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Correlation Between Physical Fitness and International Tennis Number (ITN) Levels Among Children Tennis Players

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ABSTRACT The purpose of the present research was to determine the anthropometric, body composition, physical fitness parameters and ITN scores and levels among children tennis players and to define the relationships between these anthropometric, body composition, physical fitness parameters and ITN scores and levels. 30 female children tennis players between eight to tenyears of age, who have the Turkish Tennis Federation club licence and individual licences were included in the study.The subjects were tested on four different performance variables, namely, the anthropometric, body composition, physical fitness and ITN levels profiles. For data analysis, the Pearson coefficient was calculated. According to the research findings, there are no significant relationships between ITN total scores and any of the anthropometric and body composition values. On the other hand, there are significant positive relationships between ITN total scores and ball throwing, vertical jumps, standing broad jumps, and reverse sit-ups. There is a negative significant relation between ITN total scores and auditory reactions. Similarly, there are no significant relationships between ITN values and any of the anthropometric and body composition values. There are negative significant relationships between ITN values and ball throwing, vertical jumps, standing broad jumps, and reverse sit-ups. There is a positive significant relation between ITN values and auditory reactions. In conclusion, this study indicated that ball throwing, vertical jumps, standing broad jumps and back extension variables were statistically linked to specific performance levels identified via the ITN levels.

INTRODUCTION

Tennis is a sport played by over 75 million participants worldwide. The health benefits of this activity are well recognized (Plum et al. 2007a; Barber-Westin et al. 2010). Recent research found strong evidence that tennis players have superior aerobic fitness, a decreased risk of cardiovascular disease, a lower body fat percentage, and improved bone health compared to controls (Marks et al. 2006; Plum et al. 2007; Groppet and DiNubile 2009; Sannicandro et al. 2014). Tennis has evolved from a sport in which skill was the primary prerequisite for successful performance, into a sport that also requires complex interaction of several physical components and metabolic pathways (Fernandez-Fernandez et al. 2009; Fernandez-Fernandez et al. 2014). A vital concern for tennis performance is the ability to repeat intermittently muscular forces at high speeds. Nevertheless, the ultimate functional performance of any complex chain of torque transfers depends on several factors including technique, flexibility, muscle strength, speed and power.In the long-term, athlete development structure, a basic precondition is the regular assessment of physical performance,which is also an integral part of sports science support for athletes (Fernandez-Fernandez et al. 2014).

Standardized testing is commonly used to provide a useful supplement to subjective coaching appraisals in an attempt to assess strengths and weaknesses of a given player. Therefore, research has been conducted with athletes of various backgrounds in order to identify the most influencing factors of significance in successful tournament play (Birrer et al. 1986; Roetert et al. 1992; Kraemer et al. 1995; Roetert et al. 1996; Girard and Millet 2009).

The ITN is an international tennis number that represents a player's general level of play. In time it is hoped that every tennis player worldwide will have an ITN. Under this system, players are rated from ITN 1 to ITN 10. ITN 1 represents a high level player (holding an ATP/WTA ranking or of an equivalent playing standard)

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and ITN 10 is a player that is only beginning to play competitively (can serve and return) on a full court using a normal ITF approved ball. To facilitate the rating of players, the ITF have developed a description of standards and an objective 'On Court Assessment' both of which can be used to rate players in the absence of competition results (The International Tennis Federation 2004).

The ITN On Court Assessment has been developed to assist National Associations to cater more fully to the recreational players that do not play competitively on a regular basis. Whilst the ITF recognizes some of the limitations of any non-competition based assessment in tennis (for example, the static feeding, only assessing strokes in a closed situation, only certain strokes being assessed) the researchers believe that the ITN On Court Assessment is a powerful tool that can be used in conjunction with the ITN rating system and to complement competitions, particularly for the recreational players. Not only can the assessment be used as an objective method of initially rating those players that have no history of competition results but it can also be used as a powerful promotional tool at events and as a means for players at different levels to measure their improvements in certain aspects related to tennis play.

