Correlation between Body Mass Index and Physical Performance of Lower Extremity in Adult Athletes

Diah Stephanie Putri Resubun[a*], Soenarnatalina Melaniani[b], Ditaruni Asrina Utami[c], Nuniek Nugraheni[c]

*Email: diah.resubun@gmail.com
[a]Resident Student at Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo Academic General Hospital Surabaya Indonesia
[b]Department of Epidemiology, Biostatistics, Population Studies, and Health Promotion, Faculty of Public Health Universitas Airlangga Surabaya Indonesia
[c]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Universitas Airlangga/Dr. Soetomo Academic General Hospital Surabaya Indonesia

Abstract
Decreased physical performance of lower extremity increases the risk of injury or repetitive injury. Lower extremity physical performance is objectively reflected in lower extremity motor components consisting of triple leg hop test, one leg stance test, star excursion balance test, and agility T-test. A factor associated with decreased physical performance of lower extremity is highly likely because of rising body mass index (BMI). To analyse the association of body mass index of adult athletes and the physical performance of lower extremity. Secondary data from athletes screening of Regional Exercise Center (PUSLATDA) East Java was used in this study. Analyzed variables were including BMI, triple leg hop test, one leg stance, star excursion balance test, agility T-test. Randomization technique was applied to recruit 91 proper respondents. Normality test, Spearman test for calculating the correlation between BMI and triple leg hop test, one leg stance, star excursion balance test, agility T-test was performed with the statistical significance of $p < 0.05$. This finding shows that there was a significant correlation BMI and one leg stance foot in athletes, with a correlation coefficient of -0.229 (p-value=0.029). Meanwhile, triple leg hop test, star excursion balance test (SEBT) and agility T-test showed no significant relationship with BMI of athletes. A significant correlation has been found between body mass index and one leg stance test in adult athletes.

Keywords: Body mass index, athletes, triple leg hop test, one leg stance test, star excursion balance test, and agility T-test.

INTRODUCTION

The range of sports activities have been considered as weight bearing activities which mostly performs lower extremity (Bartlett 2007). Decreased physical performance of lower extremity increases the risk of injury or repetitive injury which will cause the athlete's risk of withdrawal from training or competition (Lisman et al. 2017). Despite the fact that physical performance may decline as increasing age (Ganse et al. 2018), a factor associated with decreased physical performance of lower extremity is highly likely because of rising body mass index (BMI) (Bataweel and Ibrahim 2020; Fiori et al. 2020; Tabue-Teguo et al. 2020).

A high body mass index in athletes influences by an rise of muscle mass which also has a correlation with an increase in fat mass (Garrido-Chamorro et al. 2009). This phenomenon is related to the improvement of proinflammatory adipokines released by adiposity tissue. Moreover, the proinflammatory tend to cause metabolic disorders and leads to the musculoskeletal structural disorders (Abate 2014; Mantovani et al. 2016; Kojta, Chacińska, and Błachnio-Zabielska 2020). An increase in body mass index will also add the mechanical load that turns into disruption of the musculoskeletal structure and function of the lower extremities (Pasapula et al. 2021). Previous studies proved that there was a negative correlation between body mass index and physical performance of lower extremity in athletes or the general population (Bataweel and Ibrahim 2020; Fiori et al. 2020; Tabue-Teguo et al. 2020), however little has known about the correlation between body mass index and lower extremity physical performance in adult athletes as comprehensive study. This study aimed to analyse the association of body mass index of adult athletes and the physical performance of lower extremity.

METHODS

Secondary data from athletes screening of Regional Exercise Center (PUSLATDA) East Java was used in this study. We obtained the data from Sport Clinic of Dr. Soetomo General Hospital Surabaya as the location for the athletes to do screening process. The study was begun from October 2021 to December 2021. Analyzed variables were including BMI, triple leg hop test, one leg stance, star excursion balance test, agility T-test.

Population and Sampling

Randomization technique was applied to recruit proper respondent. The inclusion criteria were consisted of (1) athletes who were aged 18-35 years, (2) doing weight bearing activities, (3) having completed all stage of Puslatda East Java screening at Sport Clinic of Dr. Soetomo General Hospital Surabaya in March 2020, (3) athletes whose medical record has fully completed with the information including: BMI, triple leg hop test, one leg stance, star excursion balance test, agility T-test, age, gender, sports category. Finally, about 91 data respondents were collected for final analysis.

Data Analysis

The analysis of quantitative data was performed SPSS for Windows versi 24 (SPSS Inc., Chicago, IL). Specific tests were applied based on the aims of the study, namely normality test, Spearman test for calculating the correlation between BMI and triple leg hop test, one leg stance, star excursion balance test, agility T-test. The statistical significance had set at $p < 0.05$.

