SPORT TK-EuroAmerican Journal of Sport Sciences

https://revistas.um.es/sportk Online ISSN: 2340-8812

Received: **18/01/2022.** Accepted: **23/07/2022.** Published: **31/05/2023**

Talent identification among elite Czech male junior tennis players (U12) according to their future tennis performance and birthdate

Detección de talentos entre los tenistas de élite checos sub-12 en función de su futuro rendimiento tenístico y de su fecha de nacimiento

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ABSTRACT

Talent identification (TI) in sport, which is the selection of individuals disposed to achieve elite performance in adulthood, is often based on physical fitness testing. TI is linked to the phenomenon called the Relative Age Effect (RAE), referring to the influence of birthdate on sports performance. This retrospective study is based on the assumption that elite adult athletes possessed indicators predictive of a successful career already at a young age. The study aimed to assess the differences among Czech male tennis players according to 1) their tennis performance in adulthood, 2) their birthdate in each semester (S). The participants were players U12 who were later among top 1000 in the ATP Singles Rankings (SR). The research data was obtained during regular testing of the Czech Tennis Association (1998–2019). Significant differences between subgroups R1 (SR 1st - 500th) and R2 (SR 501st - 1000th) were found, surprisingly in favor of R2 in 4 variables. Significant differences were found in favor of B1 (born in S1) in 2 variables, and in favor of B2 (born in S2) in 2 variables.

KEYWORDS

Handgrip strength; Performance preconditions; Retrospective study; Tennis performance; Test battery TENDIAG1

RESUMEN

La identificación de talentos (IT) en el deporte, que es la selección de individuos dispuestos a lograr un rendimiento de élite en la edad adulta, a menudo se basa en pruebas de aptitud física. La IT está relacionada con el fenómeno llamado Efecto de la Edad Relativa (EER), que se refiere a la influencia de la fecha de nacimiento en el rendimiento deportivo. Este estudio retrospectivo se basa en la suposición de que los atletas adultos de élite poseían indicadores predictivos de una carrera exitosa desde una edad temprana. El estudio tuvo como objetivo evaluar las diferencias entre los tenistas masculinos checos según 1) su rendimiento en el tenis en la edad adulta, 2) su fecha de nacimiento en cada semestre (S). Los participantes fueron jugadores sub-12 que más tarde se ubicaron entre los 1000 mejores en el Ranking ATP de Individuales. Los datos de la investigación se obtuvieron durante las pruebas periódicas de la Asociación Checa de Tenis (1998-2019). Se encontraron diferencias significativas entre los subgrupos R1 (ranking 1 - 500) y R2 (ranking 501 - 1000), sorprendentemente favorables a R2 en 4 variables. Se encontraron diferencias significativas favorables a B1 (nacidos en S1) en 2 variables, y favorables a B2 (nacidos en S2) en 2 variables.

PALABRAS CLAVE

Fuerza de agarre; Condiciones previas de rendimiento; Estudio retrospectivo; Rendimiento en tenis; Batería de pruebas TENDIAG1

1. INTRODUCTION

The issues of talent identification in sport are closely related to the prospect of achieving high athletic performance in adulthood and has long been addressed by a number of authors in a variety of sports (Abbott & Collins, 2004; Baker, Wattie, & Schorer, 2019; Hohmann, Siener, & He, 2018; Johnston, Wattie, Schorer, & Baker, 2018; Kramer, Huijgen, Elferink-Gemser, & Visscher, 2017; Pearson, Naughton, & Torode, 2006; Romann, Rössler, Javet, & Faude, 2018; Schönborn, 2006). In many countries around the world and in many sports, there is a clear effort to identify and nurture future sporting champions through talent identification (TI) and talent development (TID) programs. This is a long-term process that should repeatedly assess what specific changes are occurring in athletes during the course of their athletic development (Schorer, Rienhoff, Fischer, & Baker, 2017). In one of the first systematic reviews of longitudinal and retrospective studies, Johnston et al. (2018) were examining the differences between performance variables in highly skilled and less-skilled participants. In an analysis of 1696 articles, the authors showed that most studies (60%; 65% of them on male samples) examined mainly the physical profiles of athletes and found a high degree of variability in the factors examined. Diagnosing the level of fitness prerequisites is therefore a usual part of TI, many authors emphasize the importance of identifying such factors of sports performance that significantly determine or influence it (Ferrauti, Maier, & Weber, 2014; Hohmann, Lames, & Letzeter, 2007; Schönborn, 2006). The principle of evaluating the diagnostic results of performance preconditions is most often based on classical set theory using normative reference values, but alternative approaches based on fuzzy set theory are also emerging (Zháněl, Holeček, & Zderčík, 2021). However, the results of physical fitness tests in adolescence cannot be relied upon to predict athletic performance in adulthood. Therefore, the concepts of growth and maturation are important concepts for understanding the process of identification, selection, and development of young talented athletes, taking into account the changes that take place during ontogenetic development (Gonçalves, Rama, & Figueiredo, 2012; Schorer, Rienhoff, Fischer, & Baker, 2017). Also, Miller, Cronin, & Baker (2015) point out that most TIs focus on the diagnosis and development of so-called primary physiological, anthropometric or technical factors (prerequisites), which, however, do not guarantee athletic success. Nevertheless, secondary factors such as the coach, material equipment or family background, which are often given little or no attention, also play an important role. Therefore, TI of young athletes is increasingly emphasizing a multidimensional approach, exemplified by a study focused on assessing the athletic potential of young basketball players (Ribeiro Junior, Vianna, Lauria, Coelho, & Werneck (2019). Based on the results of a multidimensional test battery and subjective ratings by coaches, the authors concluded the utility of this approach, along with noting that coaches tended to rate larger, more biologically advanced athletes higher. Sports performance is influenced by a number of factors, the most frequently mentioned factors are somatic, physical, technical, tactical, and psychological, with an emphasis on their interaction. Tennis performance is influenced by various factors, among which physical fitness factors play an important role. Speed, coordination, and strength are considered the most important ones, as only a well-conditioned tennis player is in a much better position to achieve optimal tennis performance. Diagnosis of the level of performance preconditions allows you to control, regulate, and manage the training process and it also plays an important role in the selection of sports talent. TI is a frequently discussed topic in tennis and has long been addressed by a number of authors (Crespo & McInerney, 2006; Fernandez-Fernandez, Ulbricht, & Ferrauti, 2014; Ferrauti et al., 2014; Hohmann et al., 2007; Kramer et al., 2017; Miranda, 2008; Myburgh, Cumming, Silva, Cooke, & Malina, 2016; Ulbricht, Fernandez-Fernandez, Mendez-Villanueva, & Ferrauti, 2016; Unierzyski, P., 2006; Unierzyski, Wielinski, & Zhanel, 2003; Zháněl et al., 2015; Zhanel, Vaverka, Zlesak, &

