DOI 10.2478/afepuc-2019-0010

© Acta Facultatis Educationis Physicae Universitatis Comenianae 2019, 59(2): 118-128

THE EFFECT OF BIOLOGICAL AGE IN THE EVALUATION OF PHYSICAL INDICATORS AND THE CHANGES IN SELECTED MOTORIC TESTS OF YOUNG FEMALE BASKETBALL PLAYERS

Ladislava Doležajová[1], Tatiana Gallová[2], Anton Lednický[1]

[1]Comenius University Bratislava, Faculty of Physical Education and Sports, Slovakia

[2]TK Hannover- TKH Basketball Damen, Germany

Summary. Basketball is a complex team sport, which combines cyclic and acyclic motion structures consisting mainly of fast and dynamic moves with or without a ball. The puberty is characterized by considerable variability that may occur earlier (developmental acceleration, early maturing) or later (developmental retardation, late maturing): an example can be a 12-year-old girl whom biological age could range from 9.5 to 14.5 years. For this study we selected 6 girls-players from the whole team. Two players were according to the norms from the zone of developmental retardation (BioRet), two players whose decimal and biological age i.e. bone age was identical (DC = BV), and the other two were in the biological acceleration zone (BioAkc.). All players were 13-years old and competed in the U14 category. We have confirmed that there are great differences in biological age in a group of 13-years old girls – in our research it has shown almost four years difference. We did not confirm the author's conclusions that biologically accelerated individuals achieved better results than the retarded ones in the speed and strength tests.

Key words: biological age, decimal age, young athlete, somatic and speed abilities, strength

Introduction

Basketball is a complex team sport, which combines cyclic and acyclic motion structures consisting mainly of fast and dynamic moves with or without a ball (Erčulj 1998). The most common moves are short sprints, rapid stops and changes of motion, acceleration, various jumps with and without a ball, shooting and passes. Successful and effective implementations of these moves in game like situations determine the performance. The quality

of performance is also affected by the age of the athletes specifically by their psychomotor and functional abilities. In Gamble's (2008) opinion „the basic movement supports the specific movement". That means that the basic abilities of an athlete will determine her ability to perform specific movement. The higher level of these abilities, faster and more efficient player can handle even the most difficult activities with and without the ball and can adjust to the fast changing conditions in game. In our case it means to learn the proper technique of running, jumping and throwing/passing. We are observing an enormous deficit in this area among young population and athletes. It is very important to train these relatively simple movements throughout the whole youth period because as it was already mentioned, „the basic movement supports the specific movement".

In ontogenesis, motoric development is functionally and morphologically connected with the development of motoric abilities. Chiviacowsky et al. (2008) explain the changes in motoric development dividing it into two components – to the "hardware" change (i.e. structural change) which includes growth/physical changes and increases in body height (BH) and body weight (BW) as well as changes in the CNS; and "software" changes when the capacity and utilization of this structure increases: meaning the cognitive changes which are result of the development of information processing capacity of the brain.

The age from 12 to 18 is the transition period between childhood and adulthood. The high rate in biological-psycho-social changes is triggered by the activity of endocrine glands and the differences in their hormone production (Perič et al. 2012). Šelingerová & Šelinger (2016) stated that growth and biological adolescence are interrelated processes that affect the level of physical fitness. The puberty is characterized by considerable variability that may occur earlier (developmental acceleration, early maturing) or later (developmental retardation, late maturing): an example can be a 12-year-old girl whom biological age could range from 9.5 to 14.5 years.

As many authors mentioned, e.g. Volkov & Filin (1983), Ortega et al. (2008) Šelingerová & Šelinger (2009/a), biological age is very important for the evaluation of the results achieved in motoric tests, because the acceleration or retardation of pubertal somatic development can significantly affect (positively or negatively) the level and development of the motor and sports performance of young athletes. Biologically accelerated or retarded individuals differ in their BH, BW, and body proportionalities, which affects their results in motoric tests. According to Šelingerová & Šelinger (2009/b) biologically accelerated young athletes achieve better results in strength and speed tests.

