FACTA UNIVERSITATIS
Series: **Physical Education and Sport** Vol. 10, N° 2, 2012, pp. 99 - 106

Original empirical article

IS THERE ANY SCIENTIFIC BASIS FOR THE TENNIS CATEGORY 12 AND 14 YEARS OF AGE?

UDC 796.342.1

Dario Novak[1], Goran Sporiš[1], Zoran Milanović[2]

[1]University of Zagreb, Faculty of Kinesiology, Zagreb, Croatia
[2*]University of Niš, Faculty of Sport and Physical Education, Niš, Serbia

Abstract. *The purpose of this study was to identify the differences in the sexual maturity level among tennis players on a sample of 95 players (53 boys and 42 girls) in the category between the ages of 12 and 14, in order to indicate the inadequacy of these competition categories. For the purpose of a self-evaluation of the sexual maturity level, a questionnaire was used, and basic morphological parameters were measured (height, weight, fat, BMI). A significant correlation between biological development and age (r=0.47-0,69), height (r=0.45-0.67), and weight (r=0.43-0.68), was determined. The variance analysis shows that the older group is at a higher level of biological development (p<0.05). The male subjects statistically differ in a significant way in terms of their biological development level (T1, p=0.00, T2, p=0.00) and the trend is followed by height (p=0.00) and weight (p=0.02). The female subjects statistically differ in a significant way in terms of their biological development level (T1, p=0.00, T2, p=0.01) as well as in all of the morphological parameters (height, p=0.00, weight, p=0.00, %FAT, p=0.01, BMI, p=0.04). Our findings indicate that it is necessary to change the official propositions of the competitions in this category because it could be expected that due to the reduced span of chronological age, fewer varieties are possible in the biological age of tennis players.*

Key words: *biological age, child, exercise, motor activity, physical fitness, sport.*

Received October 09, 2011 / Accepted June 10, 2012
Corresponding author: Zoran Milanović, PhD student
Faculty of Sport and Physical Education, University of Niš, Čarnojevica 10A, 18000 Niš, Serbia
Tel: + 381 18 510900 • Fax: + 381 18 242 482 • E-mail: zoooro_85@yahoo.com
* PhD student
Acknowledgements. The authors would like to thank the following people for their assistance with this study: Dr Goran Mijalica, University of Split, School of Medicine, Professor Lana Ruzic, Faculty of Kinesiology, University of Zagreb, Marc Kovacs, PhD, Manager of Sport Science USTA Player Development Staff, Mr Ivan Radman and the children and parents who participated in the study. No financial assistance was received to complete this project.

INTRODUCTION

As children progress through puberty, the achieved stage of sexual maturity has a profound effect on their physiological function and behavior (Hindmarsh, Di Silvio, Pringle, Kurtz, and Brook, 1988; Benson and Torpy, 1995). Normal pubertal development takes place across a range of ages and at different rates, so longitudinal studies across childhood or cross–sectional studies in adolescence need to document pubertal development (Tanner, 1962). It is known from experience that some individuals born at the same time, i.e. have the same calendar age, are not always in the same stage of development. Very often we can witness, for example, a 12-year-old being at a higher development stage than a 14-year-old. In the same way, among individuals who are chronologically at the same age there are individuals who develop below the average level, as well as those who are above average (Malina, Bouchard, and Bar-Or, 2004). The physiological development of an individual depends on many different factors: endogenous ones which include genetic factors such as race, gender, endocrine glands or exogenous ones which include the climate, season, nutrition, illnesses, physical activity, psychological factors and socio-economic circumstances (Bridges, Matthews, Hindnarsh, and Brook, 1994; Boyar et al., 1972; Wu, Butler, Kelnar, and Sellar, 1990). The data regarding the level of biological development, which show the real status of an individual, are very important for young athletes who compete in different sports (Rowlands, 2009). For instance, the competition categories in tennis are arranged in two-year spans (12-14, 14-16, 16-18), which are exceptionally sensitive periods of intense growth and the development of children. These competition systems allow individuals with a higher level of development a certain advantage in relation to the ones that are behind in development. The level of sexual maturity is commonly determined by Tanner's classification, which is based on the scale of secondary sexual characteristics (Carskadon and Acebo, 1993; Duke, Litt, and Gross, 1980; Morris and Udry, 1980; Petersen, Crockett, Richards and Boxer, 1988). The purpose of this study was to identify the differences in the sexual maturity level in the 12 to 14 category, indicating the inadequacy of these categories of competition.

