La correlación ventajosa entre la antropometría y la aptitud física en jugadores de fútbol amateur

The Advantageous Correlation Between Anthropometry and Physical Fitness in Amateur Soccer Players

Authors

Yusni Yusni [1]
Firdalena Meutia [2]
Nasyaruddin Herry Taufik [3]

1 Universitas Syiah Kuala (Indonesia)
2 Universitas Syiah Kuala (Indonesia)
3 Universitas Syiah Kuala (Indonesia)

Corresponding author:
Yusni Yusni
yusni@usk.ac.id

How to cite in APA

Yusni, Y., Meutia, F., & Taufik, N. H. (2025). The Advantageous Correlation Between Anthropometry and Physical Fitness in Amateur Soccer Players: Correlation Between Anthropometry and Physical Fitness. *Retos*, *67*, 985–995. https://doi.org/10.47197/retos.v67.112998

Abstract

Objective: This study aims to analyze the closeness of the relationship between body weight (BW) and body mass index (BMI) with physical fitness in amateur soccer players.
Materials and Methods: There were 31 participants, all male soccer players between the ages of 18 and 22. The research design was a cross-sectional study. The statistical analysis was the Pearson correlation test ($p<0.05$).
Results: The average value and category of speed (3.59 seconds) and less (>4.6 seconds), leg muscle power (69.42 cm) and very good (62-69 cm), muscle endurance (28.90 times) in good category (20-28 times), the average anaerobic endurance was 50.23 seconds with a moderate category (49.90-55.29 seconds), the average agility was 13.60 seconds with a less category (<25 seconds), and the average flexibility was 25.22 cm with category (>25 cm). The average value of abdominal muscle endurance was 38.87 times at a moderate category (30-49 times). The average aerobic capacity was 31.47 mL/kg/min at a moderate category (27-45 mL/kg/min). Pearson correlation analysis showed a weak negative correlation between BW and BMI with speed, anaerobic endurance, agility, and flexibility. On the other hand, a weak positive correlation was found between BW and BMI with leg muscle power, muscle endurance, abdominal muscle endurance, and aerobic capacity.
Conclusion: an increase in BW and BMI will be followed by a reduction in speed, anaerobic endurance, agility, and flexibility. Otherwise, an increase in BW and BMI will be continued by a rise in leg muscle power, muscle endurance, abdominal muscle endurance, and aerobic capacity.

Keywords

nutritional; body mass index; weight; physical fitness; soccer

Resumen

Objetivo: Este estudio tiene como objetivo analizar la proximidad de la relación entre el peso corporal (PC) y el índice de masa corporal (IMC) con la condición física en jugadores de fútbol amateur.
Materiales y métodos: Participaron 31 jugadores de fútbol masculino entre 18 y 22 años. El diseño de la investigación fue un estudio transversal. El análisis estadístico fue la prueba de correlación de Pearson ($p<0,05$).
Resultados: El valor medio y la categoría de velocidad (3,59 segundos) y menos (>4,6 segundos), potencia muscular de las piernas (69,42 cm) y muy buena (62-69 cm), resistencia muscular (28,90 veces) en categoría buena (20-28 veces), la resistencia anaeróbica media fue de 50,23 segundos con una categoría moderada (49,90-55,29 segundos), la agilidad media fue de 13,60 segundos con una categoría menos (<25 segundos), y la flexibilidad media fue de 25,22 cm con categoría (>25 cm). El valor promedio de la resistencia muscular abdominal fue de 38,87 veces en una categoría moderada (30-49 veces). La capacidad aeróbica promedio fue de 31,47 mL/kg/min en una categoría moderada (27-45 mL/kg/min). El análisis de correlación de Pearson mostró una correlación negativa débil entre el peso corporal y el IMC con la velocidad, la resistencia anaeróbica, la agilidad y la flexibilidad. Por otro lado, se encontró una correlación positiva débil entre el peso corporal y el IMC con la potencia muscular de las piernas, la resistencia muscular, la resistencia muscular abdominal y la capacidad aeróbica.
Conclusión: un aumento en el peso corporal y el IMC será seguido por una reducción en la velocidad, la resistencia anaeróbica, la agilidad y la flexibilidad. De lo contrario, un aumento en el peso corporal y el IMC será continuado por un aumento en la potencia muscular de las piernas, la resistencia muscular, la resistencia muscular abdominal y la capacidad aeróbica.

Palabras clave

nutricional; índice de masa corporal; peso; aptitud física; fútbol

Introduction

Soccer is the most popular team sport in the world (Darragi et al., 2024). Soccer is an intermittent sport that combines high-intensity and low-intensity activities;(Aguinaga-Ontoso et al., 2023) therefore, this sport requires good physical fitness as well as athletic performance. Components of physical fitness in soccer, such as speed, muscular strength, muscular power, aerobic fitness, anaerobic fitness, and agility (Castillo-Rodríguez et al., 2023; Chaeroni et al., 2024; Mashud et al., 2024; Side et al., 2024). In addition, nutrition is also a determining factor in the physical fitness of soccer players. Sports nutrition is one of the essential elements for athlete performance because it can reduce fatigue levels, reduce the risk of injury, increase physical fitness components, accelerate post-exercise recovery, maintain optimal body weight, and improve athlete health (Koehler & Drenowatz, 2019; Leonarda et al., 2018; Martinho et al., 2023).

Sports nutrition can help athletes maintain body composition balance, maintain ideal body weight, and increase aerobic capacity (VO2 max), therefore improving athlete performance (North et al., 2022; Oukheda et al., 2024). Exercise is part of planned, measured, structured, regular, and repetitive physical activity to improve physical fitness (Padhan & Mohapatra, 2023). Physical fitness is a set of attributes related to the ability to perform physical activities, fitness, and health (Mashud et al., 2024). The physical fitness of football players can be known through examination of several physical components, such as speed, leg muscle power, muscle endurance, anaerobic endurance, agility, flexibility, abdominal muscle endurance, and aerobic capacity (VO2max) (Chaeroni et al., 2024; Side et al., 2024; Waskita et al., 2023).

