ISSN : 2087-927X (print)
ISSN : 2685-0516 (online)
Altius: Jurnal Ilmu Olahraga dan Kesehatan
Volume 12, No. 2, November 2023, pp. 435-444
http://dx.doi.org/10.36706/altius.v12i2.22946

Investigating how body mass index affects the physical performance in elite male handball players: insights for training improvement

Wiga Nurlatifa Romadhoni[1,*], Nasuka[2], Erwin Nizar Priambodo[3], Adiska Rani Ditya Candra[4], Anggit Wicaksono[5]

[12345]Universitas Negeri Semarang, Semarang, Indonesia

[1]wiganurlatifa@mail.unnes.ac.id *; [2]nasuka@mail.unnes.ac.id ; [3]erwinnizara1@mail.unnes.ac.id
*corresponding author

ABSTRACT

The aim of this study was to analyze and compare whether body mass index (BMI) is related to the physical performance abilities of elite male handball players. In this case, the physical performance that was analyzed was power and agility. Data were collected from male handball players Semarang City who participated in top-level handball competitions (N: 14, age: 23.6 years, body mass: 67.7 kg, height: 173.5 cm, BMI: 22.9 kg/m^2). The physical parameters analyzed were BMI, power, and agility. Pearson's correlations were calculated for BMI with power and agility, and significant correlations were found between BMI and power ($p < 0.05$), as well as BMI and agility ($p < 0.01$). Significant correlations were also found between power and agility ($p < 0.01$). Linear regression was also calculated for BMI with power and agility, and the results showed that BMI was linearly related to power and agility (t: 87.689*, p: 0.00). The coefficients between BMI and power ($p < 0.20$) and between BMI and agility ($p < 0.02$) were also significant. Our findings suggest that BMI (body mass index) is associated with better power and partially higher agility in male handball players. This study provides valuable insights for coaches and athletes to improve power and agility exercises in their training performance and achieve better results in their physical performances in elite handball.*

Keywords*: body mass index, physical performance, handball players*

ARTICLE INFO

Article History:
Accepted : 05th November 2023
Approved : 20th December 2023
Available Online Januari 2024

Correspondence Address:
Wiga Nurlatifa Romadhoni
Sport Coaching Education. Universitas Negeri Semarang
Sekaran, Gunungpati, Semarang, Jawa Tengah
wiganurlatifa@mail.unnes.ac.id

INTRODUCTION

Handball is a game carried out with fast movements, which can be characterized by a large number of fast or explosive movements with high-intensity interspersed with regular rest periods (Laver et al., 2018). In addition, handball is characterized by a combination of high- and low-intensity sports activities (Wagner et al., 2019), including running, jumping, and sudden changes in direction, and demanding physical strength, including various types of exercises (Fieseler et al., 2017). Therefore, the physical fitness characteristics of handball players play a crucial role in their overall performance (Haugen et al., 2016). These physical fitness characteristics include cardiovascular endurance, muscular strength, power, agility, and flexibility. The targeted training of handball players should focus on improving these physical fitness characteristics in order to enhance performance on the field. Because in this case, handball relies on a number of certain physical characteristics such as speed, endurance, hand-eye coordination and muscle strength. Focusing on improving these characteristics in particular

can help handball players prepare their bodies for the specific demands they face during the game (Przednowek et al., 2019). Coaches must frequently test and evaluate the physical fitness level of handball players to ensure that their training programs are effective in improving these characteristics. Coaches must regularly assess and evaluate the physical fitness level of handball players in order to design targeted training programs that effectively improve these characteristics. Assessments provide a baseline for players' physical fitness levels. Regular evaluations enable coaches to monitor the progress of each player over time. This monitoring is essential to track improvements, identify plateaus, and make necessary adjustments to the training program to maintain or enhance performance (Meckel et al., 2018). Through targeted training, handball players can improve their physical fitness characteristics, such as cardiovascular endurance, muscular strength, power, agility, and flexibility. These improvements in physical fitness characteristics will have a direct impact on the performance of handball players (Akbar et al., 2022).

Some previous studies have explained that professional male handball players show good physical performance, including good endurance, speed, jumping ability, and agility (Haugen et al., 2016). Handball athletes playing for 60 min with 30 min each for two rounds of effective playing time of the game activity requires fast, intense, and dynamic movements for players to sprint, jump, and shoot, making rapid changes in direction and body contact between players (Michalsik et al., 2012). Physical performance can be defined as the extent to which an individual can complete specific physical activities (Orlandini et al., 2021). In addition, physical performance in handball is performed in response to various tactical situations in the game (Michalsik & Aagaard, 2015). However, some previous studies on handball players have shown significant differences in the results of various physical component characteristics of players (Chelly et al., 2011).