THE METHOD

The estimate for biological age was determined by a validated questionnaire developed by authors from the United Kingdom (Taylor et al., 2001). Gender-specific, pubertal development self-assessment questionnaires were used using simple line drawings taken from photographs of the Tanner standard. A small amount of simple text derived from Tanner's description was added to some illustrations [e.g. 'The breasts are flat', to the drawing of Tanner stage (breasts) 1; 'The hair has spread over the things' to the drawing of Tanner stage (pubic hair) 5]. The questionnaire asked the children to place a tick in the box (containing the illustration) 'that looks most like you now'. In order to distinguish between the stage of the genital and pubic hair development in the boys, the illustrations for genital development were shown without pubic hair, and the boys were asked to 'please look at the penis and scrotum only in these pictures'. To reflect diversity, circumcised and uncircumcised penises were also shown. Previous papers suggested that these questionnaires were acceptable and comprehensible to children in their early teens and to parents and teachers (Brooks-Gunn, Warren, Rosso, and Garqiul, 1987; Frankowski, Duke-Duncan, Guillot, McDougal, and Wasserman, 1987). The study was conducted in a

pediatric clinic where a physical examination used to determine the level of sexual maturity is routinely performed. A clinic doctor, highly experienced in the standardized assessment of pubertal status using Tanner scores, participated in the study. Ethical approval was obtained by the Ethics Committee of the Croatian Tennis Association, and written consent from both the parents and children was sought. Our aim was to recruit all children who participated in the Croatian National Championship in Tennis (boys and girls under the age 14), which was held in Split from May, 9-14, 2009. Children who agreed to join the study were given a gender–specific questionnaire and asked to complete it alone and in private. All of them (95 – 53 boys and 42 girls) agreed to participate. The children were asked not to examine themselves but to 'fill in the questionnaire from memory'. Parents were asked not to assist their children. Completed questionnaires were posted in sealed boxes. For all the participants, morphological characteristics (height, weight, body fat, BMI) were determined by means of an anthropometer and an Omron BF500 digital scale. The data were analyzed using Statistica for Windows, (version 8.0., StatSoft, Inc., 2008). Descriptive statistics were used to present means and standard deviations for each variable. Pearson correlations were calculated for all of the measured variables. To explore the differences between each category (the participants were divided into two groups – entry and exit ages based on the date of birth (12 to 13 years, and 13 to 14 years), a one–way analysis of variance (ANOVA) was used. Statistical significance was set at $p<0.05$.

RESULTS

Table 1. Descriptive statistical parameters of the morphological characteristics.

VAR	Boys Total	Girls Total	Boys Entry group	Boys Exit group	Girls Entry group	Girls Exit group
	N=53	N=42	N=22	N=31	N=17	N=25
	mean±sd	mean ±sd	mean ±sd	mean ±sd	mean ±sd	mean ±sd
AGE	13.14± 0.62	13.25±0.86	12.53±0.32	13.57±0.38	12.40±0.61	13.82±0.41
WEIGHT	51.83±10.19	53.44±7.60	48.02±6.81	54.54±11.38	48.91±6.70	56.52±6.65
HEIGHT	163.12±10.14	164.37±5.74	157.86±7.31	166.85±10.31	160.95±5.78	166.70±4.48
%FAT	10.76± 4.00	21.31±5.71	10.73±3.79	10.82± 4.21	18.91±5.35	22.85±5.49
BMI	20.25± 1.75	19.85±2.18	19.93±1.53	20.43± 1.88	18.75±2.15	20.56±1.92

