MORPHOLOGICAL CHARACTERISTICS AND PHYSIOLOGICAL PROFILE OF THE CROATIAN MALE TENNIS PLAYERS

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Original scientific paper

Abstract

The sample of twenty adult (senior) male tennis players (ten ranked on the ATP ranking list and ten ranked among the first 25 players on Croatian national ranking list), where measured by 23 morphology anthropometric measures and 11 measures assessing work capacities (functional abilities) of the tennis players. The collected data were processed by the software package SPSS for Windows, ver 18.0. Body height of the subjects ranged between 173.60 and 199.50 cm with the average of 184.42±7.14 cm, whereas their body mass ranged between 64.90 and 89.00 kg, with the average of 77.60±7.26 kg. The percentage of fat tissue varied between 6.65 and 21.77 % with the average value of 9.20±3.91%. In comparison with results of top-level tennis players (top 100 ATP), who are tall on average 183.5 cm and heavy 80.5 kilograms on average, reveals that the current study subjects are, on average, somewhat taller, but also a little bit lighter than the top professional players. In the research observed tennis players had a somewhat lower values of aerobic capacity in comparison to the professional tennis players. For the desired transition into a higher rank of competition the better physical condition is recommended since it would enable a higher rate of more quality regeneration between points, matches and tournaments, resulting in higher performance consistency in professional tennis.

Key words: *morphology, physiology, tennis, profile*

Introduction

Attractiveness and popularity of tennis, as well as numerous changes in the rules of the game and the way in which the game is played have made the game interesting for sports science and cognate scientific disciplines. It can be said that tennis has been well supported by ever more quality and informative scientific research studies over the last decade. Advances in tennis equipment technology and in sports preparation technology of tennis players have caused certain changes in tennis techniques, strength, power and accuracy of shot performance. It further has caused better utilization of space-time component of the game. Numerous research studies (Morante, 2006; Kovacs, 2006; Fernandez, 2006; Weber, 2007) have well documented acceleration of tennis play (the higher force generation the higher speed of the tennis ball flight; the higher spin generation on the ball the quicker bounce off of the ball).

That play acceleration has caused changes over the years in physical demands of top-level tennis. For example, huge advances in tennis serve, in performance of which players generate nowadays considerably greater force than ever before. A more powerful, controlling start of a point relay (and a higher percentage of aces and winners) enables the server to enhance his/her space-time pressure upon his/her opponent and facilitates winning the point from the second or third shot. Further, a good start of a point relay can significantly facilitate winning the serve games. It also has a strong influence on self-assurance of the server in play.

Although the increased speed of the serve can be attributed to technology advances and to improvements in ever more detailed yet comprehensive sports preparation programming and implementation, a longitudinal research of Schönborn (2001) indicates there is another possible cause of speed enhancement: the constant trend of average body height increment in the top 100 players of the ATP ranking lists (Association of Tennis Professionals) – the association promotes men (senior, adult-age) professional tennis and organizes tennis tournaments for the profesional players at the world class level.). Therefore, it can be said that anthropometric dimensions of tennis players have also a kind of influence on the development and dynamics of the game.

Anthropological characteristics and physiological profile, that is, general physical condition should be monitored from the very beginning of engagement in sport because particular play styles of individual players are usually determined on the basis of their anthropometric, functional and psychological characteristics (Tiley, 2005; Filipčič, Filipčič & Leskošek, 2004; Schönborn, 2001). Constant monitoring of those parameters allows quality monitoring and prediction of physical and physiological development of a child, allowing further adequate training programming, directed to the desired style of play. In that way the development of play style can be developed in harmony with the anthropological and physiological capacities of the player in question.

Such an early specialization of players can contribute to higher play quality and to the acquisition of game-specific segments of play, due to which probabilities for successful performance at the high ranked tournaments become much higher. The aim of the paper was to determine morphological characteristics and work capacities (physiological profile) of the best Croatian male tennis players.

Methods

The sample of subjects included twenty adult (senior) male tennis players; ten ranked on the ATP ranking list and ten ranked among the first 25 players on the ranking list of the Croatian Tennis Association. The latter are active contestants in the Croatian Tennis First League, suggesting that they pertain to the similar quality level of tennis play. The number of domestic and international tennis tournaments played is the only crucial difference among them, which eventually determines their standings on the international ATP list, that is, on the ranking list of the Croatian Tennis Association. Chronological age and tennis playing experience of the subjects were determined first. The sample of variables consisted of 23 morphology anthropometric measures and 11 measures assessing work capacities (functional abilities) of the tennis players. Anthropometric variables were measured in line with the IBP (International Biological Program) procedures, and the variables assessing work capacities were obtained from the progressive load continuous all-out test on the treadmill with the constant inclination conducted in the Sports diagnostic Centre of the University of Zagreb, Faculty of Kinesiology, Croatia. The collected data were processed by the software package SPSS for Windows, ver 18.0. For each variable the central and dispersion parameters were computed: arithmetic mean (Mean), standard deviation (SD), minimum (Min) and maximum (Max) values.