Unierzyski, 2003; Schönborn, 2006). Studies by the aforementioned authors often examine the correlation between age, physical fitness, and tennis performance.

However, the authors also point out that this is only one of the factors influencing the pathway to high tennis performance in adulthood. In this context, Ferrauti et al. (2014) state that tactics, techniques, and number of tournaments played are the most important factors in the under-12 category. Crespo and McInerney (2006) presented two basic models applied to TI in tennis: 1) the natural selection model where players improve their skills, play increasingly important tournaments, and become professionals. The main criterion is the "good eye of the coach" and the players' result achievements, and 2) scientifically based model incorporating findings from somatometry, physiology or psychology. The appropriate period for tennis-specific TI is considered to be ages 11–12 (girls) and 12–13 (boys) when the greatest changes in motor skills occur (Crespo, & McInerney, 2006; Unierzyski, 2006; Unierzyski et al., 2003). One possible approach to the implementation of talent identification is based on the principle of the so-called retrospective theory, which assumes that athletes who are successful in adulthood already possessed a high level of certain specific performance preconditions in their youth (Hohmann et al., 2007; Zháněl et al., 2015). Based on an analysis of 20 relevant studies on athletic talent from 2005–2015, Johnston et al. (2018) found that of these studies, 16 (80%) took a longitudinal approach, 2 (10%) took a retrospective approach, and 2 (10%) used a combination of both. Furthermore, the authors showed that most of these studies focused only on physical variables, with only a small proportion of studies (4, i.e., 20%) examining physiological and psychological characteristics in addition to physical ones.

In the literature, the concepts of talent identification and development (TID) are often associated with the issue of Relative Age Effect (RAE). Given the fact that 75% of the top 300 professional players commenced their participation in tennis between 3 to 7 years of age (Li, Weissensteiner, Pion, & De Bosscher, 2020), this connection is certainly desirable. Already Musch and Grondin (2001) referred to this RAE in sport as a worldwide phenomenon and stated that it exists in many sports with possible negative consequences. The first analyses of the effect of birthdate in sport were already conducted by Barnsley, Thompson, and Barnsley (1985, hockey) and Grondin, Deshaies and Nault (1983, volleyball), and there are numerous publications on the existence of RAE in tennis. According to Cobley, Baker, Wattie, & McKenna (2009), tennis ranks third behind football and ice hockey in the number of publications. Although the majority of publications have focused on the existence of RAE in professional tennis, many publications have also addressed junior tennis, a period, in which significant changes occur during ontogenetic development (Agricola, Zháněl, &

Hubáček, 2013; Filipčič, 2001; Gerdin, Hedberg, & Hageskog, 2018; Ulbricht, Fernandez-Fernandez, Mendez-Villanueva, & Ferrauti, 2015). Already Baxter-Jones (1995) and Dudink (1994) have shown that 85% of elite British junior tennis players were born in the first semester and almost half of 60 elite Dutch tennis players aged 12–16 was born in the first quartile. Also, Filipčič (2001) reports a significantly higher representation of Q1 among male players in the U12–U16 categories, while among female players, this phenomenon was observed only in the U12–U14 categories. Ulbricht et al. (2015) showed that the effect of RAE was stronger with increasing performance level and age category. Also, a longitudinal study of a large cohort of Czech male tennis players (U12, n = 1500) showed a significant existence of RAE (Koloničný, Bozděch, & Zháněl, 2018).

The aim of the study was to analyze the level of anthropometric and physical fitness prerequisites of Czech male junior tennis players in the context of assessing differences between subgroups of players divided by 1) tennis performance in adulthood (subgroups R1; R2), 2) date of birth in each semester (subgroups B1; B2).

