Volleyball players' somatic composition in the light of sports results at 2014 FIVB Volleyball Men's World Championship

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ORIGINAL

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Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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abstract

Background	The aim of the study was to analyse sports results and the somatic composition of participants in the 2014 FIVB Volleyball Men's World Championship held in Poland.
Material/Methods	Research material involved volleyball players participating in the World Championships (n = 280). Their age, height, weight, one-arm spike reach, both-arm block reach, and Rohrer's index were analysed. The mean value of the features and their derivatives in individual teams and groups were calculated and verified using statistical tests (t-Student, Mann Whitney and Cochran-Cox) if the differences were significant.
Results	The subjects' mean age was 26.33 years (SD = 3.90), body height 198.41 cm (SD = 6.05), body weight 89.40 kg (SD = 8.43), spike reach 344.08 cm (SD = 13.37), block reach 326.68 cm (SD = 13.09), Rohrer's index 1.15 (SD = 0.10). 90.36% of the volleyball players manifested the leptosomatic body composition, 9.28% the athletic one, and 0.36% the pyknic one. The highest and the lowest ranked teams in the analysed tournament significantly differed in the spike reach ($P < 0.005$) and in body height ($P < 0.015$).
Conclusions	The leptosomatic body composition type is dominant among volleyball players at the top level of sports championship. The body height and the spike reach significantly differentiate the top and the bottom ranked teams participating in the 2014 FIVB Volleyball Men's World Championship. These characteristics should be taken into account in selection to play men's volleyball.
Key words	High-performance, sports competition, sports result, anthropometry, body type

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INTRODUCTION

Volleyball, like other team games, requires players to have not only high technical and tactical skills and high efficiency in offensive and defensive actions, but also to possess suitable somatic composition and physical fitness [1, 2, 3]. The characteristics of a sports volleyball champion are mostly defined by his age, somatic composition, physical fitness trials and technical and tactical skills [4, 5, 6]. Both in individual and in team disciplines those players are called champions who achieve the greatest success in major sports competitions. Therefore, in volleyball, national teams participating in the most prestigious competitions, i.e. in the World Championships, the Olympic Games, the World League and continental championships are usually analysed. When making up such teams, many technical, tactical and psychological elements should be taken into account, and players with suitable somatic composition, much experience and an appropriate index ratio of weight to body height, which promotes adaptation to jumping exercising, should be selected [6].

Assessing players' somatic composition and the level of physical fitness in the light of changes in the techniques and tactics of the game as well as looking for significant differences between them and the sports result specify the development trends in men's volleyball [7, 8, 9]. The World Championships are a particularly important moment in the development of each sports discipline, as the results obtained during them constitute a summary of long-term training. Analysing the best players also provides information on the necessary changes which should be introduced to the training process in the coming years to remain in the progressive trend [7, 8, 10].

Many authors stress that players' anthropometric and physiological features and their technical skills are of fundamental importance in achieving the sports result in volleyball [11]. Gualdi-Russo and Zaccagni [12] studied the somatic composition of leading male (n = 234) and female (n = 244) volleyball players in relation to their position on the court and the place taken in Italian Serie A1. The top classified teams of Italian Serie A1 had more players with the ectomorphic body type compared to the lowest classified teams. Malousaris et al. [13], examining Greek female volleyball players, found that athletes from the best teams were taller and had lower BMI than the average. Paleo et al. [14] found that players from the highest ranked teams exhibited greater body height, body weight and one-arm spike reach and both-arm block reach compared with the lowest ranked teams. The subjects' age did not significantly differ between the two groups.

The aim of this study was to analyse athletic performance and somatic composition of participants in the 2014 FIVB Volleyball World Men's Championship held in Poland. The Authors decided to examine whether there were statistically significant differences between the characteristics of the players representing the highest and lowest ranked teams in the final classification of the World Championships in question. Also the performance of the Polish team – the winner of the tournament – was assessed in comparison to all teams. The study allowed answering the following research questions:

What is the average level of the somatic composition characteristics and one-arm spike reach and both-arm block reach in volleyball players participating in the FIVB Volleyball Men's World Championships in 2014?