Factor that can affect power in handball players is the results suggest that body mass index (BMI) (Hermassi et al., 2011). In addition to anthropometric characteristics, such as body mass index, leg muscle strength and plyometric training have been found to influence the power ability of elite male handball players (Dubey & Choudhary, 2023). In addition to anthropometric characteristics, such as body mass index, leg muscle strength and plyometric training have been found to influence the power ability of elite male handball players. Furthermore, the body mass index, which is a measure of body composition based on height and weight, has been identified as a significant factor in influencing the physical performance

of elite male handball players.

Apart from power, agility is also an important factor in handball players' performance (Paul et al., 2016). Broadly speaking, the ability to make calculated decisions when maneuvering body movements is a characteristic that must be mastered by athletes in several game sports (Bourgeois II et al., 2020). This is because game sports have characteristics in their implementation, where players are required to make frequent transitions during matches, such as when facing matches that require fast body movements over short distances and body movements with low intensity, but over long periods (Bortnik et al., 2022). Broadly speaking, agility can be defined as the result of a response to a stimulus obtained from changes in the speed or direction of body movement (Young & Farrow, 2013). Implied by this definition, it can be interpreted that agility consists of a series of decision-making processes and results that can be seen from the changes in direction that occur. In the context of handball, agility plays a crucial role in the performance of players. Agility is essential for handball players as it allows them to quickly change direction, evade opponents, and react to dynamic game situations. Anthropometric characteristics, such as body mass index and body composition, have been found to have a significant impact on the performance of handball players in terms of their agility.

Anthropometric, physiological, psychological and skill components in elite and sub-elite young handball players, it was reported that agility was the most differentiating factor (Hermassi et al., 2011). The ability to produce varied agility and speed actions is known to significantly impact handball match performance. Moreover, agility and change of direction actions are crucial moments in handball games, directly contributing to winning possession of the ball and conceding throwing the ball. In a study conducted by García-Pinillos et al., it was found that elite handball players exhibited high performance in various change of direction tests, indicating the advantage of agility and COD attributes for elite handball players compared to both the general population and higher standards of handball. Apart from physical abilities such as power and agility, which affect the best performance of handball athletes, some previous studies have also found that body mass index (BMI) also affects athletic performance, where power and agility become physical abilities that can be affected by BMI results (Hermassi et al., 2011). Body mass index (BMI) itself is a measure of weight category that is calculated based on height and weight, research results suggest that BMI can affect physical performance, including power and agility (Du et al., 2017).

Furthermore, it is necessary to know whether Body Mass Index (BMI) is related to the physical performance of male handball athletes, especially in power and agility. This needs to

be done because this information can help in the development of more effective and efficient training programs to improve athlete performance. By understanding the relationship between BMI and physical performance of power and agility in male handball athletes, coaches and health professionals can determine the best strategies to improve athletic performance. Apart from that, this research explains the emphasis on the relationship between Body Mass Index (BMI) and physical performance, especially in terms of power and agility, showing the specificity of this research. This differs from previous studies that may not explicitly highlight certain aspects of physical performance. Overall, research to analyze and compare the relationship between BMI and physical performance of male handball athletes in Semarang City is important to assist coaches and health professionals in designing more effective and efficient training programs to improve athlete performance.

METHODS

This research study utilized a correlational research design. Correlational research is ideal for gathering data quickly from natural settings, which helps to generalize findings to real-life situations in an externally valid way (Bhandari, 2021). It is used to investigate non-causal relationships, assess whether a tool consistently or accurately captures the concept it aims to measure, and spot historical patterns between two variables (Fleetwood, 2018). In this research study aimed to investigate the relationship between body mass index and physical performance in elite male handball players specifically power and agility. The findings from this study provide valuable insights for training improvement in elite male handball players. Specifically, the study aimed to determine whether there is a significant relationship between body mass index and physical performance, particularly in terms of power and agility.

The study involved the collection of data from a total of 14 elite male handball athletes in Semarang City, who served as the study's samples. The participants' body mass index was calculated using the standard formula of weight in kilograms divided by the square of height in meters. The physical performance of participants was assessed through standardized tests for power and agility, utilizing the jump DF test instrument for power measurement and the Semo agility test for assessing agility abilities. A linear regression analysis was performed to examine the relationship between Body Mass Index and physical performance in elite male handball players.

RESULTS AND DISCUSSION

Result

Can be seen displayed in table one below the results of Body Mass Index (BMI), power and agility of handball male athletes, data taken from a total of 14 elite male athletes who participated in this study.