2. METHODS

2.1. Participants

The participants were male (n = 26) elite Czech junior tennis players U12 (12.4 ± 0.4 years) included in the Youth Training Centers of the Czech Tennis Association - they were therefore selected as talented players. The participants were first divided into subgroups R1 (n = 13; age: 12.4 ± 0.40 years; body height: 159.6 ± 4.97 cm; body mass 47.6 ± 6.32 kg): players who in adulthood were ranked on the ATP Singles Rankings (ATP SR) at the 1st - 500th places and subgroups R2 (n = 13; age: 12.4 ± 0.45 years; body height: 162.6 ± 6.67 cm; body mass 47.8 ± 4.49 kg): players who ranked 501st - 1000th in adulthood. Among the tracked junior players, one player in the top 10, two players in the top 100, and two players in the top 200 were adults on the ATP SR. Players were further divided by their birthdates into quartiles (Q1= players born in January, February, and March; Q2 = players born April, May and June; Q3 = players born in July, August, and September; and Q4 = players born in October, November, and December). The division into subgroups B1 (n = 11; age: 12.5 ± 0.37 years; body height: 162.6 ± 8.38 cm; body mass 48.5 ± 5.38 kg) and B2 (n = 15; age: 12.4 ± 0.40 years; body height: 160.7 ± 4.83 cm; body mass 47.6 ± 5.93 kg) was made according to the players' belonging to semesters S1 (born in January to June) and S2 (born in July to December), respectively. The research data of each participant was obtained as part of regular testing using the

TENDIAG1 test battery, the data on the best ranking position during the career was obtained from the official ATP website (https://www.atptour.com/rankings/singles).

2.2. Procedures

The standardized test battery TENDIAG1 (Zháněl et al., 2015), with which all participants were tested, contained a total of 9 tests divided into 3 domains: anthropometric assumptions (height, weight, body mass index, and shoulder joint mobility were informative and not scored). The level of fitness (strength of the playing hand, running speed, and medium endurance) and coordination assumptions (reaction speed of arms, legs, and trunk flexibility) were diagnosed using physical fitness tests and evaluated on the basis of developed standards on a three-point scale of 0 (small), 1 (medium), 2 (large) points. The total score of the TENDIAG1 battery was given by the sum of the scores obtained in the fitness and coordination tests (6 tests in total, scores in the interval 0–12). Testing protocols were performed regularly in 1998–2019 twice a year (March, October) by a trained team of collaborators under the guidance of the same supervisor, according to a uniform methodology and with the same instruments on indoor tennis courts (hard court). The coaches of the individual centers then received the results in the form of an overall research report and part of the report was an overall assessment of the results of individual players in the form of individual test profiles with a commentary on the strengths and weaknesses in performance preconditions with recommendations for their development.

2.3. Statistical analyses

The research data were analyzed by descriptive methods (arithmetic mean, standard deviation, minimum and maximum value) and inferential statistics (chi-square goodness of fit test, Mann-Whitney U test). Shapiro Wilk test was used to test the normality of the frequency distribution of each variable ($n = 15$). In view of the fact that the assumption of normality was violated for more than 2/3 of the variables, the non-parametric Mann-Whitney U test ($p = 0.05$) was used to assess the significance of the differences between individual populations. When there is a discrepancy between the conclusions found using statistical significance (p) and statistical power, we are inclined to the conclusions drawn from the effect size (ES) assessment of the d index (Cumming, 2013). The evaluation of the ES index d was interpreted as small ($d = .20$), medium ($d = .30$) or large ($d = .50$) based on Cohen (1988). Calculations were performed using IBM SPSS Statistics software (version 25.0, SPSS INC., Chicago, IL USA) and Microsoft Excel.

3. RESULTS

The basic statistical characteristics of the results of each variable (anthropometric measurements and physical fitness tests, scores obtained in the areas of fitness and coordination tests, total scores in TENDIAG1 and the best placement in the ATP Singles Rankings during the career) describing the level of the entire research population (*n* = 26) are presented in Table 1.

Table 1. The basic statistical characteristics of performance preconditions (all players; *n* = 26)

V	Age	BH	BM	BMI	IF	T1	T2	T3	T4	T5	T6	TR1	TR2	TBP	ATP SR
M	12.4	161.4	47.9	18.3	2.5	28.0	14.7	149.9	41.0	0.55	0.42	4.7	3.7	8.3	485*
SD	0.40	6.64	5.72	1.47	0.36	4.23	0.64	7.47	3.48	0.06	0.04	1.24	1.41	2.32	-
Min	11.6	150.0	37.4	15.8	1.8	19.3	13.5	136.9	36.0	0.45	0.34	1.0	1.0	3.0	4
Max	12.9	176.0	57.0	21.1	3.3	34.9	16.3	168.8	49.0	0.71	0.50	6.0	6.0	12.0	930

*Notes: V = Variables; BH = body height; BM = body mass; BMI = body mass index; IF = index of flexibility in shoulder joints; T1 = handgrip strength; T2 = running speed; T3 = intermittent endurance; T4 = flexibility of torso; T5 = arm reaction speed; T6 = leg reaction speed; TR1 = conditioning tests results; TR2 = coordination tests results; TBP = total test battery points; ATP SR = ATP Singles Rankings; M = mean; SD = standard deviation; * = median; Min = minimum value; Max = maximum value*

3.1. Assessment of differences between subpopulations of players divided by playing performance in adulthood

The aim of this part of the research was to test the hypothesis that the players who achieved higher levels of performance preconditions in the U12 category achieved higher tennis performance in adulthood (best ATP Singles Rankings position in their career). The results of the comparison of the subgroups R1 and R2 are shown in Table 2. Significant differences - surprisingly in all 4 variables in favor of the subgroup R2 - were found between the anthropometric (unscored) variables (body height and index of flexibility in shoulder joints) as well as between the results of the T3 (intermittent endurance) test, the total score in the conditioning tests (TR1). In the ATP Rankings, the subgroup R1 players were (logically) better.

