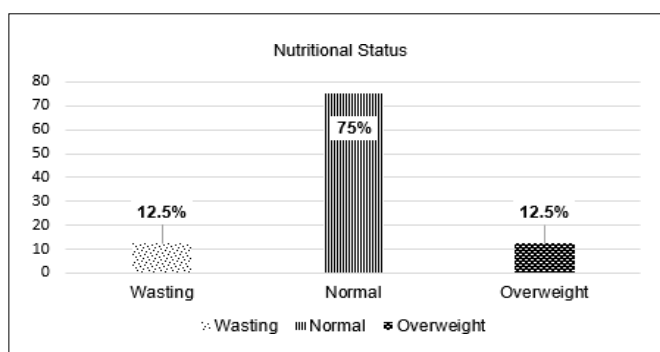
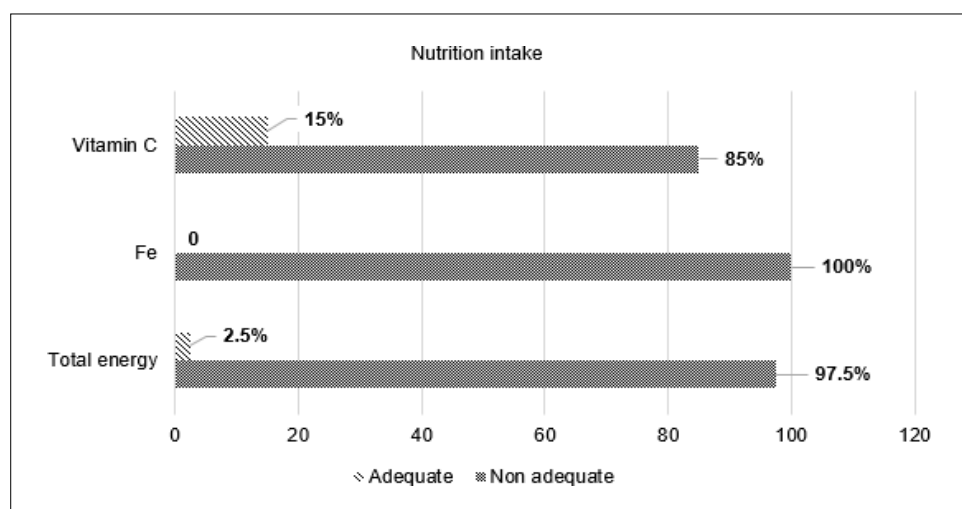


Figure 4 : Nutrition intake of subjects



Based on Figure 4, subjects who had adequate total energy were only 2.5% and the rest were classified as non-adequate (97.5%). Another nutrition intake such as vitamin C and Fe intake of the subjects were also classified as non-adequate, i.e. 85% and 100%, respectively. The dietary habit of Sundanese tribe may be one of the aspects that influence the subjects' nutrition intake. The description of the kind and culture of dietary habit will be presented on the discussion.

Factors related to physical fitness

Physical fitness is influenced by many factors, such as nutritional status, hemoglobin level, total energy, iron (Fe) intake, and vitamin C intake. In the bivariate analysis, this study found that hemoglobin level was related to physical fitness of the subjects (Table 1).

Table 1 : Factors related to physical fitness

Variables	Mean \pm SD	ρ^a
Nutritional status	-0.0008 \pm 0.87	0.330
Physical fitness	62.77 \pm 7.91	
Hemoglobin level	12.82 \pm 0.63	0.031*
Physical fitness	62.77 \pm 7.91	
Total energy	59.14 \pm 0.23	0.318
Physical fitness	62.77 \pm 7.91	
Iron (Fe) intake	6.02 \pm 3.94	0.182
Physical fitness	62.77 \pm 7.91	
Vitamin C intake	36.08 \pm 43.81	0.783
Physical fitness	62.77 \pm 7.91	

^a Rank Spearman Test

The average hemoglobin level of the subjects in this study was 12.82 ± 0.63 g/dL, so it was categorized as normal. Even though the data showed that hemoglobin level was the only factor related to physical fitness as its significance level was less than 0.05 ($p=0.031$) and eligible for multivariate analysis, iron intake was also eligible for multivariate analysis as its significance level was less than 0.25 ($p=0.182$).

