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Age-Related Patterns of Physical and Physiological Characteristics in Adolescent Wrestlers

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A B S T R A C T

The aim of the study was to examine the physical and physiological differences as dependent on age of young wrestlers. One hundred and twenty-six 15 – 17 year old wrestlers volunteered as subjects in the present study. The physical and physiological profiles included body weight, height, body mass index, flexibility, anaerobic power, aerobic endurance, strength, speed, and body composition. The statistically significant ($p<0.05$) results are as follows: Age group 17 (AG 17) had significantly higher leg and arm anaerobic power and capacity (leg power: 952±216 Watt (W); arm power: 684±194 W and leg capacity: 489±101 W; arm capacity: 354±88 respectively) as compared to the AG15 with (leg power: 718±279 Watt (W); arm power: 458±149 W and leg capacity: 376±132 W; arm capacity: 247±86 W respectively). AG17 wrestlers were significantly faster than AG 15 (4.29±.25 second - 4.53±.30 second respectively). AG 15 wrestlers had significantly lower right and left hand grip strength (right: 36.4±10.7 kg, left: 34.9±10 kg) than AG 16 (right: 43.9±8.4kg, left: 42.5±7.8 kg) and AG17 wrestlers (right: 46.6±8.7kg, left: 46.4±8.3 kg). In conclusion The results of this study suggest that height, body weight, fat free mass, arms – legs anaerobic power and capacity, speeds and hand grip strengths were increased both in one age range and in two ages range together with age progression, but it was clearly seen statistical differences in two ages range.

Key words: *Aerobic, Anaerobic, Body composition, Strength, Wrestlers.*

Introduction

Wrestling is one the first sports included in the ancient Olympic Games. It is characterized as a discipline which makes great demands on athletes in terms of physical preparation (Sterkowicz-Przybycień et al., 2011). Anaerobic and aerobic capacity, upper and lower body strength, power, agility, and flexibility are important factors needed to achieve good results in wrestling competitions (Bloomfield, 1994, Horswill, 1989, Horswill, 1992, Yoon, 2002, Mirzaei et al., 2009). The results of the study (Horswill, 1992) summarizes that the general physiological profile of the successful wrestler as one having high anaerobic power (mean ranging from 6.1 to 7.5 Wkg^{-1} for arms and from 11.5 to 19.9 Wkg^{-1} for legs); high anaerobic capacity (range for arms from 4.8 to 5.2 Wkg^{-1} and for legs from 7.4 to 8.2 Wkg^{-1}); high muscular endurance; average to above average aerobic power (range from 52 to 63 ml/kg/min); average pulmonary function (range from 1.90 to 2.02 *l/kg/min* for maximal minute ventilation ($\dot{V}_{Emax}$)); normal flexibility; a high degree of leanness (3.7–13% fat), excluding heavyweights; and a somatotype that emphasizes mesomorph. To achieve the better performance, the wrestling training has to be formulated according to these components.

Wrestling is a sport that applied based on the specific age categories. In other words, in wrestling there are many age categories, including schoolboys (14-15 years (from 13 with medical and parental certificate), cadet (16-17 years (from 15 with medical and parental certificate), junior (18-20 years (from 17 with medical and parental certificate), senior (20 years and older) and veterans (older than 35 years) (FILA, 2014). However, there is no enough information available in the literature about age – related characteristics of physical and physiological on wrestlers struggling in a category. Therefore, in the current study, we asked whether the differences of are physical and physiological based on ages in the category of cadet struggling wrestlers. It was hypothesized that depending on the age and training experience in wrestlers, physical and physiological differences occur and this promotes advantage in favor of older wrestlers.

Methods

Subjects

One hundred and twenty-six young wrestlers (age: 16.5 ± 0.7 year (yr); Height (HT): 170.2 ± 8.0 cm; body weight (BW): 67.7 ± 15.2 kg) volunteered as subjects in the present study. The wrestlers were divided into three independent age groups according to obtained personal informative form: age group 15 (AG15): n = 25; AG16: n = 41; AG17: n = 60.

Procedures

Before participating, subjects' parents (all under the age of 18) read and signed an informed consent form. It was asked for the athletes not to participate daily training program within 24 hours prior to testing. Testing was completed for all wrestlers in the same laboratory and field facilities on three consecutive days. However, all participants completed a personal information form that included their age (day/month/year), training background. The subjects and coaches were informed in detail about the experimental procedures and the possible risks and benefits of the project. The study, which complied with the Declaration of Helsinki, was approved by the Bioethics Commission of the University of Ankara.

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Physical Tests

Height and Body Weight

Body height (HT) and weight (BW) measurements were made using a digital scale (Seca gmbh & co.kg Germany) in bare feet and wearing only shorts.