The ITN test is often used to determine the levels of tennis players at sports clubs. However, ITN test is pretty complex, and requires a long time to conduct. Therefore, it is not preferred by many trainers to determine the talents and evaluate performances among children. Trainers working with children prefer anthropometric, physical, and physiological fitness tests and norms for talent selection, and performance evaluation. There haven't been much research on determining anthropometric, body composition, and physical fitness levels among children, and as far as it is know, no researchhas been conducted on the relationship between ITN test and anthropometric, physical and physiological fitness parameters (Girard et al. 2009; Berdejo-del-Fresno et al. 2010; Pion et al. 2014; Olcucu 2013; Olcucu 2015). Optimal training programs can be created, by determining physical fitness values for this age group. Additionally, by determining the possible relationships and their levels between ITN levels and aforementioned parameters, tennis skills among children can be predicted through more simple and easier to conduct tests.

For this reason, the purpose of the present research is, defining some anthropometric, body composition and physical fitness parameter values among 8 to 10 year old female tennis players, and testing the correlations between these parameter values, and ITN levels and ITN total scores.

MATERIAL AND METHODS

Subjects

30 female children tennis players aged between eight to ten years old who have the Turkish Tennis Federation club licence and individual licences were included in the study. Permission was sought form the tennis club and coaches. Permission forms containing detailed explanations concerning the study and the test procedures, were given out to the parents of the children wherein they agreed to contribute to the study voluntarily and only the children with these consent forms signed, were included into the study.

Data Collection and Measurements

All subjects were tested for four different performance variables, namely, the anthropometric, body composition, physical fitness and ITN levels profiles.

Anthropometric and Body Composition Data

Height was measured using a stadiometer (Seca Portable 217 Seca, UK) and recorded to the nearest 0.1 cm. Weight was measured with a digital electronic weighing scale (Seca 813, Seca, UK) and recorded to the nearest 0.1 kilogram. Body composition indices such as body mass index for age, waist circumference and waist height ratio were measured. BMI was calculated by using weight in kilograms divided by the square of height in meters. Waist and hip circumference was measured with a non-elastic measuring tape (Seca 201, Seca, UK) and recorded to the nearest millimetre. Skinfold thickness was measured in triplicate to the nearest 0.5 mm with the Harpenden calipers (HSK-BI, British Indicators, UK). The sum of four sites (triceps, biceps, subscapular and suprailiacal) was calculated (Lohman et al. 1988).

Physical Fitness Assessment

The physical fitness was determined using 13 physical fitness tests (Tennis Ball Throwing, 10 and 30 Meters Sprint, Standing Broad Jump, Vertical Jump, Static Balance Flamingo Balance Test, Flexibility, Curl-up, 90 Push-up, Agility, Auditory and Visual Reaction Test and ITN Mobility Tests). These were completed during the regularly scheduled tennis court (EUROFIT, 1988; Turci et al. 2013; ITF 2015) hours. At the beginning of each test, the examiner explained the testing procedures to the participants in detail.

International Tennis Number (ITN) Test

The ITN On Court Assessment is a tennis skill assessment method developed bythe International Tennis Federation.The ITN assessment is made up of the following tasks:

1. Groundstroke Depth Assessment - includes a power aspect (10 alternate forehand and backhand ground strokes)
2. Groundstroke Accuracy Assessment - includes a power aspect (6 alternate forehand and backhand down the line and 6 alternate forehand and backhand cross court)
3. Volley Depth Assessment - includes a power aspect (8 alternate forehand and backhand volleys)
4. Serve Assessment - includes a power aspect (12 serves in total, 3 serves in each target area)
5. Mobility Assessment - measures the time it takes a player to pick up five tennis balls and return them individually to a specified zone.

Scores are awarded for each shot based on where the ball lands within the singles court (ITF 2015).

Statistical Analysis

A statistical analysis was carried out using the SPSS version 18.0 (SPSS, Inc., Chicago, IL, USA). For correlation analysis, the Pearson coefficient was calculated. Statistical significance was accepted at the five percent level.

RESULTS

Thirty subjects volunteered for this study. Descriptive statistics are shown in Table 1. Subjects had a mean age of 8.87± 0.83 years.

Table 1: Descriptive statistics

	Mean±SD
Age (yr)	8.87± 0.83
Body weight(kg)	36± 4.92
Height (m)	1.39 ± 0.02
BMI (kg · m-2)	18.35 ± 2.20

The body composition values are shown in Table 2. Subjects had a mean waist circumference of 57.12±8.67 cm, hip circumference of 69.50±9.88 cm and the sum of the four thicknesses was 44.12±9.44 mm (Table 2).