The aim of this thesis was to evaluate the level of physical indicators and changes in selected motor abilities of young basketball players in the annual macrocycle with regards to their biological age.

Methodology

For this study we selected 6 players from the whole team. The selection was made on the recommendations: two players were according to the norms from the zone of developmental retardation (BioRet), two players whose decimal and biological age i.e. bone age was identical (DC = BV), and the other two were in the biological acceleration zone (BioAkc.). All players were 13-years old and competed in the U14 category.

The entire tracked period was a 1-year macrocycle. We investigated the decimal (calendar, chronologic) and biological (bone) age, level of the physical development, body height prediction, length of the sports specialization (Table 1) and the level of selected general and specific motor abilities and skills (Table 2). In the tests we evaluated the standing long jump (SLJ), throw with 2 kg med ball (TMB), 20 m acceleration run (20 m) and 20 m acceleration run with dribble (20 m dribble). Dribbling was only by the dominant arm. Both runs were measured with photocells with an accuracy of one hundredths of a second. The training process focused on the development of general motoric abilities and specific basketball skills. The first testing was conducted in August, at the beginning of the general basketball preparation phase. Output tests were made shortly before the end of the main competition period, more precisely before the final preparation for the Slovakian Championship (MSR) in April. The same conditions for warm-up and the same number of training and evaluated attempts have been administrated.

Biological maturation (assessed by bone age) and body height prediction by Tanner et al. (2001) evaluated an expert at FTVS UK. When processing and evaluating research data, we used logic methods to compare, deduct, and generalize.

Results and discussion

Decimal age, which is the age in years and months, is commonly used when assessing the performance (in tests) of children and adolescents. However, many studies have demonstrated how the performance level is different in relation to biological age, i.e. sexual maturity, especially in adolescents (Kohoutek 1995; Šelingerová & Šelinger 2016; Ortega et al.

2008). In this life period the peers undergo the most significant biological changes; nevertheless the talent and selection procedures for sports classes, sports schools, and first picks for U14, U16 national basketball teams are made as well (Lithuania, Srbi, Letter, Šelingerová & Šelinger 2016). As can be seen in Table 1, a homogeneous group of players with the same decimal year was selected in our group; the age was ranging from 13.3 to 13.9-years. However, if we look at their biological age, we see very large individual differences. The biggest variances were in the developmentally accelerated i.e. early maturing (2.2 and 1.9 years) and developmentally retarded i.e. late maturing players (1 and 1.7 years respectively). This large variation in the biological age, in our case almost 4 years, has confirmed research by authors who spoke about the problematic puberty period in terms of great developmental variability. Body height is one of the basic prerequisites for success in basketball. Therefore, the basketball clubs should focus to choose girls who are tall, or have a predisposition for an above average body height (compare to the population). In the first testing we found a more favorable, i.e. higher body height (BH) values for girls who were late maturing but also early maturing. Their height varied from 176 to 178 cm; and they were classified according to the norms above the average height of the 13-year-old population (Sedláček & Cihová 2009). On the other hand, large individual body weight (BW) values ranging from 49.5 to 76.3 kg were recorded with the players. Authors Sedláček & Cihová (2009) refer to BMI standards for a 13-year-old population as follows: average 17.0 – 20.5, above average 20.5 – 22.7 and above 22.7 significantly above average. In the comparison of these values, it can be seen that both late maturing players and one of the early maturing one have average BMI. The others are classified significantly above average. However, for a more accurate assessment of players it would be better to measure their body fat percentage than a BMI conversion that is used for the population.

Besides the biological age, it is also important to know the sport age of the players, which can also significantly affect the results in motoric tests. Trninić, Papić et al. (2008) stated that players with longer sports training/preparation more supposedly achieve better results in motoric tests. According to the authors, players who mature faster (accelerants) and who have a longer training experience are more effective in the game (even in game statistics) than those who are slower in maturing (retardants). Therefore, it is important to know that maturing retardants may have considerably greater potential in the long term than accelerants. In our case, the sport specialization age was 6 years, except for 2 players.