Results

Table 1. Descriptive statistic parameters on age and playing experience of the tennis players

	Mean	SD	Min	Max
Age	21.45	3.45	18	30
Experience	13.85	4.14	8	24

Average age of the tennis players was 21.45±3.45 years and their average tennis playing experience was 13.85±4.14 years. It can be concluded that these players started their sports career early in their childhood. Body height of the subjects ranged between 173.60 and 199.50 cm with the average of 184.42±7.14 cm, whereas their body mass ranged between 64.90 and 89.00 kg, with the average of 77.60±7.26 kg. The percentage of fat tissue varied between 6.65 and 21.77 % with the average value of 9.20±3.91%. Forced vital capacity in the examined tennis players ranged from 4.88 to 7.13 L, with the average of 5.93±0.62 L.

By means of testing the dynamic forced expiration volume in the first second of expiration the Tiffennaou's index was computed (84.14±4.28%), which was satisfactory for all the subjects on average. The subjects achieved maximal speeds from 15 to 20 km/h in progressive test, with the average maximal speed of 17.7±1.19 km/h.

Table 2. Descriptive statistical parameters of morphological characteristics of the examined tennis players

	Mean	SD	Min	Max
Body height	184.42	7.15	173.60	199.50
Body mass	77.60	7.26	64.90	89.00
% fat	9.90	3.37	6.65	21.77
Elbow diameter L	7.07	0.48	6.00	8.00
Elbow diameter R	7.20	0.48	5.80	7.80
Knee diameter L	9.73	0.53	8.30	10.60
Knee diameter R	9.80	0.49	8.80	10.50
Upper arm circumference L	29.11	2.16	26.00	34.00
Upper arm circumference R	30.08	2.33	27.00	36.00
Flexed upper arm circ. L	31.40	2.40	28.00	36.30
Flexed upper arm circ. R	32.69	2.33	29.20	37.80
Forearm circumference L	26.56	1.15	25.20	29.00
Forearm circumference R	28.45	1.56	25.50	31.50
Thigh circumference L	57.75	2.70	52.70	62.00
Thigh circumference R	57.60	2.79	52.90	61.90
Calf circumference L	37.47	2.09	33.30	42.70
Calf circumference R	37.63	1.99	33.90	42.80
Triceps skinfold	9.68	3.09	5.10	17.80
Subscapular skinfold	9.77	3.18	7.50	22.60
Chest skinfold	7.39	3.31	4.60	18.00
Abdominal skinfold	12.27	5.76	7.40	30.40
Calf skinfold	7.40	2.85	3.70	14.60
Biceps skinfold	4.60	1.46	3.20	9.60

Table 3. Descriptive statistical parameters of working capacities of the investigated tennis players (arithmetic mean – Mean, standard deviation – SD, minimum and maximum values)

	Mean	SD	Min	Max
FVC (L)	5.93	0.62	4.88	7.13
TIFF (%)	84.14	4.28	74.50	93.30
V_MAX (km/h)	17.70	1.19	15	20
V_ANT (km/h)	13.20	1.13	10	15
VO_2max (l/min)	4.17	0.51	3.25	5.02
VO_2max rel (ml/kg/min)	53.66	5.74	40.20	63.80
relVO_2ANT (ml/kg/min)	46.55	4.85	35.15	54.21
HRmax (bpm)	192.95	7.30	180	208
HR_{ANT} (bpm)	173.85	9.21	151	189
%VO2max at ANT	86.87	4.34	79.74	97.19
%HRmax at ANT	90.09	3.21	83.42	96.41

VC – vital capacity; Tiff – Tiffeneaou's index; V_MAX – maximum speed of the tread mill; V_ANT – speed of the tread mill at the anaerobic threshold; VO_{2max} – maximum oxygen uptake; VO_{2max} rel – relative maximum oxygen uptake; relVO_2ANP – relative oxygen uptake at the anaerobic threshold; HRmax – maximum heart rate; HR_{ANT} – heart rate at the anaerobic threshold; %VO_{2max} at ANT – oxygen uptake at the anaerobic threshold expressed as the percentage of the maximum oxygen uptake; %HRmax at ANP – heart rate at the anaerobic threshold expressed as the percentage of the maximum heart rate.

