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Factor Analysis of Some Distinctive Morphological Variables in Junior Tennis Players under 12 Years

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Abstract: The current research aims at identifying morphological (anthropometric) variables representing selection criteria of junior tennis players under 12 years through identifying the factorial structure of these variables. The researcher used the descriptive (survey) approach. Sample (n=62) was purposefully chosen from junior tennis players (8-11 years) registered in the Egyptian tennis federation 2010 – 2011. The researcher concluded the factorial structure suitable for the distinctive morphological (anthropometric) variables for tennis players under 12 years and factors represented with morphological (anthropometric) variables suitable to be used as selection indicators for tennis players under 12 years. Factors concluded from the factor analysis are equal in importance as variance percentage interpreting each factor is very close. This means that each factor has its own importance, regardless its order on the matrix. Factor analysis indicated that the factors matrix, perpendicularly circulated, was successful in providing the researcher with a good database for choosing the best morphological (anthropometric) variables and each factor has its own importance.

Key words: Morphological variables % Factorial matrix % Tennis % junior selection

INTRODUCTION

Sports selection is a basic process that directs junior players towards sports activities suitable for their own capabilities. Through this process we select the best individuals with the most appropriate morphological, physiological and psychological characteristics to be enrolled in regulated training programs that aim at improving athletic performance to reach the best levels. Good selection is a good guarantee for success and good investment for money, effort and equipments. As each sports activity has its own requirements, these requirements are manifested in specific morphological, physiological and psychological characteristics of athletes involved in such activities. Therefore, these characteristics should be identified to be used in athletes' selection and categorization along with achieving higher performance levels.

On both national and international levels, we need morphological and physiological evaluation to identify our own physical potentials, either morphologically or physiologically and if these potentials, acquired or inherited, can be used to achieve international levels [1].

We can not improve the performance level of an athlete unless the coach is fully aware of the athlete's morphological aspects, along with anatomical aspects and body structure and its relations to some functional aspects, including any functional changes and limits of body systems and body response to training loads [2].

Selection is a precise choice of athletes during preparation phases through testing their physical, functional, psychological and mental capabilities and measuring their anthropometric characteristics specific to the involved technical activity. Basic criteria of selection include anthropometric measurements, especially during initial phases, so that sports goals can be achieved [3-5].

Like any other sport, tennis requires specific anthropometric characteristics as they represent basic pillars for achieving higher performance levels. It is clear that anthropometric measurements of the upper limps play major roles n tennis as they contribute n improving the achievement level of players as this game needs specific requirements like arm length and upper limp length [6]. Any sports activity needs special requirements if we intend to gain medals and win championships [1].

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Anthropometric measurements are very important as there is a clear relation between international performance levels and body composition and type. Physical abilities and anthropometric measurements affect motor skills learning. They also affect body responses to different conditions. They provide sports coaches with valuable data about body indices and measurements according to age and sports levels [7]. The most important variables affecting tennis are anthropometric and physical variables, including lengths, widths and circumferences, along with reaction time, coordination, endurance and agility. All these variables affect each other and affect technical performance of tennis positively [8]. It is also clear that there is a relation between the player's body composition (height – weight – limp length) and the potentiality of achieving higher performance levels as each sports activity needs special body attributes [9].

Individual fitness to sports activities is identified with the suitability of body composition to the required performance [10]. It is clear that anthropometric measurements are very important in selecting individual athletes to involve in specific sports activities based on their physical capabilities. Physical selection of athletes depends on some anthropometric measurements that serve as indicators for athletic achievement [11].

Aim: The current research aims at identifying morphological (anthropometric) variables representing selection criteria of junior tennis players under 12 years through identifying the factorial structure of these variables.

Research Questions: The current research poses the following questions:

- What is the factorial structure of morphological (anthropometric) variables distinctive for junior tennis players under 12 years?
- What are the morphological (anthropometric) variables representing selection criteria of junior tennis players under 12 years?

MATERIALS AND METHODS

Approach: The researcher used the descriptive (survey) approach.

