Conference Paper

Assessing Musculoskeletal Fitness Using Standing Long Jump Test Among SMA Negeri 49 Jakarta Students in 2017

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Abstract

Musculoskeletal fitness is one component of fitness that is important for health and research about it in Indonesia is still rarely done, whereas it is closely related to prevention of the occurrence osteoporosis, metabolic syndrome, cardiovascular disease, heart failure, diabetes mellitus, and obesity which remain health problem. Measuring adolescent musculoskeletal fitness could use Standing Long Jump (SLJ) test which is easy, valid, reliable, and widely used for fitness measurement globally. The aim of this study was to determine the average musculoskeletal fitness and the factors that contribute. This study was a quantitative study conducted using a cross-sectional design with 133 people as the sample population. The mean value of musculoskeletal fitness using SLJ method in the sample study was 154.11 ± 37.33 cm. The score for boys was 184.76 ± 27.4 cm while for girls was 126.53 ± 19.03 cm. Bivariate analysis showed that there was a positive correlation between physical activity, energy, protein, fat, and carbohydrate intakes with musculoskeletal fitness while it showed the negative correlation between BMI for age and body fat percentage with musculoskeletal fitness.

Keywords: musculoskeletal fitness, standing long jump, adolescent

1. Introduction

Fitness is an important health determinant in adolescents [1]. One component of adolescent fitness related to health other than cardiorespiratory fitness is musculoskeletal fitness [2]. A good adolescent musculoskeletal fitness level can prevent osteoporosis in adulthood [3, 4]. Also, in adolescence, especially those aged 15-17 years old, there will be a peak bone mass. The increase in this period will optimize the formation of bone mineral [5]. Musculoskeletal fitness can also prevent metabolic syndrome [6], heart failure risk, diabetes mellitus, and obesity [7, 8].

Musculoskeletal fitness in various countries in the world has decreased. This is evidenced by the various studies in Europe that showed a decline in musculoskeletal fitness in adolescents. The results of secular musculoskeletal adolescent fitness research in Spain using standing long jump test showed a decrease in from 2001 – 2002 (149.0

± 22.9 cm) to 2006 – 2007 (137.0 ± 22.9 cm) [9]. Research in adolescents in the Netherlands throughout 26 years decreased by 49% [10]. The findings are also supported by research in the UK in 10 years which showed a decrease in musculoskeletal fitness in adolescents by 27% [11].

Musculoskeletal fitness status in adolescents is associated with several factors: sex, body mass index by age (BMI/A), body fat percentage, physical activity, and energy and nutrients intake. A significant association between sex and musculoskeletal fitness is that there is a difference in musculoskeletal fitness between male and female [12, 13]. Besides sex, body fat percentage and body mass index are associated with musculoskeletal fitness status. Research explains that musculoskeletal fitness is negatively associated with body fat percentage in adolescents [14]. From the relation between BMI and fitness, it can be explained that overweight or obese and underweight adolescents have poor performance on tests than adolescents with normal BMI [10]. Energy and macro nutrients (carbohydrates, fats, and proteins) intake is a factor that affects muscle work in providing energy (ATP) [15]. Also, protein intake is positively associated with musculoskeletal fitness [16]. Physical activity is a factor associated with. Adolescents with high levels of physical activity have greater levels than do those with less physical activity [17].

Research on teenagers using Standing Long Jump (SLJ) as a measurement in Indonesia is rarely found. Meanwhile, the measurement using the SLJ method is an easy, valid, and reliable way to measure in adolescents compared to other methods [18, 19]. This fact encourages researchers to do research using Standing Long Jump as the measurement applied to students in Indonesia.

Researchers chose *SMA* 49 (*Sekolah Menengah Atas 49*) Jakarta as the research location. The selection of the location took into consideration the extent to which the research is conducted. Moreover, research at this location has never been done. Based on the preliminary study carried out by the researchers, the average jump result of *SMA 49* Jakarta students in Standing Long Jump test was 122.28±15.5 cm for females students, while it was 171.06±30.91 cm for male students. Compared to the value of with similar tests in other Asian adolescents in Hong Kong (188.76 ± 37.6 for male adolescents and 129.83 ± 28.26 cm for a female adolescent) [20], the average value in Jakarta is still low. From this result, further research is required to assess the status of musculoskeletal fitness in *SMA Negeri* 49 Jakarta.

2. Methods

This research used in this study is a quantitative approach with a cross-sectional study. The study was conducted at *SMA 49* Jakarta in April to May 2017. The inclusion criteria in the study were students aged 15-17 years old, in good health physically and mentally, and had no physical disability. Meanwhile, the exclusion criteria are students who were also athletes, had a leg injury, and were respondents for preliminary studies. Sample selection used systematic random sampling method with a total sample of 133 students.