Table 2. Comparison of the results of performance preconditions of subgroups R1 and R2

Groups	**R1** (*n*=13)		**R2** (*n*=13)		**U Test**	**ES**
Variables	M ± SD		M ± SD		(*p*)	(*d*)
1. Age	12.4	0.40	12.4	0.45	> .05	0.43
2. Body height	159.6	4.97	162.6	6.67	> .05	**0.51**
3. Body mass	47.6	6.32	47.8	4.49	> .05	0.04
4. BMI	18.6	1.57	18.1	1.31	> .05	0.35
5. IF	2.6	0.31	2.4	0.39	> .05	**0.57**
6. T1	27.0	4.38	28.1	3.77	> .05	0.27
7. T2	14.7	0.49	14.8	0.95	> .05	0.13
8. T3	152.5	6.97	148.4	8.44	**≤ .05**	**0.53**
9. T4	41.0	3.36	41.0	3.75	> .05	0.00
10. T5	0.55	0.06	0.55	0.07	> .05	0.00
11. T6	0.42	0.05	0.42	0.03	> .05	0.00
12. TR1	4.3	0.99	5.0	1.36	> .05	**0.59**
13. TR2	3.8	1.37	3.6	1.44	> .05	0.14
14. TBP	8.1	2.16	8.6	2.43	> .05	0.22
15. SR	229*	-	688*	-	**≤ .05**	**3.39**

*Notes: n = sample size; M = mean; * = median; SD = standard deviation; U = Mann-Whitney U test; d = Cohen´s coefficient; ES = effect size; statistically significant (p ≤ 0.05) or substantively significant values (d) are in bold*

3.2. Assessment of differences between subpopulations of players divided by birthdates

The aim of this part of the research was to test the hypothesis that players who were born in semester S1 achieved better tennis performance in adulthood, i.e., better rankings on the ATP Singles Rankings. For the purpose of further statistical processing, the players were divided by birthdate into two subgroups: B1 (*n* = 11) consisted of players born between January and June (S_1), B2 (*n* = 15) consisted of players born between July and December (S_2). The numbers of players divided by their birth quartile (Q_i) and semesters (S_i) are shown in Table 3. It is clear that most players were born in the Q_1 quartile and the least in Q_2, with the majority of players born in S_2.

Table 3. Season of birth distribution of tennis players in quartile (Q_i) and semesters (S_i)

Quartile	**Q_1 (%)**	**Q_2 (%)**	**Q_3 (%)**	**Q_4 (%)**
Q_i	8 (31)	3 (11)	6 (23)	9 (35)
Semesters/B_i	B1		B2	
S_i	S_1 = 11 (42)		S_2 = 15 (58)	

Notes: Qi = quartile; S_i = semesters; B_i = subgroups

The results of the assessment of the differences between subgroups B1 and B2 are shown in Table 4. Significant differences between subgroups B1 (born in S1) and B2 (born in S2) were found in favor of B1 only in 2 variables (flexibility in shoulder joints and of torso), and in favor of B2 also in 2 variables (leg reaction speed and in ATP Singles Rankings). Contrary to expectations, the B2 subgroup, i.e., younger players, surprisingly showed significantly better ATP ranking in adulthood.

Table 4. Comparison of the results of performance preconditions of subgroups B1 and B2

Groups	**B1** (n=11)		**B2** (n=15)		**U Test**	**ES**
Variables	M ± SD		M ± SD		(*p*)	(*d*)
Age	12.5	0.37	12.4	0.40	> .05	0.26
Body height	162.6	8.38	160.7	4.83	> .05	0.28
Body mass	48.5	5.38	47.6	5.93	> .05	0.16
BMI	18.3	1.50	18.4	1.44	> .05	0.07
IF	2.4	0.34	2.7	0.32	> .05	**0.91**
T1	29.0	4.12	27.1	4.12	> .05	0.46
T2	14.8	0.80	14.6	0.49	> .05	0.30
T3	148.7	7.82	150.9	7.07	> .05	0.30
T4	43.2	3.35	40.0	2.81	**≤ .05**	**1.03**
T5	0.54	0.05	0.55	0.07	> .05	0.16
T6	0.43	0.03	0.41	0.04	> .05	**0.57**
TR1	4.7	1.42	4.6	1.08	> .05	0.08
TR2	3.8	1.47	3.6	1.36	> .05	0.14
TBP	8.5	2.71	8	1.97	> .05	0.21
SR	617*	-	297*	-	**≤ .05**	**1.39**

Notes: in Table 2.

4. DISCUSSION

Relatively few similar studies addressing the issue of TID through performance diagnostics in tennis have been published. Comparison of the results is particularly difficult due to the fact that the cited authors used different tests or test batteries, as there is no uniform, generally accepted method of physical fitness testing in tennis. The cited studies focused on the diagnosis of anthropometric and physical fitness prerequisites in the U12 age group (Cohen et al., 2010; Fernandez-Fernandez et al., 2014; Filipčič, Filipčič, & Leskošek, 2015; Juzwiak, Amancio, Vitalle, Pinheiro, & Szejnfeld, 2008; Kolínský & Zháněl, 2019; Myburgh et al., 2016; Pereira, de Oliveira Menacho, Takahashi, & Cardoso, 2011; Tudor, Vučetić, Milanović, Novak, & Dudašek, 2015; Ulbricht et al., 2016). Comparable results were found for the anthropometric variables body height (BH), body mass (BM), body mass index (BMI) and partially for handgrip strength (HGS, Figure 1). Four of the cited studies used the Takei dynamometer, two used the Baseline dynamometer and one used the Jamar dynamometer, with comparable results (Dods et al., 2014; Fredriksen, Mamen, Hjelle, & Lindberg, 2018). The aforementioned authors mostly report values for the U12 category, Juzwiak et al. (2008) report results for players aged U10–U13 (M ± SD = 12.6 ± 0.9), however, compared to our U12 age category the age values do not differ much (M ± SD = 12.4 ± 0.40), so a comparison is possible. The results of Filipčič et al. (2015) for the U12–U13 category are reported in different periods and with different numbers of participants (1992–94, *n* = 14; 1999–2001, *n* = 49; 2006–08, *n* = 59). In order to make the results comparable, we calculated the weighted arithmetic mean for the whole period 1992–2008 (*n* = 122; BH = 161.4 cm, BM = 50.1 kg, BMI = 19.1). The authors do not report the mean age (12–13-year-olds, which probably means 12.0–13.9 years; M = 12.95); therefore, given the age of our players (M = 12.4), a higher level of quoted values should be expected. The weighted average method was also used to recalculate the results of the HGS dominant hand study by Kolínský and Zháněl (2019) and the normative values of the dynamometer manufacturer Takei (Takei Scientific Instruments Co. Ltd, Tokyo, Japan). For ease of comparison of the cited data with our study (Polách et al., unpub.), we created an interval $I_{M \pm SD}$ (BH: 161.4 ± 6.64, $I_{M \pm SD}$: 154.8–168.0; BM: 47.9 ± 5.72, $I_{M \pm SD}$: 42.2–53.6; BMI: 18.3 ± 1.47, $I_{M \pm SD}$: 16.8–20.8; HGS: 28.0 ± 4.23, $I_{M \pm SD}$: 23.8–32.2) comprising 68% of the results.

