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The Effect of Body Mass Index on Agility: A Perspective on Youth Volleyball Athletes Amateur

Ella Fauziah[1], Ahmad Nasrulloh[2], Martinez Edison Putra[3], Fazarudin[4], Euis januarsi[5]

[1,2]Department of Sports Science, Faculty of Sports and Health Sciences, Yogyakarta State University, Yogyakarta, Indonesia

[3]Department of Sports Coaching Education, Faculty of Sports and Health Sciences, Yogyakarta State University, Yogyakarta, Indonesia

[4]Department of Edicational Administration, Tanjungpura University, Pontianak, Indonesia

[5]Department of Junior High School 8 Kubu, the Office of Education and Culture of Kubu Raya Regency, Kubu Raya, Indonesia

ABSTRACT: This research aims to analyze the relationship between Body Mass Index (BMI) with agility in young volleyball athletes. The problem raised in this study is the lack of understanding of roles BMI as a predictor of agility, although agility is an important component of volleyball performance. The study involved 14 male participants who took part in extracurricular volleyball activities. Measurement BMI this was done using a weight scale and a stature meter, while agility was measured with the Hexagonal Agility Test. Data were analyzed using the Pearson Product Moment correlation test. Results indicate a significant positive correlation between BMI with agility, with a correlation coefficient of 0.631 and a significance value of 0.016 ($p<0.05$). In conclusion, improvement BMI caused by increased muscle mass is associated with increased agility in young volleyball athletes. Therefore, a comprehensive evaluation of body composition in athletes' fitness management is needed to optimize their physical performance.

KEYWORDS: Body Mass Index, Agility, Volleyball

I. INTRODUCTION

The body mass index provides a general picture of a person's body composition which can be obtained from dividing body weight and height squared in meters which functions to assess the nutritional status of the population (Savita, Shantala, Parwati, & Shivaprasad, 2023), including volleyball players. Factors regarding weight and height need to be considered in the sport of volleyball, because having an ideal body can help players to bring out their best abilities through excellent physical condition (Koźlenia, Popowczak, Horička, Šimonek, & Domaradzki, 2024). If a volleyball player does not have an ideal body, it can reduce his performance in the match. According Miguel-Ortega, Calleja-González, & Mielgo-Ayuso, (2023), apart from the jumping, strength and explosive aspects, the anthropometric characteristics of the volleyball player's body also play a role in influencing performance and helping determine the ideal body shape. The assessment of an athlete's body mass index can be used to evaluate fitness and physical condition, verify the effectiveness of the training program, as well as form a specific profile that matches the demands of the sport. Besides that Pawlik & Mroczek, (2023) argue that results in volleyball games are determined by the optimal combination of motor factors and technical-tactical abilities. Elite volleyball players are generally characterized by significant height, high level of agility, and superior muscle strength, especially in terms of agility. In several sports such as volleyball, ideal body posture and good physical condition will be able to support achievement.

One of the anthropometric components that is an important indicator for an athlete is the Body Mass Index (BMI), which is a parameter used to assess body proportions by comparing body weight with height (m^2). The World Health Organization (WHO) has established international classifications for BMI, namely underweight (< 18.5 kg/m^2), normal (18.5 ≤ BMI < 25 kg/m^2), overweight (25 ≤ BMI < 30 kg/m^2), and obesity (≥ 30 kg/m^2) (Dharmajayanti, Negara, & Artini, 2023). Body mass index is used as a body composition parameter that is easy to measure and apply (Abineno & Malinti, 2022). There are several studies that have found that the body mass index correlates with various aspects of physical performance such as agility. There is data showing that

64.9% of individuals have an ideal body mass index (BMI), while 35.1% of individuals have a non-ideal body mass index (Pratama & Zulfahmidah, 2021). However, other research revealed that the level of negative body image was still quite high, namely 57.8%, while the remaining 42.2% had a positive body image, which of course affected the body mass index (Wati, Lidiawati, & Bintoro, 2019). Several factors that influence agility include age, gender, weight, and fatigue level (Popowczak et al,. 2020; Evanow et al., 2021; Azra et al., 2024).

