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*Original Article*

# Investigation of the Relationship Between Peak Power, 30-Meter Sprint Performance, and BMI in Male Handball Players

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**Abstract**

In the literature, the relationships between body composition, sprint speed, and explosive power have been extensively examined across various sports disciplines. However, studies specifically addressing these interrelationships within the context of handball remain limited. Given the unique physical demands of handball, sport-specific assessments are essential. Accordingly, the aim of the present study is to investigate the relationships among peak power, 30-meter sprint performance, and body mass index (BMI) in male handball players. This cross-sectional study included a total of 42 male handball athletes. Anthropometric measurements, including height (cm) and body weight (kg), were collected from participants, and BMI (kg/m²) was calculated accordingly. Motor performance assessments were conducted under standardized conditions using a vertical jump test (to measure peak power) and a 30-meter sprint test (to assess sprint performance). The findings revealed that 30-meter sprint performance was not significantly associated with either peak power or BMI. However, a statistically significant and strongly positive relationship was found between peak power and BMI. These findings suggest that peak power is closely related to body composition, whereas sprint performance is influenced by more complex and multifactorial determinants. Therefore, a comprehensive assessment of physical fitness in handball players, along with the development of individualized training programs and detailed analysis of body composition, is critical for performance enhancement. Future research is recommended to explore these relationships across larger sample sizes and with more comprehensive test batteries.

**Keywords:** Explosive strength, Anthropometry, Performance assessment, Motor abilities, Training individualization.

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## Introduction

Enhancing sports performance and objectively evaluating individual abilities are among the primary objectives of modern sports sciences (O'Donoghue, 2009). In this context, the assessment of various motor and physiological parameters and the analysis of performance based on these data are of particular importance, especially in team sports (İlbak et al., 2023; Mackenzie, 2005). In sports such as handball, which are characterized by high intensity, variable tempo, and multidimensional physical demands, factors such as strength, speed, agility, and body composition are directly associated with athletic performance (Radu & Abalasei, 2015). Accordingly, peak power, sprint performance, and body mass index (BMI) are considered critical parameters in determining the physical fitness levels of handball players.

Handball is a team sport in which players constantly change direction and speed, perform sudden stops and accelerations, and execute repeated high-intensity short-duration efforts (García-Sánchez et al., 2023; Muñoz et al., 2020). These demands place a significant load on the anaerobic energy systems of athletes (Bilge, 2020). Therefore, sprint speed and explosive power—particularly in the lower extremities—are regarded as key contributors to handball performance (Radu & Abalasei, 2015). For example, the 30-meter sprint test is widely employed to assess the speed capacities of athletes in sports that require explosive acceleration, such as handball (İlbak et al., 2023). Peak power is another crucial variable used to evaluate the effectiveness of lower-body strength during short, high-intensity efforts (Bubbs, 2019). Given the importance of actions such as jumping, lunging, and rapid acceleration in handball (Freitas et al., 2022; Rami, 2022), the assessment of peak power not only serves as an indicator of physical conditioning but also provides valuable guidance in training program design.

On the other hand, BMI—calculated based on an individual's body weight and height—is a fundamental indicator of body composition (Singh, 2014). Although it is not sufficient on its own to determine the ideal body composition for athletes, it serves as a useful starting point for understanding the relationship between overall health status, body fat percentage, and performance. Silva (2019) emphasized that athletes with excessive or insufficient body weight may experience declines in performance. Therefore, examining the relationship between BMI, sprint performance, and power output is essential for assessing physical fitness levels and designing individualized training programs.

A substantial body of literature has explored the interrelationships between body composition, sprint speed, and explosive power across various sports. Athletes with optimal BMI values have been shown to have shorter sprint times and higher levels of explosive power (França et al., 2022; Ishida et al., 2021). This suggests that excess body mass increases the load that must be moved during sprinting, reducing movement efficiency and extending sprint duration. Similarly, a favorable body composition—particularly a higher lean body mass ratio—may support muscular force production and positively influence peak power output.

