AN EXAMINATION OF YOUTH ATHLETES' PERFORMANCE
INDICATORS IN TERMS OF CHRONOLOGICAL AGE AND
BIOLOGICAL MATURITY ¹YILDIZLAR SEVİYESİNDEKİ ATLETLERİN PERFORMANS
GÖSTERGELERİNİN KRONOLOJİK YAŞ VE BİYOLOJİK OLGUNLUK
AÇISINDAN İNCELENMESİ

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Öz: Bu çalışmanın amacı, yıldızlar seviyesindeki sporcuların seçilmiş antropometrik özellikleri ve performans değişkenlerindeki farklılıkları ve ilişkileri takvim yaşı ve biyolojik olgunluk açısından incelemektir. Araştırma grubu, atlama (erkek = 18, kadın = 19) ve sprint branşındaki (erkek = 17, kadın = 22) toplam 76 yıldız atletten oluşmuştur. Takvim yaşı, müsabaka performansı, boy uzunluğu, vücut ağırlığı, oturma boyu, bacak boyu uzunluğu, 30 metre sürat, kavrama kuvveti, bacak kuvveti, dikey sıçrama ve esneklik yetilerine ait değerler deneklerden elde edilmiştir. Ayrıca vücut kütle indeksi (BMI), zirve hızlı boy uzama yaşı (PHV), anaerobik güç (AP) değerleri hesaplanmış, müsabaka sonuç değerleri IAAF puanlama sistemine dönüştürülmüştür. Branş ve cinsiyet gruplarının istatistiksel analizleri Mann Whitney-U testi kullanılarak gerçekleştirilmiştir. Spearman korelasyon katsayıları (ρ), parametreler arasındaki ilişkileri ifade etmek için kullanılmıştır. Esneklik değerleri dışında atlama ve sprint branşındaki sporcuların cinsiyetlerine göre antropometrik özellikleri ve seçilen performans değerlerinde farklılıklar olduğu bulunmuştur. Ayrıca, değişkenler ile atletlerin yaşları ve biyolojik olgunluk seviyeleri arasındaki ilişkiler gözlemlendi. Aynı yaş grubundaki sporcular, yaşlarına ve PHV'ye göre farklı korelasyon değerleri gösterdiler. Bu noktada, yıldız sporcularının antrenörleri, spor yaralanmalarından kaçınarak, sporculara bireysel antrenman programı hazırlamak ve uygulamak istiyorsa, sporcuların olgunluk seviyesini belirlemelidir.

Anahtar Kelimeler: IAAF Puan, Olgunluk, PHV, Takvim Yaşı, Yıldız, Atlama, Sprint

Abstract: The purpose of this study was to examine differences and relationships between selected anthropometric features and performance variables of youth athletes in terms of chronological age and biological maturity. The research group was composed of total 76 track and field athletes, jumping events (male=18, female=19) and sprint events (male=17, female=22). Chronological age, competition performance, body height, body weight, sitting height, leg length, 30 meters speed, hand grip, leg strength, vertical jump and flexibility ability values were obtained from athletes. Also body mass index (BMI), age of peak height velocity (PHV), anaerobic power (AP) values of the athletes were calculated, and their competition results were converted to IAAF scoring system point. Statistical comparison of the events and gender groups was carried out using Mann Whitney-U test. Spearman's correlation coefficients (ρ) were used to express the relationships between parameters. It was found that there are differences in selected anthropometric and performance values with regard to gender for jumping and sprint event athletes, except the values of flexibility ability. Furthermore, the relationships between variables and athletes' age as well as biological maturity levels were observed. The athletes who are in the same age group have different correlation values according to their age and PHV between the variables. In this point, the coaches of youth athletes should be identify maturity level of their athletes, if they would like to prepare and to apply individual training program to them, with refrain from injury.