Table 2: Mean and standard deviation of body composition values

	Mean±SD
Waist circumference (cm)	57.12±8.67
Hip circumference (cm)	69.50±9.88
Waist-Hip Ratio	0.81±0.05
Biceps thickness (mm)	7.12±1.45
Triceps thickness (mm)	13.87±2.90
Subscapula thickness (mm)	10.75±2.25
Subrailliac thickness (mm)	12.87±2.16
Sum of four thickness (mm)	44.12±9.44

Physical fitness values are shown in Table 3.Subjects had a mean flexibility of 17.12±5.96 cm, mean balance of 1.87±2.58, mean vertical jump of 23.12±4.25 cm, mean 30-meters sprint of 6.31±0.46 sec. and mean agility of 20.55±1.08 sec (Table 3).

Table 3: Mean and standard deviation of physical fitness values and ITN scores and levels

	Mean± SD
Auditory reaction (sec)	0.19±0.01
Visual reaction(sec)	0.24±0.05
Flexibility(Sit and Reach) (cm)	17.12±5.96
Flamingo Balance Test	1.87±2.58
Tennis Ball Throwing (meters)	15.66±4.94
Vertical jump(cm)	23.12±4.25
Standing broad jump (cm)	133.87±16.77
ITN Mobility Tests (sec)	22.97±1.32
Curl-up(n/30sec)	18.62±3.54
30-meters sprint(sec)	6.31±0.46
10-meters sprint(sec)	2.22±0.12
Back extension	24.25±6.79
Agility(Ýllinois) (sec)	20.55±1.08
Sum of ITN scores	82.00±24.93
ITN level	9.75±0.70

There are no significant differences ($p>0.05$) between ITN total scores and any of the anthropometric and body composition values. Similarly, there are no significant relationships ($p>0.05$)

between ITN values and any of the anthropometric and body composition values (Table 4).

Table 4: Pearson correlation test results between sum of ITN scores, ITN level and anthropometric and body composition values

	Sum of ITN score		*ITN level*	
	r	*p*	*r*	*p*
Age (yr)	0.58	0.12	-0.54	0.16
Height (m)	0.10	0.81	-0.01	0.96
Body weight (kg)	-0.13	0.75	0.00	1.00
Waist circumference (cm)	-0.41	0.30	0.42	0.24
Hip circumference (cm)	-0.46	0.24	0.55	0.15
Waist-Hip Ratio	0.04	0.92	-0.23	0.58
BMI (kg · m-2)	-0.17	0.68	-0.001	0.99
Biceps thickness (mm)	-.0.02	0.94	0.03	0.93
Triceps thickness (mm)	-0.41	0.31	0.40	0.32
Subscapula thickness (mm)	-0.30	0.46	0.31	0.44
Subrailliac thickness (mm)	-0.17	0.68	0.16	0.66
Sum of four thickness (mm)	-0.22	0.58	0.21	0.60

On the other hand, there are significant positive relationships ($p<0.05$) between ITN total scores and ball throwing, vertical jump, standing broad jump, and reverse sit-up. There is a negative significant relation ($p<0.05$) between ITN total scores and auditory reaction.There are negative significant relationships ($p<0.05$) between ITN values and ball throwing, vertical jump, standing broad jump, and reverse sit-up. There is a positive significant relation ($p<0.05$) between ITN values and auditory reaction (Table 5).

Table 5: Pearson correlation test results between sum of ITN scores, ITN level and physical fitness values

	Sum of ITN score		*ITN level*	
	r	*p*	*r*	*p*
Auditory reaction(sec)	-0.90*	0.00	0.83*	0.01
Visual reaction(sec)	-0.04	0.92	-0.27	0.50
Flexibility (Sit and Reach) (cm)	-0.55	0.15	0.68	0.6
Flamingo Balance Test	0.55	0.15	-0.48	0.22
Tennis Ball Throwing (meters)	0.81*	0.01	-0.70*	-0.05
Vertical jump(cm)	0.76*	0.02	-0.65	0.07
Standing broad jump(cm)	0.79*	0.01	-0.75*	0.03
ITN Mobility Tests (sec)	-0.33	0.41	0.23	0.57
Curl-up (n/30sec)	0.48	0.22	-0.27	0.51
30-meters sprint(sec)	0.23	0.58	-0.16	0.70
10-meters sprint(sec)	0.40	0.31	-0.52	-0.17
Back extension	0.89*	0.00	-0.81*	0.01
Agility (Ýllinois) (sec)	-0.47	0.23	0.31	0.44

*$p<0.05$

DISCUSSION

The purpose of the present research was to determine the anthropometric, body composition, physical fitness parameters and ITN scores and levels profiles among 8 to 10 year old children tennis players and to define the relationships between anthropometric, body composition, physical fitness parameters and ITN scores and levels.To date, there have been no findings about the relationships between anthropometric, body composition, physical fitness parameters and ITN scores and levels.