Agility in the game of volleyball is very important because it allows players to move quickly and efficiently throughout the field, anticipate and react to the movement of the ball and opponents, place themselves in optimal positions to receive, pass, or attack, maintain a good position in receiving serves or blocking, attack effectively with fast movements and variations of attacks, transition efficiently between defensive and attacking positions, use energy optimally, prevent injuries with good body control, make quick decisions, maintain hand-eye coordination, adapt to tactical changes, maintain performance in long rallies, and support position specializations such as libero, setter, and forward, all of which contribute to the player's confidence and overall performance(Cherouveim et al., 2020; Chuang, Hung, Chang, Wang, & Lin, 2022; Gulati, Jain, Lehri, & Kumar, 2021; Hale, Kollock, Pace, & Sanders, 2019). Emphasized by Dharmajayanti et al., (2023) that agility is one of the important biomotor components to train in athletes. Agility is defined as the ability of muscles to contract to produce fast, dexterous movements, or in other words, the individual's ability to change the direction of movement throughout the body quickly while keep balance. Some factors that influence agility include balance, strength, and speed.

This research focuses on a lack of in-depth understanding of the role of the body mass index as a predictor of agility in young volleyball players. Although it is generally believed that a lower BMI correlates with better agility, empirical studies that specifically confirm and quantify this association in the young volleyball player population are limited. Most existing research focuses more on the relationship between BMI and other components of physical fitness, such as speed (Popowczak et al., 2022), strength(Kushkestani et al., 2021) and durability (Wahyuti et al., 2022), without highlighting agility specifically. Given the importance of agility in the game of volleyball, an understanding of the extent to which BMI serves as a predictor of agility in young athletes is indispensable.

This research has important significance because it has the potential to provide new insights into optimizing the performance of young volleyball athletes. The findings of this study will contribute to the still limited literature on the effect of BMI on agility, especially in young players who are undergoing rapid physical development. The results are expected to provide insights for trainers and medical teams in designing appropriate training programs, as well as highlighting the importance of healthy body composition management to support optimal performance. The research also contributes to filling knowledge gaps related to factors influencing agility, through BMI measurements and standard agility tests that will be statistically analyzed to evaluate the significant relationship between the two.

II. METHODES

A. Participants

The sample selection in the study used the total sampling method, totaling fourteen men who took part in volleyball extracurriculars. Average age (M±SD=17.14±1.748), body weight (M±SD=55.29±7.710), and subject height (M±SD=165.00±4.095). The subjects have been briefed on the potential risks and benefits associated with the study, and have given their consent to participate.

B. Instruments and Procedures

In the research carried out there were two measurements taken, namely, body mass index measurements and agility. The body mass index is measured using a weight scale and a stature meter. The score used by the body mass index consists of underweight, normal, overweight, obese and extremely obese scales. Meanwhile, agility measurements use a hexagonal test which is designed to measure a person's agility. The instrument test used is a simple test in its use and shows significant validity and reliability of the test, so this test is a good choice for coaches and sports scientists in determining a person's body mass index and agility. Body mass index measurements were carried out 1 repetition and agility was carried out 3 times to determine the best score for each test with a recovery time of 10 seconds between each agility repetition.

Table 1. BMI Criteria

Criteria	Value
Underweight	18.5≤
Normal	18.6 - 25.0
Overweight	25.1 – 28.0

Obese	28.1 ≥ 31.9
Extremely Obese	≥32.0

Table 2. Agility Norms

Criteria	Value	
	Male	Female
Excellent	<11.2 secs	<12.2 secs
Above Average	11.2 – 13.3 secs	12.2 – 15.3 secs
Average	13.4 – 15.5 secs	15.4 – 18.5 secs
Below Average	15.6 – 17.8 secs	18.6 – 21.8 secs
Poor	>17.8 secs	>21.8 secs

C. Data Analysis

Data are presented in the form of average values and standard deviation. The normality assumption was tested first using the Shapiro-Wilk test before applying the parametric test. Relationship between body mass index and agility was analyzed using Pearson Product Moment Correlation. All analysis was carried out using SPSS software for Windows version 26. The value of statistical significance was set at $p < 0.05$.