N - number of participants, mean - arithmetic means, sd - standard deviation, AGE -chronological age, WEIGHT - body weight, HEIGHT - body height, %FAT - rate of body fat, BMI - body mass index

In the first 2 columns the results related to the entire sample of boys, and girls, are presented. In the other columns the participants are grouped according to age. In the so-called entry groups, the participants younger than 13 can be found, and in exit groups participants older than 13 years. It is evident that with both sexes, chronologically older subjects are taller, heavier, have a higher rate of body fat as well as a greater body mass index. The significant positive connection is evident, in the case of male and female subjects, in terms of biological maturity, age, height and weight (Table 2).

Table 2. The correlation coefficient (R) between biological age stages (T1, T2) and morphological variables.

VAR	Boys Total		Girls Total		Boys Entry group		Boys Exit group		Girls Entry group		Girls Exit group	
Bio	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
AGE	0.53	0.69	0.47	0.44	0.40	0.26	0.52	0.62	0.32	0.25	0.28	0.31
WEIGHT	0.54	0.63	0.54	0.56	0.67	0.02	0.45	0.66	0.32	0.54	0.51	0.46
HEIGHT	0.56	0.68	0.49	0.44	0.54	0.22	0.45	0.58	0.35	0.37	0.43	0.33
%FAT	0.09	-0.03	0.23	0.12	0.03	-0.30	0.06	0.04	0.13	0.23	0.39	0.03
BMI	0.26	0.10	0.11	0.08	0.42	-0.16	0.26	0.23	0.15	0.41	0.14	-0.05

T1 - genitalia development stage (breast development stage), T2 - hair stage.
Bio - Biological development, AGE - chronological age, WEIGHT - body weight, HEIGHT - body height, %FAT - body fat rate, BMI - body mass index

It could be concluded that the participants (female and male) who were older, higher and heavier were also biologically more mature. Observing the groups in terms of gender, we could note that with the entry groups, only a positive correlation can be found between weight and genitalia development (the male participants) as well as hair development (the female participants). The boys of an exit age show the same trend in the entire sample, while in the case of the girls there is a positive connection between maturity and weight, as well as breast development and height. With the participants it is evident that the older group is at a higher level of biological development and the trend is followed by height and weight (Table 3).

Table 3. Differences in the test results (ANOVA) between groups of an entry and exit age in the biological age stage.

Variables	Boys		Girls	
	F	p	F	p
T1	7.197	0.009	7.666	0.008
T2	10.524	0.002	6.211	0.016
WEIGHT	5.732	0.020	13.157	0.000
HEIGHT	12.29	0.000	13.15	0.000
%FAT	0.003	0.955	6.313	0.016
BMI	0.612	0.439	4.159	0.048

T1 - genitalia development stage (breast development stage), T2 - hair stage, WEIGHT - body weight, HEIGHT - body height, %FAT - body fat rate, BMI - body mass index

There is no significant difference between the variables %FAT and BMI. The female participants differ statistically in a significant way in the biological development level as well as in all morphological parameters.

DISCUSSION

Even though the changes in puberty occur continuously, they are for clinical purposes divided into stages, based on the level of secondary sexual characteristics development (Whincup, Cook, Papacosta, and Walker, 1992). The level of sexual maturity, known as

the Tanner classification, is based on the scale of secondary sexual characteristics, which allows scientists to determine the level of pubertal development in which the adolescent is at the moment, independent of his/her chronological age.