Nutritional status plays an important role in providing energy sources for exercise and training (Martinho et al., 2023). High physical activity and continuous training in soccer athletes require special nutrition to maintain a homeostasis between energy expenditure and food intake (Martinho et al., 2023; Pranata et al., 2024; Sebastiá-Rico et al., 2023). High physical activity during training and competing in soccer will impact changes in lean body mass, body composition, and physical fitness of athletes (El Gezrey & Abdelhaliem, 2018; Martinho et al., 2023). Athletes who consume healthy and balanced nutritious foods according to their needs will have good nutritional status and can maintain optimal physical fitness (Leonarda et al., 2018; Polikandrioti & Tsami, 2019). Food with balanced nutritional content and according to their needs plays an important role in improving athlete fitness and performance not only during training but also during competition (Aguinaga-Ontoso et al., 2023; Polikandrioti & Tsami, 2019).

Soccer is an explosive sport that requires a high level of physical fitness and a healthy diet due to its short recovery period, explosive movements, and emphasis on aerobic resistance (Castillo-Rodríguez et al., 2023). According to a number of research findings, in addition to genetics, consistent training, effective coaching, training methods, and an athlete's physical attributes, one of the factors influencing athlete performance is a healthy, balanced, and appropriate nutritional status (Hulton et al., 2022; Martinho et al., 2023). Athletes can perform and achieve more when they consume the correct nutrients (Martinho et al., 2023).

Good nutritional status, excellent health, and ideal physical components are prerequisites for athletes to perform at their best (Hambali et al., 2023; Rosman & Anuar, 2020). Good nutrition, consistent exercise, and routine physical component evaluations can all help achieve optimal physical components (Pranata et al., 2024). In order to perform to the best of their abilities in every competition, athletes must take their physical condition into consideration on a daily basis (Rabiah et al., 2022). Sustaining optimal performance requires not only consistent training but also appropriate training methods (Majid & Fauzi, 2021) and dietary habits or nutritional intake (Insani et al., 2023; Oukheda et al., 2023).

The purpose of examining the athlete's nutritional status is to determine the body composition (BMI) so that the food arrangement for athletes is based on their needs (Gogojewicz et al., 2023; Insani et al., 2023). This nutritional status examination also plays an important role in assessing the adequacy of daily nutrition for athletes according to their respective sports (Miftah et al., 2023). The nutritional status is measured by anthropometric measurements, such as weight, height, body mass index (BMI), body circumference, and subcutaneous fat thickness (Martinho et al., 2023; Pranata et al., 2024; Tomczak et al., 2022). Anthropometric values affect the quality of athletes during training or competing because anthropometry is related to physical fitness (Ilhan et al., 2023). A study result states that there

is a negative linear relationship between BMI and physical fitness in people with obesity (Shalabi et al., 2023).

This research analyzes the form and closeness of the correlation between BW and BMI with physical fitness (speed, leg muscle power, muscle endurance, anaerobic endurance, agility, flexibility, abdominal muscle endurance, and aerobic capacity (VO2 max)) in soccer athletes. The results can be used as a guide for monitoring body composition to improve physical fitness in soccer players.

Method

Study Design and Research subjects

This study's design was a cross-sectional. The research data were obtained directly from the measurements of the research subjects. The data were collected for one week (seven days). The examination of weight, height, and body mass index (BMI) was carried out at the physiology laboratory of the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia. The participants in this study were athletes from the province of Aceh, Indonesia. Samples were amateur soccer players, male, healthy, and between the ages of 18 and 22 were the requirements for inclusion. The exclusion criteria included being injured, refusing to submit to a thorough examination, and being unwilling to voluntarily participate in research. Total sampling, which uses all football respondents as research samples, was the basis used to determine the sample size. Thirty individuals made up the total sample count.

Data collection and Measures

Research data collection includes nutritional status and physical fitness. Nutritional status examination is carried out by measuring body composition: body weight (BW), height, and body mass index (BMI). BW was measured using digital scales in kilograms (kg), height was measured using a stadiometer in centimeters (cm^2), and BMI was calculated using the BMI formula by comparing weight and height in units (kg/m^2). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) are measured using a manual sphygmomanometer. The physical fitness measured includes speed, leg muscle power, muscle endurance, anaerobic endurance, agility, flexibility, abdominal muscle endurance, and aerobic capacity (cardiorespiratory endurance).

Speed is measured by running 30 meters using a stopwatch and in seconds. The speed categories for men are perfect (<4.0 seconds), very-good (4.2-4.0 seconds), good (4.4-4.3 seconds), moderate (4.6-4.5 seconds), and less (4.6 seconds). Leg muscle power examination was done using vertical jump with the unit centimeters (cm). The leg muscle power categories are perfect (≥70), very-good (62-69 cm), good (53-61), moderate (48-52 cm), and weak (38-45 cm). Muscle endurance (arms and shoulders) is measured using push-ups with unit times (x). The categories for muscle endurance are perfect (≥38), very good (29-37), good (20-28), moderate (12-19), weak (4-11). Anaerobic endurance was measured by sprinting 300 meters in seconds. Anaerobic endurance categories: Very-good (31-80-38.95 seconds), good (38.96-44.59 seconds), moderate (44.60-49.89 seconds), sufficient (49.90-55.29 seconds), and weak (55.30-60.59 seconds).

Agility is measured using an 8x5 meter shuttle run, and the unit is seconds. Categories for agility: Good (≥31 seconds), moderate (26-30 seconds), and less (<25 seconds). Flexibility is measured using a sit-and-reach test in centimeters (cm) unit. Flexibility categories for men over 20 years old are good (>25 cm), moderate (9.4-25 cm), and less (9.4 cm). Abdominal muscle endurance is measured by sit-up for a duration of 30 seconds, with the unit being timed (x). The abdominal muscle endurance categories are perfect (≥90), very good (70-89), good (50-69), moderate (30-49), and poor (10-29). The aerobic capacity or cardiorespiratory endurance was measured by VO2 max with the Balke 15-minute run method with units of mL/kg/min. The categories for VO2max are perfect (≥68 mL/kg/min), very-good (55-67 mL/kg/min), good (46-54 mL/kg/min), moderate (27-45 mL/kg/min), low (≤26 mL/kg/min).