In Table 1 we also predict players BH in adulthood. Higher values are calculated for players biologically retarded, i.e. late maturing. Still, it is necessary to stress out that the

predicted BH in the pubertal period is influenced by many factors, and it can differ greatly in adulthood.

Table 1

The characteristics of decimal and biological age, body height, body weight, BMI, height prediction in adulthood, and age of specialization

Player		DA (age)	BA (l)	BH [cm]	BW [kg]	BMI (l)	Prediction of BH [cm]	Specialization training age
BioRet	J.I.	13,3	12,3	177	58	18,58	184 - 186	6
BioRet	K.J.	13,9	12,2	176	49,5	16,35	182 - 185	6
DC=BV	Z.M.	13,5	13,6	166	65,9	23,91	173	3
DC=BV	K.H.	13,3	13,4	166	64,8	23,73	173 - 174	4
BioAcc.	P.V.	13,8	16,0	178	76,3	24,08	181 - 182	6
BioAcc.	V.M.	14,1	16,0	178	64	20,2	182	6

Note: DA - decimal age, BA - biological age, BH – body height, BW – body weight, Specialization training age – years of specific basketball preparation, BioRet - biological retardation, BioAcc. - biological acceleration

When comparing the input values of players in motoric tests (Table 2) we cannot say that the early maturing players were getting better results in all strength and speed-specific tests compare to the late maturing players or those with a same decimal and biological age.

Table 2

Input values of motoric performance in general and specific tests

Player		SLJ [cm]	TMB [cm]	20 m [s]	20 m dribble [s]
BioRet	J.I.	185	600	3,82	4,09
	K.J.	162	560	3,92	4,39
DC=BV	Z.M.	153	550	4,13	4,45
	K.H.	182	640	3,51	4,07
BioAcc.	P.V.	153	680	3,77	4,01
	V.M.	160	630	3,54	3,83

Note: SLJ - standing long jump, TMB - 2 kg medicine ball throw from standing position, 20 m – 20 m acceleration run, 20 m dribble -20 m acceleration run with dribble

The first test was to assess the explosive strength of the lower extremities, which is one of the key factors influencing the sport performance in basketball. Explosive strength is used in many individual player's actions (rebounding, shooting), as well as when starting, accelerating and changing the direction of movement (Šimonek 2004; Šimonek, Doležajová & Lednický 2007). Parisi (2008/a) considers it to be one of the components of so-called "GameSpeed". We measured a very low level of explosiveness in test results of the early maturing players (153

and 160 cm). Player P.V. attained the lowest performance, in our opinion mostly due to her high BW and BMI that were documented at the input measurement. Biologically accelerated players were by the norms for 13-years old population in SLJ (Sedláček & Cihová 2009) under average; while biologically retarded player K.J. was above average (185 cm).

However, the early maturing players used their height and weight as advantage in the TMB test. The performance of late maturing players in the TMB test was according to the standards for the population (Sedláček & Cihová 2009) average to above average, while the early maturing players were classified as above average or significantly above average.

Specific basketball tests 20 m acceleration run and 20 m acceleration run with dribbling are used for the evaluation of basketball players performance in our country (Bulík & Doležajová 2006; Tománek & Moravec 2005), but also in other countries (Paulauskas 2003; Erčulj 2005; Simovic & Mijanovic 2007; Erčulj & Bračič 2008). Nonetheless, there are not yet made the performance standards of these tests for the population, or for specific sports. The quality of running speed is an elementary basis and a necessary prerequisite for achieving a high sport performance. Running speed and its maximum level is the potential of an athlete; without it an athlete cannot successfully compete in sports where the speed abilities are limiting factors of the sport performance. In certain sports in which the running speed is mediated through others, more complex factors it can be partially compensated, but it is always problematic to a limited extent (Sedláček 1992).