Table 1. Descriptive Statistics

	BMI	Power	Agility
Valid	14	14	14
Median	23.300	59.500	12.215
Mean	22.929	59.286	12.709
Std. Deviation	1.862	5.497	3.162
Variance	3.468	30.220	9.997
Minimum	19.700	50.000	9.330
Maximum	25.100	68.000	20.610

Based on the results, it shows that the average Body Mass Index (BMI) for male handball athletes is 22.929, where in the range of values athletes are said to have a normal or healthy weight. However, it is important to remember that BMI is a rough measurement and does not consider other factors such as body composition, muscle mass, and body fat. Athletes may have higher muscle mass than the average person, so their BMI values can be different but still in very healthy physical condition.

The average result of power obtained a value of 59.286 is a result that shows the average power possessed by a group of male handball athletes in vertical jumping. The average value of these power results is in the good category. power assessment itself can help see the extent to which an athlete has the ability to jump high, which can be useful in certain situations on the handball field, such as scoring goals or maintaining defense. However, this value should also be looked at along with other factors such as speed, muscle strength, technical skills and playing strategy. Also, the average result of the agility of male handball athletes of 12.709 is a number that shows the average level of physical agility of athletes is quite good.

Table 2. Multiple Linear Regression Results

	t	Sig.
Power	-5.617	.020
Agility	-10.508	.002

The power variable has a significance value of 0.020 <0.05, the t-count gets a value of -5.617 < t-table (-4.302). Based on this, it can be said that the power variable affects the BMI variable. While for the agility variable has a significance value of 0.002 <0.05, the t-count gets a value of -10.508 < t-table (-4.302). Based on this, it can be said that the agility variable affects the BMI variable. These findings suggest that both power and agility have a significant impact on the Body Mass Index of elite male handball players.

Discussion

The average BMI of 22.929 for the male handball athletes in the study is indicative of a population that, on average, falls within the normal or healthy weight range according to the conventional BMI categories. However, it's essential to emphasize the limitations of using BMI as the sole metric to assess the physical condition and health of athletes, especially elite male handball players. BMI is a valuable tool for providing a general overview of weight status in the general population (Khanna et al., n.d.). For athletes, particularly those in power-based sports like handball, muscle mass is a significant contributor to their overall body weight (Hermassi et al., 2020). As muscle is denser than fat, an athlete with a substantial amount of muscle mass may have a higher BMI than an average person with the same height and body fat percentage (Tafeit et al., 2019). These athletes' muscle mass and agility are essential attributes that contribute to their success in handball, and their higher BMIs should be understood in the context of their sport-specific requirements. In summary, while the average BMI of 22.929 suggests that male handball athletes in this study are within the normal weight category, it's crucial to recognize the limitations of BMI when applied to athletes with unique body compositions. The findings underscore the significance of considering multiple factors when assessing the health and fitness of elite male handball players, taking into account their muscular development and sport-specific requirements, rather than relying solely on BMI as a comprehensive health indicator.

The average power value obtained from vertical jumping assessments is 59.286. This result is considered good and indicates the ability of the athletes to jump high. This power is crucial in handball for actions like scoring goals and defensive plays. However, it's essential to remember that power should be considered in conjunction with other factors like speed, muscle strength, technical skills, and playing strategy (Reiman & Lorenz, 2011). Athletes need a combination of these skills to excel in handball. While the average power value suggests that these male handball athletes possess good jumping ability, it's crucial to emphasize that power

is just one of the many attributes that contribute to overall success in handball (Massuca et al., 2015). Athletes must possess a well-rounded skill set that includes speed, agility, muscle strength, technical skills, and a deep understanding of the game's strategies (Luo et al., 2023). These elements work in synergy to excel in different aspects of handball. In conclusion, the above-average power values of the male handball athletes indicate their ability to jump high, a critical skill in handball for actions like goal scoring and defense. However, it's essential to recognize that power should be seen as just one component of a broader skill set. To excel in handball, athletes must combine power with speed, agility, muscle strength, technical proficiency, and a deep understanding of the game's strategies. Handball success relies on the effective integration of all these attributes to perform well in the dynamic and demanding nature of the sport.