The data of the dependent variable was collected by doing a fitness test with SLJ method. Data collection of independent variables including BMI/A was obtained through measurement of body height and weight. Next, the data was processed by comparing body weight, and height squared to obtain BMI/A value. Furthermore, body fat percentage was obtained through measurement with Bioelectrical Impedance Analysis (BIA). Physical activity level data was obtained from the adaptation questionnaire from the Physical Activity Questionnaire for Adolescence (PAQ-A). Finally, energy, protein, fat, and carbohydrate intake data was obtained through 2x24 hours Food Recall interviews on weekdays and weekends.

3. Results

The number of respondents in this study was 133 people. A total of 63 respondents were male while 70 respondents were female. The distribution of average musculoskeletal fitness value with Standing Long Jump (SLJ) of all respondents was 154.11 ± 37.33 cm (95% CI: 147.71–160.52) (table 1). The average value of musculoskeletal fitness in both men and women was categorized as good. 13% of respondents had low musculoskeletal fitness, 70% of respondents had moderate musculoskeletal fitness, 13% of respondents had above average musculoskeletal fitness, and 4% had high musculoskeletal fitness.

Table 1: Distribution of Dependent and Independent Variable Statistics in Students of SMAN 49 Jakarta Year 2017 (n = 133).

Variable	Mean ± SD	Median	Min - Max	95% CI
Musculoskeletal Fitness (cm)	154.11 ± 37.33	143	93-246	147.71 - 160.52
Physical Activity (score)	2.19 ± 0.57	2.2	1 - 3.9	2.09 - 2.29
IMT/U (*z-score*)	0.12 ± 1.3	0.08	-3.48 - 3.9	-0.11 - 0.33
PLT (%)	25.13 ± 6.79	26.1	8.6 - 40.4	23.97 - 26.3
Energy Intake (kcal)	1.432.8 ± 411.6	1.397.7	594.6 - 3,187.2	1.362.2 – 1.503.4
Protein Intake (g)	47.19 ± 16.1	45.2	22.6 - 112.8	44.4 - 19.96
Fat Intake (g)	54.72 ± 21.78	52.2	18.1 - 137.4	50.98 - 58.46
Carbohydrate Intake	192.2 ± 7.96	183.7	80.8 - 805.8	178.5 - 205.8

Table 2: Musculoskeletal Fitness Average Differences by Sex (n = 133).

Variable	Sex	n	Mean ± SD	p value
Musculoskeletal Fitness (SLJ)	Male	63	184.76 ± 27.4	0.0001 *
	Female	70	126.53 ± 19.02	
* *p value < 0.05 indicates a significant difference*				

The average of physical activity of all respondents falls into the low category. The distribution of BMI/A of respondents with result *Z-score* was considered normal according to WHO[21]. The average male respondents have a normal body fat percentage, whereas female respondents have a percentage of *overweight* body fat. Average energy intake has not reached either category (> 70%AKG). Average protein, fat, and carbohydrates have not reached good category (> 80%AKG).

Table 3: Result of Correlation Test and Simple Linear Regression Test between Independent Variables and Dependent Variable (n = 133).

Independent Variables	Dependent Variable (Musculoskeletal Fitness)		
	r	R^2	P value
Physical Activity	0.43	0.18	0.0001 *
IMT/U	-0.3	0.09	0.0001 *
PLT	-0.74	0.54	0.0001 *
Energy Intake	0.42	0.18	0.0001 *
Protein Intake	0.26	0.06	0.003*
Fat Intake	0.19	0.03	0.026*
Carbohydrate Intake	0.44	0.19	0.0001 *
** p value < 0.05 indicates a significant difference*			

The mean value of musculoskeletal fitness by SLJ method based on sex was obtained by T-independent test (table 2), and the results showed significant differences between mean musculoskeletal fitness and sex.

The relationship between physical activity, energy intake, protein, fat, and carbohydrates with musculoskeletal fitness resulted in a positive correlation. For IMT/U and percent body fat with musculoskeletal fitness, a negative correlation (table 3).

4. Discussion

The musculoskeletal fitness measurement for adolescents globally considered to be able to represent is the *Standing Long Jump* (SLJ) Test. This SLJ test had been tested for its validity (*Valid*) and reliability (*Reliable*). Also, the test is easy to use compared to other tests. This test is perfect for the background of research conducted in schools because it is practical and does not require complicated equipment [18–20, 23].