Table 5. Comparison with the results of other authors

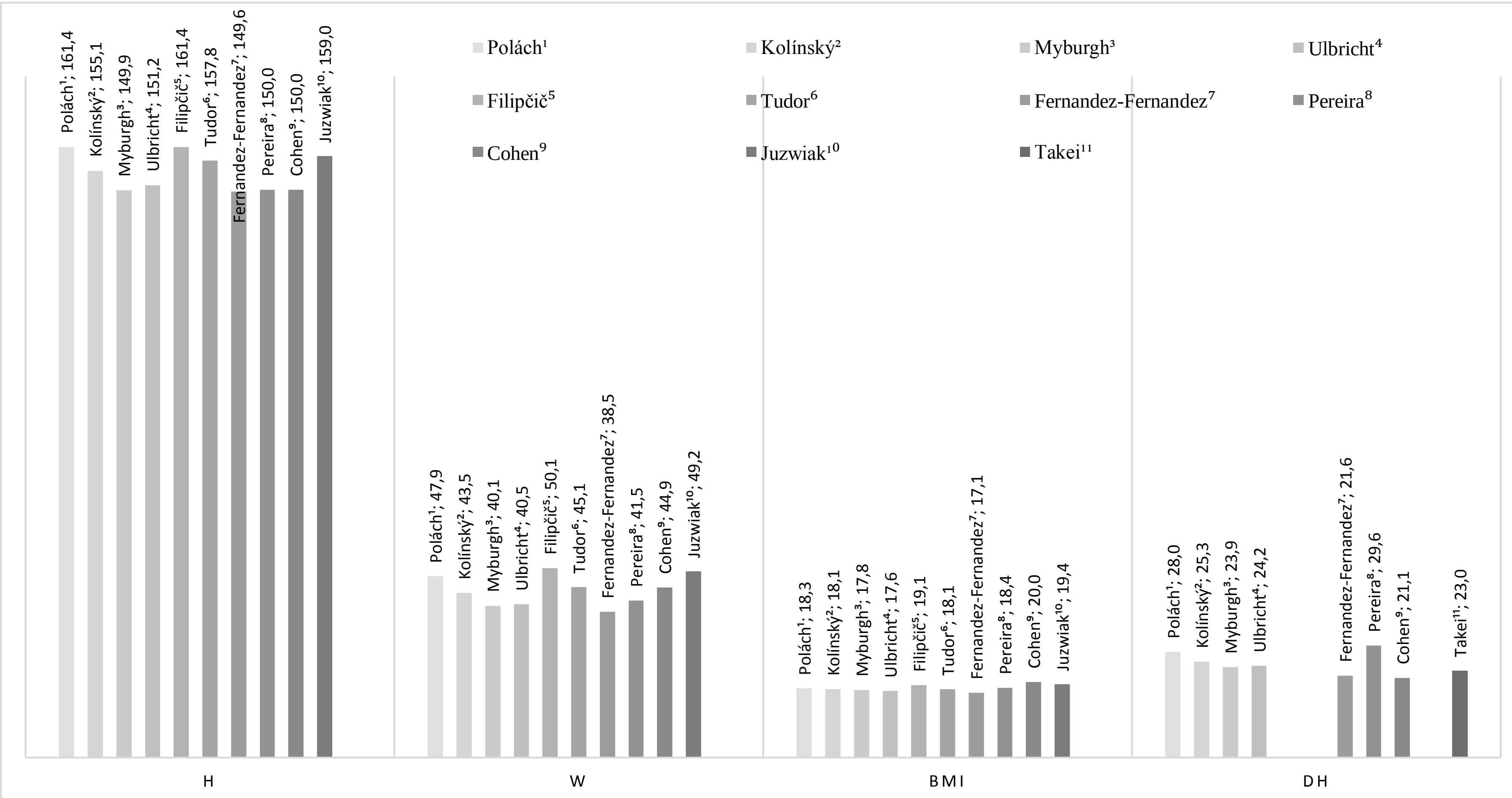
Authors	*n*	BH	BM	BMI	HGS
1. Kolínský and Zháněl (2019)	186	155.1	43.5	18.1	25.3
2. Myburg et al. (2016)	27	149.9	40.1	17.7	23.9
3. Ulbricht et al. (2016)	24	151.2	40.5	17.6	24.2
4. Filipčič et al. (2015)	122	161.4	50.1	19.1	
5. Tudor et al. (2015)	20	157.8	45.1	18.1	
6. Fernandez-Fernandez et al. (2014)	102	149.6	38.5	17.1	21.6
7. Pereira et al. (2011)	29	150.0	41.5	18.4	29.6
8. Cohen et al. (2010)	1374	150,0	44.9	20.0	21.1
9. Juzwiak et al. (2008)	17	159.0	49.2	19.4	
10. Polách et al. (unpub)	26	161.4	47.9	18.3	28.0
11. Takei (2000)					23.0
Study 1.–10. (M ± SD)	1927	154.54 ± 4.98	44.13 ± 4.02	18.40 ± 0.87	24.59 ± 2.96
Polách et al. (unpub); Interval (M ± SD)		154.8–168.0	42.2–53.6	16.8–20.8	23.8–32.2