The first stage includes prepubertal growth and development. Although it is often considered that in prepubertal children are a homogeneous group that does not show signs of differences in terms of maturity, we should note that children in prepuberty differ at the level of bone maturity. Stages 2 to 5 indicate the pubertal stage. Stage 2 indicates the initial appearance and the beginning of the development of secondary sexual characteristics– in the case of boys it means the initial growth of genitalia with the appearance of pubic hair, and in the case of girls the stage begins with the appearance of rare, weakly pigmented, fluffy hair along the labia (Tanner, 1962). This stage is also called the stage of early puberty. The female participants were mostly in this stage of biological development (33 to 42), while the male participants were in the third stage of their biological development (35 to 53). It is important to mention that the results obtained from the male participants should be taken with a certain reservation, as male participants are prone to exaggerating (Steinberg, 1999). Stages 3 and 4 indicate the continuation of maturity and are more difficult to determine. They are so-called stages of medium puberty where adolescents develop further regarding their secondary sexual characteristics. Sexual maturity is completed up to stage 5 and this is the stage that indicates the level of sexual maturity of an adult (Tanner, 1962). It is significant that in the case of both samples in the research, the smallest number of participants belong to this category. The average adolescent passes through stages 2 to 5 in a period of 4 years; however, significant discrepancies are possible, and Lowrey (1986) states that the span of pubertal stages could last up to 18 months and even 8 years, and the same author expresses his opinion that only 60% of adolescents follow the development described by Tanner. The beginning of puberty and pubertal changes in the case of boys can vary significantly. Thus, the growth of testicles and changes in the color of the scrotum, which are the first signs of puberty in boys, and the lifting of breasts and nipples in the form of a small bud, with an increase in the diameter of the areola with the girls, can appear between 10.5 and 14.5 years of age (the average is 11.6). It happens in stage 2, and the development of pubic hair also starts in this stage, where the majority of the participants involved in the study were at the time, especially the girls. The varieties of physiological changes can be expressed during the beginning, duration and completion of the changes, both on an individual and group level. With children and young athletes in the current sport system, chronological age is the criterion that dominates over the criterion of biological age, whether in terms of planning and programming training or placing young athletes into the age-defined categories in order for them to participate in competitions. The life span of a young athlete in which the conflict between chronological and biological age is highly emphasized is the period of chronological age between the ages of 10 and 16 (Lowrey, 1986). In accordance with the aforementioned, an identical problem occurs in the case of young tennis players (category 12 – 14 years), as well. Following the division of the research sample into biologically younger and biologically older participants, the results show the presence of statistically significant differences between the two studied groups of tennis players. The differences were justifiably determined for the reason that both groups of participants belong to the same category defined by chronological age. Biologically older tennis players are significantly taller and heavier than their biologically younger peers, and they dominate in all other observed morphological variables. All of the aforementioned differences are significant and quantifiably great. Moreover, in additional analyses (which due

to insufficient space are not mentioned in the paper) a statistically significant difference was determined when within the exit category of boys a division was made into those born within the first six months of the same year and those born in the second half of the year (p=0.00) in terms of height (p=0.00), weight (p=0.00) and the body mass index (p=0.00). In the case of the girls of the exit age a difference was determined in height (p=0.01). It is conclusive that such differences give an advantage to biologically older tennis players in the sense of morphological requirements for tennis competitions. Through their sport activities, children achieve better and better results; however, a question arises, which is not easy to answer, as to which extent the improvements are the result of the training process, and to which extent these are the consequence of natural growth and development. The research results show that in planning and programming the training of young athletes, primarily in an individual approach to every athlete, it is necessary to know the stage of biological age the athlete is in . In the same way it is important to recognize athletes – tennis players who are behind in terms of biological development (Nolte, 2005). They should not be described as players with no talent; on the contrary, with patient work we should wait for the time when in their biological development they achieve physical equality with their peers who have matured earlier.

The greatest contribution of this research is the contribution in respecting biological age when categorizing tennis players into single categories to participate in official competitions. At the moment, the existing categorization of young tennis players places the ones who are behind in their biological development in a subordinate position. Finally, the research was initiated because it has been noticed that in the category of tennis players between the ages of 12 and 14 there were significant morphological differences among individuals.

