Research Paper

The Relationship Between Block Jump Height and Demographic Characteristics: Based on a Kinetics Approach

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ABSTRACT

Purpose: It is essential to analyze demographic characteristics to enhance the performance of the block jump skill based on the kinetics domain. For this reason, this study aims to analyze the relationship between jump height and the demographic characteristics of young volleyball players while performing block jumps based on kinetics.

Methods: This study included twenty-one young male volleyball players. Each player was instructed to perform 3 block jumps on a force plate using maximum power, and their jump height was estimated using a kinetics method. Moreover, the players' demographic features, such as height and weight were also measured for the analysis. To determine the relationship between the players' jump height and demographic characteristics, a one-way linear regression statistical method was used.

Results: No significant relationship was found between height and weight (demographic characteristics) and jump height. However, height had a higher factor loading with jump height, indicating more correlation with jump height than weight ($P \leq 0.05$).

Conclusion: To enhance the jumping and landing abilities of elite volleyball players, it is suggested that coaches, players, and specialists assess biomechanical performance through various means. Demographic characteristics can serve as useful indicators to improve performance. A thorough analysis of these indicators can significantly aid in achieving success in volleyball.

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Highlights

- According to the study, no significant correlation is observed between the jump height and the individual's height or weight.
- The loading factor for height is greater than that for weight when it comes to measuring jump height.
- It can be inferred that demographic characteristics do not significantly impact on block jump performance among elite volleyball players.

Plain Language Summary

The ability of athletes to perform well in sports depends on several crucial factors. Among these factors, demographic characteristics play a significant role in determining how well players can defend on the net and execute this skill successfully against their opponents' spikes. For this reason, a study was conducted to analyze the correlation between the height of jumps and the demographic characteristics of young volleyball players during block jumps. According to the study, no significant relationship is observed between height and weight and the height of the jump. However, height has a greater impact on the height of the jump than weight. Therefore, demographic characteristics are not reliable indicators for improving the jump and landing skills of elite volleyball players during block jumps. Coaches, players, and volleyball professionals are recommended to evaluate the performance of other variables instead.

Introduction

In volleyball, jumping and landing are fundamental components for block jumps, jump serves, and spikes [1, 2]. In the realm of athletics, both athletes and coaches place a significant emphasis on improving their jumping ability to enhance their overall performance [3]. During the game, players make the highest percentage of jumps to control the ball, then to attack, and finally to serve [4]. The higher the vertical jump during serving or spiking, the greater the chance of success [5]. Increased vertical jump during block jumps decreases the opponent's attack effectiveness. Scoring actions (service, spike, and block jump) require jumping [6]. From a biomechanical perspective, the effectiveness of jumping and landing techniques in defending on the net and performing different types of spikes depends on several factors. These include the height of the jump, the kinetics and kinematics of the segments involved, the position of the body mass center, and the correct timing of the movements [7]. Advanced sports skills and peak performance require a combination of anthropometric indicators, body composition, and physiological characteristics to function at their best [8, 9].

In modern volleyball, players are specialized in particular positions based on demographic, physical, and other variables [10]. The two main positions are power spikers and speed spikers, with the former having more attacks on the net. During a block jump by the players against the opponent's spikers, the players must have greater access to the ball on the net, which in turn requires them to reach higher jump heights [2]. Therefore, special attention must be given to the demographic characteristics of the players to ensure they possess the necessary physical attributes to achieve this. The question is whether the players' demographic characteristics are related to the height of their jump during block jump.

Several studies have demonstrated that height, weight, and body composition play a vital role in the athletic performance of athletes [11]. Previous research has revealed a direct correlation between muscle mass and players' vertical jumps. Conversely, an inverse relationship is observed between body fat percentage and athletic performance. Despite these results, still some uncertainties exist about the impact of these factors on the success of athletes [12].

Studies have been conducted on the differences in vertical performance between genders during vertical jumps.Sieron et al. [12] found a significant difference in flight time during a 30.5 cm drop jump, with men performing better [13]. This difference in performance can be explained by differences in force parameters [14]. The performance of a vertical jump depends on the vertical speed achieved during takeoff, which correlates with the output power [15]. To rise, a large average force must be applied to the ground during the contact phase [16]. Many studies have shown that men have better power output than women in the field of jumping [17].