Numerous studies have identified explosive power as a strong predictor of sprint time, particularly among adolescent football players, where it explains a significant proportion of variance in sprint performance (França et al., 2022). Both upper and lower body explosive strength are important for sprinting performance. Research among young football players has revealed strong correlations between sprint times and horizontal jump performance (Diker et al., 2021). However, studies examining such relationships specifically in handball are relatively limited. Furthermore, the unique physical demands of handball necessitate sport-specific assessments. In this regard, the aim of the present study is to investigate the relationships among peak power, 30-meter sprint performance, and BMI in male handball players, and to determine the extent to which these variables interact with one another. The findings obtained are expected to contribute not only to the evaluation of current athletes but also to the identification and monitoring of talented young players during their developmental processes.

**Material and Methods**

***Participants***

The minimum sample size required for this study was determined using the G*Power statistical analysis software (version 3.1.9.3, Germany). A priori power analysis for correlation analysis was conducted with the following parameters: a Type I error rate ($\alpha$) of 0.05, statistical power (1-β) of 0.80, and a medium effect size (H1) of 0.50. The results indicated that a minimum of 29 participants would be sufficient to achieve the desired statistical power. To enhance the robustness of the findings and account for potential data loss, the study was ultimately conducted with 42 voluntarily participating male handball players. Inclusion criteria required that participants be between 17 and 32 years of age, have a minimum of four years of continuous experience as licensed handball athletes, and be actively training at least three times per week. Furthermore, all participants were required to provide informed consent and voluntarily agree to participate in the study. Exclusion criteria included: sustaining a serious sports-related injury within the previous six months, having a chronic medical condition or a history of neurological disorders, and providing incomplete or inaccurate data during the data collection process. Descriptive characteristics of the participants are presented in Table 1.

**Table 1.** Descriptive characteristics of the participants.

| Variable | n | Minimum | Maximum | Mean±SD |
|---|---|---|---|---|
| **Age (years)** | 42 | 17.00 | 32.00 | 20.60 ± 3.23 |
| **Height (cm)** | 42 | 165.00 | 198.00 | 183.45 ± 6.82 |
| **Body weight (kg)** | 42 | 60.30 | 104.70 | 80.37 ± 10.56 |
| **Training age (years)** | 42 | 5.00 | 22.00 | 9.60 ± 3.05 |
| **Body Mass Index (kg/m²)** | 42 | 18.41 | 31.29 | 23.85 ± 2.57 |
| **30 m Sprint Performance (s)** | 42 | 4.08 | 4.93 | 4.36 ± 0.19 |
| **Peak Power Performance (W)** | 42 | 5663.91 | 7911.70 | 6821.88 ± 551.31 |

n = Number of participants; SD = Standard Deviation; cm = Centimeter; kg = Kilogram; kg/m² = Kilogram per square meter; s = Seconds; W = Watts.

According to Table 1, the 42 male handball players who participated in the study had a mean age of 20.60±3.23 years. Their average height was 183.45±6.82 cm, and their mean body weight was 80.37±10.56 kg. The mean training experience was 9.60±3.05 years. The average Body Mass Index (BMI) was 23.85±2.57. The mean 30-meter sprint performance was 4.36±0.19 seconds, and the average peak power performance was 6821.88±551.31 Watts.

***Research Design***

This study was conducted using a cross-sectional research design. The data collection process was initiated following the approval of the Düzce University Ethics Committee (Approval No: 2024/268, dated 05.09.2024). The aim, scope, and testing procedures of the study were thoroughly explained to all participants. Informed consent forms were obtained from each participant in writing, and all procedures were carried out in accordance with ethical standards. As part of the anthropometric assessments, body height (cm) and body weight (kg) were measured, and Body Mass Index (BMI) was calculated using the formula weight (kg) divided by height squared (m²). Additionally, participants' chronological age (years) and training age (years)—defined as the duration since they began regular sports participation—were recorded. For the assessment of motor performance, two tests were administered sequentially: the vertical jump test (for evaluating peak power) and the 30-meter sprint test (for assessing sprint performance). All measurements were conducted on the same day to ensure consistency. In the morning session (between 09:00 and 09:30), demographic and anthropometric data—including height, weight, chronological age, and training age—were collected. In the afternoon session (between 13:00 and 14:00), motor performance tests were carried out. A standardized 5-minute rest interval was provided between each test to minimize fatigue effects. All assessments were performed under uniform environmental conditions and in accordance with standardized testing protocols. The research design is illustrated in Figure 1.