The authors are of the opinion that it is not appropriate for children (adolescents) of such a different biological age, and therefore of different morphological, motor and functional characteristics to be under the same pressure. From all of the above it is evident that in tennis, in the aforementioned age category it is necessary to make changes in the official competition propositions. As the determination of biological age requires observation by a professional (a specialist pediatrician) and also presents a violation of the privacy of the participants, it could be proposed that, on the national and international level, the studied category be divided into two, i.e. that each age represents a separate category. It is to be expected that by the reduction of the chronological age span smaller variations in the biological age of young athletes would be achieved. Even though it would not represent an ideal solution, the differences would be reduced, and with that a more equal and fair competition would be achieved at competitions. In the same way, inappropriate training pressure and an inadequate competition system would be avoided, both of which could lead to the loss of an individual's motivation as well as endangering his/her health, and the dispersion of talents whose biological development curve of growth and development is more or less set towards a higher chronological age. In the concluding part of the paper it is necessary to list some methodological-research advantages and disadvantages. The method used to determine biological maturity is rather non-invasive and does not violate the intimacy of the participants in their sensitive stage of growth and development, allowing for a wider and more frequent application of the method. The disadvantage is the possible non-objectivity of the subjects which could happen if they are not motivated or the approach to the research is superficial and frivolous. Within the scope of this research only the differences between the competition categories were determined; however, the wider influence of biological maturity on anthropological status has not been studied. Some researchers reported on the positive influence on motor and func-

tional abilities and the acquisition of motor knowledge. The influence of biological maturity on competitive success in tennis leaves room for further research in this field.

CONCLUSION

The findings from this study highlight the importance for changing the official propositions for the category of players between the ages of 12 and 14, due to the biological differences between entry and exit groups. It could be expected that due to the reduced span of chronological age fewer varieties are possible in the biological age of tennis players. Therefore, we propose the introduction of separate competition categories of 12-13 and 13-14 years of age.

Practical Implications:

- From the results it arises that in this category it is necessary to change the official propositions of the competitions.
- Morphological variables may partly explain the sexual maturity level of tennis players between the ages of 12 and 14.
- The used questionnaire may be reliably used to estimate the biological age of young tennis players.

REFERENCES

Benson, M.D., and Torpy, E.J. (1995). Sexual behavior in junior high school students. *Obstetrical and Gynecological Survey*, 85 (2), 279-284.

Boyar, R.J., Finkelstein, H., Roffwarg, S., Kapen, S., Weitzman, E., and Hellman, L. (1972). Synchronization of augmented luteinizing hormone secretion with sleep during puberty. The *New England Journal of Medicine*, 287 (6), 582-586.

Bridges, N.A., Matthews, D.R., Hindnarsh, P.C., and Brook, C.G. (1994). Changes in gonadotropin secretion during childhood and puberty. *Journal of Endocrinological Investigation*, 141 (1), 169-176.

Brooks-Gunn, J., Warren, M.P., Rosso, J., and Garqiulo, J. (1987). Validity of self-report measures of girls' pubertal status. *Child Development*, 58 (3), 829-841.

Carskadon, M.A., and Acebo, C.A. (1993). Self-administered rating scale for pubertal development. *Journal of Adolescent Health*, 14 (3), 190-195.

Duke, P.M., Litt, I.F., and Gross, R.T. (1980). Adolescents' self-assessment of sexual maturation. *Pediatrics*, 66 (6), 918-920.

Frankowski, B., Duke-Duncan, P., Guillot, A., McDougal, D., and Wasserman, R. (1987). Young adolescents' self-assessment of sexual maturation. *American Journal of Diseases of Children*, 141 (2), 385-386.

Hindmarsh, P., Di Silvio, L., Pringle, P.J., Kurtz, A.B., and Brook, C.G. (1988). Changes in serum insulin concentration during puberty and their relationship to growth hormone. *Clinical Endocrinology*, 28 (4), 381-388.

