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Full Length Research Paper

Normative values for evaluation of children physical education level: According to chronological age or biological age?

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ABSTRACT

This research was conducted to determine whether there are differences between the norm values used in the evaluation of children who train in different sports and physical education lessons according to the chronological age and biological age of the children. The research group consists of a total of 239 male students of 13 (n=116) and 14 (n=123) chronological years, who study in grades 7 and 8. In addition, the biological ages of the students who make up the research group are calculated and divided into 13 (N=140) and 14 (n=86) biological age groups. Within the scope of the research, heights, body weights, body mass indexes and body fat percentages of students were determined as anthropometric variables. Hand grip, leg strength, flexibility, horizontal and vertical jump, medicine ball throwing, ball throwing and sprint running skills were measured as motoric performance variables. The differences of variables according to chronological age and biological age were calculated by the Independent-Samples t-test. According to age groups, the arithmetic mean (x) is shown as 10%. While establishing the norm, the ratings accepted as Canadian criteria were used. In our study, significant differences were found between body weights in 13 and 14 age groups according to both chronological age and biological age. While there is a similarity in 13 age group in terms of heights, difference in favor of biological age was calculated in 14 age group. Even if there is no difference in the comparisons made for the biomotor abilities that are the subject of our study, percentage differences were found in comparing norm values in 10% slices according to chronological age and biological age. Thanks to norm values generated according to both chronological and biological age, the physical condition of the children, strengths and weaknesses related to the level of students in physical education classes, according to the separation of the application groups of children directed to the appropriate sport or the athletes and the students about training programs that will be applied to the course content it is envisaged that the results of this research will provide guidance. In this way, it is thought that by dividing the chronological age and biological age in children, a possible loss of motivation will be prevented in both physical education and training and competitions.

Keywords: Chronological age, biological age, physical education, norm.

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INTRODUCTION

Growth is expressed by the increase in cell size and number, and by the increase in body size (length and body weight) and the increase in the size of organs (İnce et al., 2011). Development is the structure of the tissues of the growing organism (Özer, 1990), changes in the biochemical composition (Hills et al., 2007) and a term that refers to the acquisition of biological functions (Bakkaloğlu et al., 2019). Generally, growth is considered as chronological age and development is considered as biological age. Although the age of the chronological is easily determined, the biological age cannot be determined easily (Lloyd et al., 2014). In addition, the

growth acceleration that started between 11-16 years and continued for 2-3 years is called PGS (Pubertal Growth Spurt). Approximately half of the weight in adult life is gained during the growth period and height increase reaches its maximum (Köseoğlu and Çelebi, 2017).

Calculated as a time point from birth, chronological age has traditionally been used to classify age groups, identify talented athletes and prescribe exercise (Lloyd et al., 2014). However, it is clearly emphasized in the literature that children with the same chronological age may differ significantly according to biological maturity (Baxter-Jones et al., 2005). Biological age refers to progress towards timing, adaptation, development and change between different body systems (Beunen and Malina, 2008). Due to these changes, children can biologically mature before their chronological age (early maturation), at the same time as their chronological age (average ripening) and after their chronological age (late ripening). The wide variety and incompatibility of biological maturation among children of the same chronological year highlights the limitations in using chronological age as a global exercise prescription marker (Lloyd et al., 2014). Especially when evaluating the motor efficiency of adolescent and pre-adolescent children, their somatic and functional development should not be ignored. It is necessary to know the biological maturation of the child related to a certain age norm in order to correctly evaluate the development trends. This evaluation is made by determining the biological age (Suchomel, 2003).

Peak height velocity (PHV), which is defined as rapid growth in the early maturation period, is important in determining biological age in sports applications and preparing appropriate training contents, as well as femoral head pineal shift (Sanders, 2007; Sitasikelis et al., 1996), scoliosis (Little et al., 2000) is an extremely important indicator of physiological maturity in various diseases such as potential limb length inequality and adolescent Blount's disease (leg curvature) (Hans et al., 2008). During PGS, the maximum increase in height is used to estimate biological age with PHV (Malina et al., 2004; Söğüt, 2019).

Many researchers assume that different biomotor abilities and performance components that are closely related to biological growth can be developed in certain developmental processes and a greater part of the genetic potential can be acquired at these stages (Açıkada and Hazır, 2016; Balyi and Hamilton, 2004). It is known that biomotor abilities, which are classified as strength, speed, endurance, mobility and coordination, accelerate the development of sports-related movements phase (Hürmüz and Tekin, 2011) and physical education lessons also contribute to development (Hekim and Hekim, 2015). However, since children are routinely classified according to chronological ages regardless of biological development, some misclassifications may occur regarding their biological development (Ortega et al., 2008). Therefore, normalization studies are important.

There are 700 tests about biomotor abilities. These tests, which have a complex structure, are also combined in many test batteries. Bös (2003) states that these complex tests can be reduced to fewer basic applications (standing long jump, 20 m. Running, push-ups, shuttle etc.) and test type (fitness, fitness, coordination tests) by examining in detail (Bös, 2003). There are some protocol examples where test reliability is very high and test application method is standardized. There are age and gender-specific test result norms in the literature (Muratlı, 2003). The expressiveness, applicability, norm and comparability values of the data obtained from the tests are important (Bös, 2003). Motoric tests, determined by the need of measurement in sports, are applied to a high number of groups, results and norms are formed. Thanks to this normal, objectivity will increase in future decisions regarding the application group (Bayraktar, 2010). Normalization methods are quite enough in the world (Berisha, 2018).

According to Sevim, the concept of standardization that we encounter at the point of making the test results available refers to the determination of the visual status of a candidate in the group (Sevim, 2002). Norm comes to the meaning of the dictionary as a rule, it means the situation, regularity, the model or standard, sample, size, and standard meant for a certain group (TDK, 2020).