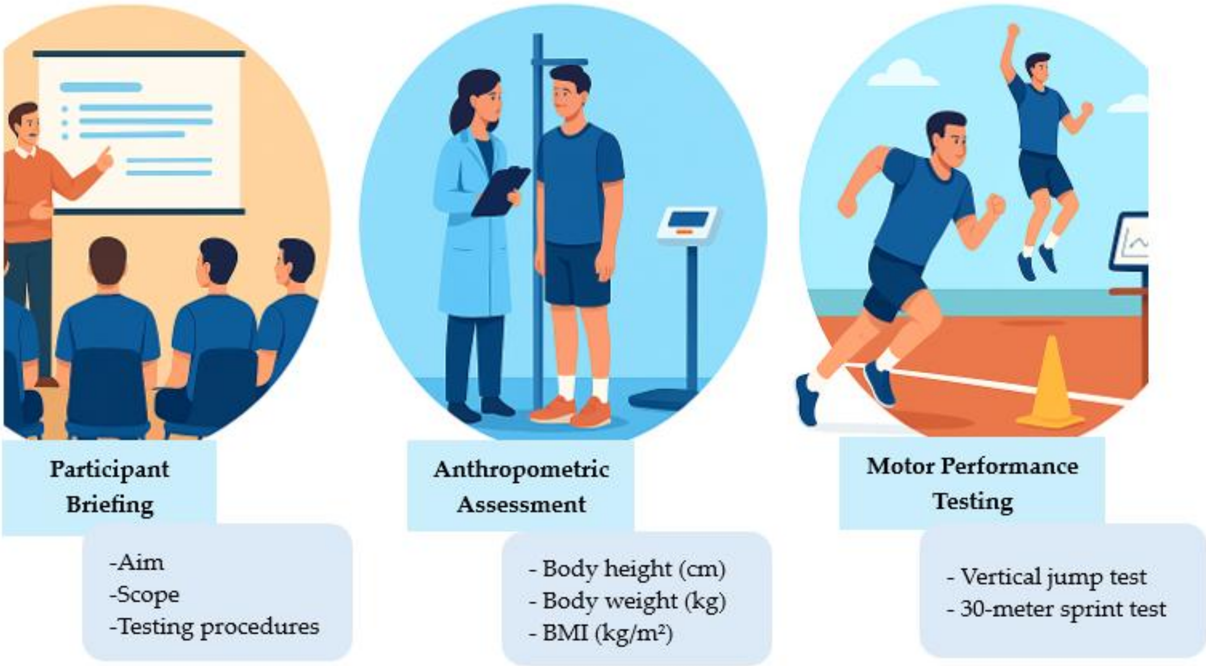


**Figure 1.** The research design.

***Anthropometric Measurements***

All anthropometric assessments in this study were carried out in accordance with the standardized protocols of the International Society for the Advancement of Kinanthropometry (ISAK) (Olds, 2006).

*Height Measurement*

Participants' standing height was measured with the head positioned in the Frankfurt horizontal plane and the body in an upright posture, while barefoot. A Seca 213 portable stadiometer (Seca GmbH & Co. KG, Hamburg, Germany) was used, and values were recorded in centimeters (cm).

*Body Weight Measurement*

Body weight was assessed using an Omron HN-289 digital scale (Omron Healthcare Co., Ltd., Kyoto, Japan). Measurements were taken with participants standing on a flat surface, barefoot, and wearing light clothing. The results were recorded in kilograms (kg).

*Body Mass Index (BMI)*

Based on the height and weight data collected, Body Mass Index (BMI) was calculated for each participant using the following formula:

$$BMI = 70\ kg / (1.75\ m \times 1.75\ m) = 22.86\ kg/m^2$$

BMI values were expressed in kilograms per square meter ($kg/m^2$) and were used as a general indicator of body composition.

***Motor Performance Tests***

In this study, vertical jump and 30-meter sprint tests were administered to assess the motor performance levels of athletes. The vertical jump test was used to evaluate peak power, while the 30-meter sprint test was employed to assess speed performance.

*Speed Measurement*

Speed performance was evaluated using a 30-meter sprint test. Measurements were taken with a photocell device (Sport Expert, Turkey) with an accuracy of ±0.1 seconds. After the 30-meter distance was marked, photocell sensors were placed at the start and finish lines. Athletes were instructed to complete the distance at maximum effort without a running start. Following a four-minute rest period, the test was repeated. The better of the two recorded times was considered for analysis and documented in seconds (s) (Günay, 2013).