Despite the recent significant developments in volleyball in Iran, insufficient research has been conducted to investigate the relationship between jump height, demographic characteristics, and sports performance of young volleyball players. It is essential to identify the vital factors affecting athletic performance. In other words, demographic characteristics can lead to differences in players' ability to defend on the net and successfully perform this skill against the opponent's spike. Therefore, this study was conducted to analyze the relationship between jump height and demographic characteristics of young volleyball players during block jumps.

Materials and Methods

This study was conducted using a quasi-experimental and cross-sectional survey method. Twenty-one young male volleyball players (age: 17.71±0.90 years old, weight: 768.268 59 59.68 N, height: 195.66 2 2.93 cm, body mass index: 20.47 20 1.54 [Kg/m^2] participated in this study, as professional elite volleyball players using the convenience sampling method. The exclusion criteria included participants with any musculoskeletal or neurological defects that can affect their jump performance. All participants were fully informed about the research process and signed a consent form before participation. Evaluations were carried out in the sports biomechanics laboratory of the National Olympic Committee of the Islamic Republic of Iran.

The focus of the study was on the block jump skill. It involves placing the hands in front of the chest and opening the fingers, followed by moving down to a position where the knee and hip joints are flexed and the ankle is in dorsiflexion. The player then performs a high-speed, explosive jump, extending the knee, hip, and ankle joints in a plantar flexion position while simultaneously opening the arms and placing them on top of the head (Figure 1) [13, 14]. Before starting the evaluation protocol, each player underwent a 15-minute warm-up session that simulated the game and training sessions. Each player was then asked to perform the defensive skill on the net three times with the maximum jump height on the force plate (Kistler 1000 Hz), and the highest jump height obtained was calculated and analyzed using Equation 1. To calculate and analyze the variables discussed in this study, including demographic variables, such as height and weight, a wall gauge without shoes was used to determine the height of each subject [15] and the weight was estimated by considering the Fz force plate component when the person was placed statically on this instrument. The subjects also estimated the flight time of the subjects by considering the time difference between the frames when the vertical reaction force of the ground from the force plate reached less than 10 N until it returned to 10 N [16, 17]. All the data analysis procedures were performed using MATLAB software, version 2020.

1. $JH=(9.8\times(ft)^2)/8$

For statistical analysis of the current study, SPSS software version 22 was utilized. The normality of data distribution was examined using the Shapiro-Wilk test. The descriptive statistics (Mean±SD) were then computed, followed by the implementation of a linear univariate regression statistical method to determine the relationship between jump height and demographic characteristics, such as height and weight. All statistical analysis in the present study was performed at a significance level of $P<0.05$.

Results

The results of the Shapiro-Wilk test showed that the data distribution was normal. Table 1 presents the results of descriptive statistics of research variables.

Tables 2 and 3 present the results of inferential statistics and outputs of the linear regression test.

Based on the results of Table 3, it is evident that neither the height nor the weight variables exhibit a significant correlation with the height of the jump. However, the height variable has a higher factor load on the height of the jump compared to weight.

Discussion

This study was conducted to examine the correlation between the jump height of young volleyball players during block jumps and their demographic characteristics, based on kinetics. The results revealed that height has a greater impact on jump height than weight ($P\leq0.05$).

No research has been found on the relationship between demographic characteristics of speakers when giving tours, but previous studies have analyzed the correlation between height and weight and the optimal performance of volleyball players' skills.

The study found no significant correlation between the weight and jump height of elite volleyball players. These results contradict the results of Barnes [18] and Martin Matilla et al. [19] who reported that higher weight is linked to increased explosive power and jump height in volleyball players Milic et al. [11] reported that in-

Figure 1. Block jump test performed in the present study

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creased body surface area is associated with higher fat percentage and subcutaneous weight gain. This, in turn, is negatively linked to strength production. Therefore, athletes with weight gain and high-fat percentage require special attention. The discrepancy between our results and this study may be due to differences in the subjects' levels. This can be expressed because the weight gain of elite individuals is monitored. Nutritionists and sports physiologists often help athletes gain weight by increasing muscle mass and reducing fat mass, which can significantly improve their performance. However, for non-professionals, weight gain caused by higher fat percentage may lead to weight gain, but it will make no difference in their performance.