According to research findings, there are no significant relationships between ITN total scores and any of the anthropometric and body composition values. On the other hand, there are significant positive relationships between ITN total scores and ball throwing, vertical jump, standing broad jump, and back extension. There is a negative significant relation between ITN total scores and auditory reaction. Similarly, there are no significant relationships between ITN values and any of the anthropometric and body composition values, there are negative significant relationships between ITN values and ball throwing, vertical jump, standing broad jump, and back extension, and there is a positive significant relation between ITN values and auditory reaction.

Worldwide and in all sports, talent identification (TI) and talent development (TD) of young athletes has become important for every federation, tennis included, that has a programme for elite athletes wherein their resources (time, money, energy) are spent on those athletes who have the most chance of achieving success at the international level. The process involves increasingly younger children, some as young as 6, 7 or 8-year-olds, who are a part of the Tennis10's programmes.Unlike many other sports, which may require high levels of physical fitness in a few components, tennis players require high performances in most components (speed, mobility, strength, power, aerobic and anaerobic endurance, flexibility, balance) (Kovacs 2007). There are studies conducted with elite senior tennis players. They have analyzed the skeletal muscle-bone structure and function, (Gallotta et al. 2014; Lädermann et al. 2014; Bodor and Jarosz 2015) cardiac structure and function (Baiget et al. 2014), injury (Maquirriain and Baglione 2015; Dines et al. 2015), aerobic fitness and physiolog-

ical response to competition (Murphy et al. 2014; Gallo-Salazar et al. 2014; Brink-Elfegoun et al. 2014; Fernandez-Fernandez et al. 2015). However, when focussing on children tennis players, relatively few studies have investigated the antropometric, body composition and physical fitness levels (Girard et al. 2009; Berdejo-del-Fresno et al. 2010; Pion et al. 2014; Olcucu 2013; Olcucu 2015).

With the results obtained from the testing protocols and the normative values, coaches and physical trainers can develop individual profiles of the players, based on age and sex group percentiles, with their respective strengths and weaknesses. This would lead to a more efficient design of physical training programmes, saving time for tennis-specific training (Ulbricht et al. 2013).

The researchers found that as vertical jump values increased, ITN total scores increased as well. The vertical jump is a common action in most sports and is biomechanically similar to various acceleration and game-related dynamic movements. It would, therefore, appear valid to include some form of vertical-jump assessment to evaluate explosive power in tennis. The strong correlations observed between sprint times and vertical jumps in previous researchunderline the importance of muscle strength and power in the lower extremities to produce explosive actions in tennis players (Kraemer et al. 2003; Girard et al. 2005; Reid et al. 2008; Fernandez-Fernandez et al. 2013).

No significant correlations were found between ITN total scores, ITN levels, and flexibility, balance, mobility, curl-up, velocity and agility in the present research. The possible reason for this finding may be that the ITN total scores of the children in the study group are at very young ages. Further research on higher-level tournament players can provide more accurate information on the possible relationships between these parameters.

CONCLUSION

This study indicate that ball throwing, vertical jump, standing broad jump and back extension variables were statistically linked to specific performance levels identified via the ITN levels. In attempting to shed light on the contribution of physical attributes used to predict specific performance level in tennis players, the possibility of testing the relationships between these measures and performance during on court movements and strokes production may warrant further investigation. Determining regular fitness tests, and their relationships with specific performance levels such as ITN, determining databases specifically for younger players, and developing more effective physical fitness training programs are very important for determining performances of tennis players.

RECOMMENDATIONS

Tennis is one of the most popular sports worldwide. However, relatively few studies have investigated the physical fitness demands during play. A better understanding of the anthropometric, body composition, physical fitness demands profile of tennis is important, to develop optimal practice drills and to give sound training recommendations. Further research is required to determine the anthropometric, body composition, physical fitness demands profile of tennis in different player groups. Further research on higher-level tournament players can provide more accurate information on the possible relationship between these parameters and ITN levels.

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