Key Words: IAAF Score, Maturity, PHV, Chronological Age, Youth, Jump, Sprint

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INTRODUCTION

In recent years, researchers have focused on the biological maturity level of children because growth and maturation levels do not occur to a linear increasing by the years for each person. In other words, the children who are at the same chronological age may obviously differ in their level of biological maturity (Armstrong, 2007: 2). There is a dilemma at this point owing to the fact that the general approach of talent identification, training programs and national or international competitions which have been arranged according to chronological age of athletes. Thus maturity levels are unfortunately neglected for youth athletes.

Chronological age gives poor information in the evaluation of growth and maturation. There are several methods for assessment of maturation. Age of peak height velocity (PHV) is the most frequently employed indicator of the biological maturity (Malina et al., 2015: 854, Cossio-Bolaños et al. 2015: 12086). Girls ordinarily attain PHV about 12 years and boys around 14 years of age. But, the timing of this event in relation to chronological age shows great variance. When PHV has been identified, children can be ranked by biological maturity age (years from PHV) rather than chronological age (Armstrong, 2007: 11).

The current study was applied to youth athletes of the sprinting and jumping events. Sprinters have moderate stature, generally possess a low relative lower limb length. Whereas jumpers are among the tallest of elite athletes, with a high relative lower limb length. Because both events are power events and require rapid power generation, they should have naturally with a high proportion of fast-twitch muscle fibres (Ackland et al., 2009: 259).

The movements in these sports are explosive and of short duration and use high loads; in other words, they require maximum strength and power. A high level of relative strength is important in track-and-field sprints and jumps (Bompa and Buzzichelli, 2015: 40). Since the sprinting and jumping events of track and field are anaerobic system-dominant sports, the training methods are similar (Bompa and Buzzichelli, 2015: 160).

Flexibility is crucial to sprinting and hurdling, as well as to jumping. Good technique in sprint events depends on excellent flexibility ability. Also in the jumping events, jumpers should have superior level of flexibility in all part of body to show good performance (Ackland et al., 2009: 262–263).

In the current study, chronological age, competition performance, body height, body weight, sitting height, leg length, 30 meters

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speed, hand grip, leg strength, vertical jump and flexibility ability values were obtained from sprinters and jumpers. Also BMI, PHV, AP values of the athletes were calculated. The purpose of this study was to examine differences and relationships between selected anthropometric features and performance variables of youth athletes in terms of chronological age and biological maturity.

METHODS

The research group was composed of total 76 track and field athletes, jumping events (male=18, female=19) and sprint events (male=17 , female=22). The measurements and tests were applied during the Turkish U18 National Team training camp in 2015 indoor season. Athletes have competed in two consecutive competitions one week in between, and the tests were applied on Wednesday between the competitions. The best performances of athletes from the two competitions were evaluated in the study. The competition results were converted to IAAF scoring system point (Spiriev, 2017) for each athlete. The anthropometrics values which are the stature (BH) and body mass (BM) were assessed using a Seca stadiometer and weighing scales (Seca Instruments Ltd., Hamburg, Germany). Sitting height (SH) was measured using a Holtain stadiometer (Holtain Ltd., Crosswell, Wales, U.K.). The BMI was calculated as a ratio of the BM (kg) and squared

BH (m). Right-left hand grip strength (HG) and leg strength (LS) tests were performed by dynamometers (Baseline dynamometer, Fabrication Enterprises, USA). The HG total value was obtained with sum of the right and left hand results. All strength test results were calculated as relative strength values, dividing the test performance by the athlete's body weight. In order to determine the subjects' sprint ability, running tests of 30 meters were performed. All results were recorded using photoelectric timing gates (Smartspeed, Fusionsport, Australia). Flexibility of the athletes were determined with using modified sit-and-reach test by normalized arm length (Baseline sit-reach scale, Fabrication Enterprises, USA). Jumping mat device for counter movement jump (CMJ) test was utilized (Smartjump, Fusionsport, Australia). In determining anaerobic power (AP) with Lewis nomogram, the subjects' CMJ heights (d) and body weight were calculated by using the jump formula (given below).

$$AP = [(\sqrt{4,9 \times \text{Weight}}) \times \sqrt{d}]$$

The PHV was calculated by the predictive equations of Mirwald et al. (2002: 691-692) for each gender. The equations require such data as the chronological age (Chr-Age),

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body mass (BM), standing height, seated height and leg length of subjects.