This research was carried out to determine whether there are differences between physical education lessons and the norm values used in the evaluation of children training in different sports according to the chronological age and biological age of the children.

MATERIALS AND METHODS

Participants

The research group consists of 239 male students studying in 7th and 8th grades, 13 (n = 116) and 14 (n = 123) chronological years. In addition, the biological ages of the students constituting the research group were divided into 13 (n = 140) and 14 (n = 86) biological age groups.

Applied measurements and tests

Within the scope of the research, heights, body weights, body mass indexes and body fat percentages of students were determined as anthropometric variables. Hand grip, leg strength, flexibility, horizontal and vertical jump, medicine ball throwing, ball throwing and sprint running abilities were measured as motoric performance variables.

Portable stadiometer (Charder HM-200P) was used for length measurements, and Tanita MC 780 S was used

for body weight and body fat percentage measurements. The data in the grip force (Takei) and leg strength (Baseline) tests were collected with the help of dynamometers. Smart Jump (Fusionsport) bounce mat was used in CMJ (counter movement jump) and free arm vertical jump tests. In anaerobic power calculation, the CMJ values (d) and body weights (BM) of the students were calculated (AP (watt) = {(√4.9 × BM) × √d} × 9.81). Steel meter was used for the measurement of standing long jump and medicine ball (2 kg) throw tests. In the sit and reach (Baseline) test, flexibility values were determined with the modified protocol in which the arm length was normalized. Electronic photocell system (Smartspeed, Fusionsport) was used to measure the 30-meters sprint test used as a speed test.

The PHV was calculated by the predictive equation of Mirwald et al. (2002). The equation require the information which are the chronological age, body mass, standing height, seated height and leg length of students.

Statistical analysis

The mean and standard deviation values of the variables of the research group were calculated for 13 and 14 years of age according to both chronological age and biological age. The differences between chronological age and biological age were examined by the Independent-Samples t-test.

Pearson correlation statistics were used to calculate the relationships between chronological age and biological age and research variables**.** Interpretation of correlation coefficients was as follows: r≤ 0.49 weak relationship; 0.50 ≤ r ≤ 0.74 moderate relationship; and r≥ 0.75 strong relationship (Portney and Watkins, 2015).

For the statistical procedure IBM-SPSS 20.0 pocket program was applied and statistical significance was set at $p < 0.05$. Arithmetic means (x) were shown in the tables according age groups as slices of 10%. In use of the norms in the tables; the following grading accepted as Canada criterion was taken as criterion (Adams, 1998).

It was calculated as follows:

- Scores below 20%; “weak” or “low”
- Scores between 21-40%; “below average”
- Scores between 41-60%; “average”
- Scores between 61-80%; “above average”
- Scores above 81%, “very high” or “perfect”

RESULTS

Anthropometric characteristics of the students grouped by the same chronological age and the same biological age, and comparison results of biomotor power variables are given in Tables 1 to 4. Chronological age of research variables and relationship statistics with biological age are described in Table 5. Tables 6 to 13 shows normative values for research variables have been established according to their ages.

13 and 14 age groups, significant differences were observed between the chronological and age and body weight according to biological age at $p < 0.05$ level. While there was a similarity in 13 age group in terms of height, a significant difference was calculated at $p < 0.05$ level in favor of biological age at age 14. It was found that there was a similarity in body mass index and body fat percentage values in both chronological age and biological age groups at 13 and 14 years of age (Table 1).

When the results of the T-test of the strength variables were examined, similarities were found between the chronological age and biological age of both ages. Total hand grip and leg strength averages are higher in the chronological age group of 13, while relative hand grip and relative leg strength averages are higher for the biological age group. The average of 14 years of age in the chronological age of relative hand grip is higher, while the average of total hand grip, leg strength and relative leg strength are higher in the biological age group (Table 2).

There were no significant differences in standing long jump, CMJ and arms free vertical jump values between the groups in both age groups. In the anaerobic power findings, which were calculated based on CMJ and body weight, statistically significant differences were calculated in both age groups according to chronological age and biological age. Standing long jump and VJ-Free Arm are on average higher in favor of biological age in both age groups. CMJ and Anaerobic Power appear to be in favor of chronological age in 13 age group and biological age in 14 age group (Table 3).

Similarities for both age groups in terms of biological and chronological age were observed in the values of medicine ball throw over the knee distance, throwing ball speed, flexibility and speed capabilities. In both age groups, the 30 m feature has a higher average in favor of the chronological age. The medicine ball throw feature appears to be in favor of the biological age in the 14 age group and the chronological age in the 13 age group (Table 4).

When the relationships of the research variables according to chronological age and biological age were examined, it was seen that all other relationships detected were more related to the biological age than the chronological age, except for the low relationship level with the long jump (Table 5).

Body weight differs between chronological age and biological age in the age group of 13 by 3.9%, height by 0.9%, BMI by 4.1% and body fat by 8.6% (Table 6).

Chronological age and biological age differed in 14 age groups by 7.2% in body weight, 1.6% in body height, 4% in BMI and 7.4% in body fat (Table 7).

In the 13-year age group, total hand grip was found to

Table 1. Comparison results of anthropometric features by chronological age and biological age.