Data analysis

The data were analyzed using the Pearson correlation test at a significance level of alpha 5% ($p<0.05$). Correlation values (r) were displayed according to the Pearson correlation analysis criteria as follows:

0.00-0.10=negligible correlation, 0.10-0.39=weak correlation, 0.40-0.69=moderate correlation, 0-70-0.89=strong correlation, and 0.90-1.00=very-strong correlation (Schober & Schwarte, 2018).

Ethical Approval

The Medical Research Ethics Committee of the Faculty of Medicine, Universitas Syiah Kuala, Banda Aceh, Indonesia, has approved the implementation of this research based on its ethical approval letter number 236/EA/FK-RSUDZA/2021.

Results

The results include data on respondent characteristics, nutritional status, blood pressure, and fitness of soccer players. The nutritional status measured includes body weight (BW), height, and body mass index (BMI). The blood pressure measured includes systolic blood pressure (SBP) and diastolic blood pressure (DBP). Fitness levels are assessed based on examinations of several physical components, such as speed, leg muscle power, muscle endurance, anaerobic endurance, agility, flexibility, abdominal muscle endurance, and aerobic capacity (cardiorespiratory endurance). Characteristic data is shown in Table 1.

Tabel 1. Characteristics of Soccer player

Data	n	Means±SD	Minimum	Maximum
Age (year)	31	19.00±1.16	17.00	18.00
Weight (kg)	31	54.52±9.57	51.01	58.03
Height (cm^2)	31	162.18±7.77	159.33	165.03
BMI (kg/m^2)	31	20.62±2.76	19.61	21.63
SBP (mmHg)	31	120.15±6.92	118.11	120.18
DBP (mmHg)	31	81.61±5.06	79.76	83.47

Table 1 demonstrates that the participants in this study were adult athletes (17 years of age and older), with the lowest age being 17 and the highest age being 18. The average of the research subjects' BMIs (18.50–22.90 kg/m2) is known to be in the normal range, and every subject has a BMI in this range.(1) Likewise, the mean blood pressure of the subjects had SBP and DBP within the normal range, and all subjects had normal blood pressure (SBP 120-129 mmHg, DBP 80-84 mmHg) (2).

Table 2. An overview of physical fitness in Soccer players

Data	n	Means±SD	Minimum	Maximum
Speed (second)	31	3.59± 0.37	3.45	3.72
Leg muscle power (cm)	31	69.42±12.47	64.84	73.99
Muscle endurance (time)	31	28.90±12.90	24.17	33.63
Anaerobic endurance (second)	31	50.23±4.55	48.56	51.90
Agility (second)	31	13.60±1.44	13.07	14.13
Flexibility (cm)	31	25.22±9.66	21.67	28.76
Abdominal muscle endurance (time)	31	38.87±20.33	31.41	46.33
Aerobic capacity (mL/kg/min)	31	31.47±10.07	27.79	35.18

Table 2 indicates that the speed component average, as well as the lowest and highest values, for soccer players fall into the less category (>4.6 seconds). With an average of 69.42 cm, the leg muscle power component falls into the very good range (62-69 cm). The mean muscle endurance score (28.90 x) of soccer players falls within the favorable range (20-28 times). Soccer players' anaerobic endurance falls into a sufficient category (49.90-55.29 seconds) with an average of 50.23 seconds. The average agility of soccer players is 13.60 seconds, in the less category (<25 seconds). Their flexibility is in a Good category (>25 cm) with an average value of 25.22 cm. Abdominal muscle endurance obtained an average value of 38.87 times with a sufficient category (30-49 times). The results of the aerobic capacity analysis obtained an average value of 31.47 mL/kg/min in the moderate category (27-45 mL/kg/min).

Table 3. The link between Weight and Physical Fitness in Soccer player

Variable	n	Pearson Correlation (r)	*p*-value
Link between weight and speed	31	-0.05	0.78
Link between weight and leg muscle power	31	0.38	0.04*
Link between weight and muscle endurance	31	0.19	0.30

Link between weight and anaerobic endurance	31	-0.07	0.69
Link between weight and agility	31	-0.19	0.29
Link between weight and flexibility	31	-0.13	0.50
Link between weight and abdominal muscle endurance	31	0.21	0.27
Link between weight and aerobic capacity	31	0.19	0.29

Table 3 shows that there is a negative correlation that is not significant between body weight (BW) with speed (r = -0.05; p = 0.78), anaerobic endurance (r = -0.07; p = 0.69), agility (r = -0.19; p = 0.29), and flexibility (r = -0.13; p = 0.50). These results indicate that there is a tendency that if there is an increase in BW, it will followed by a decrease in speed, anaerobic endurance, agility, and flexibility in soccer players, but because the correlation value shows a value of p > 0.05, it was negligible. Therefore, further analysis using a large number of subjects is needed.

Other variables revealed the opposite: a significant positive relationship (r=0.38; p=0.04*) was observed between BW and leg muscle power. These findings suggest that soccer players' leg muscle power capacity tends to increase along with an increase in body weight. In the same way, there is a weak positive correlation between BW with muscle endurance (r = 0.19), abdominal muscle endurance (r = 0.21), and aerobic capacity (r = 0.19); however, this relationship is not statistically significant (p > 0.05). These findings suggest a tendency for increases in BW to be accompanied by increases in muscular endurance, abdominal muscle endurance, and aerobic capacity.