Statistical Analysis

General characteristics of the participants were presented as means and standard deviations ($\pm$ SD). Statistical comparison of the events and gender groups was carried out using Mann Whitney-U test. Spearman's correlation coefficients (ρ) were used to express the relationships between parameters. Interpretation of correlation coefficients was as follows: $r \leq 0.49$ weak relationship; $0.50 \leq r \leq 0.74$ moderate relationship; and $r \geq 0.75$ strong relationship (Portney and Watkins, 2015: 524-525). A p value less than 0.05 was considered statistically significant.

RESULTS

The variables of the jumping events athletes were compared to gender in Table 1, the athletes of sprint events were in Table 2, as well. The IAAF-score of athletes and their ages mean values have shown similarities both by gender and events. It was found that there are differences in selected anthropometric and performance values with regard to gender for jumping and sprint event athletes, except the values of flexibility ability.

This comparisons were also utilized between events for male (Table 3) and female (Table 4) athletes. It was found differences between male jumpers and sprinters for the sitting height values. Besides that it was observed that there are differences in terms of biological maturity, leg length and hand grip values between female jumpers and sprinters.

Spearman's correlation coefficients were used to express the relationships between the selected variables and Chr-Age as well as PHV for the athletes by gender and events. These results were presented in Table 5. According to the findings, there were found the moderate significant relationships between IAAF-score, AP and both age and PVH for male jumpers, it is likewise found between relative HG and Chr-Age as well as PHV for male sprinters. It was found that there is a moderate relation between Chr-Age and AP for sprinters both gender, but this relationship was not found for PHV. For the male sprinters, there were moderate relationships between PHV and IAAF point, relative LS, whereas the same relation was not found in terms of Chr-Age. The weak significant relationships between Chr-Age and IAAF-score were shown with reference to female jumpers ($\rho=0.47$, $p<0.05$).

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Table 1. Comparison of Jumping Event Athletes' Variables by Gender

Jumping Events							
	Gender	n	Mean	SD	Mean Rank	Sum of Ranks	p
IAAF-score	M	18	759,6	88,3	18,25	328,5	0,68
	F	19	770,2	102,4	19,71	374,5	
Chr-Age (year)	M	18	15,8	0,7	21,06	379,0	0,26
	F	19	15,4	1,0	17,05	324,0	
PHV (year)	M	18	1,1	0,7	18,92	340,5	0,96
	F	19	1,0	1,2	19,08	362,5	
Body Mass (kg)	M	18	62,3	6,3	28,08	505,5	0,00
	F	19	51,4	3,2	10,39	197,5	
Height (cm)	M	18	174,4	5,7	27,67	498,0	0,00
	F	19	163,4	4,0	10,79	205,0	
Sitting Height (cm)	M	18	91,5	3,5	27,11	488,0	0,00
	F	19	85,8	2,2	11,32	215,0	
Leg Lenght (cm)	M	18	82,7	3,3	26,00	468,0	0,00
	F	19	77,7	2,9	12,37	235,0	
BMI (kg/m^2)	M	18	20,5	1,6	22,94	413,0	0,03
	F	19	19,2	1,1	15,26	290,0	
Flexibility (cm)	M	18	49,7	5,9	19,11	344,0	0,95
	F	19	49,3	5,1	18,89	359,0	
Relative HG	M	18	1,3	0,2	26,28	473,0	0,00
	F	19	1,0	0,1	12,11	230,0	
Relative LS	M	18	2,4	0,3	26,36	474,5	0,00
	F	19	1,8	0,3	12,03	228,5	
CMJ (cm)	M	18	50,5	4,8	28,44	512,0	0,00
	F	19	37,5	3,3	10,05	191,0	
AP (kgm/s)	M	18	98,2	13,5	28,39	511,0	0,00
	F	19	69,5	5,0	10,11	192,0	
0-30 m (s)	M	18	4,03	0,16	9,67	174,0	0,00
	F	19	4,50	0,14	27,84	529,0

