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Body height prediction of young volleyball female players

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Abstract

The aim of this study is to predict the „adult" body height of female volleyball players by using the method of Sherar et al. The sample of participants included 49 senior Croatian female volleyball players (22.14±1.26 years). Varibales assessed were: Body height, Body mass, Age at Peak height velocity (PHV), Coefficient of variation in PHV, Prediction of adult height, and Variation in predicted adult height. T test was used to analyze the differences between active volleyball players and drop-outs, 8 years after the first measurement of anthropometric characteristics, with the level of significance set at p≤0.05. By using the Bland-Altman method, a plot of the differences between the measured body height and the lowest predicted body height was presented. The obtained results indicate that the predictive values of adult body height in active volleyball players are lower than the actual values, i.e., drop-outs have lower values of deviation from actual adult body height. Significant differences were found between active and inactive volleyball players/drop-outs in the 4 applied variables.

Keywords: *Anthropometric characteristics, Bland-Altman method, Prediction of body height, Volleyball*

Introduction

Volleyball is a sport that is divided into 2 complexes (attack and counter-attack); complexes consist of phases (serving, receiving serve, setting for spike in attack, spike in side-out attack, spike coverage for side-out attack, blocking, court defense, setting for counter attack, spike on counterattack and spike coverage on counterattack) (Valladares, García-Tormo & João, 2016). The phases consist of technical and tactical elements and volleyball players perform five specific playing roles during the game (outside hitter, libero, setter, middle blocker, opposite). (Valladares, García-Tormo & João, 2016). Regardless of the specificity of the playing roles, each player should be able to perform the elements of volleyball with equal quality so that the player can specialize in a particular position. Specialization in volleyball is very complex and demanding, and the determination of playing positions is based on various factors, body height being one of the most important.

Body height is largely genetically determined, and there are various indicators of final body height. Arm span has proven to be one of the more reliable predictors of body height (Popović, Bjelica, Tanase, & Milasinovic, 2015; Mitrović, 2018; Radulović and Kovačić, 2018; Vukotić, 2018; Radulović, 2019). Also, the following indicators are used: sitting height, upper arm length, upper leg length (Mirwald, Baxter-Jones, Bailey & Beunen, 2002). Previous research has shown differences in the longitudinal dimensionality of the skeleton and the volume and mass of the body between female volleyball players of different age groups (Grgantov, Katić & Janković, 2006). According to Milić (2014), indicators of biological age significantly affect differences between playing positions when observing body height, body mass and body mass index.

Furthermore, Mirwald, Baxter-Jones, Bailey & Beunen (2002) longitudinally track a sample of 152 Canadian children (79 boys, 73 girls) through adolescence from the ages of 8 to 16 years. To calculate the age of Peak height velocity, (PHV) they used 3 morphological measures (body height, sitting height and leg length). Likewise, Sherar, Mirwald, Baxter-Jones & Thomis, (2005) in a sample of 224 boys and 120 girls determined how

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adult body height can be predicted using maturity-derived reference values and sex-specific cumulative velocity curves. The authors finally conclude that this method is valid, non-intrusive, cheap and simple and can predict adult height within ±5.35 cm with 95% certainty in boys and ±6.81 cm with 95% certainty in girls.

Following the above, in this work we will apply the modified Mirwald equation according to Sherar, Mirwald, Baxter-Jones & Thomis (2005) applying it in the calculation of the prediction of the final height of young volleyball players. The main goal of the research is to predict the final body height of volleyball players. Also, the goal is to compare the values obtained by the mentioned method with the currently measured (achieved) body height, and to determine possible differences between two groups of volleyball players: active and those who have given up sports activities in the meantime.

Methods

Subjects

The sample of subjects represents 49 Croatian volleyball players of the senior age group, with an average chronological age of 22.14±1.26 years. The subjects were divided into 2 groups: active (N=26) and inactive (N=23). The inactive group is represented by those volleyball players who, during a period of 8 years, have given up actively playing volleyball.

Variables and procedures

Body height and Body mass were measured according to the ISAK protocol (Stewart, Marfell-Jones, Olds and De Ridder, 2011). Measurements were repeated twice and the mean average was considered for analysis (Milić, 2014). The values represent the achieved final body height and body mass.

Age at Peak height velocity (PHV) was determined according to the method of Mirwald, Baxter-Jones, Bailey and Beunen (2002), Coefficient of deviation from PHV and Prediction of body height was calculated using the method of Sherar et al. (2005) which were performed based on the initial measurement of variables 8 years ago (body height, sitting height, chronological age) and the variable deviation from final body height (difference between achieved and predicted body height).