Maximum oxygen uptake varied across the sample of subjects from 3.25 to 5.02 L/min, with the average of 4.17 L/min, whereas the obtained parameters for relative maximum oxygen uptake ranged between 40.20-63.80 ml/kg/min, with the average of 53.66±5.74 ml/kg/min. The subjects were crossing the anaerobic threshold within the range of 79.74 do 97.19 %, that is, on average at 86.87±4.34 % of the maximum oxygen uptake, which indicated the aerobic character of their physical fitness.

Discussion

The obtained parameters of morphological characteristics indicate certain specificities in the morphology status of the top Croatian male players. The average body height of the subjects was 184.42±7.14 cm, average body mass 77.60±7.26 kg, whereas the values of skin-folds were low as well as according to them assessed the average percentage of fat tissue (9.90±3.37%). When the results obtained in the current research are compared to the scores of the subjects from the non-selected adult male population, then the following becomes obvious: the tennis players are higher and heavier (Mišigoj-Duraković et al., 1995), whereas they have smaller amount of fatty tissue than the non-selected counterparts. Such a result was expected due to active involvement of the tennis players in regular strenuous physical activity, thus indicating that the greater body mass was related to the greater muscular mass. On the other hand, the comparison of the obtained results with the scores of the world top-level tennis players (top 100 ATP), who are tall on average 183.5 cm and heavy 80.5 kilograms on average (www.atptennis.com, October 22, 2007), reveals that the current study subjects are, on average, somewhat taller, but also a little bit lighter than the top professional players. Pronounced body height may be advantageous in tennis, therefore, it is considered as being one of the important morphological characteristics (Filipčič, Filipčič & Leskošek, 2004), especially when playing on fast-paced court surfaces. Previous studies indicated significant contribution of body height above 180 cm to powerful serves, faster than 200 km/h (Zmajić, 2003). The mentioned was also confirmed by the research by Schönborn (2001) where the author mentioned that one of the important factors of serve acceleration was a constant increment of average body height in the players ranked first 100 on the ATP list over the last decade. Pronounced longitudinal dimensionality of tennis players allows higher impact point (impact point between the racket and the ball) when serving, resulting in positive influence on not only speed of the ball served, but also on accuracy and more beneficial performance angle of the starting shot (Schönborn, 2001; Filipčič, Filipčič & Leskošek, 2004). It also facilitates performance of forehand, backhand, volley i smash shots at a higher impact point and provides a player with the better reach possibilities to catch remote balls (Filipčič, Filipčič & Leskošek, 2004), being especially beneficial when covering space during the on net play.

The mentioned contributes very often to the aggressive style of play accompanied usually with frequent approaches to the net. As opposed to the tall players, the players with the less pronounced body height move faster across the court, their agility is better (due to the lower centre of gravity), and because they approach the net less frequently then the tall players, they have a wider repertoire of the base line shots. Due to their style of play (either the offensive, defensive, or versatile style of play at the base line), they usually have better aerobic condition, their endurance is higher, and therefore, they do not get tired easily during longer point relays. The obtained elbow and knee diameter and circumference values of the tennis players are higher than the same average values in the non-selected population (Mišigoj-Duraković et al., 1995). If their lower percentage of fatty tissue is taken into account, then all indicates they have bigger muscular mass. Muscular mass in tennis players is highly developed. However, the obtained differences between the dominant and non-dominant body sides in elbow diameter values and in circumference values of the upper arm, both extended and flexed, and forearm circumference values indicate specific nature of lawn tennis in which the upper extremity of the dominant body side is more developed. The dominant arm in tennis players may have up to 20% bigger circumference values than the non-dominant arm (Kannus et al., 1994). The mentioned suggests that long-lasting tennis training stimuli have a considerable influence on the increments in circumference and diameter values of the dominant upper extremity (Köning et al., 2001), but it also accentuates importance of compensation exercises for body muscular balance attainment and maintenance. Namely, muscular balance is of outmost importance to injury prevention, but also to the continuity in competition appearances and to the prolongation of sports career (Lees, 2003). Tennis training and competition position players in specific space-time relations (conditions), determined by the rules of the game (for example: length, shape and weigth of the racket, court length, quality and size of the tennis ball, the game rules related to the court surface, etc.), which characterize the tennis game.

Tennis is usually regarded as an anaerobic sport, with the prevailing glycolytic or glycogenolytic metabolic processes providing energy during a point relay. Previous analyses of loadings during a tennis match agree that average work intensity ranges between 60 and 70% of the maximum oxygen uptake. If time parameters of play are observed, it becomes obvious that players do not have enough time to recover completely between points. This lack of recovery time is even more detrimental to physical condition of players on the wider scale of the annual compact competition calendar of singles' tournaments and matches. Therefore, although the bioenergetic basis of tennis play is anareobic, good aerobic capacity is also indispensable to provide tennis players with high cardio-respiratory endurance, thus contributing to their consistent perforamnce and sport success.