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Table 2. Comparison of Sprint Event Athletes' Variables by Gender

Sprint Events							
	Gender	n	Mean	SD	Mean Rank	Sum of Ranks	p
IAAF-score	M	17	783,8	65,3	18,79	319,5	0,56
	F	22	799,9	54,8	20,93	460,5	
Chr-Age (year)	M	17	15,6	1,0	23,62	401,5	0,08
	F	22	15,1	1,0	17,20	378,5	
PHV (year)	M	17	1,2	0,6	27,21	462,5	0,00
	F	22	0,2	0,7	14,43	317,5	
Body Mass (kg)	M	17	64,7	4,1	30,88	525,0	0,00
	F	22	48,9	5,1	11,59	255,0	
Height (cm)	M	17	175,5	3,0	30,85	524,5	0,00
	F	22	160,7	5,7	11,61	255,5	
Sitting Height (cm)	M	17	92,8	2,2	30,38	516,5	0,00
	F	22	85,1	2,8	11,98	263,5	
Leg Length (cm)	M	17	82,8	1,8	29,97	509,5	0,00
	F	22	75,6	4,0	12,30	270,5	
BMI (kg/m ²)	M	17	21,0	1,3	27,26	463,5	0,00
	F	22	18,9	1,8	14,39	316,5	
Flexibility (cm)	M	17	48,0	5,6	18,44	313,5	0,45
	F	22	48,8	4,9	21,20	466,5	
Relative HG	M	17	1,3	0,1	27,71	471,0	0,00
	F	22	1,1	0,1	14,05	309,0	
Relative LS	M	17	2,4	0,6	26,71	454,0	0,00
	F	22	1,8	0,4	14,82	326,0	
CMJ (cm)	M	17	51,0	5,5	31,00	527,0	0,00
	F	22	37,6	3,4	11,50	253,0	
AP (kgm/s)	M	17	102,1	8,2	31,00	527,0	0,00
	F	22	66,3	7,6	11,50	253,0	
0-30 m (s)	M	17	3,93	0,14	9,12	155,0	0,00
	F	22	4,45	0,18	28,41	625,0

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Table 3. Comparison of Male Athletes' Variables by Events

Male							
	Event	n	Mean	SD	Mean Rank	Sum of Ranks	p
IAAF-score	J	18	759,6	88,3	17,47	314,5	0,75
	S	17	783,8	65,3	18,56	315,5	
Chr-Age (year)	J	18	15,8	0,7	19,33	348,0	0,43
	S	17	15,6	1,0	16,59	282,0	
PHV (year)	J	18	1,1	0,7	17,39	313,0	0,72
	S	17	1,2	0,6	18,65	317,0	
Body Mass (kg)	J	18	62,3	6,3	15,14	272,5	0,09
	S	17	64,7	4,1	21,03	357,5	
Height (cm)	J	18	174,4	5,7	15,58	280,5	0,15
	S	17	175,5	3,0	20,56	349,5	
Sitting Height (cm)	J	18	91,5	3,5	14,75	265,5	0,04
	S	17	92,8	2,2	21,44	364,5	
Leg Lenght (cm)	J	18	82,7	3,3	18,00	324,0	1,00
	S	17	82,8	1,8	18,00	306,0	
BMI (kg/m^2)	J	18	20,5	1,6	16,28	293,0	0,31
	S	17	21,0	1,3	19,82	337,0	
Flexibility (cm)	J	18	49,7	5,9	19,72	355,0	0,31
	S	17	48,0	5,6	16,18	275,0	
Relative HG	J	18	1,3	0,2	17,53	315,5	0,77
	S	17	1,3	0,1	18,50	314,5	
Relative LS	J	18	2,4	0,3	18,61	335,0	0,72
	S	17	2,4	0,6	17,35	295,0	
CMJ (cm)	J	18	50,5	4,8	17,97	323,5	0,99
	S	17	51,0	5,5	18,03	306,5	
AP (kgm/s)	J	18	98,2	13,5	15,11	272,0	0,09
	S	17	102,1	8,2	21,06	358,0	
0-30 m (s)	J	18	4,03	0,16	20,92	376,5	0,08
	S	17	3,93	0,14	14,91	253,5