The average musculoskeletal fitness of SMA 49 Jakarta students as measured by the SLJ method is 154.11 ± 37.33 cm. The average is lower than previous studies with the same method, that is in adolescents in Europe with 163.9 ± 34.2 cm [24]. The difference in average with adolescents in Europe is due to ethnic differences. According to Gurrici et al. [25] and Duerenberg [26] which compares Asian ethnic body composition with Caucasian ethnicity, Caucasian muscle mass is greater than that of its Asian counterpart. In line with the study, ethnic Caucasians have a larger amount of muscle mass that will result in greater muscle strength as well [22]. Therefore, the results using the SLJ method in adolescents in Europe will be higher than the average results in this study.

Sex is one of the factors related to musculoskeletal fitness [12, 13, 22]. T-independent test results show below p-value average in the male and female groups of p = 0.0001 (p-value <0.05). This means that there is a significant difference between mean musculoskeletal fitness and gender. The result of analysis of the mean difference by sex is in line with the research that has been done by Castro-Pinero et al. [19], Chung et al. [20], Gontarev et al. [23]. These three studies used SLJ method in measuring musculoskeletal fitness. In these three studies, the mean value of SLJ scores in men is greater than for women.

The average difference in musculoskeletal fitness in men and women is influenced by physiological factors. The amount of anabolic testosterone in men is higher than that of women, so the greater muscle mass is male [22]. Because the male muscle mass is larger, the resulting muscle strength is greater [27]. The tendency of women's muscle strength is 60-85% compared to the absolute strength of men [22].

Physical activity is all the movements of skeletal muscles that require energy [28]. Physical activity is closely related to fitness. Regular physical activity can improve a person's fitness. The relationship between physical activity and musculoskeletal fitness with bivariate analysis found that there was a significant relationship p-value = 0.0001 with medium strength and positive pattern of r = 0.43. From these results, the higher the physical activity, the higher the level of musculoskeletal fitness.

The relationship between physical activity and musculoskeletal fitness is similar to that of Martinez-Gomez et al. [13] that there is a positive relationship between musculoskeletal fitness and physical activity. Severe physical activity associated with muscle fitness with p-value = 0.04 and the strength of the strong relationship is r = 0.67. Adolescents who perform heavy physical activity have higher levels of musculoskeletal fitness than teenagers who perform low physical activity [13]. Teenagers who regularly perform physical activity have higher musculoskeletal fitness than inactive ones [17].

Body mass index by age (IMT/U) is the index to assess the nutritional status of leanness or fatness in children [21]. The result of the bivariate analysis showed that there was a significant relationship between IMT/U with musculoskeletal fitness which is p = 0.0001 (p-value <0.05) with moderate relationship strength and negative pattern (r = -0.3). This means that the smaller the IMT/U, the higher the level of musculoskeletal fitness. The results of this study are in line with a study in Portugal in school children showing that there is a negative relationship between IMT/U and musculoskeletal fitness. The higher the IMT/U, the lower the level of musculoskeletal fitness. The *Overweight* and obesity nutritional statuses (z-*Score*> 1) tend to have lower musculoskeletal fitness levels than children with normal nutritional status [29]. *Overweight*/Obese teenagers perform poorly on musculoskeletal fitness tests than teenagers with normal IMT [12].

The existence of this negative relationship is because fat people store more fat than normal people. Also, body fat in the muscle tissues can inhibit muscle work in the process of movement [30]. In addition, a person with *overweight*/ obese nutritional statuses tend to spend energy not only to do work, but there is energy that must be paid or spent to withstand the burden of its body mass [12].

Body fat is one component in the body. Body fat is composed of 10% water and 90% adipose tissue [31]. The association of percent body fat with musculoskeletal fitness showed a significant association p value= 0.0001 (p value<0,05) with strong relation and negative pattern (r = -0.74). Negatively patterned relation means less depletion of body fat and the higher the level of musculoskeletal fitness. The relation of body fat percentage with fitness shows a negative pattern by the research that has been done by Setiowati [16]. In this study, there was a negative relation between body fat percentage with musculoskeletal fitness (r = - 0.67; p value= 0.024). Another study conducted by

Nikolaidis [32] also proves the same. Body fat percentage negatively affects musculoskeletal fitness (r = -0.24; p-value <0.05) in adolescents. A person who has a high percent body fat score will have low musculoskeletal fitness level.

The body fat percentage is associated with musculoskeletal fitness. Katch, McArdle, and Katch [33] explain that individuals who have few body fats and more muscle mass can produce greater total energy so that musculoskeletal fitness will increase. In addition, body fat and located near the muscle tissue can inhibit muscle work in the process of movement [30].

In this study, energy intake was obtained through interviewing the participant's *food recall* 2x24 hours at a time *weekend* and *weekday*. Average energy intake has not reached the average "good" category. The relation of energy intake with musculoskeletal fitness showed a significant association p value= 0.0001 (p value<0.05) with moderate and positive patterned strength (r = 0.42). The positive relation shows that the higher the energy intake, the higher the musculoskeletal fitness level.