III. RESULT

Data from the results of the descriptive analysis carried out on male students taking part in volleyball extracurriculars can be found in table 3. In table 3, data were obtained regarding the number of samples consisting of 14 subjects with an average age of 17.4 years and a standard deviation of 1.748, which showed that the age variation between subjects was quite small. Furthermore, the average height of the subjects was 160 cm with a standard deviation of 4.095 indicating that there was little variation in the height of the subjects. Next the mean body weight of the subjects was 55.29 kg with a standard deviation of 7.710 indicating a greater variation in body weight between subjects. Then the average body mass index was 20.21 with a standard deviation of 2.694, this value shows that there is a fairly moderate difference in BMI between subjects. And the mean subject agility score was 7.0593 with a standard deviation of 1.05756, indicating that there was little variation in the level of agility the subject had. The entire data can be seen in the following table.

Table 3. Results of statistical descriptive of mean values and standard deviations

Descriptive Statistics			
	N	Mean	Std. Deviation
Age	14	5.14pm	1,748
Height	14	165.00	4,095
Weight	14	55.29	7,710
BMI	14	8.21 PM	2,694
Agility	14	7.0593	1.05756
Valid N (listwise)	14		

The normality test results shown in table 4 according to *shapiro-wilk* with a significance value of .948 (p>0.05), it can be concluded that there is a residual value with a normal distribution. Next, correlation analysis was carried out *Pearson Products* Moments to see the relationship between BMI and agility in extracurricular students of volleyball players. The following is normality test data.

Table 4. Normality test analysis results

	Shapiro-Wilk Statistics	df	Sig.
Unstandardized Residual	.976	14	.948

After calculating the prerequisite test, the correlation test between independent and dependent variables is then carried out. Based on table 5, the Pearson Product Moment correlation value in the body mass index is .631 with a significance value of .016 (p<0.05), so it can be concluded that the body mass index and agility have a large relationship according to considering the

correlation as infimum (0.00-0.20), low (0.20-0.40), medium (0.40-0.60), large (0.60-0.80), and very large (0.80-1.00). The following is the correlation test data between variables.

Table 5. Correlation test results

Correlations

		Agility	BMI
Agility	Pearson Correlation	1	.631*
	Sig. (2-tailed)		.016
	N	14	14
BMI	Pearson Correlation	.631*	1
	Sig. (2-tailed)	.016	
	N	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

IV. DISCUSSION

Based on the results of correlation tests that have been carried out, it was found that the body mass index (BMI) has a significant positive relationship with agility, with a correlation coefficient of 0.631 and a significance value of 0.016 ($p < 0.05$). This suggests that the increase in BMI is directly proportional to the increase in agility. The correlation indicated a moderate relationship between the two variables, but with a fairly high level of significance in the context of this study. The relationship between body mass index (BMI) and agility is an important topic in sports science, especially because these two variables are often associated with physical performance and health. BMI is a composite indicator that calculates the weight-to-height ratio and is often used to assess a person's body composition, whether they are classified as normal, underweight, overweight, or obese (Hernandez-Martinez et al., 2024; Pawlik & Mroczek, 2023). Meanwhile, agility refers to the ability to change direction or body position quickly and efficiently, which is one of the key components in various sports (Paška, Horička, Šimonek, Czakova, & Poláčková, 2023).

The positive correlation results between BMI and agility in this study may seem contradictory to general findings, which often suggest that high BMI is usually associated with being overweight, associated with reduced physical performance, including agility (Fiori et al., 2020; Hermassi, van den Tillaar, Bragazzi, & Schwesig, 2021; Mora-Gonzalez et al., 2019). However, it should be understood that BMI does not differentiate between muscle mass and fat mass. In the athlete population, a high BMI often reflects large muscle mass rather than excess fat(Abramowitz et al., 2018). Athletes with significant muscle mass may have a high BMI, but that muscle mass can support good physical performance, including agility. Studies show that greater muscle mass, if trained appropriately, can support the fast, explosive movements required in a variety of sports, including team sports such as volleyball(Aghajani, Hojjati Zidashti, & Elmieh, 2014; Tanghe & Martin, 2020). Research by Sonoda et al., (2018) emphasizes that agility is greatly influenced by the strength of the main muscles and the body's ability to coordinate movements efficiently. Therefore, individuals with a higher BMI due to significant muscle mass tend to have better agility performance than those with a lower BMI but with a greater proportion of fat mass.

The results of the studies that have been carried out show a positive relationship between BMI and agility, which results contradict the findings of many previous studies, which generally report a negative relationship between these two variables. For example, research Ruiz-Ariza et al., (2020) reveals that increased BMI is usually associated with decreased agility, as greater body mass increases mechanical load during rapid movement or change of direction. However, the positive association found in this study may be due to special characteristics of the sample, such as age or high levels of physical activity in subjects, who tend to be more active or athletic, and thus have a greater distribution of body mass while still being able to maintain optimal agility (Usher, 2019).