What is the somatic composition and one-arm reach (attack) and both-arm reach (block) of the world champion – the Polish national team?

Do the somatic composition characteristics and one-arm spike reach and both-arm block reach significantly differentiate the highest and the lowest ranked teams in the analysed tournament?

MATERIAL AND METHOD

The research sample involved players of 24 teams participating in the 2014 FIVB Volleyball Men's World Championship held in Poland from 30 Aug.–21 Sep. 2014. The total number of the examined volleyball players was 280. Players from the libero position were excluded from the analysis due to their different tasks on the court. The study was conducted in four groups. The first research group was made of all participants in the World Championships. The second one comprised four top classified teams: 1. Poland, 2. Brazil, 3. Germany, 4. France. The third one included four lowest ranked teams (all finished the tournament in 21st place): Cameroon, Tunisia, Egypt, Puerto Rico. The last group included the Polish team.

Data on age, body height, body weight, one-arm spike reach and both-arm block reach were obtained from the official website of the 2014 FIVB Volleyball Men's World Championship in Poland [15]. One-arm spike reach and both-arm block reach were examined using a measuring tape to test the reach. To test one-arm spike reach, having taken a run-up a subject jumped from both feet, as in attack, to mark the maximum reached height with fingers of one hand on the measure. Both-arm block reach was tested with a trial in which the subject jumped from the spot with both feet, as in block, and marked with fingers of both hands the point reached on the measure (both hands at the same height).

Rohrer's slenderness index was calculated taking into account the data on body height and weight. Types of body composition were defined by means of Curtius's key with a use of Rohrer's index, according to Kretschmer's typology: x–1.27 the leptosomatic type, 1.28–1.49 the athletic type and 1.50–x the pyknic type [16]. The leptosomatic type is characterised by slender and elongated body composition, low body weight, and the length dimensions predominate over the width ones. The athletic type is distinguished by a strong skeletal structure and the muscle system, and the length and width dimensions are proportionate. The pyknic type is characterised by short limbs and a predominance of width dimensions over the length ones.

Mean values of the features and their derivatives in particular teams and groups were statistically analysed. In order to verify the statistical significance of differences in particular groups, statistical tests were used. Student's t test was used to compare the body height, body weight, both-arm block reach and Rohrer index. Mann-Whitney test was used to compare the subjects' age. The Cochran-Cox test was used to determine differences in one-arm spike reach. The obtained results were developed with a use of statistical software STATISTICA 10.

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RESULTS

Analysed features of the surveyed top volleyball players, participating in the 2014 FIVB Volleyball Men's World Championship are shown in Table 1.

Table 1. Numeric characteristics of the examined features and Rohrer's index of participants in the 2014 FIVB Volleyball Men's World Championship

Subjects	Total (n = 280)		Group 1-4 (n = 48)		Group 21 (n = 43)		Poland (n = 12)	
Feature/index	x̄	SD	x̄	SD	x̄	SD	x̄	SD
Age	26.53	3.90	27.40	3.32	27.86	4.74	27.58	3.90
Body height (cm)	198.41	6.05	199.73	7.14	196.14	6.67	200.08	5.88
Body weight (kg)	89.40	8.43	91.21	9.00	87.35	9.76	87.08	5.35
Spike reach (cm)	344.08	13.37	345.27	12.66	336.02	16.84	347.00	11.67
Block reach (cm)	326.68	13.09	323.57	11.45	321.19	15.54	324.09	10.86
Rohrer's index	1.15	0.10	1.15	0.10	1.16	0.10	1.09	0.07

x̄ – mean, SD – standard deviation

The subjects' mean age was 26.53 years old (SD = 3.90), body height – 198.41 cm (SD = 6.05), body weight – 89.40 kg (SD = 8.43), spike reach 344.08 cm (SD = 13.37), block reach – 326.68 cm (SD = 13.09), Rohrer's index – 1.15 (SD = 0.10) (Table 1).