Variables		Age of 13				Age of 14			
		n	Mean	SD	*p*	n	Mean	SD	*p*
Body mass (kg)	CA	116	60.10	10.54	0.046*	123	58.75	10.53	0.003*
	BA	140	57.53	9.76		86	63.15	10.05	
Body height (cm)	CA	116	170.44	6.46	0.21	123	172.42	6.30	0.000*
	BA	140	169.57	4.58		86	175.40	4.42	
BKİ (kg/m^2)	CA	116	20.60	3.21	0.08	123	19.63	3.10	0.07
	BA	140	19.91	3.15		86	20.44	3.18	
Body Fat (%)	CA	116	18.21	4.67	0.05	123	16.44	4.44	0.12
	BA	140	17.05	4.73		86	17.41	4.45	

Table 2. Comparison results of force abilities.

Variables		Age of 13				Age of 14			
		n	Mean	SD	*p*	n	Mean	SD	*p*
Total hand grip (kg)	CA	116	63.55	11.35	0.87	123	67.89	12.84	0.06
	BA	140	63.33	10.15		86	71.25	12.01	
Relative hand grip	CA	116	1.07	0.20	0.07	123	1.17	0.19	0.37
	BA	140	1.12	0.20		86	1.15	0.20	
Leg strength (kg)	CA	116	92.68	25.45	0.68	123	104.03	27.00	0.05
	BA	140	91.44	23.01		86	111.39	26.86	
Relative leg strength	CA	116	1.56	0.43	0.33	123	1.79	0.43	0.97
	BA	140	1.61	0.42		86	1.80	0.45	

Table 3. Comparison results of horizontal and vertical jump skills.

Variables		Age of 13				Age of 14			
		n	Mean	SD	*p*	n	Mean	SD	*p*
Standing long jump (cm)	CA	116	161.03	22.66	0.52	123	168.64	27.05	0.81
	BA	140	162.96	24.09		86	169.55	26.99	
CMJ (cm)	CA	116	28.23	5.24	0.89	123	27.82	6.35	0.75
	BA	140	28.14	5.15		86	28.10	6.64	
VJ - free arm (cm)	CA	116	32.28	6.32	0.80	123	32.75	7.38	0.96
	BA	140	32.48	6.43		86	32.80	7.53	
Anaerobic power (watt)	CA	116	687.65	120.56	0.03*	123	663.55	121.95	0.002*
	BA	140	656.38	104.10		86	717.32	128.07	

be 1.5%, relative hand grip by 4.1%, leg strength by 4.2% and relative leg strength by 3.7% between chronological age and biological age. It is seen that these differences are in favor of biological age (Table 8).

In the 14-year age group, there was a difference between chronological age and biological age by 5% of

Table 4. Comparison results of throwing, flexibility and speed capabilities.

Variables		Age of 13				Age of 14			
		n	Mean	SD	*p*	n	Mean	SD	*p*
Medicine ball throw (cm)	CA	116	530.74	103.26	0.98	123	553.30	116.00	0.22
	BA	140	530.36	106.32		86	572.98	108.62	
Throwing ball (km/h)	CA	116	71.28	11.99	0.17	123	77.88	14.15	0.79
	BA	140	73.33	11.55		86	77.33	15.53	
Sit & Reach (cm)	CA	116	31.86	7.73	0.66	123	33.57	7.95	0.07
	BA	140	31.44	7.58		86	35.59	7.78	
30 m (s)	CA	116	5.10	0.40	0.76	123	4.97	0.38	0.56
	BA	140	5.08	0.39		86	4.94	0.39	

Table 5. Relationship between research variables and chronological age and biological age.

Parameter		13 Age (n = 116)		14 Age (n = 123)	
		CA	BA	CA	BA
Body fat (%)	r	-0.10	0.00	0.00	0.29**
	p	*0.27*	*0.98*	*0.96*	*0.001*
Total hang grip (kg)	r	0.20*	0.55**	0.06	0.49**
	p	*0.03*	*0.000*	*0.49*	*0.000*
Leg strength (kg)	r	0.11	0.32**	0.18	0.42**
	p	0.26	0.001	0.05	0.000
SLJ (cm)	r	0.18*	0.11	0.12	0.07
	p	*0.05*	*0.22*	*0.20*	*0.42*
CMJ (cm)	r	0.17	0.21*	-0.11	-0.06
	p	*0.07*	*0.02*	*0.23*	*0.52*
VJ - free arm (cm)	r	0.10	0.14	-0.05	-0.03
	p	*0.29*	*0.14*	*0.61*	*0.78*
AnP (watt)	r	0.15	0.58**	-0.05	0.47**
	p	*0.10*	*0.000*	*0.59*	*0.000*
M-Ball throw (cm)	r	0.00	0.35**	0.09	0.30**
	p	*0.96*	*0.000*	*0.35*	*0.001*
Throwing ball (km/h)	r	0.08	0.06	0.16	0.12
	p	*0.37*	*0.53*	*0.08*	*0.18*
Sit & Reach (cm)	r	0.05	0.23*	0.12	0.18
	p	*0.59*	*0.01*	*0.20*	*0.05*
30m (s)	r	-0.20*	-0.24*	-0.15	-0.19*
	p	*0.03*	*0.01*	*0.10*	*0.03*

** p < 0.05*

Table 6. Normative values of anthropometric variables for the age of 13.