The positive relation between energy intake and musculoskeletal fitness can be explained by the research conducted by Rozenek et al. [34]. The results of this study explain that increased energy intake can increase muscle mass by a combination of muscle hypertrophy-resistant exercise. Enhanced energy intake is produced from carbohydrate and protein sources. Both will contribute to perform muscle hypertrophy and increase muscle strength.

Protein intake plays a role for someone who does strength training and explosive muscle power [31]. The average protein intake of respondents has not reached the good category. The relation of protein intake with musculoskeletal fitness showed a significant association, p value= 0.001 (p value< 0.05) with medium correlation strength and positive pattern, that is r = 0.26. This means that the higher the protein intake, the higher the level of musculoskeletal fitness would be. The results of this study are supported by previous research that has been done by Setiowati [16] that there is a positive relation between protein intake and musculoskeletal fitness. Protein intake affects muscle mass through protein synthesis mechanism. The presence of protein intake will improve the protein balance in a positive direction. Increased protein synthesis slowly performs in muscle hypertrophy that affects muscle strength [35].

The source of protein that supports musculoskeletal fitness is the source of animal and vegetable protein. Animal protein contains complete protein (complete essential amino acid) than vegetable protein. Examples of animal protein are meat, milk, eggs, and fish. The vegetable protein contains such as nuts and rice. However, animal protein contains higher fat volume, so it needs the selection of low-fat food sources (*Low-fat*) and fat-free (*Fat-free*) [22].

The fat intake of respondents has not reached either the "good" category. The association of fat intake with musculoskeletal fitness showed a significant association p value= 0.026 (p value<0.05) with the weak relationship and positive pattern (r = 0.19). The positive relationship between fat intake and musculoskeletal fitness in this study differs from previous studies. Jeukendrup research results [36] explained that a high intake of fat could reduce the production of muscle strength and glycogen concentration so that performance will decrease. High fat intake also has negative health effects such as an increased risk of obesity and cardiovascular disease. High-fat intake can lead to insulin resistance [37].

The fat intake of respondents has not reached either good category. The relation of carbohydrate intake with musculoskeletal fitness showed a significant association (p value< 0.05) with medium correlation strength and positive pattern (r = 0.44). The results showed there was a positive relationship between carbohydrate intake with musculoskeletal fitness. This study is in accordance with existing research. According to research Oliveira et al. [18], there is a relation between carbohydrate intake with a wider area and muscle strength. Provision of carbohydrates can be influential because this addition followed the addition of protein intake to give a better effect on the protein balance in muscle formation. Besides, muscle formation is caused by protein synthesis that will be stimulated by resistance exercises [35].

Good carbohydrate types to support musculoskeletal fitness are complex carbohydrates such as rice, bread, wheat, and pasta. Complex carbohydrates will experience a longer breakdown and do not cause an increase in blood sugar. For a simple carbohydrate source, it will rapidly increase the rise in blood sugar and cause fat storage [22].

In this study, some limitations of the instrument found in measuring SLJ using mattress tools as a springboard. To obtain a more valid result, and should be used as a springboard area. This can prevent measurement errors due to post-leap shift. In addition, the measurement of physical activity in this study only describes general physical activity using PAQ-A questionnaire. Therefore, the results of specific physical activity to improve musculoskeletal fitness can not be identified in detail.

5. Conclusion

Measurements of musculoskeletal fitness in Indonesia are very rare; therefore, it is indispensable for further research in Indonesia. One method that can be applied is SLJ method. This method is very easy and cheap, and it produces the right level of measurement. The average of musculoskeletal fitness obtained with SLJ method in SMA 49 Jakarta students in 2017 amounted to 154.11 ± 37.33 cm including in either category. A significant difference was found between the average of musculoskeletal fitness values by gender in SMA 49 Jakarta students in 2017. The result of the bivariate analysis shows that there is a positive relation between musculoskeletal fitness and physical activity, energy, protein, fat, and carbohydrate intake. Nevertheless, there is a negative relationship between musculoskeletal fitness and BMI/A and body fat percentage.

5.1. Suggestion

Musculoskeletal fitness is one component of fitness that is important for health. Indispensable monitoring of musculoskeletal fitness in adolescents in Indonesia, given the national fitness measurement for the Indonesian population, has not been a priority. The presence of musculoskeletal fitness measurements can be a preventive measure against many health problems. One of the recommended measures of musculoskeletal fitness in adolescents can be applied with the SLJ method. SLJ method has been applied in various countries in the world. This method is very easy to do in the school setting and produces the right level of education for teenagers in Indonesia.

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