In the present study, no significant correlation was found between the jump height and height of elite volleyball players. These results are incongruent with several other studies [11]. According to a study conducted by Carter et al. [24], the ability to perform a vertical jump depends on various factors, such as the torque generated in the joints and external forces. The research suggests that players with a taller physique possess a greater ability to produce force and torque, owing to the higher levers in their bodies [24]. This, in turn, leads to higher explosive power and better performance for high jumps. This study contradicts Milic et al.'s research on the relationship between height and sports performance [11]. The discrepancy between our results and this study may be due to differences in age and gender. Barnes et al. [18] conducted research that showed a significant difference in jump heights between men and women [17]. This may be a contributing factor to the inconsistency between the two studies.

Table 1. The results of descriptive statistics related to research variables

Variables	Mean±SD
Weight (N)	68.59±68.28
Height (cm)	2.93±195.66
Jump height (cm)	5.05±40.83

N: Newton.

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Table 2. Correlation analysis between jumping performance, height and weight variables (n=21)

Variables		Weight	Height	Jump Height
Weight	Pearson correlation	1	0.251	0.195
	Sig. (2-tailed)		0.273	0.398
Height	Pearson Correlation	0.251	1	0.379
	Sig. (2-tailed)	0.273		0.091
Jump Height	Pearson correlation	0.195	0.379	1
	Sig. (2-tailed)	0.398	0.091	

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The study's results indicated that height was a stronger predictor of jump height than weight. According to previous research results, height is not affected by training [20]. Height is positively correlated with maximum jump height, making it a crucial factor for success in game situations that involve frequent spiking and blocking. In modern volleyball, teams that excel at the top game of the tour are more likely to win. Therefore, selecting tall players to play in situations that require top defense at the net is a vital requirement for success.

As per Newton's second law, objects with mass are harder to move, stop, or change direction than those with less mass. The acceleration of an object is inversely proportional to its mass, meaning that objects with higher mass experience a stronger gravitational force. Additionally, excessive weight can negatively impact even frequent jump performance [21]. It is not advisable to have excess subcutaneous adipose tissue if you're into playing volleyball, given that the sport involves frequent jumps and rapid changes of direction. Studies conducted on top female elite players have suggested that weight gain can limit their maximum potential and increase the risk of back or knee injury [22, 23]. In the event of frequent landings and sudden changes in speed and direction [24], certain movements are quite frequent in volleyball. This implies that, during a volleyball game, players with a higher body mass index and weight tend to move slower compared to those who have a lower body mass index and weight, provided that both have equal strength and skills. These players jump less and move on the ground more [21]. Height is a more critical factor than weight in determining height jump and enhancing the skill performance of elite volleyball players. Therefore, coaches should choose tall and lean players with low torso strength and agility to perform skills on the net effectively. This will ensure better execution of the skill.

One of the main limitations of the present study is that all the players included in the research were part of the national team's permanent camp and followed the same nutritional and physical training plan. This may have influenced their performance and affected the generalizability of the results. Additionally, the study did not define the differences in game positions and match roles of the subjects, which could have played a significant role in their performance. To get a more accurate understanding of the interactions between variables, it is recommended to include biomechanical parameters, such as kinematics and kinetics of jumping, along with demographic variables.

Table 3. Regression coefficient between jump height and demographic characteristics including height and weight variables

Model	Not Standardized Coefficients		Standard Coefficients	T	Sig.
	β	Standard Error	B		
Fixed coefficient	-84.67	73.18		-1.15	0.26
Weight (N)	0.009	0.019	0.10	0.47	0.64
Height (cm)	0.60	0.38	0.35	1.57	0.13

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N: Newton.

*Significance level P≤0.05.

Conclusion

Based on the results of this study, it can be concluded that demographic factors are not reliable predictors for improving the performance of jump and landing skills of elite volleyball players during the block jump. Coaches, players, and volleyball experts are advised to assess various performance variables instead. Additionally, a comprehensive study of different biomechanics and their interaction should be considered to achieve more success.

Ethical Considerations

Compliance with ethical guidelines

All stages of the research were carried out with the approval of the Ethics Committee of the Physical Education Research Institute (Code: IR.SSRI.REC.1151).

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Authors' contributions

All authors contributed equally to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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