*Jump Performance Measurement- Peak Power Calculation*

Vertical jump performance was assessed using an active jump test. Athletes performed a countermovement jump by bending their knees and squatting down, keeping their hands on their hips to prevent arm swing. They then jumped vertically with maximum effort using both legs. Measurements were taken with a photocell device (Sport Expert, Turkey) accurate to ±0.1 cm. The test was performed twice with a four-minute rest between trials. The best result was recorded in centimeters (cm) (Günay, 2013). Peak power values were calculated using the formula developed by Harman et al. (1991), based on vertical jump height and body weight:

Peak Power (W) = 61.9 × Jump Height (cm) + 36 × Body Weight (kg) + 1822

### *Statistical Analysis*

The research data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS, version 26.0, Armonk, NY, USA). Descriptive statistics were used to obtain demographic information of the participants. The normality of the data was assessed using Skewness and Kurtosis values within the acceptable range of ±2 (Kim, 2013; Mishra et al., 2019), and the data were found to be normally distributed. To examine the relationships between variables, Pearson correlation analysis was conducted. All statistical results were evaluated at a significance level of $p < 0.05$.

## Results

The results section should present the data objectively and clearly. Data should be supported by tables and graphs to enhance clarity. Statistical findings must be reported with significance levels (p-values) and confidence intervals.

**Table 2.** Pearson Correlation Coefficients Between 30-Meter Sprint Performance, Peak Power, and BMI.

| Variable | | 30m Sprint Performance | Peak Power Performance | BMI |
|---|---|---|---|---|
| **30m Sprint Performance** | Pearson Correlation | 1 | .075 | .075 |
| | P value | | .635 | .636 |
| **Peak Power Performance** | Pearson Correlation | | 1 | .662** |
| | P value | | | .000** |

**p<0.01

Table 2 presents the Pearson correlation coefficients among 30-meter sprint performance, peak power performance, and BMI. No statistically significant correlation was found between sprint performance and either peak power or BMI ($r=0.075$, $p>0.05$). However, a strong and statistically significant positive correlation was observed between peak power performance and BMI ($r=0.662$, $p<0.01$), indicating that higher BMI values are associated with greater peak power outputs.

**Discussion**

The primary aim of this study was to investigate the relationships between peak power, 30-meter sprint performance, and body mass index (BMI) in male handball players. The findings revealed no statistically significant association between 30-meter sprint performance and either peak power or BMI. In contrast, a strong and statistically significant positive correlation was identified between peak power and BMI. These results suggest that the relationships among physical fitness indicators may vary depending on sport type, age group, and individual physical profiles.

The most notable finding of the study was the significant positive correlation between BMI and peak power. This suggests that body weight may not merely function as a load during movement, but also as an indicator of muscle mass and, consequently, muscular strength. Several studies have highlighted the strong association between lean body mass (LBM) and both athletic performance and force production. For instance, Zaras et al. (2020) reported very high correlations between trunk LBM and both snatch and clean & jerk performance in female weightlifters. Similarly, Correas-Gómez et al. (2023) demonstrated that LBM was significantly correlated with vertical jump performance in youth basketball players. Furthermore, resistance training interventions involving varied load intensities during high-intensity functional training also led to increases in both LBM and power output (Kapsis et al., 2022), thereby supporting the parallel increase hypothesis. These findings suggest that when body composition is evaluated with a focus on muscle mass, it can play a decisive role in performance assessment.

However, this study did not find a significant relationship between 30-meter sprint performance and either peak power or BMI. This indicates that sprint performance cannot be solely explained by explosive strength or body composition. Other physiological and biomechanical factors—such as reaction time, running technique, neuromuscular coordination, and balance—likely play critical roles. Indeed, Sedeaud et al. (2014) noted that although BMI has been associated with performance in various track events, this relationship weakens in sprinting disciplines, where muscle mass and power characteristics are more influential.