Table 4. The link between BMI and Physical Fitness in Soccer player

Variable	n	Pearson Correlation (r)	*p*-value
Link between BMI and speed	31	-0.05	0.77
Link between BMI and Leg Muscle power	31	0.38	0.03*
Link between BMI and Muscle endurance	31	0.28	0.19
Link between BMI and anaerobic endurance	31	-0.15	0.43
Link between BMI and agility	31	-0.23	0.21
Link between BMI and flexibility	31	-0.05	-0.79
Link between BMI and abdominal muscle endurance	31	0.17	0.35
Link between BMI and aerobic capacity	31	0.23	0.19

Table 4 demonstrates that the negative relationship between BMI and anaerobic endurance (r = -0.15; p = 0.43), speed (r = -0.05; p = 0.77), agility (r = -0.23; p = 0.21), and flexibility (r = -0.05; p = 0.79) is not statistically significant. These findings suggest that there may be a tendency for soccer players' speed, anaerobic endurance, agility, and flexibility to decrease with rising BMI; however, this tendency is disregarded because the correlation value is p>0.05. On the other hand, a weak positive linear relationship (r = 0.38; p = 0.03*) was discovered between leg muscle power and BMI. This finding indicates that an increase in BMI will be followed by an increase in leg muscle power capacity in soccer players. As well, there was a weak positive relationship that was not significant (p > 0.05) between BMI and muscle endurance (r = 0.28; p = 0.19), abdominal muscle endurance (r = 0.17; p = 0.35), and aerobic capacity (r = 0.23; p = 0.19). These results indicate that an increase in BMI will cause an increase in muscle endurance, abdominal muscle endurance, and aerobic capacity.

Discussion

The results of our study indicate that there is a negative linear correlation between BW and BMI with physical fitness components, such as speed, anaerobic endurance, agility, and flexibility; therefore, if there is an increase in BW and BMI, it will be followed by a decrease in speed, anaerobic endurance, agility, and flexibility in soccer players. On the other hand, there was a positive linear correlation between BW and BMI with physical fitness components, including leg muscle power, muscle endurance, abdominal muscle endurance, and aerobic capacity. According to these findings, there will be a corresponding rise in muscle endurance, abdominal muscle endurance, and aerobic capacity with elevations in BW and BMI. These results also indicate that physical fitness is related to the nutritional status of soccer athletes. Anthropometric assessment (BMI and BW) is very relevant to the physical fitness condition of athletes (Conde-Pipo et al., 2023; Falces-Prieto et al., 2024). Nutrition is included in physical fitness along with all other aspects of physical fitness (Rosman & Anuar, 2020).

Optimal nutritional status is crucial to improving overall physical fitness and all fitness components for soccer players (Aguinaga-Ontoso et al., 2023; Carey et al., 2023). The achievements of soccer players are highly dependent on physical, psychological, technical, and tactical factors (Asimakidis et al., 2024; Chaeroni et al., 2024; Kariyawasam et al., 2019). Every soccer player needs perfect physical fitness components as initial capital for the training and tournament (Mon-López et al., 2019). The primary components of physical fitness for soccer players are cardiovascular endurance, flexibility, muscle strength, muscle endurance, and body composition (body fat) (Baro et al., 2016; El-Kalana et al., 2025; Farley et al., 2024). Secondary components of physical fitness in soccer players include balance, coordination, agility, reaction time, speed, and power (Farley et al., 2024). Soccer sports are highly dependent on speed and anaerobic endurance because of the very high risk of fatigue (Aguinaga-Ontoso et al., 2023).

Football players' nutritional state has a significant impact on their performance because (Ilhan et al., 2023), during an exercise or competition in one set, they must run a minimum of 10–14 km, with 8% of that distance being high-intensity running (sprint) (Aguinaga-Ontoso et al., 2023; Hulton et al., 2022; Ilhan et al., 2023). As a result, to avoid fatigue and sports injuries, football players need to maintain an extremely high level of fitness (Ameer, 2020). Each football tournament requires a minimum of 150–250 intense actions, including a high-intensity run of approximately 419.8 km every 72 seconds or with a total distance of 10 and 13 km; hence, being in peak physical condition is essential for accomplishment (Altmann et al., 2020; Castillo-Rodríguez et al., 2023; Hardinata et al., 2023; Hulton et al., 2022). Regular exercise is also necessary to enhance muscular strength, muscular endurance, flexibility, cardiovascular endurance, and body composition (Schwartz et al., 2015). Therefore, physical activity plays a significant role in improving athletes' physical fitness.

Physical components differ in each type of sport (Farley et al., 2024). In soccer players, the most crucial physical fitness components are muscle endurance, cardio-pulmonary endurance, and BMI, or low-fat composition, in the body (Haegele et al., 2019; Villaseca-Vicuña et al., 2021). Therefore, soccer athletes need to maintain their weight; that's why no one should be overweight or obese. The result of the study showed a relationship between the anthropometric profile (BMI) and the performance of soccer athletes during the competition (Martinho et al., 2023). BMI is calculated by di viding body weight by height squared (Polikandrioti & Tsami, 2019; Vasileva et al., 2022). Routine monitoring of nutritional status must continue to be carried out, especially to control the weight of soccer players (Koehler & Drenowatz, 2019; Martinho et al., 2023). Soccer players who are highly muscular with low adiposity will have a high level of physical fitness (Atakan et al., 2017).

A study found that there was a negative relationship between high body fat percentage and low sports performance (Conde-Pipo et al., 2023). Muscle percentage has a significant effect on the distance traveled during a soccer match in soccer players (Conde-Pipo et al., 2023). Athletes must weigh themselves daily to determine their weight and prevent weight gain due to excess fat, influencing their physical capacity and poor athlete performance (Martinho et al., 2023). Therefore, monitoring BW and BMI must be done routinely with accurate methods.

Cardiovascular endurance (aerobic capacity) is the ability of the body's system to process, collect, and deliver oxygen (Chaeroni et al., 2024; Haegele et al., 2019). Cardiovascular endurance is the ability of the heart to transport blood and use it in the working muscle area (Shalabi et al., 2023). Cardiovascular endurance is closely related to the body's ability to maintain long-term exercise involving the cardiovascular and respiratory systems (Hardinata et al., 2023). Cardiovascular endurance examination is done by measuring VO2 max (Hardinata et al., 2023). Cardiovascular endurance is a very vital component of physical fitness for soccer players because a soccer game lasts for 90 minutes, which requires high physical strength as a result of high-speed running, jumping, tackling, and turning activities (Hardinata et al., 2023).