Sample: Sample (n=62) was purposefully chosen from junior tennis players (8-11 years) registered in the Egyptian tennis federation 2010 – 2011. Another 10 junior players (from the same research community and outside the main sample) were chosen for the pilot study.

Data Collection Tools and Forms

Anthropometric Measurements: Through literature review for previous studies related to anthropometric measurements (1, 5, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23) the researcher concluded 22 measurements. These were reduced to 18 measurements according to experts' opinions. Measurements were as follows: body weight – total height – upper limp length – upper arm length – forearm length – palm length - lower limp length – thigh length – leg length – shoulder width – chest width – upper arm circumference – forearm circumference – chest circumference – abdomen circumference – thigh circumference – leg circumference.

Forms: The researcher used the Experts opinion form to identify anthropometric measurements that can be used as indicators for junior tennis players selection.

Tools: A medical balance – a restameter – a measuring tape – pluviometer.

Pilot Study: Pilot study was done on 10 junior players (from the same research community and outside the main sample) from 8-10-2010 to 11-10-2010 to identify any difficulties that may hinder the main application.

Main Study: The researcher performed the anthropometric measurements from 15-10-2010 to 10-12-2010 under the suitable protocols for each measurement. Data were collected and recorded for statistical treatment.

Statistical Analysis: The researcher used SPSS software to calculate the following: mean – standard deviation – median – skewness – (t) test – Person's correlation coefficient – multi correlation coefficient – factor analysis.

RESULTS AND DISCUSSION

Table 1 shows that skewness values for the research variables ranged between - 0.723 and 0.214. This indicates that sample was homogenous in the chosen variables.

Table 2 shows correlation coefficients for the anthropometric variables. Raw data was used to generate intermediary correlations via Pearson's equation for raw data. This led to a matrix of 153 positive correlation coefficients, from which 147 were statistically significant

Table 1: Mean, standard deviation, median and skewness for anthropometric variables (n=62)

	Measurement	Mean	SD±	Media	Skewness
1-	Weight	31.80	7.92	30.50	0.512
2-	Height	130.59	9.89	133.00	-0.214
3-	upper limp length	56.48	5.16	56.00	0.723
4-	Arm length	62.61	5.79	63.00	0.259
5-	upper arm length	2.06	2.61	25.00	0.126
6-	Forearm length	22.74	2.24	23.00	0.163
7-	Palm length	14.80	1.30	15.00	0.555
8-	Lower limp length	74.11	8.89	74.00	0.283
9-	Thigh length	35.09	5.16	35.00	0.448
10-	Leg length	34.98	4.01	35.00	0.419
11-	Shoulder width	32.06	2.64	32.00	0.070
12-	Chest width	32.04	3.41	32.00	0.420
13-	Upper arm circumference	16.91	4.43	17.50	0.437
14-	Forearm circumference	15.62	4.50	16.00	0.545
15-	Chest circumference	61.48	8.41	60.00	0.713
16-	Abdomen circumference	56.62	8.59	56.00	0.464
17-	Thigh circumference	31.40	6.11	32.00	-0.037
18-	Leg circumference	22.12	6.15	22.00	0.013

Table 2: Intermediary correlations matrix for anthropometric variables (n=62)