Table 2. Body types of the examined volleyball players participating in the 2014 FIVB Volleyball Men's World Championship

Subjects	Total (n = 280)		Group 1-4 (n = 48)		Group 21 (n = 43)		Poland (n = 12)	
Body type	n	%	n	%	n	%	n	%
Leptosomatic	253	90.36	42	87.50	38	88.37	12	100.00
Athletic	26	9.28	6	12.50	5	11.63	-	-
Pyknic	1	0.36	-	-	-	-	-	-

n – number of subjects, % – percentage value

90.36% of the volleyball players participating in the tournament had leptosomatic body composition, 9.28% were athletic and 0.36% pyknic (Table 2). The winner of the tournament, the Polish team, compared to all the participating teams, manifested a higher mean age of the players – d = 1.05 years, a taller body – d = 1.67 cm and one-arm spike reach – d = 2.92 cm. By contrast, they had lower mean body weight d = 2.32 kg and both-arm block reach – d = 2.59 cm as well as lower Rohrer's index – d = 0.06 (Table 1). All representatives of the Polish national team exhibited the leptosomatic body type (Table 2).

In the next stage of the research statistically significant differences in the values of the features of the players from teams occupying the top (1–4) and the bottom (21) places in the tournament were determined. Teams in both groups were characterised by players' similar mean age and Rohrer's slenderness index. The top ranked teams were, however, taller (d = 3.59 cm) and heavier (d = 3.68 kg) than the teams which took the bottom place in the tournament; they also had greater spike reach (d = 9.25 cm) and block reach (d = 2.38 cm) (Table 1).

The highest and the lowest ranked teams in the tournament had a similar number of players with the leptosomatic and athletic type of composition. There were no players with the pyknic type of composition in either of the groups (Table 2). The highest and lowest ranked teams significantly differed from each other in spike reach (P < 0.005) and in body height (P < 0.015) (Table 3).

Table 3. A comparison of the features of somatic composition and Rohrer's index in players representing the highest and the lowest ranked teams in the 2014 FIVB Volleyball Men's World Championship (n = 91)

Feature/index	Teams from places 1-4 (n = 48)		Teams from place 21 (n = 43)		D
	x̄	SD	x̄	SD	
Age	27.40	3.32	27.86	4.74	0.46
Body height (cm)	199.73	7.14	196.14	6.67	3.59*
Body weight (kg)	91.21	9.00	87.53	9.76	3.68
One-arm reach – spike (cm)	345.27	12.66	336.02	16.84	9.25**
Both-arm reach – block (cm)	323.57	11.45	321.19	15.54	2.38
Rohrer's index	1.15	0.10	1.16	0.10	0.01

x̄ – mean, SD – standard deviation, d – differences between means

Statistically significant differences for *p ≤ 0.05, **p ≤ 0.01

DISCUSSION

The characteristics of somatic composition of athletes from various disciplines are a subject of extensive research. Each sports discipline and event has its own specific requirements, which is why every athlete should have appropriate anthropometric characteristics conducive to reaching sports championship in their own discipline [17]. According to Massuça and Fragoso [18], body height, weight and composition are important factors contributing to the optimization of the training process and the achievement of top results in handball and volleyball. Together with technical and tactical skills, they are necessary to achieve sports proficiency [18]. Volleyball players are characterised, among others, by a significant body height and the length of the upper limbs. This affects a long one-arm and both-arm reach, which, in turn, allows them to shorten the distance and the time necessary to come into contact with the ball during attack and block. Taller players hit the ball at a greater height above the net. They perform their offensive actions – in attack and defensive actions – in block with greater ease and more efficiently [19].

Multidirectional analyses of individual athletes and entire teams playing at the championship level allow monitoring the changing trends in any sports game, including volleyball [8]. The research conducted for decades on volleyball players during world championships and the Olympic games allows specifying which characteristics of somatic composition have changed the most and where the changes are insignificant [6, 8, 10, 20, 21]. In the Olympics in Seoul in 1988, the players' mean body height (n = 144) was 193.8 cm, in Barcelona in 1992 (n = 144) it was already 194.6 cm, in Beijing in 2008

(n = 144) 197.0 cm, and in the analysed in this study world championships (n = 280) 198.4 cm. This indicates a gain in this trait in volleyball players over the past years. It was slightly different in the case of the age of participants in the most important sporting events in men's volleyball. The mean values of age of all the players over the last three decades are about 26 years old, with the exception of the Olympic Games in Beijing in 2008, during which the subjects' mean age was significantly higher and amounted to 28.2 years. In the World Championships in 2014 the participants' mean age was 26.5 years. It has been noted that the mean age of medallists in the analysed tournament is slightly higher than of the total sample. This can be explained by the fact that medallists are characterised by longer training experience, ergo more sports experience, thus achieving better sports results [8].