Football is a high-intensity sport; therefore, cardiorespiratory endurance has an important role in maintaining strength and speed during the competition (Altmann et al., 2020; Asimakidis et al., 2024; Rosman & Anuar, 2020). A study conducted in India in 2022 stated that there is a relationship between body fat percentage and BMI with VO2max in adolescent footballers (Gaurav & Maman, 2022). Body composition has a significant relationship with the aerobic capacity of younger football players (Gaurav & Maman, 2022). BMI is correlated with aerobic capacity in futsal players (Pantelis T. Nikolaidis et al., 2019).

Muscle strength is the capacity to apply force to an outside object or the maximum force produced by a muscle measured using a handgrip strength test (Suchomel et al., 2016). Muscle strength is an important component for soccer players because muscle strength is closely related to other fitness components such as balance, speed, and vertical jump (Bogalho et al., 2022). Based on a study finding, BMI has a significant effect on muscle strength in both hands but does not affect the explosive strength of the upper extremities (Gashi et al., 2023). BMI is inversely related to local muscle endurance, aerobic power, and anaerobic power in soccer players aged 12–14 years (Pantelis Theodoros Nikolaidis, 2012). BMI also has a significant positive relationship with muscle strength (Shalabi et al., 2023).
Muscle endurance is the ability of muscles to create and maintain their strength repeatedly (Sarah et al., 2019). The results of the study by Konieczna et al. found that aerobic endurance is positively related to free fat mass in soccer players aged 13-16 years (Konieczna et al., 2019). Other studies also concluded that BMI has a negative relationship with anaerobic endurance and muscle strength in adult male basketball players (18-22 years) (Kumar et al., 2023). BMI has a non-significant positive relationship with muscle endurance in soccer players (Sarah et al., 2019).

Agility is the ability to change the direction and position of the body in a certain position quickly and precisely when the body is moving without losing balance (Hambali et al., 2023). Agility is crucial for improving the performance of the sport of football. Agility functions to be able to coordinate multiple movements, make it easier to master high techniques, produce effective, efficient, and economical movements, and also make it easier to adapt to opponents and the environment (Hambali et al., 2023). A study conducted in 2017 found that there was a relationship between BMI and BW with agility in university prayers (Cricket, Football, Hockey, and Handball) (Singh Dhapola & Verma, 2017). BMI has a significant negative linear relationship with agility, meaning that the lower the BMI, the higher the agility in football athletes (Hidayat et al., 2022).

Speed is the body's ability to perform similar movements in succession in the shortest possible time, or it is also the ability to cover a distance in the shortest possible time. Speed, strength with a combination of maximum aerobic and anaerobic capacity, and agility are essential factors for the performance of football athletes (Bujnovsky et al., 2019). A study result states that there is a relationship between BMI and BW with speed in university exercises (Cricket, Football, Hockey, and Handball) (Singh Dhapola & Verma, 2017). Other research also states that anthropometry (body mass and height) is related to sprint performance in football players aged 12 years (Martiri & Mema, 2021). Flexibility is a fundamental physical component that must be maximal in athletes (Side et al., 2024; Singh Dhapola & Verma, 2017). Flexibility is an important component of athletic performance in soccer players and relates to the risk of injury (Bogalho et al., 2022). A study conducted in Saudi Arabia stated that BMI was not related to flexibility (Shalabi et al., 2023). Research conducted on soccer players aged 12–14 years found that there was a low, non-significant relationship between BMI and flexibility (Pantelis Theodoros Nikolaidis, 2012).

Conclusions

It is clear that in soccer players, BW and BMI have a negative relationship with anaerobic endurance, speed, agility, and flexibility. On the other hand, there is a positive correlation between BW and BMI with aerobic capacity, leg muscle power, and abdominal muscle endurance. A rise in BW and BMI will cause a fall in anaerobic endurance, speed, agility, and flexibility. Increasing BW and BMI, on the other hand, will cause soccer players' leg muscle power, muscle endurance, abdominal muscle endurance, and aerobic capacity to increase.

Acknowledgements

We are grateful to Universitas Syiah Kuala and the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia, through grant number 174/UN11/SPK/PNBP/2021 dated February 22, 2021, for the Implementation of Product-Based Community Service for the 2021 Fiscal Year, helped fund this study.

Financing

This research was funded by Universitas Syiah Kuala with grant number 174/UN11/SPK/PNBP/2021 dated February 22, 2021.

References

Aguinaga-Ontoso, I., Guillen-Aguinaga, S., Guillen-Aguinaga, L., Alas-Brun, R., & Guillen-Grima, F. (2023). Effects of Nutrition Interventions on Athletic Performance in Soccer Players: A Systematic Review. *Life*, *13*(6), 1–20. https://doi.org/10.3390/life13061271

Altmann, S., Neumann, R., Woll, A., & Härtel, S. (2020). Endurance Capacities in Professional Soccer Players: Are Performance Profiles Position Specific? *Frontiers in Sports and Active Living*, *2*(September), 1–6. https://doi.org/10.3389/fspor.2020.549897

Ameer, A. Al. (2020). The effects of plyometric and resistance training on selected fitness variables among university soccer-playing adults. *Annals of Applied Sport Science*, *8*(3), 1–5. https://doi.org/10.29252/AASSJOURNAL.817

Asimakidis, N. D., Bishop, C. J., Beato, M., Mukandi, I. N., Kelly, A. L., Weldon, A., & Turner, A. N. (2024). A survey into the current fitness testing practices of elite male soccer practitioners: from assessment to communicating results. *Frontiers in Physiology*, *15*(1376047), 1–13. https://doi.org/10.3389/fphys.2024.1376047

Atakan, M. M., Unver, E., Demirci, N., Cinemre, A., Bulut, S., & Turnagol, H. H. (2017). Effect of body composition on fitness performance in young male football players. *Turkish Journal of Sport and Exercise*, *19*(1), 54–59. https://dergipark.org.tr/en/pub/tsed/issue/29096/311331