Notes: n = sample size; BH = body height; BM = body mass; BMI = body mass index; HGS = handgrip strength; unpub. = unpublished

Comparison of anthropometric characteristics showed lower levels in the BH and BW variables compared to the 68% interval ($I_{M \pm SD}$) for four results of tennis players (Myburg et al., 2016; Ulbricht et al., 2016; Fernandez-Fernandez et al.; 2014, Pereira et al., 2011) and one result of English schoolchildren (Cohen et al., 2010); the values of the other four authors (tennis) are comparable to our results as well as all cited BMI values. A comparison of HGS results showed lower values than our results for tennis players in one study (Fernandez-Fernandez et al., 2014) and also (logically) for English schoolchildren (Cohen et al., 2010); the normative value given for boys 11–12 years old by the dynamometer manufacturer (Takei) is also lower.

A comparison of comparable variables with the results of our research (Polách et al., unpub.) is presented in Figure 1.

Figure 1. Comparison of results of different authors (anthropometric characteristics and handgrip strength).



Notes: BH = body height; BM = body mass; BMI = body mass index; DH = dominant hand; 1 = Polách et al., 2022 (n = 26); 2 = Kolínský et al., 2019 (n = 186); 3 = Myburg et al., 2016 (n = 27); 4 = Ulbricht et al., 2016 (n = 24); 5 = Filipčič et al., 2015 (n = 122); 6 = Tudor et al., 2015 (n = 20); 7 = Fernandez-Fernandez et al., 2014 (n = 102); 8 = Pereira et al., 2011 (n = 29); 9 = Cohen et al., 2010 (n = 1374); 10 = Juzwiak et al., 2008 (n = 17); 11 = Takei, 2000.

Fitness performance is considered by a number of authors as an important prerequisite for tennis performance and, especially at the level of elite tennis players, its importance has been clearly demonstrated (Ferrauti et al., 2014; Fernandez-Fernandez et al., 2014, Ulbricht et al., 2016; Zháněl et al., 2015). Therefore, a somewhat surprising finding of our study is the fact that the differences between the more successful players (R1; SR 1st - 500th) and the less successful players (R2; SR 501st - 1000th) according to their results in adulthood were non-significant in 11 variables (73%) and significant in 4 variables (27%) in favor of the R2 subgroups (body height, flexibility of shoulder, intermittent endurance, conditioning tests) among the 15 variables studied. While this finding does not negate the importance of regular diagnosis of the level of performance preconditions in tennis as a relevant tool to control, regulate, and manage the training process, it is only one of many factors influencing tennis performance in adulthood. It should also be mentioned that in the U12 category, the factors of tactics, technique, and number of tournaments played are considered the most important. The regular fitness training of young players is only at the beginning and especially the all-round coordination training is considered as an important concept of talent support. However, only physical fitness testing results during adolescence cannot be considered relevant to predict tennis performance in adulthood (Ferrauti et al., 2014; Schönborn, 2006). Yet, fitness testing of tennis players is undoubtedly an essential part of the training process and allows for the discovery of strong and weak fitness markers of athletes.

In another part of the study looking at the effect of RAE, it was found that there were no significant differences between subgroups B1 (players born in S1) and B2 (players born in S2) in 11 (73%) of 15 variables, and only 2 variables (flexibility of shoulder and torso) were significant in favor of B1; also 2 variables (leg reaction speed and surprisingly also SR) were significant in favor of B2. Although a number of authors have published studies demonstrating significant RAE in the U12 category in the context of tennis performance (Filipčič, 2001; Gerdin et al., 2018; Ulbricht et al., 2015; Koloničný et al., 2018), the predicted impact of RAE in R1 subgroups in terms of the observed performance characteristics has not been demonstrated (with the exception of 2 non-fitness tests, flexibility of shoulder and torso).

5. CONCLUSION

A retrospective study focused on the analysis of the level of performance preconditions of Czech male junior tennis players (U12) in the context of assessing the differences between subgroups of players divided by tennis performance in adulthood or date of birth in individual semesters yielded somewhat unexpected results. In terms of tennis performance in adulthood, no significant differences were found between subgroups R1 (ATP SR 1st - 500th) and R2 (ATP SR 501st -1000th) in most of the anthropometric and physical fitness variables studied (73%), surprisingly in favor of the subgroups R2, significant differences were found in 4 variables (27%). In terms of the impact of RAE, no significant differences were again found between subgroups B1 (born in S1) and B2 (born in S2) in most of the observed variables (73.3%); the expected significant differences in favor of B1 were found only in 2 anthropometric variables (13.3%) and significant differences in favor of B2 were found in 2 variables (13.3%). The results of our study among junior players (U12) have not demonstrated the predicted importance of anthropometrics and physical fitness variables and thus, they cannot be considered predictors of tennis performance in adulthood. Nevertheless, physical fitness testing in tennis has an important role, especially as a tool for continuous checking of the level of performance preconditions, and is an important part of the control, regulation, and management of the training process.