Body Composition

Body composition analysis was determined by measurement of skinfold thickness and was measured at 3 sites (subscapular, triceps, abdominal) with a Holtain caliper. Body fat percent was calculated from the formula developed by Lohman (1992). Fat free mass (FFM) was calculated by subtracting the fat tissue mass (in kg) from the total body mass.

Physiological Tests

Anaerobic test

The Wingate (WAnT) tests were used for the arms and legs during separate tests (Inbar et al., 1996). The leg Wingate test consisted of a 30-s supramaximal cycling against a resistance load. Each test was performed on a Monark cycle ergometer (Model 894-E) and the load was calculated as 0.075 kg $x.kg^{-1}$ body mass for each participant (Hübner-Woźniak et al., 2004). Arm cranking was performed at standing body posture using ergometer (Monark 894E). Resistance of 0.055 $kp.kg^{-1}$ body mass was used for the athletes (Hübner-Woźniak et al., 2004).

Sprint running test (10 – 30 m)

After a standardized 15-min warm-up period (low-intensity running, several acceleration runs, and stretching exercises), the subjects undertook a sprint running test consisting of two maximal sprints of 30 m, with a 3 min rest period between each sprint. Maximal sprints of 10 m were measured during 30 m sprint running test. The better of two measurements were recorded. The running speed of the wrestlers was evaluated using dual-beam electronic timing gates (Sport Expert MPS 501 Model). Speed was measured to the nearest 0.01 s.

Maximal hand grip and back strength tests

Hand grip strength was measured for right and left hands with a Dynamometer (Takei A5001 Hand Grip Dynamometer Tokyo, Japan). Maximal back and leg strength (BS) were measured using a back and leg muscle dynamometer (Takei A5002 Back and Leg Dynamometer, Tokyo, Japan). The average of two trials was recorded.

Flexibility test

Flexibility of the trunk was determined from a sit and reach test using a standard sit and reach box. Two trials were performed for this test. The better of two measurements were recorded

Aerobic endurance test

Aerobic endurance was determined by using shuttle run (20 meter) test. The wrestlers started running back and forth a 20 m course and touched the 20 m line. The initial speed was 8.0 km/h which got progressively faster (0.5 km/h. every minute), in accordance with a pace dictated by a sound signal on an audiotape. The wrestlers were instructed to keep pace with the signal for as long as possible. When the subjects could no longer follow the pace, the last stage recorded was used to predict VO2max. A predicted VO2max was obtained using the equation of Leger and Gadoury (1989).

Statistical Analysis

General characteristics of the participants were presented as means and standard deviations. Standard statistical methods were used for the calculation of the mean and standard deviations (SD). The differences between the three age groups (AG: 15, AG: 16, and AG: 17) were determined using the one-way analysis of variance (ANOVA). Post hoc comparisons were made using the tukey procedure. Additionally, Pearson correlation was calculated to examine the relationships between variables. The level of significance for all statistics was set at $p<0.05$.

Results

According to age groups, characteristics, body composition (Fat%, FFM), hand grip, leg, and back strength, speed, flexibility, aerobic endurance, arms and legs anaerobic power and capacity values are presented in the tables below.

Table 1. The Characteristics of Wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
Height(cm)	163.3±9.0	169.8±8.0	171.6±7.3	0.00	A-B, A-C
Weight (kg)	55.9±15.1	66.4±15.6	70.4±14.1	0.01	A-B, A-C
Fat %	6.5±3.6	8.6±5.6	9.5±5.8	0.20	
FFM (kg)	51.9±11.8	60.0±10.3	63.2±9.1	0.00	A-B, A-C
BMI	20.7±3.2	22.8±3.7	23.7±3.3	0.02	A-C
Training Experiences	4.5±1.3	5.4±1.5	5.8±1.6	0.02	A-C

Legend: A - AG 15, B - AG 16, C - AG 17, FFM - fat free mass, BMI - body mass index

According to age groups, there was significant difference in height variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0,05$). There was significant difference in weight variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in FFM variable between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There were significant differences in BMI and sport experiences variables between AG 15 and AG 17 ($p<0.05$) Table 1.

According to aerobic and anaerobic performance values, there was significant difference in leg anaerobic peak power (W) between AG 15 and AG 17 ($p<0.05$). There was significant difference in leg anaerobic average power (W) between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in arm anaerobic peak power (W) between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in relative arm peak

power (W/kg), arm average power (W) and relative arm average power (W/kg) between AG 15 and AG 17 ($p<0.05$). There was no significant difference in aerobic endurance (V02 Max) among all age groups ($p>0.05$) Table 2.