In the test 20 m acceleration run, the best performance 3.51 s was achieved by K.H., a player in the DV = BV group. Little bit lower values were recorded by the early maturing players: 3.54 s and 3.77 s, while players biologically retarded obtained the worst results in this test. In the specific basketball test 20 m acceleration run with dribble is the speed of the run combined with the specific dribbling skill. This means that this is not a "pure" conditional test. The best performances 3.83 s and 4.01 s achieved the biologically accelerated players.

Player V.M. achieved a good result (3.54 s) in acceleration speed test, but showed a relatively low, under average explosive strength of the lower extremities evaluated by the SLJ test (only 160 cm). Lower performance was recorded also by the biologically retarded player K.J. (4.39 s), with similar result in the test 20 m run. The worst result was achieved by player Z. M. from the group DV=BV (4.45 s). This result could have been affected by her age of sport specialization because this player had the lowest (3 years) specialization age of all participants observed.

Table 3

Characteristics of the output somatic indicators after 8 months

Player		**BH [cm]**		**BW [kg]**		**BMI (I)**	
		output	change	output	change	output	change
BioRet	J.I.	185	+8	64,6	+6,4	18,88	+0,30
	K.J.	181	+5	57,1	+7,6	17,43	+1,08
DC=BV	Z.M.	170	+4	66,7	+0,8	23,08	+0,83
	K.H.	170	+4	64,8	0,0	22,42	-1,31
BioAcc.	P.V.	179	+1	78,2	+1,9	24,41	+0,33
	V.M.	181	+3	67,4	+3,2	20,57	+0,37

As we mentioned in the introduction, the puberty period is one of the most dynamic periods in terms of physical growth. This fact was proved in our group of girls. At the end of the 8-months period we evaluated the body indicators (Table 3). We recorded significant individual increases in all monitored indicators. We monitored that the biggest changes of individual BH occurred with the late maturing players (values increased by 8- and 5 cm). Their BH was getting closer to their predicted maximum values (185 and 186 cm respectively). We monitored the lowest growths (1 and 3 cm) with the early maturing players.

Major changes in BW occurred in a group of late maturing players (6.4 and 7.6 kg). None or very low increases (0 - 3.2 kg) were recorded in the other two groups. Anyhow, these changes in the BH and BW indicators were proportional and did not really show on BMI.

Table 4

Output level and changes in the general and specific motoric tests during macrocycle

Player		**SLJ [cm]**		**TMB [cm]**		**20 m akc. [s]**		**20 m dribble [s]**	
		output	change	output	change	output	change	output	change
BioRet	J.I.	185	0	630	+30	3,64	-0,18	3,94	-0,15
	K.J.	190	+28	630	+70	3,86	-0,06	3,98	-0,46
DC=BV	Z.M.	167	+14	550	0	3,89	-0,24	3,98	-0,47
	K.H.	200	+18	740	+100	3,32	-0,19	3,61	-0,46
BioAcc.	P.V.	170	+17	660	-20	3,73	-0,03	3,98	-0,03
	V.M.	189	+29	580	-50	3,31	-0,23	3,51	-0,32

In the final testing of general and specific motoric abilities, we found great differences in all three groups of players (Table 4). In the speed-strength test SLJ, we have seen varying levels of players performance - from stagnation to improvement by 29 cm. Among the more significant improvement are those which were the lowest in the initial test (28 and 29 cm). We assume that these results were affected not only by biological development but also by the

general training effects. In the TMB test, the range of changes was even more obvious (from decrease of 50 cm to 100 cm improvement). Surprisingly, we measured lowering of the achieved result by biologically accelerated players and improvements of both late maturing players. The most significant improvement was recorded by the DV = BV player. In the 20 m acceleration run test the peak performances was achieved by players with DV = BV (improvement -0.24 s) and by one of the biologically accelerated player (-0.23 s). Interestingly, the smallest improvement (only -0.06 s) we recorded by the biologically retarded player although she had almost the highest increase in the test 20 m run with dribble (-0.46 s). This fact confirmed conclusion made by Hirtz et al. (1985) that those significant changes in body height might negatively affect the level of coordination capabilities, especially frequency of movement. The improvement in the 20 m test with dribble indicates the positive impact of the training process. This player had almost the worst performance at the first testing (4.39 s). The same applies to a DV=BV player who achieved an improvement -0.47 s in the test 20 m with dribble from the entry level of 4.45 s. Improvement occurred despite the fact that this player was the youngest according to the sport age from the whole group.