One-arm and both-arm reach are the characteristics defining volleyball players' potential in attack and block. One-arm and both-arm reach affect the players' efficiency of game. In analysis of the measurements conducted during the Olympic Games in Atlanta in 1996, it was found that the volleyball players' average reach in attack was 341.3 cm and 321.6 cm block. In Sydney in 2000 it was 344.2 cm in attack and 326.3 cm in block, while in Athens 343.0 cm in attack and 323.9 cm in block. Values similar to those obtained by volleyball players in Sydney were reported during the Olympic Games in Beijing in 2008 (343.7 cm in attack and 327.1 cm in block) and in the tournament analysed here (344.1 cm in attack and 326.7 cm in block) [6, 8]. Noticeably, the results obtained by volleyball players (spike reach and block reach) in tournaments over two decades are comparable and do not change significantly.

The research conducted by Dziąsko and Naglak [20] show that 65.1% of players were characterised by the leptosomatic composition body, 28.2% by the pyknic one and 6.6% by the athletic one. In the latest studies by Palao et al. [14] the types of volleyball players' body composition were assessed according to Sheldon's typology. Sheldon distinguishes three types of body composition: ectomorphic, mesomorphic and endomorphic, which correspond to the leptosomatic, athletic and pyknic type of composition in Kretschmer's typology. The research showed that in the top classified teams Italian Series A1 in men's volleyball, the ectomorphic type of body composition dominates over the mesomorphic and endomorphic one. In the analysed here 2014 FIVB Volleyball Men's World Championship the leptosomatic composition type was dominant among volleyball players (90.36%) in comparison with the athletic (9.26%) and the pyknic (0.36%) type of composition.

A search for correlations between selected features of somatic composition, spike reach and block reach, and the level of sports championship has been going on for many years [4, 6, 7, 9, 21, 22, 23, 24, 25, 26]. Volleyball players representing the highest and the lowest ranked teams participating in the 2014 FIVB Volleyball Men's World Championship mostly vary as to the body height and one-arm spike reach. For this reason, teams with taller players having greater one-arm spike reach achieved better sports results in the tournament. It must be stressed, however, that volleyball belongs to games where a team's sports outcome is influenced by many different factors (e.g. players' somatic composition, motor skills, technical and tactical skills, volitional traits), and low levels of one of them may be compensated by a high level of another one [20]. Changes in the rules of the game taking place also in recent years

have contributed to strengthening the role of defensive actions in sports competition. Therefore, the presented study is still valid and necessary.

CONCLUSIONS

The study results presented in this paper regarding the mean values of the characteristics of volleyball players participating in the 2014 FIVB Volleyball Men's World Championship enable volleyball coaches to perform various analyses. The best volleyball players' results, considered as a model and confronted with the level of other players' characteristics, indicate directions of team building. The obtained results and those from other research papers define development trends in volleyball. The analysis of results has also contributed to indicating the direction of choice and selection by specifying which characteristics of somatic composition and fitness trials affect the most the sports results of the best sports teams in the world.

By far the largest number of subjects were characterised by the leptosomatic body composition. This confirms earlier studies on the dominance of the leptosomatic body type among the top level volleyball players [20].

The world champions, representatives of Poland, were taller players with greater than average one-arm spike reach. All players from the Polish national team were characterised by the leptosomatic body composition type.

Body height and one-arm spike reach significantly differentiate the highest and lowest ranked teams participating in the 2014 FIVB Volleyball Men's World Championship. The teams made of taller players with greater spike reach took higher places in the tournament.

Test results of the presented research should be taken into account by coaches in the process of proper team building. Yet, frequent changes in rules of the game cause that the long-term planning of the training process should be based on observations of the development of the sports discipline.

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