



RETRACTED ARTICLE: Correlation Between Anthropometric, Physical Fitness Traits, Lung Capacity, and Success of Iranian Elite Greco-Roman Wrestlers

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Abstract

Objectives: This study aimed to evaluate whether lung capacity and anthropometric and physical fitness traits are associated with success of Iranian elite Greco-Roman wrestlers.

Methods: Twenty-five male Iranian elite Greco-Roman wrestlers (± 4 years old) (both of light and heavy weights) participated in the present study. Anthropometric characteristics, physical fitness traits, and lung capacity were tested in the exercise physiology laboratory.

Results: Our results showed a significant and positive correlation between arm span, as the only anthropometric trait, and success of Iranian elite Greco-Roman wrestlers. Also, maximal oxygen consumption, dead lift, squat, bench press, agility, shoulder and wrist elevation, sit and reach, eye/left hand reaction time, eye/foot reaction time, ear/left hand reaction time, ear/foot reaction time were positively correlated with success. Furthermore, there were significant and positive correlations between inspiratory reserve volume, tidal volume, forced vital capacity, forced expiratory volume (1st second), maximal voluntary ventilation, and success. In contrast, we observed a negative and significant correlation between body fat (%) and success of Iranian elite Greco-Roman wrestlers.

Conclusions: Physical fitness traits and lung capacity have a greater potential than anthropometric characteristics in the prediction of Greco-Roman wrestler's success in championship levels.

Keywords: Anthropometric Characteristics, Physical Fitness Traits, Lung Capacity, Wrestler's Success, Greco-Roman Wrestling

1. Background

Practiced worldwide, Greco-Roman wrestling is one of the more popular events of the modern Olympic Games (1, 2). Wrestling is described as a sport where factors such as speed, power, quickness, flexibility, balance, muscular and cardiovascular strength, and coordination affect the wrestler's performance (1). In addition, it is an aerobic and anaerobic exercise that allows only upper body moves and lasts for about 6 min (2×3 -min bouts) (3).

Knowledge of physiological and physical factors that contribute to successful Greco-Roman wrestling is a challenge confronting sport scientists (2). A significant portion of studies have been built on physiological/anthropometrical profiles (1, 3) and physical fitness tests to reveal wrestlers' current physiologic capability

for competition (2, 4). It has been shown that elite Turkish (3) and Canadian wrestlers (5) have an anthropometric and physiological profile similar to elite wrestlers from other countries. Also, elite junior wrestlers compared to elite senior wrestlers have a lower anaerobic and aerobic power, respectively (4). Furthermore, top-level wrestlers have significantly greater aerobic and anaerobic power, muscle strength, muscle endurance (6), and flexibility (7) than the lower level wrestlers. In addition, the physiological profile of elite wrestlers has been used as a training target for developing athletes (8). Also, wrestlers have shown higher levels of muscular strength and aerobic and anaerobic power 7 months before a major event (9).

One of the most important factors that determine a

coach's success is the ability to predict the general performance of a wrestler, capabilities of the wrestler, and the progress s/he may have based on his/her technical capacities (1). As a result, for progress in wrestling, it is necessary that all the physiological capacities, anthropometric aspects, and bio-motor abilities be evaluated. So far, there are insufficient studies that have investigated the relationship between anthropometric, physical fitness traits, lung capacity, and success of wrestlers. In one study, it was shown that motor abilities contributed to success and technical efficiency in wrestling competitions (10). Since the information regarding top level Greco-Roman wrestlers is limited (in terms of anthropometric, physical fitness, and lung capacity characteristics), no distinct criterion or norm is available for coaches and athletes to predict competitive success. The results of the present study will provide useful information to identify important factors involved in the process of talent identification for Greco-Roman wrestling.

2. Objectives

The aim of the present study was (i) to investigate the relation between anthropometric, physical fitness traits, lung capacity, and success of Iranian elite Greco-Roman wrestlers and (ii) to determine which of the mentioned parameters has a greater potential in the prediction of Greco-Roman wrestler's success in championship levels.

3. Methods

3.1. Subject

Twenty-five male Iranian elite Greco-Roman wrestlers (22 ± 4 years old) (both light and heavy weight wrestlers) participated as volunteers in this study. The subjects and coaches were informed in detail about test procedures, possible risks, and benefits of the results. They signed an informed consent statement in adherence with the human subject's guidelines of Iran's National Olympic Committee Research Center. Before the research, the participants filled out the general health questionnaire, and there were no health problems or injuries. The training experience of the participants was 10 ± 2 years. The athletes were asked not to participate in daily training programs within 24 h prior to testing. They were tested in the exercise physiology laboratory of Shahid Chamran University of Ahvaz (Iran) on three consecutive days.

3.2. Anthropometric Measurements

Anthropometric parameters including wrist circumference, shin circumference, height from hip joint to the top of the head, height from iliac crest to the top of the

head, and arm span to height ratio were measured by a tape measure. The subject's height was also recorded by a wall-mounted stadiometer (YG-200; Yagami, Nagoya, Japan). A digital scale was used to measure body weight with light clothing and without shoes (TBF-551; Tanita, Tokyo, Japan). Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Also, body fat percentage and fat and muscle weight were measured by body composition analyzer (Olympia 3.3; Jawon Medical Co., Gyeongsangbuk-do, Korea). Length and circumference of limbs were determined by a tape measure.