Experimental procedure

In the first phase of the research, in 2014, with the prior consent of the volleyball clubs, dates and volleyball training halls were agreed for conducting the measurements. The parents of the volleyball players (minor of age at that time) received instructions and were informed about the purpose of the research. The coaches collected written consent from the parents for their children to participate in the study. Permission was also obtained from the regional volleyball associations and the Croatian Volleyball Association. All measurements were made in the morning by only one assessor (Milić, 2014).

In the second phase of the research, after 8 years, the anthropometric characteristics (body height and body weight) were measured again, and the status of the volleyball players was determined with regard to their active training or giving up on volleyball.

Statistical analysis

Data processing methods included the calculation of descriptive statistical indicators of the distribution of the 6 variables used: arithmetic mean (AS), standard deviation (SD), minimum (Min) and maximum (Max) values. The sensitivity of the metric feature was tested by the coefficients of asymmetry (Skewness) and roundness (Kurtosis) of the distribution. The Kolmogorov-Smirnov test was used to determine the normality of the distribution.

T-test was used to analyze the differences between active and retired volleyball players for anthropometric characteristics with a significance level set on $p \leq 0.05$.

By applying the Bland Altman method, a plot of the difference between the final (achieved) body height and the predicted body height is shown.

The data were processed with the Statistica version 13 computer software.

Results

Table 1 shows the results of descriptive statistics of all 6 used variables, on the total sample of subjects (N=49). Also, the metric features of the measuring instrument are shown.

Analysis of Table 1 shows that the average final height of female volleyball players is 178.38±6.39 cm, while the average predicted body height is 175.45±6.16 cm. The first measurement was made in 2014, when the volleyball players belonged to the younger cadet age category, and the average value of PHV was 11.77±0.43 years, that is, the average coefficient of PHV was 2.45±0.83. All symmetry and roundness coefficients indicate a good sensitivity of the used variables. The analysis of the distribution indicators of the total sample of volleyball players shows that there are no significant deviations from the normal distribution in any variable, which means that all variables are suitable for further parametric statistical processing.

Table 1. Descriptive characteristics and sensitivity of the used variables on the total sample of female volleyball players (N=49)

Variable	AM	SD	MIN	MAX	SKEW	KURT	MAX D
Coefficient of deviation PHV (years)	2.45	0.83	0.52	3.90	-0.32	-0.42	0.08
PHV (years)	11.77	0.43	10.59	12.85	-0.14	0.49	0.10
Final body height (cm)	178.38	6.39	161.00	191.00	0.01	-0.04	0.13
Final body mass (kg)	65.79	7.40	54.00	81.00	0.25	-0.86	0.10
Predictor of final body height (cm)	175.45	6.16	160.00	187.67	0.04	-0.12	0.06
Deviations from the final body height (cm)	2.99	2.99	-3.19	9.84	0.44	-0.13	0.14

Note: AM – mean; SD – standard deviation; MED – median; MIN – minimal reult; MAX – maximal result; SKEW – skewness (measures the symmetry of the distribution); KURT – Kurtosis (measure of degree of tailedness in the distribution) ; MAX D – maximal result distance

Table 2 shows the values of the analysis of differences of two subgroups: active volleyball players (N=26) and those who gave up (N=23) in 6 applied variables, using the T-test for independent samples.

Analysis of Table 2 shows a significant difference in 4 of the 6 applied variables. The final (achieved) body height of active volleyball players is 181.15±6.08 cm, and that of retired volleyball players is 175.24±5.25 cm with a significance level of $p<0.001$. The two subgroups differ significantly in the variables Final body mass and Deviation from final body height with a significance

Table 2. Analysis of differences in variables according to groups with regard to the continuation of playing volleyball (active or retired) (N=49)

VARIABLE	CONTINUATION OF VOLLEYBALL PRACTICE				T-test	P
	ACTIVE (N=26)		RETIRED (N=23)			
	AM	SD	AM	SD		
Coefficient of deviation PHV (years)	2.57	1.00	2.30	0.56	1.13	0.26
PHV (years)	11.71	0.41	11.83	0.44	-1.00	0.32
Final body height (cm)	181.15	6.08	175.24	5.25	3.62	0.00**
Final body mass (kg)	68.48	7.78	63.10	6.03	2.62	0.01*
Predictor of final body height (cm)	177.17	6.81	173.50	4.74	2.16	0.04*
Deviations from the final body height (cm)	3.98	3.10	1.86	2.46	2.63	0.01*

Note: AM – mean; SD – standard deviation; P – value; * p<0.05; ** p<0.01.

level of p=0.01, while the values of the variable Predictor of final body height significantly differentiate active (3.98±3.10 cm) from retired volleyball players (1, 86±2.46) with a significance level of p=0.04. All significant variables have higher values in the subjects who are still active in volleyball.