In addition, recent research in the field of exercise has also increasingly highlighted the importance of more specific body composition, such as the comparison between muscle mass and body fat, which can affect agility in different ways compared to BMI as a whole. Azra et al., (2024) emphasizes that greater muscle mass, especially in parts of the body actively used in sports, can contribute positively to agility despite higher BMI values.

The present invention has important relevance for trainers and sports nutritionists in managing the body composition of athletes. Although BMI is often used as a measuring tool quick to assess body proportions, in the context of athletes, a high BMI does not necessarily reflect a less than ideal body composition. Athletes who undergo intensive strength training tend to have greater muscle mass, which can actually contribute positively to agility and overall sports performance (Pauli et al., 2023).

Therefore, it is important for coaches not only to focus on the ideal BMI number, but also to consider the athlete's body composition more thoroughly. These results also highlight the importance of a multidimensional approach in assessing athlete fitness. Relying on BMI alone as an indicator of agility or physical fitness can be too narrow. More detailed body composition measurements, such as densitometry or bioelectric impedance analysis, can provide a more comprehensive picture of muscle and fat proportions and their impact on physical performance (Campa et al., 2022; Kasper et al., 2021).

Mala et al., (2020) explains that young athletes tend to be in a stage of physical development where their bodies naturally build muscle mass so that having a higher BMI means having healthy muscles that can help support their physical performance. Yapici et al., (2022) emphasizes that muscle strength can increase with age, the increase in muscle mass that occurs is highest during the growth and development period in teenagers. Therefore, at a young age volleyball athletes have a relationship between BMI and agility which is more influenced by positive components such as muscle mass. Furthermore, the structured exercise carried out can also increase muscle strength, coordination and agility, thus, athletes who have a higher BMI because it is caused by large muscle mass can be trapped with increased agility. Emphasized by Chang, Sun, Lin, & Tsai, (2022) that regular and structured exercise can increase muscle mass, muscle strength and functional performance by approximately 30 minutes. Then greater muscle mass can provide stability when moving quickly or turning, this can have an influence on increasing rapid changes in direction (França et al., 2022).

Today's scientific understanding increasingly focuses on the importance of a more in-depth evaluation of body composition rather than using BMI as the only indicator. Research by Alzoubi & Nashwan, (2022) showed that the relationship between muscle mass and agility performance was stronger compared to overall BMI. Thus, although BMI is still relevant as an indicator of general health, more and more research is now focusing on lean body mass (lean body mass) and fat mass (fat mass) and their relation to physical performance (Pomeroy et al., 2018; ten Haaf et al., 2018). The positive correlation between BMI and agility in this study supports the view that higher BMI especially in athletes with significant muscle mass, can contribute positively to agility performance. However, it is important to carry out a more in-depth evaluation of body composition, because BMI alone does not provide an accurate pictureregarding the influence of body composition on physical performance. Trainers, fitness experts and nutritionists need to take this aspect into account in designing exercise and weight management programs for athletes.

V. CONCLUSIONS

Based on the research results, a positive and significant correlation was found between body mass index (BMI) and agility, with a correlation coefficient of 0.631 and a significance value of 0.016. This suggests that increased BMI in study subjects is related to increased agility, although this contradicts some previous studies that generally reported a negative association between the two variables. However, these findings can be explained by the specific characteristics of the study subjects, such as high levels of physical activity and greater distribution of muscle mass.

Although BMI is often used as a general indicator of body composition, this study highlights the importance of a more in-depth evaluation of body composition, especially in the athlete population. In athletes, a higher BMI often reflects greater muscle mass, which can support optimal physical performance, including agility. Thus, body composition characterized by a significant proportion of muscle mass can contribute positively to agility, despite high BMI values.

In conclusion, although imt is a commonly used measuring tool, more detailed body composition, such as the proportion between muscle mass and fat mass, needs to be taken into account in the evaluation of physical performance. Therefore, trainers and sports nutritionists are advised not only to rely on imt, but also to use more accurate measurement methods, such as bioelectric impedance analysis or densitometry, in order to manage athletes' fitness and performance more comprehensively.

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