Table 2 : Linear Regression Analysis

Factor	B	SE	p	CI
Constant	9.607	23.834	0.689	-38.703 - 57.917
Hemoglobin level	3.906	1.873	0.044	0.112 - 7.700
Iron intake	0.512	0.301	0.097	-0.097 - 1.121

The multivariate analysis found that hemoglobin level was the only factor that was strongly related to physical fitness of the subjects ($p<0.05$). The determination coefficient (R^2) of this analysis was 14.2%, meaning that 14.2% of the subjects' physical fitness was affected by hemoglobin level while 85.8% was affected by other factors. This study also showed that every 1 g/dL increase in hemoglobin levels would increase 3.906 of the subjects' physical fitness scores.

Discussion

The definition of being healthy according to World Health Organization (WHO) is not always related to the presence of disease, but also a condition of being well physically, mentally, and socially. People with healthy status could do various activities comfortably; therefore having a good physical fitness is quite important. The level of physical fitness is one of the factors that affect adolescent's health. Adolescents with an average age of 19 years need good physical fitness. A good level of physical fitness is expected to improve the quality of physical activity both academically, practically and in everyday situations.⁹ This study found that 75% of the subjects had poor level of physical fitness, although most of the subjects had normal nutritional status. Several studies have linked the relationship between high body mass index (BMI) with poor performance in weight-bearing activities. However, the relationship between children's weight and muscle strength has not been consistent.¹⁰⁻¹³ A study reported that the status of obesity and overweight had a negative impact on aerobic capacity, agility, lower limb strength, and body balance. However, several studies have reported that overweight children do better than obese children in weight-bearing activities. This condition can be caused by the fact that the quantity of fat mass as an inert load is higher in obese children than overweight children, therefore it limits the physical movement, physical activity, and the development of motor skills of obese children.^{14,15}

This study also found that physical fitness among female adolescents were not related to nutrition intake. The iron intake of all of subjects were classified as non-adequate. Based on RDA, the recommended intake of iron for female adolescents aged 16-18 years is 26 mg, while the average intake of the subjects in this study was 6.02 ± 3.94 mg. The low level of iron adequacy may be due to low knowledge of iron sources and a lack of diversity in food consumption. Dietary habit in rural area is usually still related to the cultural aspect. The Sundanese tribe often provides tea in their daily consumption. Tea (*Camellia sinensis*) is one of the plant species which contains tanin. If the subjects had high consumption of tea, it would make the iron intake became poorly absorbed by the body as tanin could impair iron absorption. Insufficient consumption of iron in the daily diet increases the risk of anemia in female adolescents. Iron (Fe) is an important trace element for humans which acts as an activator and cofactor of energy metabolism, hemoglobin synthesis, and oxygen transport of muscle tissue.¹⁶

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Lack of hemoglobin in the blood will cause a decrease in oxygen that is being transported to the body and brain cells, and it will also cause symptoms of fatigue. A person who has hemoglobin deficiency or abnormal red blood cells experiences abnormality in the exchange process of oxygen and carbon dioxide in the blood vessels, which will result in decreasing physical fitness.¹⁹ During muscular endurance and cardiorespiratory endurance activities, the diffusion of oxygen and carbon dioxide throughout the capillaries and alveolar membrane capillary tissue increases. Oxygen and carbon dioxide are transported by the blood, mainly in chemical combination by diffusing and dissolving in the plasma. Oxygen that diffuses into red blood cells combines chemically with hemoglobin (Hb) to form oxyhemoglobin (HbO₂). This process increases the oxygen attraction carrying

capacity of the blood by about 65 times. An increase in the amount of hemoglobin will increase the oxygen carrying capacity as well as muscle endurance and cardiorespiratory endurance.²⁰

Conclusion

Physical fitness is one of the indicators of human health and it is influenced by many factors including hemoglobin level. The hemoglobin level among female adolescents in rural area depended on the dietary habit of the area itself. In this situation, culture's belief also became a main factor that determined the dietary habit. Execution of a strategic intervention is very needed to solve this case. Therefore, nutrition education regarding dietary habit that can fight against anemia should be provided in rural area.

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