We are aware of the complexity and the timeliness of this subject, because in this age the development of the motor abilities and learning the skills is influenced by many factors, which might not be noticed by a coach. Besides the visible factors resulting in changes in the physical indicators, there are many other hidden factors the coach might not be aware of (family problems, poor school results, social environment, etc.). Changes in the physical indicators can positively affect the performance in speed- strength tests and also mediate and improve the individual sport specific skills.

On the other hand, the higher somatic gains negatively affect the running speed, especially the frequency of a movement (Hirtz et al. 1985). Another factor is the process of motoric learning of new motoric skills (e.g. dribbling) and their transition into e.g. acceleration run with a dribble. The length of sports specialization also has an impact on the changes in performance.

Conclusions

1. We have confirmed that there are great differences in biological age in a group of 13-years old girls – in our research it has shown almost four years difference.

2. We found out that differentiated gains occurred in physical indicators and in motor performance in groups with the same decimal and biological age; and in groups of biologically retarded (late maturing) or accelerated girls (early maturing).
3. We did not confirm the author's conclusions that biologically accelerated individuals achieved better results than the retarded ones in the speed and strength tests.
4. It is necessary to monitor body weight gains and levels of motor abilities (as well as other factors) that interrelate to increasing the performance in the pubertal period.
5. We found out those biologically retarded individuals i.e. late maturing players achieve greater improvements in the test results and they were gradually catching up on the biologically accelerated ones. On this basis we recommend to pay attention in the training process to the players who appear as non-perspective due to their current biological development.
6. We are aware of the fact that the above test results are indicative, given the number of players, and their validity should be proved on a larger number of players.

The contribution is a part of the grant project VEGA no. 1/0852/18: Laczo E.: Identification of Biological Factors Conditioning the chosen Indicators of Motor Performance, Healthy Growth and Children's Development during their Elementary Stage of Sport Preparation.

References

1. BULÍK, M. & L. DOLEŽAJOVÁ, 2006. Efektivita rozvoja rýchlostných schopností mladých basketbalistov špecifickými prostriedkami. In MAČURA, P. *Zborník vedeckých prác Katedry FTVŠ UK č. 5.* Bratislava: Občianske združenie Športové hry a FTVŠ UK: pp. 13-18. ISBN 80-89197-51-5.
2. ERČULJ, F., 2005. Impact of Speed of Alternating Leg Movements and Take-off Power on Acceleration Speed in Young Basketball Players. In DIKIĆ, N., ZIVANOVIĆ, S., et al. (ed). *10th Annual Congress of the European College of Sport Science*, Beograd : Sport Medicine Association of Serbia: pp. 262-263. [elektronická pošta]. Správa pre: Tatiana GALLOVÁ. 2010-8-4 (citované 8.4.2010). Osobná komunikácia.
3. ERČULJ, F. & M. BRAČIČ, 2008. Raven razvitosti nekaterih motoričnih sposobnosti mladih košarkaric iz devetnajstih evropskih držav in Slovenije. In *Trener košarke.* dec. 2008, letn. 7, št. 1: pp. 78-84, ilustr., graf. prikazi. [elektronická pošta]. Správa pre: Tatiana GALLOVÁ. 2010-8-4 (citované 8.4.2010). Osobná komunikácia. Dostupné z: <http://orbis.kzs-zveza.si/slozkts/ftp/trener_kosarke_1_2008.pdf>.