Table 2. Aerobic and leg and arm anaerobic performance values of wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
LPP (W)	718±279	868±204	952±216	0.00	A-C
RLPP (W/kg)	12.6±1.8	13.2±1.9	13.5±1.8	0.20	
LAP (W)	376±132	462±102	489±101	0.00	A-B, A-C
RLAP (W/kg)	6.6±0.7	7.0±0.8	7.0±0.7	0.25	
APP (W)	458±149	616±193	684±194	0.00	A-B, A-C
RAPP (W/kg)	8.2±1.2	9.3±2.2	9.7±2.0	0.05	A-C
AAP (W)	247±86	315±96	354±88	0.00	A-C
RAAP (W/kg)	4.4±0.6	4.7±0.9	5.0±0.8	0.02	A-C
Aerobic (V02 Max)	51.9±4.6	49.6±5.7	50.8±5.9	0.38	

Legend: LPP - Leg peak power, RLPP - Relative leg peak power, LAP - Leg average power, RLAP - Relative Leg average power, APP - Arm peak power, RAPP - Relative arm peak power, AAP - Arm average power.

Table 3. Speed, strength and flexibility values of wrestlers

	A M±SD	B M±SD	C M±SD	p	Post Hoc Significant Result
10 meter (s)	1.82±.10	1.78±.12	1.80±.11	0.55	
30 meter (s)	4.53±.30	4.36±.21	4.29±.25	0.01	A-C
Right hand grip (kg)	36.4±10.7	43.9±8.4	46.6±8.7	0.00	A-B, A-C
Left hand grip (kg)	34.9±10	42.5±7.8	46.4±8.3	0.00	A-B, A-C, B-C
Back strength (kg)	135±32	150±32	153±35	0.23	
Leg strength (kg)	176±36	189±40	194±38	0.30	
Flexibility (cm)	30.6±6.3	32.0±7.5	33.6±5.9	0.21	

According to speed, Strength and flexibility values, there was significant difference in 30 meter (m) between AG 15 and AG 17 ($p<0.05$). There was significant difference in right hand grip strength between AG 15 and AG 16; and between AG 15 and AG 17 ($p<0.05$). There was significant difference in left hand grip strength among all age groups ($p<0.05$). There was no significant difference in back strength, leg strength and flexibility among age groups ($p>0.05$) Table 3.

Table 4. The correlation of selected physical and physiological parameters

N=126 (r)	LPP	LAP	APP	AAP	RHS	LHS	BS	LS
Height	.74**	.77**	.65**	.75**	.70**	.69**	.67**	.56**
Weight	.82**	.89**	.71**	.82**	.75**	.74**	.77**	.61**
BMI	.76**	.84**	.65**	.77**	.70**	.69**	.73**	.56**
FFM	.85**	.92**	.77**	.87**	.80**	.81**	.77**	.62**

Legend: RHS - right hand strength, LHS - left hand strength, BS - back strength, LS - leg strength, **p=0.01.

It was identified high level correlation between height, weight, BMI, FFM and arms-legs anaerobic performance values (power and capacity) (Table 4).

Discusion

The primary findings of this investigation indicate that AG 15 wrestlers were shorter than AG 16 and AG 17 wrestlers (3.8 and 4.8 % respectively) significantly. AG 17 wrestlers were significantly heavier than AG 15 wrestlers (21 %). AG 15 wrestlers had significantly lower FFM than AG 16 and AG 17 wrestlers (13.5 and 17.9 % respectively). AG 15 wrestlers had significantly lower BMI than AG 17 wrestlers (12.7 %). However, AG 17 had more training experience (22 %) than AG 15 wrestlers according to Table 1. When the results for the three elite groups (AG 15, AG16, and AG 17) were compared, some anthropometric variables such as height (HT), body weight (BW), body mass index (BMI), and fat free mass (FFM) seem to be related to age differences. Camic et al. (2009) confirmed that in young wrestlers the increase of BW, HT, and FFM were related to age in a similar pattern to that in non-trained adolescents. Housh et al. (1993) who compared age-related changes in HT and BW in a sample of 477 high school wrestlers with those of a national sample of 14- to 18-yr-old males. They reported average yearly increases of 2.1 cm in HT and 2.6 kg in BW. Whereas Camic et al. (2009) found yearly increases of 5.7 cm in HT and 4.3 kg in BW (8–13 yr). Housh et al. (1997) reported yearly increases of 2.1 cm in HT and 4.0 kg in BW in a sample of 67 high school wrestlers in a longitudinal investigation. These differences in yearly increases in HT and BW for the young wrestlers likely reflected the growth spurt associated with adolescence in the young wrestlers. In addition, the increase of FFM with age may be as a result of both more training experience and age related.