The findings indicate that the male handball athletes in the study have an average agility score of 12.709, which is indicative of good physical agility. This attribute is of paramount importance in the context of handball, as it equips players with the ability to make rapid directional changes, elude opponents, and execute swift and precise movements. While agility is a critical component, success in handball demands a multifaceted skill set (Georgescu et al., 2019). It's important to highlight that the interaction of different attributes is what makes elite handball athletes truly exceptional. Athletes need to integrate their agility with skills like speed, power, endurance, and tactical understanding to excel in this dynamic sport (Farley et al., 2020). Nevertheless, it's imperative to remember that agility is just one piece of the puzzle. Success in handball relies on the integration of agility with other attributes, including speed, power, endurance, and a deep understanding of the game's strategies. Handball players must have a well-rounded skill set that enables them to adapt to the ever-changing demands of the game.

The multiple linear regression analysis indicates that both power and agility have a significant impact on the BMI of elite male handball players. The significance values (p-values) for both power and agility are less than 0.05, suggesting that they are statistically significant predictors of BMI. The negative standardized coefficients for both variables (-0.370 for power and -1.158 for agility) imply that as power and agility increase, BMI tends to decrease. This relationship suggests that athletes with higher power and agility levels are more likely to have lower BMIs, which aligns with the notion that handball players often have lower body fat percentages due to their rigorous training and physical demands of the sport.

CONCLUSION

In conclusion, the results suggest that power and agility are significant factors associated with the BMI of elite male handball athletes. While their BMI falls within the normal or healthy weight range, these athletes exhibit strong power and agility, which are essential attributes for their sport. It's important for sports scientists and coaches to consider these findings when designing training programs and assessing the overall fitness of handball players, recognizing that BMI alone may not fully capture their physical condition.

Although this study provides valuable insight into the relationship between Body Mass Index (BMI) and power and agility factors in elite male handball athletes, there are several limitations that need to be noted. First, this study was limited to elite male handball athletes in Semarang City, so generalization of the findings to a wider handball population or athletes from different locations may require further research. Additionally, a focus on BMI, power, and agility provides a specific picture, but there are potential other factors that may influence athletes' physical performance that were not considered in this study.

REFERENCES

Akbar, S., Soh, K. G., Jazaily Mohd Nasiruddin, N., Bashir, M., Cao, S., & Soh, K. L. (2022). Effects of neuromuscular training on athletes physical fitness in sports: A systematic review. *Frontiers in Physiology*, *13*, 939042. https://doi.org/10.3389/fphys.2022.939042

Bhandari, P. (2021, July 7). *Correlational Research | When & How to Use*. Scribbr. https://www.scribbr.com/methodology/correlational-research/

Bortnik, L., Burger, J., & Rhodes, D. (2022). The mean and peak physical demands during transitional play and high pressure activities in elite football. *Biology of Sport*, *39*(4), 1055–1064. https://doi.org/10.5114/biolsport.2023.112968

Bourgeois II, F., Gamble, P., Gill, N., & Mcguigan, M. (2020). *THE RELATIONSHIP BETWEEN MULTIDIRECTIONAL JUMPING AND PERFORMANCE IN CHANGE OF DIRECTION TASKS*.

Chelly, M. S., Hermassi, S., Aouadi, R., Khalifa, R., Van den Tillaar, R., Chamari, K., & Shephard, R. J. (2011). Match analysis of elite adolescent team handball players. *The Journal of Strength & Conditioning Research*, *25*(9), 2410–2417.

Du, T., Zhu, E., & Jiao, S. (2017). Poor Physical Performance is Associated with Obesity Among University Students in China. *Medical Science Monitor Basic Research*, *23*. https://doi.org/10.12659/msmbr.904380

Dubey, S., & Choudhary, P. K. (2023). Comparative analysis on selected coordinative abilities among female team sports players. *International Journal of Physical Education, Sports and Health*, *10*(1), 07–11. https://doi.org/10.22271/kheljournal.2023.v10.i1a.2745

Farley, J. B., Stein, J., Keogh, J. W. L., Woods, C. T., & Milne, N. (2020). The Relationship Between Physical Fitness Qualities and Sport-Specific Technical Skills in Female,

Team-Based Ball Players: A Systematic Review. *Sports Medicine - Open*, *6*, 18. https://doi.org/10.1186/s40798-020-00245-y

Fieseler, G., Hermassi, S., Hoffmeyer, B., Schulze, S., Irlenbusch, L., Bartels, T., Delank, K.-S., Laudner, K. G., & Schwesig, R. (2017). Differences in anthropometric characteristics in relation to throwing velocity and competitive level in professional male team handball: A tool for talent profiling. *The Journal of Sports Medicine and Physical Fitness*, *57*(7–8), 985–992.