5. REFERENCES

1. Abbott, A., & Collins, D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: considering the role of psychology. *Journal of Sports Sciences*, *22*(5), 395–408. https://doi.org/10.1080/02640410410001675324
2. Agricola, A., Zháněl, J., & Hubáček, O. (2013). Relative age effect in junior tennis (male). *Acta Universitatis Palackianae Olomucensis. Gymnica*, *43*(1), 27–33. https://gymnica.upol.cz/
3. Baker, J., Wattie, N., & Schorer, J. (2019). A proposed conceptualization of talent in sport: The first step in a long and winding road. *Psychology of Sport and Exercise*, *43*(2019), 27–33. https://doi.org/10.1016/j.psychsport.2018.12.016
4. Barnsley, R., Thompson, A., & Barnsley, P. (1985). Hockey success and birthdate: the relative age effect. *CAHPER Journal*, *51*(8), 23–28.
5. Baxter-Jones, A. D. G. (1995). Growth and development of young athletes. *Sports Medicine, 20*(2), 59–64.
6. Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual Age-Grouping and Athlete Development: A Meta-Analytical Review of Relative Age Effect in Sports. *Sports Medicine*, *39*(3), 235–256. https://doi.org/10.2165/00007256-200939030-00005

7. Cohen, D. D., Voss, C., Taylor, M. J., Stasinopoulos, D. M., Delextrat, A., & Sandercock, G. R. (2010). Handgrip strength in English schoolchildren. *Acta Paediatrica*, *99*(7), 1065-1072. https://doi.org/10.1111/j.1651-2227.2010.01723.x
8. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd ed.).* Hillsdale, NJ: Lawrence Erlbaum Associates.
9. Crespo, M., & McInerney, P. (2006). Talent identification and development in tennis. *ITF Coaching & Sport Science Review*, *14*(39), 2–3. https://www.itftennis.com
10. Cumming, G. (2013). The new statistics: A how-to guide. *Australian Psychologist, 48*(3), 161–170. https://doi.org/10.1111/ap.12018
11. Dodds, R. M., Syddall, H. E., Cooper, R., Benzeval, M., Deary, I. J., Dennison, E. M., ... & Sayer, A. A. (2014). Grip Strength across the Life Course: Normative Data from Twelve British Studies. *PLoS ONE, 9*(12), e113637. https://doi:10.1371/journal.pone.0113637
12. Dudink, A. (1994). Birth date and sporting success. *Nature*, *368*(6472), 592–592.
13. Fernandez-Fernandez, J., Ulbricht, A., & Ferrauti, A. (2014). Fitness testing of tennis players: How valuable is it? *British Journal of Sports Medicine, 48*(8), 22–30. http://dx.doi.org/10.1136/bjsports-2013-093152
14. Ferrauti, A., Maier, P., & Weber, K. (2014). *Handbuch für Tennistraining: Leistung – Athletik - Gesundheit.* Aachen, Německo: Meyer & Meyer Verlag.
15. Filipčič, A. (2001). Birth date and success in tennis. *Coaching & sport science review*, 23, 9–11.
16. Filipčič, A., Filipčič, T., & Leskošek, B. (2015). Differences in physical fitness among young tennis players in between 1992 and 2008. *Collegium Antropologicum*, *39*(1), 131–143.
17. Fredriksen, P. M., Mamen, A, Hjelle, O. P. & Lindberg, M. (2018). Handgrip strength in 6–12-year-old children: The Health Oriented Pedagogical Project (HOPP). *Scandinavian Journal of Public Health, 46*(21), 54–60. https://doi.org/10.1177/1403494818769851
18. Gerdin, G., Hedberg, M., & Hageskog, C. (2018). Relative age effect in Swedish male and female tennis players born in 1998–2001. *Sports, 6*(2), 38. http://doi:10.3390/sports6020038
19. Gonçalves, C. E. B., Rama, L. M. L., & Figueiredo, A. B. (2012). Talent identification and specialization in sport: An overview of some unanswered questions. *International Journal of Sports Physiology and Performance*, *7*(4), 390–393. https://journals.humankinetics.com/
20. Grondin, S., Deshaies, P., & Nault, L. (1983). Trimestre de naissance et participation au hockey et au volleyball. *Revue Quebecoise De L'activite Physique, 2*(3), 97–103.

21. Hohmann, A., Lames, M., & Letzeter, M. (2007). *Einführung in die Trainingswissenschaft*. Wiebelsheim: Limpert Verlag.

22. Hohmann, A., Siener, M., & He, R. (2018). Prognostic validity of talent orientation in soccer. *German Journal of Exercise and Sport Research*, *48*(4), 478–488. https://doi.org/10.1007/s12662-018-0549-5

23. Juzwiak, C. R., Amancio, O. M., Vitalle, M. S., Pinheiro, M. M., & Szejnfeld, V. L. (2008). Body composition and nutritional profile of male adolescent tennis players. *Journal of Sports Sciences*, *26*(11), 1209–17. https://doi.org/10.1080/02640410801930192

24. Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent identification in sport: A systematic review. *Sports Medicine*, *48*(1), 97–109. https://doi.org/10.1007/s40279-017-0803-2

25. Kolínský, R., & Zháněl, J. (2019). Lateral differences in maximal grip strength in Czech male tennis players aged 11–12 in the context of injury prevention. *Studia Sportiva*, *13*(1), 55–62. https://doi.org/10.5817/StS2019-1-6

26. Koloničný, R., Bozděch, M., & Zháněl, J. (2018). Longitudinal study of the influence of the relative age effect (RAE) on Czech tennis players aged 10–12. *Studia sportiva*, *12*(1), 125–131. https://doi.org/10.5817/StS2018-1-14