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Table 4. Comparison of Female Athletes' Variables by Events

Female							
	Event	n	Mean	SD	Mean Rank	Sum of Ranks	p
IAAF-score	J	19	770,2	102,4	19,92	378,5	0,59
	S	22	799,9	54,8	21,93	482,5	
Chr-Age (year)	J	19	15,4	1,0	23,63	449,0	0,19
	S	22	15,1	1,0	18,73	412,0	
PHV (year)	J	19	1,0	1,2	25,47	484,0	0,03
	S	22	0,2	0,7	17,14	377,0	
Body Mass (kg)	J	19	51,4	3,2	24,37	463,0	0,09
	S	22	48,9	5,1	18,09	398,0	
Height (cm)	J	19	163,4	4,0	23,84	453,0	0,16
	S	22	160,7	5,7	18,55	408,0	
Sitting Height (cm)	J	19	85,8	2,2	22,79	433,0	0,37
	S	22	85,1	2,8	19,45	428,0	
Leg Length (cm)	J	19	77,7	2,9	25,05	476,0	0,04
	S	22	75,6	4,0	17,50	385,0	
BMI (kg/m ²)	J	19	19,2	1,1	22,29	423,5	0,52
	S	22	18,9	1,8	19,89	437,5	
Flexibility (cm)	J	19	49,3	5,1	21,29	404,5	0,89
	S	22	48,8	4,9	20,75	456,5	
Relative HG	J	19	1,0	0,1	16,32	310,0	0,02
	S	22	1,1	0,1	25,05	551,0	
Relative LS	J	19	1,8	0,3	20,66	392,5	0,86
	S	22	1,8	0,4	21,30	468,5	
CMJ (cm)	J	19	37,5	3,3	20,03	380,5	0,63
	S	22	37,6	3,4	21,84	480,5	
AP (kgm/s)	J	19	69,5	5,0	24,26	461,0	0,10
	S	22	66,3	7,6	18,18	400,0	
0-30 m (s)	J	19	4,50	0,14	23,79	452,0	0,17
	S	22	4,45	0,18	18,59	409,0

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Table 5. The Correlations Between Variables and Chr-Age as Well as Biological Maturity for the Athletes

			IAAF- score	Flexibility	Relative HG	Relative LS	CMJ	AP	0-30 m
Male Jumper (n=18)	Chr-Age	rho	0,67*	0,05	0,28	0,43	0,45	0,58*	-0,26
		p	0,00	0,84	0,25	0,08	0,06	0,01	0,30
	PHV	rho	0,61*	0,30	0,23	0,27	0,33	0,62*	-0,22
		p	0,01	0,24	0,36	0,29	0,19	0,01	0,39
Male Sprinter n=17)	Chr-Age	rho	0,41	0,06	0,56*	0,30	0,33	0,52*	-0,33
		p	0,11	0,81	0,02	0,24	0,20	0,03	0,20
	PHV	rho	0,73*	0,06	0,57*	0,52*	-0,05	0,28	-0,04
		p	0,00	0,83	0,02	0,03	0,85	0,28	0,87
Female Jumper (n=19)	Chr-Age	rho	0,47*	0,07	-0,25	-0,29	0,34	0,33	-0,42
		p	0,04	0,79	0,31	0,23	0,16	0,17	0,07
	PHV	rho	0,36	0,15	0,00	-0,10	0,37	0,41	-0,44
		p	0,13	0,54	0,99	0,70	0,12	0,08	0,06
Female Sprinter (n=22)	Chr-Age	rho	0,42	0,23	-0,10	0,31	0,25	0,50*	0,03
		p	0,05	0,30	0,67	0,16	0,27	0,02	0,89
	PHV	rho	-0,11	0,27	0,19	0,08	-0,16	-0,14	-0,01
		p	0,63	0,23	0,39	0,71	0,48	0,53	0,95