13 Age			Body mass (kg)			Body height (cm)			BMI (kg/m^2)			Body fat (%)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	48.5	46.4	4.4	162.9	163.5	0.4	25.2	24.5	3.1	25.5	23.7	7.1
		20	51.6	48.8	5.4	166.3	165.6	0.4	22.7	21.7	4.4	21.4	20.5	4.4
	Below average	30	54.8	51.3	6.5	168.5	167.4	0.6	21.5	20.8	3.0	19.3	18.1	6.0
		40	57.1	54.6	4.3	169.5	168.6	0.5	20.6	20.0	3.2	17.9	17.2	4.2
	Average	50	58.7	56.6	3.7	170.4	169.6	0.5	20.0	19.3	3.5	17.3	16.2	6.1
		60	60.6	58.5	3.6	171.6	170.5	0.7	19.3	18.8	2.4	16.4	15.3	6.2
	Above average	70	63.6	60.3	5.2	173.3	171.8	0.8	18.9	18.1	4.2	15.3	14.2	7.1
		80	66.0	63.6	3.6	174.9	173.6	0.7	18.0	17.3	4.1	14.2	13.0	8.7
	Very high	90	72.0	71.1	1.3	177.7	175.5	1.3	17.0	16.3	3.9	12.9	12.1	6.0
		99	92.0	91.1	1.0	187.2	180.6	3.5	15.9	14.5	8.8	11.2	7.9	30.0
Mean					3.9			0.9			4.1			8.6

CA: n = 116; BA: n = 140.

Table 7. Normative values of anthropometric variables for the age of 14.

14 Age			Body mass (kg)			Body height (cm)			BMI (kg/m^2)			Body Fat (%)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	46.0	52.9	14.9	164.8	169.6	2.9	23.9	24.6	3.2	22.3	22.4	0.6
		20	49.2	54.3	10.4	167.1	171.3	2.5	21.8	22.4	2.8	19.8	20.3	2.4
	Below Average	30	53.0	57.6	8.6	169.1	172.3	1.9	21.0	21.6	2.9	18.0	19.3	7.3
		40	55.2	59.4	7.6	170.8	174.1	1.9	19.6	20.7	5.4	16.7	17.8	6.7
	Average	50	57.7	61.9	7.3	172.2	175.6	2.0	19.1	20.1	5.0	15.7	17.1	8.6
		60	60.2	63.7	5.8	174.1	177.0	1.7	18.4	19.2	4.3	14.8	15.7	6.2
	Above Average	70	62.8	66.6	6.0	176.4	178.0	0.9	17.7	18.8	6.1	13.8	14.7	6.4
		80	67.3	69.9	3.9	177.6	179.3	0.9	17.0	17.6	3.8	12.9	13.7	6.7
	Very High	90	71.1	74.6	4.9	179.6	180.8	0.7	16.2	17.0	4.8	11.6	12.8	10.3
		99	89.3	91.9	2.9	186.5	185.3	0.6	14.3	14.5	1.6	7.6	9.0	18.7
Mean					7.2			1.6			4.0			7.4

CA: n=116; BA: n=140

Table 8. Normative values of strength variables for the age of 13.

13 Age			Total hand grip (kg)			Relative hand grip			Leg strength (kg)			Relative leg strength		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	48.7	51.5	5.7	0.8	0.9	7.6	57.6	63.5	10.2	1.0	1.1	8.1
		20	54.8	54.7	0.2	0.9	0.9	2.4	77.1	72.6	5.8	1.2	1.3	6.8
	Below Average	30	58.5	58.1	0.6	1.0	1.0	6.5	81.6	81.6	0.0	1.3	1.4	4.3
		40	60.9	60.7	0.4	1.0	1.1	4.9	81.6	83.4	2.3	1.4	1.5	4.5
	Average	50	63.1	62.6	0.9	1.1	1.1	3.7	90.7	90.7	0.0	1.5	1.6	3.3
		60	67.2	65.0	3.3	1.1	1.2	7.9	99.8	95.3	4.5	1.6	1.7	1.2
	Above Average	70	69.6	69.1	0.7	1.2	1.2	3.3	104.3	99.8	4.3	1.8	1.8	2.3
		80	71.8	71.9	0.3	1.3	1.3	0.8	111.6	108.9	2.4	2.0	2.0	1.1
	Very High	90	76.6	75.6	1.3	1.3	1.3	2.2	128.4	126.6	1.4	2.1	2.2	1.9
		99	98.6	96.9	1.7	1.6	1.6	1.7	170.9	152.1	10.9	2.9	2.8	3.6
Mean					1.5			4.1			4.2			3.7

CA: n=116; BA: n=140.

Table 9. Normative values of strength variables for the age of 14.

14 Age			Total hand grip (kg)			Relative hand grip			Leg strength (kg)			Relative leg strength		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	51.9	57.0	9.8	0.9	0.9	1.3	68.0	81.6	20.0	1.3	1.2	6.8
		20	57.0	60.5	6.2	1.0	1.0	0.6	81.6	83.4	2.3	1.4	1.4	2.0
	Below	30	60.3	63.9	5.9	1.1	1.0	6.4	90.7	91.2	0.5	1.5	1.5	1.8
	Average	40	63.8	67.5	5.8	1.1	1.1	0.0	90.7	103.4	14.0	1.6	1.7	3.4
	Average	50	66.3	70.3	6.0	1.2	1.1	8.3	99.8	108.9	9.1	1.8	1.8	0.6
		60	71.1	73.3	3.0	1.2	1.2	0.3	108.9	117.9	8.3	1.9	1.9	0.0
	Above	70	74.8	77.2	3.3	1.3	1.3	0.6	117.9	126.6	7.3	2.0	2.0	0.0
	Average	80	79.1	81.5	3.1	1.3	1.3	1.2	127.0	136.1	7.2	2.2	2.2	0.0
	Very	90	84.2	87.0	3.4	1.4	1.4	0.0	136.1	146.5	7.6	2.3	2.4	3.0
	High	99	99.3	103.4	4.1	1.6	1.5	1.7	165.9	177.1	6.8	2.8	2.9	6.2
Mean					5.0			2.0			8.3			2.4

CA: n=116; BA: n=140.

Table 10. Normative values of jumping variables for the age of 13.