4. GAMBLE, P., 2008. Approaching Physical Preparation for Youth Team-Sports Players. In *Strength and Conditioning Journal.* **1**, vol. 30, February 2008: p. 29-42. ISSN 1524-1602
5. HIRTZ, P. et al., 1985. *Koordinative Fähgkeiten im Schulsport*. Berlin : Volk und Wissen volkseigner Verlag.
6. CHIVIACOWSKY, S. et al., 2008. Learning Benefits of Self-Controlled Knowledge of Results in 10-Year-Old Children. In *Research Quarterly for Exercise and Sport*, Vol. 79, No. 3, September 2008, Reston, VA : American Alliance for Health, Physical Education, Recreation and Dance: pp. 312-318. ISSN 0270-1367.
7. ORTEGA, F.B. et al., 2008. Health-related physical fitness according to chronological and biological age in adolescents. The AVENA study. In *The Journal of Sports Medicine and Physical Fitness.* **48(**3). Torino: Edizioni Minerva Medica: pp. 371-379. pISSN 0022-4707, eISSN 1827-1928.
8. PAULAUSKAS, R., 2003. Altitude training for basketball. In *FIBA ASSIST MAGAZINE 2.* May/June: pp. 59-60.
9. PERIČ T., A. LEVITOVÁ & M. PETR, 2012. *Sportovní příprava dětí*. Praha: Grada. ISBN 978-80-247-7142-7
10. SEDLÁČEK, J., 1992. Efektivita výberu talentovanej mládeže v behoch na krátke vzdialenosti so zameraním na motorické faktory. Dizertačná práca. FTVŠ UK.
11. SEDLÁČEK, J. & I. CIHOVÁ, 2009. *Športová metrológia.* Bratislava: ICM Agency. ISBN 978-80-89257-15-7
12. SIMOVIĆ, S. & M. MIJANOVIĆ, 2007. Diskriminativna analiza parametra izabranih i odbačenih kadetkinja za sudjelovanje u ljetnjoj školi sporta „Trebinje 2007“. In BILIĆ, Ž. *Acta Kinesiologica. International Scientific Journal on Kinesiology.* **1**(2): pp. 23-28. ISSN 1840-2976.
13. ŠELINGEROVÁ, M. & P. ŠELINGER, 2009/a. Biologické aspekty športovej prípravy mládeže. In *Výsledky somatických a antropomotorických výskumných meraní v oblasti mládežníckeho športu*. Bratislava: FTVŠ UK: pp. 76-88. ISBN 978-80-89257-17-1.
14. ŠELINGEROVÁ, M. & P. ŠELINGER, 2009/b. Vzťah medzi biologickým vekom a motorickou výkonnosťou u mládeže v puberte. In *Výsledky somatických a antropomotorických výskumných meraní v oblasti mládežníckeho športu*. Bratislava: FTVŠ UK: pp. 97-104. ISBN 978-80-89257-17-1.
15. ŠELINGEROVÁ M. & P. ŠELINGER, 2016. *Športová antropológia.* Bratislava. ICM Agency.

16. ŠIMONEK, J., L. DOLEŽAJOVÁ & A. LEDNICKÝ, 2007. *Rozvoj výbušnej sily dolných končatín v športe*. Bratislava: SVSTVŠ. ISBN 978-80-89075-32-4.
17. VOLKOV, V. & V. M. FILIN, 1983. Sportivnyj otbor. Moskva: FiS.
18. TOMÁNEK, Ľ. a R. MORAVEC, 2005. Úroveň rýchlostných schopností vo vzťahu k hernej výkonnosti u 14 – 15 ročných basketbalistov. In MAČURA, P., TÓTH, I. *Zborník vedeckých prác Katedry hier FTVŠ UK č. 3.* Bratislava : Občianske združenie Športové hry a FTVŠ UK: pp. 157-161. ISBN 80-89197-30-2.
19. TRNINIĆ, S., V. PAPIĆ, V. et.al., 2008. Players selection procedures in team sports games. In BILIĆ, Ž. *Acta Kinesiologica. International Scientific Journal on Kinesiology.* **2(**1): pp. 24-28. ISSN 1840-2976.