Baro, M., Singh, O. J., Thapaa, S. K., & Sonowal, A. (2016). Physical Fitness and Wellness-Challenge in the 21 st Century. *International Journal of Physical Education, Fitness and Sports*, *5*(1), 29–32. https://doi.org/10.26524/1616

Bogalho, D., Gomes, R., Mendes, R., Dias, G., & Castro, M. A. (2022). Impact of Flexibility on Vertical Jump, Balance and Speed in Amateur Football Players. *Applied Sciences*, *12*(11). 1-11 https://doi.org/10.3390/app12115425

Bujnovsky, D., Maly, T., Ford, K. R., Sugimoto, D., Kunzmann, E., Hank, M., & Zahalka, F. (2019). Physical fitness characteristics of high-level youth football players: Influence of playing position. *Sports*, *7*(2), 1–10. https://doi.org/10.3390/sports7020046

Carey, C. C., Doyle, L., & Lucey, A. (2023). Nutritional priorities, practices and preferences of athletes and active individuals in the context of new product development in the sports nutrition sector. *Frontiers in Sports and Active Living*, *5*(February), 1–13. https://doi.org/10.3389/fspor.2023.1088979

Castillo-Rodríguez, A., Alejo-Moya, E. J., Figueiredo, A., Onetti-Onetti, W., & González-Fernández, F. T. (2023). Influence of physical fitness on decision-making of soccer referees throughout the match. *Heliyon*, *9*(9), 1–9. https://doi.org/10.1016/j.heliyon.2023.e19702

Chaeroni, A., Ahmed, M., Talib, K., Orhan, B. E., & Govindasamy, K. (2024). In-depth Review: Analysis of Soccer Players' Physical Condition in Game Dynamics. *International Journal of Human Movement and Sports Sciences*, *12*(4), 747–757. https://doi.org/10.13189/saj.2024.120417

Conde-Pipo, J., Latorre, J. A., Gimenez-Blasi, N., Olea-Serrano, F., Requena, B., & Mariscal-Arcas, M. (2023). Comparative Analysis of Body Composition Profiles among Latin American Elite Football Players Competing in Europe. *Applied Sciences (Switzerland)*, *13*(11), 1–13. https://doi.org/10.3390/app13116778

Darragi, M., Zouhal, H., Bousselmi, M., Karamti, H. M., Clark, C. C. T., Laher, I., Hackney, A. C., Granacher, U., & Zouita, A. B. M. (2024). Effects of In-Season Strength Training on Physical Fitness and Injury Prevention in North African Elite Young Female Soccer Players. *Sports Medicine - Open*, *10*(1), 1–20. https://doi.org/10.1186/s40798-024-00762-0

El-Kalana, G., Akroush, S., Al-Qarra, S., Fattah, O. A., & Ahmad, M. (2025). Anthropometric and physical indicators among Jordanian female soccer according to playing position. *Retos*, *65*, 749–761. https://doi.org/10.47197/retos.v65.111502

El Gezrey, H., & Abdelhaliem, H. (2018). Evaluation of nutrition intake of football players. *Journal of Medicine in Scientific Research*, *1*, 54-58. https://doi.org/10.4103/jmisr.jmisr_13_18

Falces-Prieto, M., Martín-Moya, R., Delgado-García, G., Silva, R. M., Ceylan, H. I., & de la Cruz-Márquez, J.

C. (2024). Quarterly Percentual Change in Height, Weight, Body Fat and Muscle Mass in Young Football Players of Different Categories. *Applied Sciences (Switzerland)*, *14*(9), 1–10. https://doi.org/10.20944/preprints202403.1594.v1

Farley, Ij. B., Hara, M. O., Id, J. W. L. K., Woods, C. T., Rathbone, E., & Milne, N. (2024). Relationships between physical fitness characteristics, technical skill attributes, and sports injury in female Australian football players. *PLoS ONE*, *19*(2), 1–19. https://doi.org/10.1371/journal.pone.0298267

Gashi, F., Kovačič, T., Bllaca, V., & Gashi, A. I. (2023). Assessment of body weight in 14–15-year-old children and differences in dominant side and explosive force of upper extremities. *Journal of Physical Education and Sport*, *23*(8), 2016–2022. https://doi.org/10.7752/jpes.2023.08232

Gaurav, K., & Maman, P. (2022). Correlation of body composition and aerobic capacity with heart rate variability in Indian elite soccer players. *International Journal of Health Sciences*, *6*(S4), 11524–11536. https://doi.org/10.53730/ijhs.v6ns4.11172

Gogojewicz, A., Straburzyńska-Lupa, A., Podgórski, T., Frajtag, P., Bibrowicz, K., & Śliwicka, E. (2023). Assessment of the Dietary Intake and Nutritional Status of Polish Professional Futsal Players: A Descriptive Study-Do Futsal Players Require Nutritional Education? *Nutrients*, *15*(3720), 1–12. https://doi.org/10.3390/nu15173720

Haegele, J. A., Wilson, P. B., Yang, D., Zhu, X., Haegele, J. A., & Wilson, P. B. (2019). The Association Between Health-Related Fitness and Physical Activity During Weekdays : Do Fit Students Exercise More After School? *Sustainability*, *11*(15), 1–8. https://doi.org/10.3390/su11154127

Hambali, S., Syamsudar, B., Ishak, M., Bernhardin, D., & Taufik, M. S. (2023). Status of nutritional and physical condition of football athletes. *Journal of Physical Education Health and Sport*, *10*(1), 58–63. https://doi.org/10.15294/jpehs.v10i1.45429

Hardinata, R., Putra Sastaman, B., Okilanda, A., Prabowo, T. A., Tjahyanto, T., Rozi, M. F., Suganda, M. A., & Suryadi, D. (2023). Analysis of the physical condition of soccer athletes through the yo-yo test: a survey study on preparation for the provincial sports week. *Retos*, *50*, 1091–1097. https://doi.org/10.47197/retos.v50.100300