	Variables	Weight	Height	upper limp length	Arm length	Upper arm length	Forearm length	Palm length	Lower limp length	Thigh length	Leg length	Shoulder width	Chest width	Upper arm circum-ference	Forearm circum-ference	Chest circum-ference	Abdomen circum-ference	Thigh circum-ference	Leg circum ference
1-	Weight		0.840**	0.321*	0.842**	0.800**	0.842**	0.685**	0.747**	0.649**	0.757**	0.866**	0.777**	0.885**	0.908**	0.908**	0.912**	0.904**	0.902**
2-	Height			0.445**	0.884**	0.824**	0.878**	0.761**	0.852**	0.734**	0.864**	0.870**	0.727**	0.827**	0.815**	0.837**	0.837**	0.881**	0.873**
3-	upper limp length				0.284*	0.338**	0.227	0.196	0.089	0.200	0.058	0.439**	0.195	0.459**	0.437**	0.358**	0.339**	0.399**	0.389**
4-	Arm length					0.950**	0.949**	0.903**	0.817**	0.727**	0.821**	0.853**	0.749**	0.788**	0.783**	0.808**	0.813**	0.846**	0.824**
5-	upper arm length						0.828**	0.787**	0.719**	0.622**	0.751**	0.801**	0.661**	0.762**	0.756**	0.759**	0.761**	0.794**	0.771**
6-	Forearm length							0.833**	0.844**	0.772**	0.820**	0.819**	0.779**	0.792**	0.791**	0.811**	0.818**	0.851**	0.844**
7-	Palm length								0.733**	0.653**	0.727**	0.773**	0.661**	0.607**	0.598**	0.671**	0.677**	0.686**	0.661**
8-	Lower limp length									0.945**	0.927**	0.717**	0.695**	0.651**	0.651**	0.722**	0.733**	0.747**	0.744**
9-	Thigh length										0.765**	0.570**	0.623**	0.540**	0.546**	0.594**	0.615**	0.637**	0.645**
10-	Leg length											0.791**	0.713**	0.685**	0.679**	0.755**	0.758**	0.761**	0.745**
11-	Shoulder width												0.796**	0.783**	0.787**	0.813**	0.819**	0.840**	0.823**
12-	Chest width													0.696**	0.700**	0.679**	0.696**	0.715**	0.823**
13-	Upper arm circumference													0.983**	0.939**	0.929**	0.956**	0.954**	
14-	Forearm circumference														0.930**	0.910**	0.940**	0.949**	
15-	Chest circumference															0.988**	0.959**	0.958**	
16-	Abdomen circumference																0.956**	0.947**	
17-	Thigh circumference																	0.990**	
18-	Leg circumference																		
	Number of significant correlations on p=0.05	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Number of significant correlations on p=0.01	-	1	1	2	4	4	5	6	7	8	10	10	12	13	14	15	16	17

* R table value on p=0.05 = 0.250 ** R table value on p=0.01 = 0.325

Table 3: Factors matrix for anthropometric variables before perpendicular circulation

	Measurement	1st factor	2nd factor	Communions
1-	Weight	0.936	0.089	0.885
2-	Height	0.943	0.009	0.889
3-	upper limp length	0.331	0.831	0.800
4-	Arm length	0.941	0.107	0.896
5-	upper arm length	0.878	0.007	0.700
6-	Forearm length	0.934	0.147	0.894
7-	Palm length	0.810	0.205	0.698
8-	Lower limp length	0.855	0.475	0.957
9-	Thigh length	0.746	0.579	0.892
10-	Leg length	0.866	0.314	0.848
11-	Shoulder width	0.905	0.092	0.824
12-	Chest width	0.809	0.097	0.664
13-	Upper arm circumference	0.913	0.290	0.918
14-	Forearm circumference	0.910	0.276	0.904
15-	Chest circumference	0.933	0.178	0.903
16-	Abdomen circumference	0.935	0.149	0.896
17-	Thigh circumference	0.955	0.171	0.942
18-	Leg circumference	0.948	0.171	0.928
Latent root		13.789	1.724	15.51
Variance percentage		76.60%	9.57%	86.17%

Table 4: Factors matrix for anthropometric variables after perpendicular circulation

	Measurement	1st factor	2nd factor	Communions
1-	Weight	0.641	0.988	0.885
2-	Height	0.699	0.633	0.889
3-	upper limp length	0.304	0.841	0.800
4-	Arm length	0.775	0.544	0.896
5-	upper arm length	0.662	0.576	0.770
6-	Forearm length	0.796	0.510	0.894
7-	Palm length	0.742	0.384	0.698
8-	Lower limp length	0.955	0.212	0.957
9-	Thigh length	0.942	0.061	0.892
10-	Leg length	0.856	0.340	0.848
11-	Shoulder width	0.616	0.670	0.828
12-	Chest width	0.670	0.464	0.664
13-	Upper arm circumference	0.491	0.823	0.918
14-	Forearm circumference	0.497	0.810	0.904
15-	Chest circumference	0.581	0.752	0.903
16-	Abdomen circumference	0.601	0.732	0.896
17-	Thigh circumference	0.601	0.762	0.942
18-	Leg circumference	0.596	0.757	0.928
Latent root		8.47	7.03	15.50
Variance percentage		47.10%	39.07%	47.49%

(96.08%) and only 6 were not (3.92%). The percentage of statistically significant correlations was above 50% indicating the validity of performing factor analysis of the matrix.