RESULT

The proportion of respondents were divided into 50 male's athletes (54.9%) and 41 female athletes (45.1%). The majority of athletes came from athletic sports recorded as many as 29 athletes (31.9%) following by 15 athletes of wrestling (16.5%), 11 athletes of fencing (12.1%), 10 athletes of hockey (11%), 8 athletes of wushu (8.8%), 7 athletes of basketball (7.7 %), 9 athletes of handball (9.9%) and 2 athletes of aerobics 2.2% . Respondents of study who categorized as underweight counted as much as 5 athletes (5.5%), while those who have normal index were 54 athletes (59.3%). Based on the standard deviation value, men have the average of high index of BMI (24.55±4.36) compared to female athletes (21.82±2.45). These numbers mean that BMI of male's athletes is likely higher compared to BMI of females. According sports categories, wrestling athletes recorded as a high number of BMI (27.57 ± 5.60) comparing to the other sports categories, especially aerobics athletes. (Table 1)

Table 1. Characteristics of Respondents

Variables	n	(%)	SD of BMI
Gender			
Male	50	54.9	24.55 ± 4.36
Female	41	45.1	21.82 ± 2.45
Sports Categories			
Fencing	11	12.1	22.88 ± 2.58
Athletic	29	31.9	22.55 ± 3.14
Basket	7	7.7	22.26 ± 1.84
Wrestling	15	16.5	27.57 ± 5.60

Handball	9	9.9	20.11 ± 1.69
Hockey	10	11	22.77 ± 3.66
Aerobics	2	2.2	17.72 ± 0.91
Wushu	8	8.8	23.36 ± 1.40
BMI Level			
Underweight	5	5.5	
Normal	54	59.3	
Overweight	18	19.8	
Obese	14	15.4	

Characteristics of BMI and physical performance of lower extremities showed that the average age of the respondents was 22.32 years with the youngest age being 18 years and the oldest being 32 years. The average body weight was 65.36 kg and the lowest weight was 41 kg, while the highest weight was being 131 kg. The average height was 166.78 cm, while the lowest height was being 147 cm and the highest was being 185 cm. The BMI was 23.32 on average with the lowest body mass index was 16.97 and the highest was 41.11. An average triple leg hop score counted as many as 489.48 with the lowest score of 277 and the highest score of 749.50. The respondents had an average one-leg test score of 48.57 with the lowest score being 2.5 and the highest score being 157.

The average anterior Star excursion balance test (SEBT) score was 77.12 with the lowest score of 52.80 and the highest score of 77.12. The average anterolateral SEBT score was 75.26 with the lowest score being 51.50 and the highest score being 115.50. The average value of lateral SEBT recorded 76.41 with the lowest score of 46 and the highest score of 121.20. The average posterolateral SEBT score counted 84.92 with the lowest score of 53.70 and the highest score of 274. Meanwhile, the average posterior SEBT score was 86.03 with the lowest score of 52.30 and the highest score of 130.70. The average posteromedial SEBT score was 82.92 with the lowest score being 54 and the highest score being 117.30. The average medial SEBT score was 76.17 with the lowest score being 48.80 and the highest score being 119.70. The average anteromedial SEBT score was 74.93 with the lowest score being 54.80 and the highest score being 102.20. moreover, agility T-test showed an average of 11.39 with the lowest score of 9.16 and the highest score of 16.34.

Table 2. Characteristics of BMI and Physical Performance of Lower Extremity

Variable	Mean	Min	Max	SD
Age	22.32	18.00	32.00	3.65
Weight	65.36	41.00	131.00	14.79
High	166.78	147.00	185.00	7.79
BMI	23.32	16.97	41.11	3.85

Triple leg hop test	489.48	277.00	749.50	96.45
One leg stance	48.58	2.50	157.00	37.04
Star excursion balance test (SEBT)				
SEBT of Anterior	77.13	52.80	101.20	9.99
SEBT of Anterolateral	75.27	51.50	115.50	11.77
SEBT of Lateral	76.42	46.00	121.20	15.54
SEBT of Posterolateral	84.93	53.70	274.00	24.85
SEBT of Posterior	86.03	52.30	130.70	15.93
SEBT of Posteromedial	82.92	54.00	117.30	15.12
SEBT of Medial	76.17	48.80	119.70	14.63
SEBT of Anteromedial	74.93	54.80	102.20	10.61
Agility T Test	11.39	9.16	16.340	1.17

The BMI and one leg test showed a correlation coefficient of -0.229 (p-value=0.029), which means that both have a negative correlation. This finding shows that there was a significant correlation BMI and one leg stance foot in athletes. Meanwhile, the right triple leg hop test has a correlation coefficient value of 0.034 (p-value=0.75), which means that there was no correlation between BMI and the triple leg hop test.