Most research papers indicate tennis players have well developed aerobic capacity, which in professional players can range from 55 to 65 ml/kg/min (Kovacs, 2006). The subjects in the current research had somewhat lower average values (the result range 40.2-63.8 ml/kg/min), probably due to the part of the sample not being on the ATP ranking list; that finding undoubtedly indicates their lower quality despite their high ranking on the national list of players. A quality indicator of cardio-respiratory endurance is also a level at which the anaerobic threshold occurrs. In the observed sample this level was on average at 86.87±4.34 % of the maximum oxygen uptake, indicating their still good physical condition. The finding is extremely important because it suggests their quality ability to resist fatigue and quite an acceptable rate of regeneration processes in their metabolisms, allowing the players for good performance in professional tennis.

Conclusion

The developmental level of particular morphological characteristics (body height, muscular mass of the upper extremity of the dominant body side and muscular mass of the lower extremities) can contribute to a more powerful shot performance in a game, to a fewer number of relays in a point and to its shorter duration. Although many authors (Filipčič, Filipčič & Leskošek, 2004; Schönborn, 2001; Zmajić, 2003, Tiley, 2005) have stated that body height and weight and other morphological characteristics (except fatty tissue, perhaps) do not limit performance, they still have influence on style of play, players' attitude towards sports training, tactics selection and strategy of individual play.

Based on the already mentioned, one can conclude that the observed subjects should pertain, according to their measured morphological characteristics, to the population of tennis players whose style of play is characterized by powerful serves and by the tendency to play more aggressively. In the research observed tennis players had a somewhat lower values of aerobic capacity in comparison to the professional tennis players.

In spite of that a bit poorer result, a still enough quality parameter of cardio-respiratory endurance of the measured players was obtained; it was the level of oxygen uptake at the anaerobic threshold. In the sample of the measured subjects the level was on average 86.87±4.34 % of the maximum oxygen uptake. Based on the obtained results it can be said that the physiological profiles (functional abilities) of the observed tennis players resemble physiological profiles obtained in previous research with tennis players of similar age, ranking and playing experience (Bergeron et al., 1991; Cristmass et al.,1993; Smekal et al., 2003; Reilly & Palmer, 1993; Girard & Millet, 2003; Kovacs, 2006; Fernandez, 2006; Weber, 2007). The already mentioned confirms adequate physical condition of the examined tennis players, that is, transformational effects induced by the perennial engagement in tennis training and competition. However, for the desired transition into a higher rank of competition the better physical condition is recommended since it would enable a higher rate of more quality regeneration between points, matches and tournaments, resulting in higher performance consistency in professional tennis.

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MORFOLOŠKE ZNAČAJKE I FIZIOLOŠKI PROFIL HRVATSKIH MUŠKIH TENISAČA

Sažetak

Uzorak ispitanika sastavljen od dvadeset tenisača seniorskog uzrasta (deset rangiranih na ATP ljestvici i deset rangiranih do 25 mjesta na listi Hrvatskog teniskog saveza), izmjeren je s 23 morfološke antropometrijske mjere te 11 varijabli za procjenu funkcionalnih sposobnosti. Obrada podataka je obavljena programskim paketom SPSS for Windows, ver 18,0. Rezultati prikazuju kako se tjelesna visina izmjerenih ispitanika kreće između 173,60 i 199,50 cm s prosjekom od 184,42± 7,14 cm, dok se tjelesna masa kretala između 64,90 i 89,00 kg, a prosječno iznosi 77,60± 7,26 kg. Postotak masnog tkiva varira između 6,65 i 21,77 % uz prosječnu vrijednost od 9,20± 3,91%. Usporede li se dobiveni rezultati s rezultatima vrhunskih svjetskih tenisača (top 100 ATP) koji su u prosjeku visoki 183,5 cm, te prosječne mase 80,5 kilograma, može se zamijetiti kako su ispitanici ove studije u prosjeku nešto viši te nešto manje tjelesne mase u odnosu na vrhunske tenisače. Istraživanjem je također utvrđeno kako naši tenisači bilježe nešto niže vrijednosti aerobnog kapaciteta u odnosu na profesionalne igrače. Za prijelazak u nešto bolji rang natjecanja, preporuča se svakako bolja funkcionalna spremnost tenisača, budući ista omogućava kvalitetniju mogućnost regeneracijskih procesa između poena, mečeva i turnira, što svakako može doprinijeti većoj konzistentnosti i uspjehu u profesionalnom tenisu.

Ključne riječi: *morfologija, fiziologija, tenis, profil*

Received: November 21, 2011
Accepted: December 15, 2011
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