DISCUSSION

The study compares the selected variables which are age, PHV, anthropometric features, strength, jump, anaerobic power, speed and flexibility abilities by gender and events in track and fields athletes. Besides that the relationships between selected variables and Chr-Age as well as biological maturity for the athletes were examined.

The IAAF-score, which is an indicator of athletes' performance, and their ages mean values have shown similarities both by gender and events. It may show that the study group is homogeneous in terms of athlete performance levels and their ages. It was observed that there were differences in anthropometric features and biomotoric performance abilities in terms of gender for jumping and sprint event athletes as expected, except flexibility ability since men and women differ physio-

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logically. The average male is approximately 13 cm higher and 15 kg heavier than average female. Likewise, there are strength differences between gender due to higher production of the hormone testosterone in males (Ackland et al., 2009: 129).

In the comparison of events by gender, the sitting height values have shown differences for male jumpers and sprinters. Additionally, there were differences in biological maturity, leg length and hand grip values between female jumpers and sprinters. Ackland et al. (2009: 95–96) have declared that the jumpers should have a high lower limb/trunk ratio but a low lower limb/trunk ratio for the sprinters. The findings of current study are coherent with them.

The relationships between selected variables and Chr-Age for the youth athletes by gender and events were examined in this study. Also the same correlation coefficient was used to express relations between these variables and PHV values of the athletes. According to the study findings, the competition performance levels of male sprinters have correlated with their PHV values ($\rho=0.73$, $p<0.05$), but a relation between their Chr-age and performance values was not found. Also this situation is likewise for leg strength ability for male sprinters ($\rho=0.52$, $p<0.05$). Whereas, statistically significant moderate relationships between AP and Chr-age (not with

PHV) for male and female sprinters were found ($\rho=0.50$ - 0.52 , $p<0.05$, respectively).

The findings of the current study have demonstrated that youth athletes' performance indicators have not the same correlations with their age and PHV, especially for sprint event athletes. The literature review on this matter has clearly shown that the same chronological age may be conspicuously different concerning biological maturity (Bayraktar et al., 2016: 1894–1902; Jones et al., 2000: 57-65; Lloyd et al., 2014: 1454; Yaman et al., 2016: 94–108). The athlete who is less mature when they have competed with the same age group peers will be disadvantageous, even if the athlete is technically talented than others (Malina et al., 2012: 1715). Because the level of strength, power, speed and jump abilities are identified in accordance with maturity status of youth athletes (Malina et al., 2004: 556-61).

In this case, early matured athlete seems super talented and late matured athlete will be early sport specialized because of same training program with the same age group. Therefore early sport specialization can lead to be expose to higher volumes of training and overuse injury as well as burnout (Lloyd et al., 2014: 1462).

In conclusion, the present study has found differences in selected anthropometric features

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values and selected performance indicators of athletes between genders and events. Furthermore, the relationships between variables and athletes' age as well as biological maturity levels were observed. The athletes in the same age group have different correlation values according to their age and PHV between the variables. In this point, the coaches of youth athletes should be identify maturity level of their athletes, if they would like to prepare and to apply individual training program to them, with refrain from injury.

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