27. Kramer, T., Huijgen, B. C. H., Elferink-Gemser, M. T., & Visscher, C. (2017). Prediction of tennis performance in junior elite tennis players. *Journal of Sports Science and Medicine*, *16*(1), 14–21. https://www.jssm.org/

28. Li P., Weissensteiner, J. R., Pion, J. and De Bosscher, V. (2020). Predicting elite success: Evidence comparing the career pathways of top 10 to 300 professional tennis players. *International Journal of Sports Science & Coaching*, *15*(5–6), 793–802. https://doi.org/10.1177/1747954120935828

29. Miller, P. K., Cronin, C., & Baker, G. (2015). Nurture, nature and some very dubious social skills: An interpretative phenomenological analysis of talent identification practices in elite English youth soccer. *Qualitative Research in Sport, Exercise and Health*, *7*(5), 642–662. https://doi.org/10.1080/2159676X.2015.1012544

30. Miranda, M. (2008). Considerations on talent in tennis. *ITF Coaching and Sport Science Review*, *15*(44), 7–8.

31. Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental Review*, *21*(2), 147–167. https://doi.org/10.1006/drev.2000.0516

32. Myburgh, G. K., Cumming, S. P., Silva, M. C., Cooke, K., & Malina, R. M. (2016). Maturity-associated variation in functional characteristics of elite youth tennis players. *Pediatric exercise science*, *28*(4), 542–552. https://doi.org/10.1123/pes.2016-0035
33. Pearson, D. T., Naughton, G. A., & Torode, M. (2006). Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. *Journal of Science and Medicine in Sport*, *9*(4), 277–287. https://doi.org/10.1016/j.jsams.2006.05.020
34. Pereira, H. M., de Oliveira Menacho, M., Takahashi, R. H., & Cardoso, J. R. (2011). Handgrip strength evaluation on tennis players using different recommendations. *Revista Brasileira de Medicina do Esporte*, *17*(3), 184–188.
35. Ribeiro Junior, D. B., Macedo Vianna, J., de Assis Lauria, A., Coelho, E. F., & Zacaron Werneck, F. (2019). Sports potential modeling of young basketball players: A preliminary analysis. *Brazilian Journal of Kineanthropometry & Human Performance*, *21*, 1–12. https://doi.org/10.1590/1980-0037.2019v21e59832
36. Romann, M., Rössler, R., Javet, M., & Faude, O. (2018). Relative age effects in Swiss talent development - a nationwide analysis of all sports. *Journal of Sports Sciences*, *36*(17), 2025–2031. https://doi.org/10.1080/02640414.2018.1432964
37. Schorer, J., Rienhoff, R., Fischer, L., & Baker, J. (2017). Long-term prognostic validity of talent selections: Comparing national and regional coaches, laypersons and novices. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01146
38. Schönborn, R. (2006). *Optimales Tennistraining: Der Weg zum erfolgreichen Tennis vom Anfänger bis zur Weltspitze*. Balingen: Spitta Verlag.
39. Tudor, P. B., Vučetić, V., Milanović, D., Novak, D., & Dudašek, B. (2015). Morphological and physiological profile indicators of physical fitness in male tennis players aged 12, 14 and 16 years. *Kinesiology*, *47*(1), 82–90.
40. Ulbricht, A., Fernandez-Fernandez, J., Mendez-Villanueva, A., & Ferrauti, A. (2015). The relative age effect and physical fitness characteristics in German male tennis players. *Journal of Sports Science & Medicine*, *14*(3), 634–642.
41. Ulbricht, A., Fernandez-Fernandez, J., Mendez-Villanueva, A., & Ferrauti, A. (2016). Impact of fitness characteristics on tennis performance in elite junior tennis players. *Journal of Strength and Conditioning Research*, *30*(4), 989–998. https://doi.org/10.1519/JSC.0000000000001267
42. Unierzyski, P. (2006). Foundations for Talent Identification and Player Development Programmes. *ITF Coaching & Sport Science Review*, *14*(39), 3–5.

43. Unierzyski, P., Wielinski, D., & Zhanel, J. (2003). Searching for reasons for success and failure in the careers of young tennis players – a study of two individual cases. In S. Miler (Ed.), *Tennis Science & Technology 2,* 253–259. London: International Tennis Federation.
44. Zháněl, J., Černošek, M., Zvonař, M., Nykodým, J., Vespalec, T., & López Sánchez, G. F. (2015). Comparison of the level of top tennis players' performance preconditions (Case study). *Apunts: Educación Física y Deportes, 122,* 52–60. https://doi.org/10.5672/apunts.2014-0983.es.(2015/4).122.06
45. Zháněl, J., Holeček, P. & Zderčík, A. (2021). Comparison of the Evaluation of Performance Preconditions in Tennis with the Use of Equal and Expertly Judged Criteria Body Masss. *International Journal of Computer Science in Sport, 20*(1), 79–91. https://doi.org/10.2478/ijcss-2021-0005
46. Zhanel, J., Vaverka, F., Zlesak, F., & Unierzyski, P. (2003). The performance preconditions of Czech world junior tennis champions, 14 years and under, girls. In S. Miler (Ed.), *Tennis Science & Technology 2,* 247–252. London: International Tennis Federation.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This publication was written at Masaryk university as part of the project "Laterality in the context of diagnostics of selected factors of sports performance in tennis and injury prevention" number MUNI/A/1637/2020 with the support of the Specific University Research Grant, as provided by the Ministry of Education, Youth and Sports of the Czech Republic in the year 2021. The Research Ethics Committee of Masaryk University reviewed the application to conduct the research project as specified above and on June 26, 2021, the Committee approved this project to be conducted

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