13 Age			SLJ (cm)			CMJ (cm)			VJ - Free Arm (cm)			AnP (watt)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	134	135	0.7	20.9	20.8	0.3	23.6	24.0	1.6	533.3	530.3	0.6
		20	140	140	0.0	23.3	23.6	1.2	27.0	26.9	0.3	590.4	566.2	4.1
	Below	30	146	146	0.1	26.2	26.0	0.7	29.1	29.1	0.0	621.6	593.5	4.5
	Average	40	153	155	1.3	27.2	27.2	0.1	31.1	30.6	1.4	655.6	626.4	4.5
	Average	50	160	160	0.3	28.7	28.5	0.6	32.5	32.2	1.1	684.6	656.1	4.2
		60	165	168	1.3	29.4	29.2	0.8	33.8	34.2	1.3	709.4	685.3	3.4
	Above	70	175	177	1.0	30.7	30.7	0.3	34.8	35.7	2.6	731.8	705.1	3.7
	Average	80	181	185	2.2	32.5	32.5	0.3	37.2	37.6	1.2	770.0	731.6	5.0
	Very	90	189	195	3.0	34.5	34.8	0.9	39.9	40.8	2.2	855.4	793.9	7.2
	High	99	202	215	6.1	40.9	40.7	0.3	49.6	48.4	2.6	1079.0	979.2	9.3
Mean					1.6			0.6			1.4			4.6

CA: n=116; BA: n=140.

Table 11. Normative values of jumping variables for the age of 14.

14 Age			SLJ (cm)			CMJ (cm)			VJ - Free Arm (cm)			AnP (watt)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	135	134	1.0	19.9	21.3	6.9	24.8	25.7	3.6	517.5	555.4	7.3
		20	141	147	4.1	23.3	23.4	0.4	27.1	27.4	1.1	556.6	591.0	6.2
	Below	30	154	155	0.5	24.8	25.3	2.0	29.2	29.6	1.3	584.3	653.1	11.8
	Average	40	160	160	0.0	26.9	27.1	1.0	30.2	30.7	1.4	623.4	677.3	8.6
	Average	50	165	169	2.4	27.8	28.5	2.5	32.2	32.7	1.8	659.0	698.9	6.0
		60	178	178	0.1	29.2	29.7	1.6	34.3	33.9	1.4	687.0	751.4	9.4
	Above	70	182	185	1.6	31.4	31.4	0.1	37.0	36.8	0.6	727.4	772.7	6.2
	Average	80	193	194	0.6	33.6	33.7	0.5	39.6	39.5	0.1	768.0	840.2	9.4
	Very	90	203	203	0.0	36.4	36.2	0.6	42.1	43.1	2.3	840.2	868.6	3.4
	High	99	229	227	0.9	39.9	40.7	1.9	47.1	47.7	1.3	960.9	1030.7	7.3
Mean					1.1			1.8			1.5			7.6

CA: n=116; BA: n=140.

Table 12. Normative values of throwing, flexibility and speed ability for the age of 13.

13 Age			M-Ball Throw (cm)			Throwing Ball (km/h)			Sit & Reach (cm)			30m (s)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	399	403	1.0	55.0	56.1	2.0	22.4	21.7	3.3	5.66	5.63	0.6
		20	446	435	2.5	59.8	64.0	7.0	24.7	25.0	1.2	5.43	5.39	0.7
	Below Average	30	471	470	0.1	65.0	68.0	4.6	27.6	27.2	1.5	5.27	5.21	1.2
		40	500	497	0.5	68.0	71.0	4.4	29.3	29.7	1.3	5.10	5.10	0.1
	Average	50	529	525	0.8	72.0	74.0	2.8	32.3	31.7	1.9	5.03	5.03	0.1
		60	561	548	2.4	75.0	77.0	2.7	34.0	33.0	2.9	4.94	4.95	0.2
	Above Average	70	580	577	0.5	78.0	79.0	1.3	35.0	34.5	1.4	4.86	4.86	0.0
		80	608	615	1.2	82.0	82.8	1.0	38.3	36.9	3.7	4.79	4.79	0.0
	Very High	90	653	675	3.3	86.0	87.0	1.2	42.1	42.0	0.3	4.67	4.62	0.9
		99	820	850	3.7	100.7	102.6	1.9	49.0	48.3	1.5	4.28	4.28	0.1
Mean					1.6			2.9			1.9			0.4

CA: n=116; BA: n=140.

Table 13. Normative values of throwing, flexibility and speed ability for the age 14.

14 Age			M-Ball Throw (cm)			Throwing Ball (km/h)			Sit & Reach (cm)			30m (s)		
			CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)	CA	BA	Diff (%)
Percentage (%)	Low	10	402	444	10.4	57.0	55.7	2.3	22.7	24.1	6.3	5.45	5.40	0.8
		20	441	483	9.6	68.0	64.4	5.3	26.9	29.0	7.8	5.27	5.24	0.6
	Below Average	30	495	526	6.1	71.2	69.0	3.1	29.6	32.5	9.8	5.13	5.09	0.8
		40	529	549	3.7	75.0	74.0	1.3	31.9	34.5	8.2	5.04	4.98	1.3
	Average	50	545	572	5.0	77.0	75.5	1.9	33.0	36.0	9.1	4.98	4.90	1.5
		60	571	590	3.3	79.0	80.2	1.5	35.6	38.0	6.8	4.86	4.81	1.0
	Above Average	70	600	618	2.9	84.6	85.0	0.5	37.9	39.0	2.8	4.78	4.73	1.1
		80	652	659	1.1	89.2	93.2	4.5	39.5	41.9	6.1	4.63	4.63	0.1
	Very High	90	705	713	1.1	97.8	99.0	1.2	44.5	46.2	3.7	4.49	4.49	0.2
		99	818	812	0.8	108.0	109.6	1.4	50.3	52.2	3.7	4.14	4.10	0.9
Mean					4.4			2.3			6.4			0.8

CA: n=116; BA: n=140.

total hand grip, 2% of relative hand grip, 8.3% of leg strength, and 2.4% of relative leg strength (Table 9).