The comparison of anaerobic performance indicates that

AG 17 had significantly higher leg peak power than AG15 (25 %). AG 15 wrestlers had significantly lower leg average power than AG 16 and AG 17 wrestlers (18.6 and 23 % respectively). AG 15 had significantly lower arm peak power than AG 16 and AG 17 wrestlers (26 and 33 % respectively). However, AG 15 had significantly lower relative arm peak power and relative arm average power than AG 17 wrestlers (15 and 12 % respectively). In addition, AG 15 had significantly lower arm average power than AG 17 wrestlers (30 %) (Table 2). In the available literature, there are little reports of studies of legs and arms anaerobic peak and mean power in the same group of different age wrestlers or any other combat sport discipline (Terbizan and Selievold, 1996). Terbizan and Selievold (1996) while studying 15, 16, and 17 year-old wrestlers, established that arm and leg anaerobic mean power increased with age, but statistically significant differences were only observed between the youngest group and both older groups. Laskowski and Smaruj (2008) monitored the changes in anaerobic capacity influenced by during three years of judo training of 14–16 year-old boys. They found that maximal anaerobic power 801.12 W and relative maximal anaerobic power 12.29 W/kg after 3 years process training of 16.6 year-old boys. The results of our study compared with the study, it is seen that similar age and body weight of the wrestlers have more anaerobic power values than judo athletes. The reason may be different training experiences. In our study, statistically significant differences were only leg anaerobic peak and average power, arm anaerobic peak and average power, relative arm anaerobic peak and average power observed between AG15 and AG17 wrestlers. However significant differences were observed leg anaerobic peak power, arm peak power between AG16 and AG17. It was shown that the anaerobic performance values in adolescent wrestlers increased with age according to Table 2. The study results are seen to being similar to Terbizan and Selievold (1996) found no statistical differences in one age range, but it was clearly seen statistical the differences in two ages range. Age-related increases in average anaerobic power and peak power during adolescence have been shown to coincide with increases in BW, FFM and HT. We suggest that both body composition (especially the increase of FFM rate) and HT have considerable importance for sports that have predominately anaerobic aspects in high level performance. The numerous studies are generally about differences between successful and less successful wrestlers or between male and female wrestlers (Roemmich and Frappier, 1993; Hübner-Woźniak et al., 2004; Vardar et al., 2007; Pallares et al., 2011; Pallares et al., 2012). The studies that compared different competitive level judoists (elite and amateur) have found that elite judoists had higher anaerobic power and capacity values than amateur judoists (Franchini et al., 2011). The average power and peak power capabilities of wrestlers are associated with explosive maneuvers (Lansky, 1999) and can differentiate between successful and less successful wrestlers (Horswill et al., 1989). For example, Horswill (1989) reported that the anaerobic capabilities of elite junior wrestlers were as much as 13% greater than the average power and peak power of non-elite junior wrestlers. Kim et al. (2011) found that peak and mean power of legs was correlated with fat free mass while studying South Korean judokas. Vardar et al. (2007) established that peak power was positively correlated with FFM in male wrestlers aged from 15 to 19 years. It suggested that FFM rather than %FM may be a predictor of anaerobic performance in wrestlers (Vardar et al., 2007; Demirkan et al., 2013).

The comparison of speed, strength values of cadet wrestlers indicate that AG17 wrestlers were significantly faster than AG 15 (5.6 %). AG 15 wrestlers had significantly lower right hand grip strength than AG 16 and AG17 wrestlers (17.1 – 22 % respectively) to Table 3. And also AG 15 wrestlers had significantly lower left hand grip strength than AG 16 and AG17 wrestlers (18 and 25 % respectively). AG16 wrestlers had significantly lower left hand grip strength than AG 17 wrestlers (8.4 %). Although there was no significant differences back and leg strength values among age groups, AG 15 wrestlers had relatively lower back strength than AG 16 and AG17 wrestlers (10 and 12 % respectively). Also, AG15 wrestlers had lower leg strength than AG17 wrestlers (9.3%). The development of absolute strength during childhood and adolescence has been shown to be highly related to chronological age (De Ste Croix et al., 2003). Previous studies have reported moderate to high correlations (r = 0.36–0.96) for muscular strength versus HT, BW, or FFM (Housh et al., 1995; Housh et al., 1996; Almuzaini, 2007). In our study, it was seen that moderate to high correlations (r = 0.61- 0.81) between the HT, BW, FFM and muscular strength which obtained from hand grip and leg- back strengths to Table 4.

Conclusion

The present study demonstrated that HT, BW, FFM, and arms – legs anaerobic power and capacity, speeds and hand grip strengths were increased both in one age range and in two ages range together with age progression, but it was clearly seen statistical differences in two ages range. In addition this, it was seen that older wrestlers have more training experiences compared with the youngest wrestlers. Therefore, the youngest wrestlers appear to be at a disadvantage due to lower values for HT, BW, FFM, arms – legs anaerobic power and capacity, speed, strength and training experiences. However, these findings indicate that height and fat free mass are considerable factors to achieve the better anaerobic power and capacity. The paper presents also age-related normative data of young wrestlers.

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