Hidayat, M. Y., Saraswati, P. A. S., Widnyana, M., & Kinandana, G. P. (2022). Correlation Between Body Mass Index Towards Agility Football Athletes in Melawi Regency. *Sport and Fitness Journal*, *10*(3), 215-222. https://doi.org/10.24843/spj.2022.v10.i03.p06

Hulton, A. T., Malone, J. J., Clarke, N. D., & Maclaren, D. P. M. (2022). Energy Requirements and Nutritional Strategies for Male Soccer Players: A Review and Suggestions for Practice. *Nutrients*, *14*(3), 0–27. https://doi.org/10.3390/nu14030657

Ilhan, A., Muniroglu, S., & Raklcloğlu, N. (2023). Effect of body composition on the athletic performance of soccer referees. *Journal of Nutritional Science*, *12*(312), 1–6. https://doi.org/10.1017/jns.2023.47

Insani, H. M., Santanu, A. M., & Sentani, M. R. (2023). The Relationship between Food Consumption and Nutritional Status of Male Junior Athletes: A Cross Sectional Study in Sumedang. *International Journal of Human Movement and Sports Sciences*, *11*(5), 1036–1043. https://doi.org/10.13189/saj.2023.110512

Kariyawasam, A., Ariyasinghe, A., Rajaratnam, A., & Subasinghe, P. (2019). Comparative study on skill and health related physical fitness characteristics between national basketball and football players in Sri Lanka. *BMC Research Notes*, *12*(1), 1–5. https://doi.org/10.1186/s13104-019-4434-6

Koehler, K., & Drenowatz, C. (2019). Integrated Role of Nutrition and Physical Activity for Lifelong Health. *Nutrients*, *11*(1437), 1–4. https://doi.org/10.3390/nu11071437

Konieczna, A., Radzimiński, Ł., Paszulewicz, J., Lopez-Sanchez, G. F., Dragos, P., & Jastrzębski, Z. (2019). Physical capacity and body composition in 13-16 year old soccer players during three-year training cycle. *Baltic Journal of Health and Physical Activity*, *11*(4), 47–57. https://doi.org/10.29359/BJHPA.11.4.06

Kumar, A., Bharadwaj, A., Sharma, R., & Kumari, R. (2023). An Observational Study Assessing the Relationship between Body Mass Index and Physical Fitness in Adult Males. *International Journal of Current Pharmaceutical Review and Research*, *15*(7), 16–21. https://www.ijcpr.com/

Leonarda, G., Fedele, E., Vitale, E., Lucini, D., Mirela, V., & Anca, I. (2018). Healthy Athlete's Nutrition. *Journal of the Romanian Sports Medicine Society*, *XIV*(1), 2967–2985. https://www.researchgate.net/publication/326848424

Majid, N. C., & Fauzi. (2021). The effect of sprint training on vertical jump height of female youth

volleyball players. *International Journal of Human Movement and Sports Sciences*, *9*(2), 334–339. https://doi.org/10.13189/SAJ.2021.090222

Martinho, D. V., Field, A., Rebelo, A., Gouveia, É. R., & Sarmento, H. (2023). A Systematic Review of the Physical, Physiological, Nutritional and Anthropometric Profiles of Soccer Referees. *Sports Medicine-Open*, *9*(1), 1–29. https://doi.org/10.1186/s40798-023-00610-7

Martiri, A., & Mema, F. (2021). Anthropometric and Physical Data of Children in Football. *Research & Investigations in Sports Medicine*, *7*(3), 611–615. https://doi.org/10.31031/rism.2021.07.000661

Mashud, M., Arifin, S., Warni, H., Samodra, Y Touvan, J., Yosika, G. F., Basuki, S., Suryadi, D., & Suyudi, I. (2024). Physical Fitness: Effects of active lifestyle internalization through physical literacy awarenes based project. *Retos*, *52*, 1299–1308. https://doi.org/10.47197/retos.v51.101662

Miftah, F., Elhisadi, T. A., Alnafati, F. M., FFarjani, M., & Emnaina, A. A. (2023). Evaluation of nutritional status on football players' performance. *British Journal of Medical & Health Sciences (BJMHS)*, *5*(4), 1376–1383. https://www.jmhsci.org

Mon-López, D., Silva, F. M. da, Morales, S. C., López-Torres, O., & Calvo, J. L. (2019). What Do Olympic Shooters Think about Physical Training Factors and Their Performance ? *International Journal of Environmental Research and Public Health*, *16*(4629), 1–12. https://doi.org/10.3390/ijerph16234629

Nikolaidis, Pantelis T., Chtourou, H., Torres-Luque, G., Rosemann, T., & Knechtle, B. (2019). The relationship of age and BMI with physical fitness in futsal players. *Sports*, *7*(4), 1–10. https://doi.org/10.3390/sports7040087

Nikolaidis, Pantelis Theodoros. (2012). Elevated body mass index and body fat percentage are associated with decreased physical fitness in soccer players aged 12-14 years. *Asian Journal of Sports Medicine*, *3*(3), 168–174. https://doi.org/10.5812/asjsm.34687

North, M., Kelly, A. L., Ranchordas, M. K., & Cole, M. (2022). Nutritional Considerations in High Performance Youth Soccer: A Systematic Review. *Journal of Science in Sport and Exercise*, *4*(3), 195–212. https://doi.org/10.1007/s42978-022-00171-3

Oukheda, M., Bouaouda, K., Mohtadi, K., Lebrazi, H., Derouiche, A., Kettani, A., Saile, R., & Taki, H. (2023). Association between nutritional status, body composition, and fitness level of adolescents in physical education in Casablanca, Morocco. *Frontiers in Nutrition*, *10*(November), 1–17. https://doi.org/10.3389/fnut.2023.1268369

Oukheda, M., Bouaouda, K., Mohtadi, K., Lebrazi, H., Derouiche, A., Kettani, A., Saile, R., & Taki, H. (2024). The Cardiorespiratory Endurance (VO2max), Body Composition and Macronutrient's Intake in the Pre-competitive Period: A Correlation Study among Moroccan Professional Soccer Players. *International Journal of Human Movement and Sports Sciences*, *12*(2), 288–301. https://doi.org/10.13189/saj.2024.120203