In the 13-year age group, SLJ 1.6%, CMJ 0.6%, VJ-Free Arm 1.4% and AnP 4.6% differences were found between chronological age and biological age. It is observed that these differences are in favor of biological age (Table 10).

In the age group of 14, SLJ was found to be 1.1%, CMJ 1.8%, VJ-Free Arm 1.5% and AnP 7.6% between chronological age and biological age. It is observed that these differences are in favor of biological age (Table 11).

In the 13 age group, M-Ball Throw 1.6%, Throwing Ball 2.9%, Sit & Reach 1.9% and 30m 0.4% were found between chronological age and biological age (Table 12).

In the 14-year age group, the M-Ball Throw 4.4%, Throwing Ball 2.3%, Sit & Reach 6.4% and 30 m 0.8% were found between chronological age and biological age (Table 13).

DISCUSSION

Similar studies related to our study in the literature have been done on topics such as body height, body weight, BMI, body fat percentage (BFP), balance, flexibility, vertical jump, standing long jump, force, shuttle, barfic, medicine ball shot, speed, physical, functional and motor features (Volbekiene and Griciute, 2007). These features are made by many researchers to direct children to sports, to improve sports, to follow health status, to be used in planning physical education and sports lessons and sports training. Although there are studies in the

literature examining the relationship between normative values with chronological and biological age in evaluating children's physical education levels, the results are controversial (Bakkaloğlu et al., 2019; Suchomel, 2003; Volbekiene and Griciute, 2007). The vast majority of the studies conducted examine the minus of the chronological age's biomotor abilities (Açıkada and Hazır, 2016; Ortega et al., 2008). However, the number of studies examining the effect of biological age on biomotor abilities has been increasing in recent years (Bayraktar, 2017; Bayraktar et al., 2016; Saç and Colak, 2019).

Many studies have been reported that developmental and talented children are taller and have a higher body weight than other children, regardless of chronological age (Abdelkrim et al., 2010; Hoare, 2000). In our study, significant differences were observed between 13 and 14 age groups in terms of both chronological age and body weight according to biological age. While there is a similarity in 13 age group in terms of height, difference in favor of biological age was calculated in the 14 age group. In studies conducted, it has been determined that athletes who are taller and heavier, regardless of chronological age, have a better score average (Saç and Colak, 2019; Torres-Unda et al., 2013). It is known that the increase in performance due to body weight and height in children is related to biological age. In our study, there is a similarity in BMI and BFP values in chronological age and biological age groups at both 13 and 14 years of age. In many studies, although BMI and BFP are more common in those with high chronological age (Ortega et al., 2008), different results appear when biological age is considered. There are studies indicating that fat mass makes the skills such as excess, speed, vertical jump and dribbling difficult (Shephard, 1999). For this reason, keeping the fat percentage under control in children doing sports is important for performance (Saç and Colak, 2019). Studies examining the changes in the anthropometric properties of biological age are football (Malina et al., 2004; Vandendriessche et al., 2012), basketball (Carvalho et al., 2013), tennis (Myburgh et al., 2016), and handball (Matthys et al., 2012) found that the athletes that matured early in their sports showed higher values than their peers at the same chronological year of late or normal maturity levels (Söğüt, 2019).

It is stated that early maturation provides advantage in force measurements (Myburgh et al., 2016). However, in our study, similarities were found in both age groups in terms of force variables according to both chronological and biological age. It is understood that strength training before PHV should not be done and why it is in the long-term athlete development to focus on speed ability in the period before PHV due to the completion of neural development much earlier (Bayraktar, 2019).

In our study, there was no significant difference in the standing long jump, CMJ and free arm vertical jump values between the groups in both age groups. In anaerobic power findings calculated based on CMJ and body weight, statistically significant differences were calculated in both age groups according to chronological age and biological age. Similarities for both age groups in terms of biological and chronological age were observed in the values of medicine ball throw over the knee distance, throwing ball speed, flexibility and speed capabilities. The period when it starts to affect parameters such as biological age, muscle mass and body composition and related biomotor abilities is between 12-14 years (Saç and Colak, 2019). The differences in children's chronological or biological ages may be due to these reasons. The differences that occur at these ages can cause differences in body composition, muscle and fat mass as well as physiological capacity (Gil et al., 2007). This phenomenon, called the relative age effect, has been the subject of many studies. Although the factors on relative age effect have not been clarified yet, it is claimed that the most important factor may be PHV (Delorme and Raspaud, 2009).

According to the findings of our study, it is seen that there are differences in biomotor abilities of childhood athletes. By analyzing these differences with biological age, it was found that the measurement results were statistically related to the maturation status. In our study, the chronological age of the 13-years-old group with total hand grip, SLJ and 30 m sprint test. It was determined that there is a relation between sprint, but it is related with biological age and total hand grip, leg strength, CMJ, AnP, M-Ball throw, sit & reach and 30 m sprint. No relation was found between chronological age and biomotor abilities for the age group of 14, it was determined that biological age was associated with body fat, total hand grip, leg strength, AnP, M-ball throw and 30 m sprints. When the relationship of the research variables according to the chronological age and biological age was examined, it was observed that all other relationships detected were more related to the biological age than the chronological age, except for the low relationship level with the standing long jump. It is determined that the biological age status is related to all biomotor abilities (Saç and Colak, 2019). According to the chronological age, it is seen in the results of the studies that the athletes maturing earlier than their peers show better results (Malina et al., 2004; Myburgh et al., 2016; Saç and Colak, 2019; Torres-Unda et al., 2013).