Lowrey, G.H. (1986). *Growth and development of children*. Chicago: Year Book Medical.

Malina, R.M., Bouchard, C., and Bar-Or, O. (2004). *Growth, maturation and physical activity*. Champaign, IL: Human Kinetics.

Morris, N.M., and Udry, J.R. (1980). Validation of a self-administered instrument to assess stage of adolescent development. *Journal of Youth Adolescence*, 9 (1), 271-280.

Nolte, V. (2005). Long *term athlete development*. Istanbul: Rowing Press.

Petersen, A.C., Crockett, L., Richards, M., and Boxer, A. (1988). A self-report measure of pubertal status: reliability, validity and initial norms. *Journal of Youth and Adolescence*, 17 (6), 117-133.

Rowlands, A.V. (2009). Methodological Approaches for Investigating the Biological Basis for Physical Activity in Children. *Pediatric Exercise Science*, 21 (3), 273–278.

Steinberg L. (1999). *Adolescence*. Boston: McGraw-Hill.

Tanner, J.M. (1962). *Growth at Adolescence*. Oxford: Blackwell Scientific Publications.

Taylor, S.J.C., Whincup, P.H., Hindmarsh, P.C., Lampe, F., Odoki, K., and Cook, D.G. (2001). Performance of a new pubertal self-assessment questionnaire: a preliminary study. *Paediatric and Perinatal Epidemiology*, 15 (1), 88-94.

Whincup, P.H., Cook, D.G., Papacosta, O., and Walker, M. (1992). Childhood blood pressure, body built and birth weight: geographical associations with cardiovascular mortality. *The Journal of Epidemiology and Community Health*, 46 (4), 396-402.

Wu, F.C.W., Butler, G.E,, Kelnar, C.J.H., and Sellar, R.E. (1990). Patterns of pulsatile leuteinizing hormone secretion before and during the onset of puberty in boys: a study using an immunoradiometric assay. The *Journal of Clinical Endocrinology and Metabolism*, 70 (3), 629-637.

DA LI POSTOJANJE KATEGORIJE TENISERA STAROSTI IZMEDJU 12 I 14 GODINA IMA NAUČNU OSNOVU?

Dario Novak, Goran Sporiš, Zoran Milanović

Cilj ove studije bio je da odredi polne razlike u stepenu biloške zrelosti kod mladih tenisera izmedju 12 i 14 godina starosti i da se ukaže na neadekvatnost ovih kategorija prilikom takmičenja. Devedeset i pet igrača (53 dečaka i 42 devojčice) starosne dobi od 12-14 godina učestvovali su u istraživanju. Za samoprocenu nivoa zrelosti koričćen je upitnik a za odredjivanje morfoloskog statusa izmereni su sledeći parametri: visina tela, težina tela, procenat masti i BMI. Utvrdjena je statistički značajna korelacija izmedju biološke zrelosti i godina starosti (r=0.47-0,69), visine (r=0.45-0.67) i težine tela (r=0.43-0.68). Analiza varijanse je pokazala da je starija grupa na višem stupnju biološke zrelosti (p<0.05). Dečaci se statistički značajno razlikuju u nivou biološke zrelosti (T1, p=0.00, T2, p=0.00) trend razvoja je praćen visinom (p=0.00) i težinom tela (p=0.02) dok kod devojčica ovaj trend prate i sve morfološke dimenzionalnosti tela (visina, p=0.00, težina, p=0.00, %FAT, p=0.01, BMI, p=0.04). Naše istraživanje pokazuje da je u ovoj kategoriji potrebno izmeniti oficijalne propozicije takmičenja jer hronološka starost samih takmičara se dosta ralikuje od njihove biološke starosti bez obzira na pol.

Ključne reči: *biološka starost, deca, vežbanje, motorna aktivnost, fizički fitnes.*