Padhan, S., & Mohapatra, A. (2023). Physical Exercise and Health. In *Physical Education and Sports Science* (Vol. 2, pp. 9–27). AkiNik Publications. https://doi.org/https://www.researchgate.net/publication/375695139

Polikandrioti, M., & Tsami, A. (2019). Nutrition for exercise and health: a brief review. *Health Science Journal*, *1*, 1–7. http://www.hsj.gr

Pranata, D. Y., Hidayatullah, F., Sulaiman, Sumartiningsih, S., Pramono, H., & Setiawaty, H. (2024). Health and fitness study of Semarang soccer players: the role of VO2 max, body mass index, age and length of training. *Retos*, *61*, 400–404. https://doi.org/10.47197/retos.v61.108184

Rabiah, A. N., Ratnawati, & Reski, S. (2022). The Relationship between Nutritional Status and Food Intake with the Physical Fitness Level of Athletes at the Samkot Samarinda Football School in 2022. *Formosa Journal of Science and Technology*, *1*(7), 945–960. https://doi.org/10.55927/fjst.v1i7.1307

Rosman, N. A. B., & Anuar, M. F. Bin. (2020). Cardiovascular endurance profile of male soccer players under 18 years old in secondary school in Perak, Malaysia. *European Journal of Molecular and Clinical Medicine*, *7*(2), 6041–6044. https://www.academia.edu/88755882/Cardiovascular_Endurance_Profile_Of_Male_Soccer_Players_Under_18_Years_Old_In_Secondary_School_In_Perak_Malaysia

Sarah, D. M., Siregar, Y., & Eyanoer, P. C. (2019). Relationship between Body Mass Index, Age, and Muscular Endurance among Soccer Players in Medan, North Sumatra. *Indonesian Journal of Medicine*, *4*(1), 21–27. https://doi.org/10.26911/theijmed.2019.04.01.04

Schober, P., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation.

Anesthesia and Analgesia, *126*(5), 1763–1768. https://doi.org/10.1213/ANE.0000000000002864

Schwartz, J., Takito, M. Y., Del Vecchio, F. B., Antonietti, L. S., & Franchini, E. (2015). Health-related physical fitness in martial arts and combat sports practitioners. *Sport Sciences for Health*, *11*(2), 171–180. https://doi.org/10.1007/s11332-015-0220-6

Sebastiá-Rico, J., Martínez-Sanz, J. M., González-Gálvez, N., & Soriano, J. M. (2023). Differences in Body Composition between Playing Positions in Men's Professional Soccer: A Systematic Review with Meta-Analysis. *Applied Sciences*, *13*(4782), 1–18. https://doi.org/10.3390/app13084782

Shalabi, K. M., Alsharif, Z. A., Alrowaishd, S. A., & Al Ali, R. E. (2023). Relationship between body mass index and health-related physical fitness: a cross-sectional study. *European Review for Medical and Pharmacological Sciences*, *27*(20), 9540–9549. https://doi.org/10.26355/eurrev_202310_34127

Side, M. Y., Chalachew, A. A., & Tesfaye, Z. B. (2024). Comparison of physical fitness status of Ethiopian youth football players trained by coaches from formal and informal coach learning systems. *Retos*, *60*, 377–382. https://recyt.fecyt.es/index.php/retos/index

Singh Dhapola, M., & Verma, B. (2017). 4(2): Relationship of body mass index with agility and speed of university players. *International Journal of Physical Education, Sports and Health*, *4*(2), 313–315. https://doi.org/www.kheljournal.com

Suchomel, T. J., Nimphius, S., & Stone, M. H. (2016). The Importance of Muscular Strength in Athletic Performance. *Sports Medicine*, *46*(10), 1419–1449. https://doi.org/10.1007/s40279-016-0486-0

Tomczak, A., Any˙zewska, A., Bertrandt, J., Lepionka, T., Kruszewski, A., & Gazdzinska, A. (2022). Assessment of the Level of Physical Activity and Body Mass Index of Soldiers of the Polish Air Force. *International Journal of Environmental Research and Public Health*, *19*(8392), 1–12. https://doi.org/10.3390/ijerph19148392

Unger, T., Borghi, C., Charchar, F., Khan, N. A., Poulter, N. R., Prabhakaran, D., Ramirez, A., Schlaich, M., Stergiou, G. S., Tomaszewski, M., Wainford, R. D., Williams, B., & Schutte, A. E. (2020). 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension*, *75*(6), 1334–1357. https://doi.org/10.1161/HYPERTENSIONAHA.120.15026

Vasileva, F., Shukova-Stojmanovska, D., Vasilev, A., & Georgiev, G. (2022). BMI and Nutritional Status in Physical Active Population Involved in Recreational Sport. *Journal of Anthropology of Sport and Physical Education*, *6*(1), 13–19. https://doi.org/10.26773/jaspe.220103

Villaseca-Vicuña, R., Molina-Sotomayor, E., Zabaloy, S., & Gonzalez-Jurado, J. A. (2021). Anthropometric profile and physical fitness performance comparison by game position in the Chile women's senior national football team. *Applied Sciences*, *11*(5), 1–16. https://doi.org/10.3390/app11052004

Waskita, G. I., Hariono, A., Paryadi, Ramadhan, K., & Yudhistira, D. (2023). Analysis of Speed, Power and Agility of Football Players Reviewed from Age Differences. *International Journal of Sport, Exercise and Health Research*, *7*(2), 99–102. https://doi.org/10.31254/sportmed.7211

Yusni, Y., Rahman, S., & Naufal, I. (2024). Positive correlation between body weight and body mass index with blood pressure in young adults. *Narra J*, *4*(1), 1–9. https://doi.org/10.52225/narra.v4i1.533

Authors' and translators' details:

Yusni Yusni	yusni@usk.ac.id	Author and translator
Firdalena Meutia	firdalenameutia@usk.ac.id	Author
Nasyaruddin Herry Taufik	nasyaruddin_herry@usk.ac.id	Author