In our study, in a representative example of Turkish 13-14 age group children, the normative data of biomotor abilities according to chronological and biological age are given as a percentage. Even if there is no difference in the comparisons made for the biomotor abilities that are the subject of our study, there are percent differences in comparing the norm values in 10% slices according to the chronological age and biological age.

In our study, according to the anthropometric features between the chronological age and biological age of the 13 age group; body weight, body height, BMI were below 5% and body fat was above 5%. In the 14 age group,

body weight, body fat is above 5% and body height, BMI is below 5%.

According to the 13 years age group biomotor abilities; the differences in total hand grip, relative hand grip, leg strength, relative leg strength, SLJ, CMJ, VJ-free arm, AnP, M-Ball throw, throwing ball, sit & reach and 30 m sprint are below 5%. In the age group of 14, the differences in relative hand grip, relative leg strength, SLJ, CMJ, VJ-free arm, M-Ball Throw, Throwing ball and 30 m sprint are below 5% and total hand grip, leg strength, AnP and The differences in sit & reach feature are over 5%. The differences in both age groups are in favor of biological age.

The percentage differences in the comparison of chronological age and biological age in 10% slices above emphasize the importance of the research.

As a result, it is observed in our study that children of the same chronological age and maturing early yield better data than children with late or normal maturation levels. In particular, the rapid increase in height and body weight accelerates the increase on speed, agility and strength development. In addition, it is envisaged that the results of this research will be a guide to the appropriate sports and the determination of the course content to be applied to the students or the training programs of the athletes in the physical education courses by means of the norm values created according to both the chronological and biological age in our study. In this way, it is thought that by dividing the chronological age and biological age in children, a possible loss of motivation will be prevented in both physical education lesson and sports training and competitions.

REFERENCES

Abdelkrim, N. B., Castagna, C., El Fazaa, S., and El Ati, J. (**2010**). The Effect of players' standard and tactical strategy on game demands in men's basketball. Journal of Strength and Conditioning Research, 24(10): 2652–2662.

Açıkada, C., and **Hazır**, T. (**2016**). Uzun Süreli Sporcu Gelişim Programları : Hangi Bilimsel Temellere Oturuyor ? Hacettepe Journal of Sport Sciences, 27(2): 84–99.

Adams, G. (**1998**). *Exercise Physiology Laboratory Manual* (3rd ed.). WCB/MacGraw-Hill Publishers.

Bakkaloğlu, H., Sucuoğlu, B., and Özbek, A. B. (**2019**). Okul Öncesinde Özel Gereksinimli Olan ve Normal Gelişen Çocukların Sosyal Kabul Düzeylerinin İncelenmesi. Elementary Education Online, 18(2), 521–538.

Balyi, I., and **Hamilton**, A. (**2004**). Long-term athlete development: trainability in childhood and adolescence. Olympic Coach, 16(1): 4–9.

Baxter-Jones, A. D., Eisenmann, J. C., and Sherar, L. B. (**2005**). Controlling for maturation in pediatric exercise science. Pediatric Exercise Science, 17(1): 18–30.

Bayraktar, I. (**2010**). 13-17 Yaş Grubu Atlet ve Güreşçilerin Bazı Fiziksel ve Fizyolojik Parametrelerinin Normatif Çalışması. Yayınlanmamış Doktora Tezi.

Bayraktar, I. (**2017**). An examination of youth athletes' performance indicators in terms of chronological age and biological maturity. International Refereed Academic Journal of Sports, Health and Medical Sciences, 23: 15–26.

Bayraktar, I. (**2019**). Geleneksel Yetenek Seçimi Mi, Uzun Dönem Sporcu Gelişimi Mi? In Her Yönüyle Spor (Issue August, pp. 11–31).

Bayraktar, I., Yaman, N., Zorba, E., Yaman, M., and Günay, M. (**2016**). The analysis of certain differences in motor skills of sedentary male children in the 9-14 age group based on the biological maturity. Universal Journal of Educational Research, 4(8): 1894–1902.

Berisha, M. (**2018**). Determination of norm values in evaluation of physical and bio-motoric developments in 11-17 years children in Kosovo (Issue November).

Beunen, G., and **Malina**, R. M. (**2008***). The Young Athlete* (H. Bebestreit & O. Bar-Or (eds.); Growth and). Blackwell Publishing.

Bös, K. (**2003**). Motorische leistungsfähigkeit von kindern und jugendlichen. Erster Deutscher kinder-und jugendsportbericht, 3: 85-107.

Carvalho, H. M., Coelhoe-Silva, M. J., Eisenmann, J. C., and Malina, R. (**2013**). Aerobic fitness, maturation, and training experience in youth basketball. International Journal of Sports Physiology and Performance, *8*(4): 428–434.

Delorme, N., and **Raspaud**, M. (**2009**). The relative age effect in young French basketball players : a study on the whole population. Scandinavian Journal of Medicine & Science in Sports, 19: 235–242.

Gil, F., Ruiz, F., Irazusta, A., Gil, J., and Irazusta, J. (**2007**). Selection of young soccer players in terms of anthropometric and physiological factors. Journal of Sports Medicine and Physical Fitness, 47(1): 25–32.

Hans, S. D., Sanders, J. O., and Cooperman, D. R. (**2008**). Using the Sauvegrain method to predict peak height velocity in boys and girls. Journal of Pediatric Orthopaedics, 28(8): 836–839.