On the correlation between BMI and Star excursion balance test (SEBT) components (anterior, anterolateral, lateral, post lateral, posterior, posteromedial, medial, anteros medial), none of them indicated the significant relationship with BMI of athletes. The data above are depicted in the table 2.

Table 3. Spearman Rank Test of BMI and Physical Performance of Lower Extremity

Variable	r	Sig.
Triple leg hop test	0.034	0.750
One leg stance test	-0.229	*0.029
Star excursion balance test (SEBT)		
SEBT of Anterior	-0.054	0.610
SEBT of Anterolateral	-0.110	0.301
SEBT of Lateral	-0.086	0.416
SEBT of Posterolateral	0.028	0.791

Variable	r	Sig.
SEBT of Posterior	0.004	0.968
SEBT of Posteromedial	0.097	0.361
SEBT of Medial	-0.016	0.879
SEBT of Anteromedial	-0.030	0.779
Agility T test	0.018	0.866

r= correlation coefficient

DISCUSSION

The present study found that there was a significant relationship between BMI and one leg stance test in adult athletes, with a weak negative correlation. Similarly, Cancela Carral et al. (2019) also found a significant relationship between an increase in body mass index and a decrease in static balance and a stronger correlation in individuals with a BMI above 30 kg/m2. This finding might be based on the systematic of one leg stance test which is a functional test to assess static balance ((Perez-Cruzado, González-Sánchez, and Cuesta-Vargas 2014). On the other side, BMI can cause static balance disorders through several mechanisms, including decreased sensory function of the lower extremities, both foot mechanoreceptors and joint proprioception.

An increased BMI influences musculoskeletal structural disorders due to rising proinflammatory adipokines and excessive load, especially in the lower extremities (Wearing et al. 2006; Gupta et al. 2007; Paz-Filho et al. 2012; Tanaka, Narazaki, and Kishimoto 2014; Tomlinson et al. 2016; Collins et al. 2018; Yung and Giacca 2020). In addition, an increase in BMI stimulates an increase in fat mass associated with changes in body posture which result on the changes in the center of mass (COM) and momentum acting in the joints of the lower extremities (Foster et al. 2010; Del Porto et al. 2012; Bowser and Roles 2021).

The finding of this study indicated that there was no significant relationship between BMI and the triple leg hop test in adult athletes. The finding is supported by previous study by Hardy et al. (2013) which found a significant negative correlation between an increase in BMI and lower extremity physical performance in the general adult population. Since, athletes are individuals who require optimal physical performance by increasing muscle mass. Thus, an increase in BMI in athletes was considered as an increase in muscle mass (Garrido-Chamorro et al. 2009). Nasuka, Setiowati, and Indrawati (2020) also found that a high body mass index in athletes has a close correlation with an increase in lower extremity muscle strength in elite athletes compared to beginners, with the average body mass index of elite athletes being 24.4 kg/m2.

The relationship between BMI and SEBT in adult athletes reveal negative significant. In this study, there was a very weak negative correlation between increased body mass index and anterior, anterolateral, lateral, medial and anteromedial SEBT, while a very weak positive correlation was also found in posterolateral, posterior and posteromedial SEBT. Rationally, the trends may be due to a greater decrease in hip and knee flexion flexibility than hip extension, along with an increase in body mass index. As in previous studies found similar findings: a significant relationship between increased body mass index and passive joint range of motion in hip flexion, adduction and increased external rotational movements in the paediatric population (Maria Amado João et al. 2014).

Finally, according to BMI and agility T-test, the significancy between boot variables had no proven in present study. Since the agility T-test is a test to assess agility, power, speed and coordination of the lower extremities (PAUOLE et al. 2000), the similar finding had been found by several studies (Nikolaidis et al. 2015). Since this study is a non-reactive study using secondary data, therefore some confounding variables

cannot be measured or excluded which might affect the results of the study.

CONCLUSION

A significant correlation has been found between body mass index and one leg stance test in adult athletes. However, there is no significant association between body mass index and the triple leg hop test, star excursion balance test and agility T test.

Acknowledgments

Not Applicable.

Ethics and consents

Ethical clearance was approved by the Ethics Committee of Dr. Soetomo General Hospital, Surabaya, Indonesia (No.0621/LOE/301.4.2/IX/2021) on 28 September 2021.

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