Fleetwood, D. (2018, June 7). Correlational Research: What it is with Examples. *QuestionPro*. https://www.questionpro.com/blog/correlational-research/

Georgescu, A., Varzaru, C., & Rizescu, C. (2019). Improving Speed to Handball Players. *Revista Romaneasca Pentru Educatie Multidimensionala*, *11*(1), Article 1. https://doi.org/10.18662/rrem/97

Haugen, T. A., Tønnessen, E., & Seiler, S. (2016). Physical and physiological characteristics of male handball players: Influence of playing position and competitive level. *J Sports Med Phys Fitness*, *56*(1–2), 19–26.

Hermassi, S., Bragazzi, N. L., & Majed, L. (2020). Body Fat Is a Predictor of Physical Fitness in Obese Adolescent Handball Athletes. *International Journal of Environmental Research and Public Health*, *17*(22), 8428. https://doi.org/10.3390/ijerph17228428

Hermassi, S., Chelly, M. S., Tabka, Z., Shephard, R. J., & Chamari, K. (2011). Effects of 8-Week in-Season Upper and Lower Limb Heavy Resistance Training on The Peak Power, Throwing Velocity, and Sprint Performance of Elite Male Handball Players. *Journal of Strength and Conditioning Research*, *25*(9). https://doi.org/10.1519/jsc.0b013e3182030edb

Khanna, D., Peltzer, C., Kahar, P., & Parmar, M. S. (n.d.). Body Mass Index (BMI): A Screening Tool Analysis. *Cureus*, *14*(2), e22119. https://doi.org/10.7759/cureus.22119

Laver, L., Landreau, P., Seil, R., & Popovic, N. (2018). *Handball Sports Medicine: Basic science, injury management and return to sport*. Springer.

Luo, S., Soh, K. G., Zhao, Y., Soh, K. L., Sun, H., Nasiruddin, N. J. M., Zhai, X., & Ma, L. (2023). Effect of core training on athletic and skill performance of basketball players: A systematic review. *PLOS ONE*, *18*(6), e0287379. https://doi.org/10.1371/journal.pone.0287379

Massuca, L., Branco, B., Miarka, B., & Fragoso, I. (2015). Physical Fitness Attributes of Team-Handball Players are Related to Playing Position and Performance Level. *Asian Journal of Sports Medicine*, *6*(1), e24712. https://doi.org/10.5812/asjsm.24712

Meckel, Y., Doron, O., Eliakim, E., & Eliakim, A. (2018). Seasonal Variations in Physical Fitness and Performance Indices of Elite Soccer Players. *Sports*, *6*(1), 14. https://doi.org/10.3390/sports6010014

Michalsik, L. B., & Aagaard, P. (2015). Physical demands in elite team handball: Comparisons between male and female players. *J Sports Med Phys Fitness*, *55*(9), 878–891.

Michalsik, L. B., Aagaard, P., & Madsen, K. (2012). Locomotion characteristics and match-induced impairments in physical performance in male elite team handball players. *International Journal of Sports Medicine*, 590–599.

Orlandini, L., Rolland, Y., & Cesari, M. (2021). Measurements of Physical Performance. *Sarcopenia*, 253–270.

Paul, D., Gabbett, T., & Nassis, G. (2016). Agility in Team Sports: Testing, Training and Factors Affecting Performance. *Sports Medicine*, *46*. https://doi.org/10.1007/s40279-015-0428-2

Przednowek, K., Śliż, M., Lenik, J., Dziadek, B., Cieszkowski, S., Lenik, P., Kopeć, D., Wardak, K., & Przednowek, K. H. (2019). Psychomotor Abilities of Professional

Handball Players. *International Journal of Environmental Research and Public Health*, *16*(11). https://doi.org/10.3390/ijerph16111909

Reiman, M. P., & Lorenz, D. S. (2011). INTEGRATION OF STRENGTH AND CONDITIONING PRINCIPLES INTO A REHABILITATION PROGRAM. *International Journal of Sports Physical Therapy*, *6*(3), 241–253.

Tafeit, E., Cvirn, G., Lamprecht, M., Hohensinn, M., Moeller, R., Hamlin, M., & Horejsi, R. (2019). Using body mass index ignores the intensive training of elite special force personnel. *Experimental Biology and Medicine*, *244*(11), 873–879. https://doi.org/10.1177/1535370219848986

Wagner, H., Fuchs, P., Fusco, A., Fuchs, P., Bell, J. W., & von Duvillard, S. P. (2019). Physical performance in elite male and female team-handball players. *International Journal of Sports Physiology and Performance*, *14*(1), 60–67.

Young, W., & Farrow, D. (2013). The Importance of a Sport-Specific Stimulus for Training Agility. *Strength and Conditioning Journal*, *35*, 39–43. https://doi.org/10.1519/SSC.0b013e31828b6654