To generate the simple factorial structure, the researcher used cluster analysis of the correlations. This led to two factors. Table 3 shows the factorial matrix of the anthropometric variables, the latent root and communions of these factors, along with variance percentage for each factor to total variance of the matrix before perpendicular circulation.

To reach the closest and most suitable solutions, axes were circulated perpendicularly using VARIMAX method. Table 4 shows Factors matrix for anthropometric variables after perpendicular circulation.

Table 5 shows saturations of anthropometric variables on factors after perpendicular circulation and omitting saturations less than 0.5. The researcher accepted 15 variables in the first factor (lower limp length factor) as it reached a saturation value of 0.955 and 13 variables in the second factor (upper limp length factor) as it reached a saturation value of 0.841.

Table 5: Final results of perpendicular circulation after omitting all saturations less than ±0.5

		Factors	
	Measurement	1st factor	2nd factor
1-	Weight	0.641	0.688
2-	Height	0.699	0.633
3-	upper limp length		0.841
4-	Arm length	0.775	0.544
5-	upper arm length	0.662	0.576
6-	Forearm length	0.796	0.510
7-	Palm length	0.742	
8-	Lower limp length	0.955	
9-	Thigh length	0.942	
10-	Leg length	0.856	
11-	Shoulder width	0.616	0.670
12-	Chest width	0.670	
13-	Upper arm circumference		0.823
14-	Forearm circumference		0.810
15-	Chest circumference	0.581	0.752
16-	Abdomen circumference	0.601	0.732
17-	Thigh circumference	0.601	0.762
18-	Leg circumference	0.596	0.757
Total		15	13

The researcher thinks that saturation of most measurements in the first factor was due to homogeneity of sample, homogeneity of anthropometric variables and application of measurements following the same protocols.

In the light of these results, the researcher concluded the following distinctive morphological variables that can be used as selection indicators for junior tennis players under 12 years: lower limp length - thigh length – leg length – palm length – total body height – chest width – upper arm length – body weight – shoulder width – abdomen circumference – thigh circumference – leg circumference – chest circumference – upper limp length – upper arm circumference – forearm circumference.

CONCLUSION

The Researcher Concludes the Following:

- The factorial structure suitable for the distinctive morphological (anthropometric) variables for tennis players under 12 years.
- Factors represented with morphological (anthropometric) variables suitable to be used as selection indicators for tennis players under 12 years.
- Factors concluded from the factor analysis are equal in importance as variance percentage interpreting each factor is very close. This means that each factor has its own importance, regardless its order on the matrix.
- Factor analysis indicated that the factors matrix, perpendicularly circulated, was successful in providing the researcher with a good database for choosing the best morphological (anthropometric) variables and each factor has its own importance.

CONCLUSION

The Researcher Recommends the Following:

- Anthropometric variables should be among the bases of selecting junior tennis players under 12 years, especially for the national team.
- Performing similar studies in other aspects (technical – physiological – psychological) related to selecting junior tennis players under 12 years.
- Performing similar studies using inclined circulation to validate these results.
- Regular follow-up for junior tennis players under 12 years and studying evolution rates of anthropometric variables concluded in this study.
- Designing anthropometric measurement forms for junior tennis players, considering any changes that may appear during the follow-up.
- Establishing standard levels for anthropometric variables concluded in the current study.
- Performing comparative studies for junior tennis players under 12 years in Egypt and other countries with higher levels in tennis using anthropometric variables.

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