Hekim, M., and **Hekim**, H. (**2015**). Çocuklarda Kuvvet Gelişimi ve Kuvvet Antrenmanlarına Genel Bakış. The Journal of Current Pediatrics, 13, 110–115.

Hills, A. P., King, N. A., and Armstrong, T. P. (**2007**). The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents. Sports Medicine, *37*(6): 533–545.

Hoare, D. G. (**2000**). Predicting success in junior elite basketball players — the contribution of anthropometic and physiological attributes. Journal of Science and Medicine in Sport, 3(4): 391–405.

Hürmüz, K., and **Tekin**, A. (**2011**). Beden Eğitimi Derslerinin Çocuklarda Seçilmiş Motorik Özellikler Üzerine Etkisi. Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi Özel Sayısı, 9–17.

İnce, O. T., Kondolot, M., and Yalçın, S. S. (**2011**). Büyümenin izlenmesi ve büyüme duraklamasi. Türkiye Çocuk Hastalıkları Dergisi, *5*(3): 181–192.

Köseoğlu, S. Z. A., and **Çelebi**, T. (**2017**). Adölesan Dönemi Beslenme ve Sorunları. Güncel Pediatri, 15(2): 50–62.

Little, D. G., Song, K. M., Katz, D., and Herring, J. A. (**2000**). Relationship of peak height velocity to other maturity indicators in idiopathic scoliosis in girls. The Journal of Bone and Joint Surgery, 82(5): 685–693.

Lloyd, R. S., Oliver, J. L., Faigenbaum, A. D., Myed, G. D., and Croix, M. B. D. (**2014**). Chronological age vs. biological maturation: implications for exercise programming in youth. Journal of Strength and Conditioning Research, 28(5): 1454–1464.

Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B., and Aroso, J. (**2004**). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13 – 15 years. European Journal of Applied Physiology, 91(5): 555–562.

Matthys, S. P. J., Vaeyens, R., Coelhoe-Silva, M. J., Lenoir, M., and Philippaerts, R. (**2012**). The contribution of growth and maturation in the functional capacity and skill performance of male adolescent handball players. International Journal of Sports Medicine, 33(7): 543–549.

Mirwald, R. L., Baxter-Jones, A. D. G., Bailey, D. A., and Beunen, G. P. (**2002**). An assessment of maturity from anthropometric measurements. Medicine and Science in Sports and Exercise, 34(4): 689–694.

Muratlı, S. (**2003**). Çocuk ve spor antrenman bilimi yaklaşımıyla. Nobel Basımevi.

Myburgh, G. K., Cumming, S. P., Silva, M. C. E., Cooke, K., and Malina, R. M. (**2016**). Maturity-associated variation in functional characteristics of elite youth tennis players. Pediatric Exercise Science, 28(4): 542–552.

Ortega, F. B., Ruiz, J. R., Castillo, M. J., Moreno, L. A., Urzanqui, A.,

González-Gross, M., Sjöström, M., and Gutierrez, A. (**2008**). Health-related physical fitness according to chronological and biological age in adolescents: The AVENA study. Journal of Sports Medicine and Physical Fitness, 48(3): 371.

Özer, K. (**1990**). Büyüme ve gelişme sürecinde egzersiz. Beden Eğitimi ve Spor Araştırmaları Dergisi, 1(1): 30–32.

Portney, L. G., and **Watkins**, M. P. (**2015**). Foundations of clinical research. Applications to practice (3rd ed.). F. A. Davis Company.

Saç, A., and **Çolak**, H. (**2019**). Adolesan Basketbolcularda Biyolojik Olgunlaşma Düzeyi Ve Antropometrik, Fizyolojik Özelliklerde Yaşa Bağlı Farklılıklar. Spor ve Performans Araştırmaları Dergisi, 10(3): 208–222.

Sanders, J. O. (**2007**). Maturity indicators in spinal deformity. The Journal of Bone and Joint Surgery, 89(1), 14–20.

Sevim, Y. (**2002**). Antrenman Bilgisi (1. Basım). Nobel Yayınevi.

Shephard, R. J. (**1999**). Biology and medicine of soccer : An update biology and medicine of soccer : An update. Journal of Sports Sciences, 17: 757–786.

Sitasikelis, P. J., Sullivan, C. M., Philips, W. A., and Polard, J. A. (**1996**). Slipped capital femoral epiphysis. The Journal of Bone and Joint Surgery, 7(8): 1149–1155.

Söğüt, M. (**2019**). Bio-Banding in Sport. Spor Hekimliği Dergisi, 54(2): 143–147.

Suchomel, A. (**2003**). The biological age of prepubescent and pubescent children with low and high motor efficiency. Anthropologischer Anzeiger, 1, 67–77.

TDK (Türk Dil Kurumu) (**2020**). Genel Açıklamalı Sözlük. Erişim tarihi: 27.05.2020, Erişim adresi: https://sozluk.gov.tr/.

Torres-Unda, J., Zarrazquin, I., Gil, J., Ruiz, F., Irazusta, A., Kortajarena, M., and Irazusta, J. (**2013**). Anthropometric , physiological and maturational characteristics in selected elite and non-elite male adolescent basketball players. Journal of Sports Sciences, 31(2): 196–203.

Vandendriessche, J. B., Vaeyens, R., Vandorpe, B., Lenoir, M., Lefevre, J., and Philippaerts, R. M. (**2012**). Biological maturation, morphology , fitness , and motor coordination as part of a selection strategy in the search for international youth soccer players (age 15 – 16 years). Journal of Sports Sciences, 30(15): 1695–1703.

Volbekiene, V., and **Griciute**, A. (**2007**). Health-related physical fitness among schoolchildren in Lithuania: A comparison from 1992 to 2002. Scandinavian Journal of Public Health, 35(3): 235–242.

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