In multidirectional and dynamic sports such as handball, sprint performance is inherently more complex and may not be fully captured by standard field tests. Diker et al. (2021) found significant correlations between horizontal jump performance and sprint times in soccer players but emphasized that such relationships may vary depending on the sport. Likewise, Galvan-Alvarez et al. (2024) reported that lower limb LBM was a strong predictor of peak power output during sprinting, explaining a substantial portion of the performance variance. Moreover, Kukolj et al. (1999) and Ishida et al. (2021) suggested that even though peak power and BMI may not directly correlate with sprint performance, they still provide valuable insights into an athlete's overall physical capacity and developmental potential. Therefore, a multidimensional approach that incorporates various performance parameters may enhance the validity of performance assessments and support the design of more targeted and effective training strategies.

Although numerous studies (e.g., Asadi, 2016; Young et al., 2011) have reported significant associations between explosive strength and sprint performance, the absence of such a relationship in the current study may be attributed to the participant profile and testing conditions. Similarly, Healy et al. (2019) found no significant correlations between reactive strength index and sprint measurements. In addition, Santos-García et al. (2008) reported that maximal strength obtained through squat exercises did not significantly correlate with sprint performance, implying that alternative training modalities may be more effective. These findings collectively suggest that sprint performance cannot be explained solely by explosive strength or related physical attributes and that individual, methodological, and contextual factors may significantly influence performance outcomes.

The lack of a significant relationship between BMI and sprint performance also contradicts some findings in the literature (Ben Brahim et al., 2023; Sedeaud et al., 2014). Notably, a high BMI can result from either increased muscle mass or excess fat, each of which has very different implications for sprint performance. For example, Barbieri et al. (2017) found that elite male sprinters with higher performance levels had both higher BMI and greater fat-free mass, indicating that a high BMI characterized by muscle mass correlates with better sprint outcomes. Therefore, more precise assessment methods—such as body fat percentage and lean body mass measurements—are recommended. This underscores the importance of analyzing body composition in its component parts, rather than relying solely on BMI, when evaluating sprint performance.

This study has several limitations. First, the sample size was relatively small (n = 42) and comprised only male handball players, limiting the generalizability of the findings. Additionally, only BMI was used as a basic anthropometric measure; more detailed indicators of body composition, such as fat percentage or muscle mass, were not included. Furthermore, sprint performance was assessed using only a single 30-meter test distance. Other sprint phases—such as initial acceleration or maximal velocity—were not examined, which limits the ability to capture the complete sprint profile.

**Conclusions**

In conclusion, this study identified a strong and statistically significant relationship between peak power and BMI in male handball players, whereas 30-meter sprint performance was not significantly associated with either variable. These findings suggest that while peak power is strongly influenced by body composition, sprint performance is likely determined by a broader set of factors, including neuromuscular and biomechanical components. This study contributes to the growing body of literature by providing sport-specific insights into the physical performance parameters relevant to handball, a relatively underexplored area in this context. The results highlight the importance of individualized fitness assessments and training programs that consider body composition not just as body mass, but in terms of its muscular and fat components. From a practical standpoint, coaches and performance specialists are encouraged to monitor lean mass development and muscular power, rather than relying solely on general indicators like BMI. Additionally, multidimensional assessments—including sprint technique analysis, muscle coordination, and reaction time—may provide a more complete understanding of sprint-related capabilities. Given the limited sample size and focus on only male athletes, future research should include female athletes, employ advanced body composition tools (e.g., DEXA scans), and investigate multiple sprint phases such as acceleration and top speed to better capture performance variability in handball-specific contexts.

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**Ethical Approval Statement:** This study was approved by the Düzce University Ethics Committee on September 5, 2024, with the decision number 2024/268.

**Informed Consent Statement:** Informed consent was obtained from all participants involved in the study.

**Conflict of Interest:** The author declares no conflicts of interest regarding this study.

**Data Availability Statement:** Data supporting this study is available from the author upon reasonable request.

**Artificial Intelligence (AI) Usage Disclosure:** During the preparation of this manuscript, the authors used AI tools, including ChatGPT (OpenAI) and Google Translate (Google LLC), solely for language editing, translation, and proofreading purposes. These tools were not used for generating scientific content, conducting data analysis, interpreting results, or drawing conclusions. All scientific contributions, including the design, methodology, analysis, and interpretation, are the sole work of the authors. Additionally, the study flowchart figure was generated using ChatGPT (OpenAI) to enhance visual clarity; however, the content and structure of the figure were entirely determined by the authors.

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