Graph 1 shows the results of the Bland Altman plot of the difference between the achieved final body height and the lowest predicted body height.

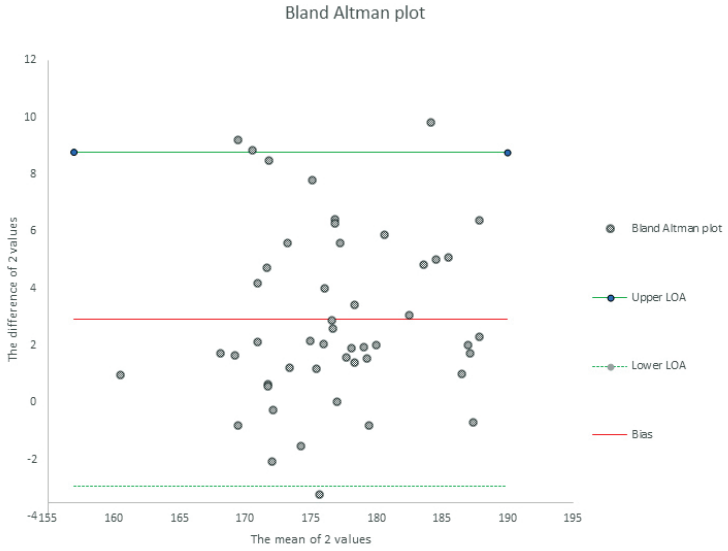

FIGURE 1. Bland Altman plot of the difference between actual body height and predicted body height

Analysis of Figure1 shows a comparison of the achieved final body height of senior volleyball players and the predicted final body height of adult volleyball players. In the Bland Altman procedure, the averages of the predicted and realized final body height of adult volleyball players are shown in relation to the difference between these two values.

Discussion

The aim of this study was to predict the final body height and analyze the predicted and achieved body height between active and retired volleyball players. Active volleyball players have greater deviations from the final values for the measured anthropometric parameters than inactive ones. Furthermore, differences were found in some variables between the groups, namely: Final body height, Final body mass, Deviation from final body height and Predictor of final body height with a significance level of p<0.05.

By applying the method of predicting body height (Sherar et al., 2005), it was determined that inactive volleyball players have a lower body mass and predicted final body height as well as deviation values from final body height. The obtained findings indicate that the predicted values of the final body height in active volleyball players are lower than the actual values, that is, the retired volleyball players have smaller values of deviation from the achieved final body height.

Also, a significant difference was found in 4 out of a total of 6 applied variables: Final body height, Final body mass, Deviation from final body height and Predictor of final body height with a significance level of p<0.001 to p=0.04. All significant variables have higher values in the subjects who are still active in volleyball. The values of deviations from the final body height: active (3.98±3.10 cm) and retired volleyball players (1.86±2.46) can be precisely compared with the findings in the research of Sherar et al., (2005) who obtained higher deviations in predicted body height of an adult within ±5.35 cm with 95% certainty in boys and ±6.81 cm with 95% certainty in girls. The significantly higher body height of active compared to retired volleyball players is probably partly a consequence of the selection process. Body height is a very important success factor in volleyball for all playing roles characterized by play above the net, namely middle blockers-attackers of the first tempo, receivers-attackers and opposites. A possible cause of giving up active training can be the

independent decision of volleyball players of lower body height due to insufficient motivation and non-objective self-assessment of their capabilities, short participation in competitions, or poor performance in training and competitions. (Botić, 2019).

Furthermore, we could speculate that the significantly larger difference between the predicted and realized body height in active volleyball players points to a possible positive influence of the training process in volleyball on the growth of the body in height. However, Malina (1994) states that the data obtained in the study suggest that regular physical activity, participation in sports and training for sports have no effect on final body height, PHV time and height growth rate.

Conclusion

By using the method according to Sherar (2005), smaller differences between the predicted and achieved final height were obtained compared to previous research. Also, the findings obtained in this research indicate a significantly higher achieved final body height in active volleyball players. Furthermore, the results indicate a significant difference in the predicted and actual final body height as well as significantly greater differences between the predicted and achieved body height of active volleyball players compared to those who gave up.

Therefore, it can be concluded that the obtained results are probably the result of the selection process. The influence of the training process, which is full of jumps, landings and changes in the direction of movement, could be an additional cause, but the research so far does not support this speculation. Further research is needed with the stated research problems.

Future research should involve a larger number of subjects. Also, measurements should be carried out in men's volleyball players.

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