3.3. Physical Fitness Measurements

Right-left hand grip strength and dead lift were determined by biodex dynamometer (Yagami Co., Japan). Flexibility of muscles and reaction time were measured by digital biodex flexible gauge and reaction timer (Yagami Co., Japan), respectively. Squat and bench press were determined by free weights based on one repetition maximum. Maximal oxygen consumption (VO_2 max) was evaluated by the Astrand test on treadmill (h/p/Cosmos, Mercury® Med, Germany). Agility was determined by a 4×9 -m shuttle run test, lung capacity was measured by a digital spirometer (HI-601, Japan).

3.4. Wrestler's Success Measurements

A wrestler's success was rated based on his success in provincial and national competitions, official tournaments, and Asian games in the last three years. The points 100, 90, and 85 were allocated respectively to the first to third positions in official tournaments and Asian games. Also, for the first to third positions in national competitions, points 80, 70, and 65 were assigned, respectively. In addition, points 60, 50, and 45 were allocated respectively to the first to third positions gained during provincial competitions. Finally, in order to control the number of attendance in competitions by each athlete in the last 3 years, their scores were multiplied by the number of attendance and subsequently divided by the sum of the attendance times.

3.5. Statistical Analyses

Data were analyzed in SPSS software (version 16.0) and presented in terms of means \pm SD. Initially, the normality and homogeneity were assessed by Shapiro-Wilk and Levene's tests, respectively. Then, Pearson's correlation coefficient was calculated to determine the relationship between variables. An alpha of 0.05 was used to determine statistical significance.

4. Results

Means and standard deviations of anthropometric measurements and physical fitness parameters are presented in Tables 1 and 2, respectively. The wrestlers' success based on their success in competitions was 68.94 ± 15.14 . Results showed that from among the anthropometric characteristics, arm span correlated positively and body fat (%) was associated negatively with success of elite Greco-Roman wrestlers, both in a significant manner (Table 1). Also, dead lift, squat, bench press, VO_2 max, agility, shoulder and wrist elevation, sit and reach, eye/left hand reaction time, eye/right hand reaction time, ear/left hand reaction time, ear/right hand reaction time correlated positively with the success of elite Greco-Roman wrestlers (Table 2). Furthermore, there were significant positive correlations between inspiratory reserve volume (IRV), tidal volume (VT), forced vital capacity (FVC), forced expiratory volume (second) (FEV1), maximal voluntary ventilation (MVV), and success of elite Greco-Roman wrestlers (Table 3).

5. Discussion

Knowledge of anthropometric and physical fitness traits in any sport is an important and decisive determinant of athletic performance. Elite athletes have special anthropometric and physiological characteristics that determine their successes in their sports (11). In the present study, we showed the relationship between success and anthropometric and physiological traits of Iranian elite Greco-Roman wrestlers. Collectively, anthropometric traits do not seem to be a determining factor in the success of Greco-Roman wrestlers, whilst physical fitness traits appear to be definitive factors influencing the success of wrestlers.

Arm span, as an anthropometric characteristic, positively correlated with the success of Iranian elite Greco-Roman wrestlers. Also, arm-span measurements were 6 cm more than the height measurement (181 cm versus 175 cm). Because having long arms is a mechanical advantage in Greco-Roman wrestling, this trait is probably one of the reasons for successful performance of the subjects in techniques such as the reverse lift, back arch, and gut-wrench (1).

The subjects' body fat (%) in this study was higher than the reported value in the study by Mirzaei et al. (1) where the participants included 55 kg Greco-Roman wrestlers (14% versus 8.4%, respectively). In addition, it has been reported that the body fat percentage of international male wrestlers varies from 4.5% to 16% (12). Moreover, it is demonstrated that body fat rate changes according to the athlete's sport type and gender (1, 2). Researchers agree

that the percentage of the body fat rate ranges from 6% to 15% for male athletes. As a result, the body fat rate that we observed in our study is at the upper end of this continuum. However, body fat (%) in the present study was determined for both light and heavy weights of Greco-Roman wrestling. In contrast to Roemmich and Frappier's study (6), our findings showed a negative correlation between body fat (%) and success. This contradiction may be due to difference in the method of measuring body fat. Moreover, it should be reminded that changes in body composition induced by strength training have a positive effect on muscle performance (13).

Superior upper body strength and anaerobic capacity in Greco-Roman wrestling might be more beneficial for the initiation of attacks and explosive execution of wrestling techniques because only upper body moves are allowed (3). Moreover, hip and leg strength is a prerequisite for the successful performance of techniques such as the high-dive and lifting of the opponent as in the reverse-lift (1). Therefore, success in skillful implementation of such techniques against international competitors is made possible through lower body strength (1). In line with other researchers (1, 6, 7), the results showed that higher levels of strength (dead lift, squat, and bench press) are associated with higher levels of success in championships. In reality, wrestling is a sport in which making progress depends substantially upon body strength. In the evaluations based on body weight, wrestlers are shown among the strongest athletes. As a biomotor ability, strength is crucial not only in defense but also in the employment of techniques in attacks and resistance to attacks (counter-attack) (14). In addition, senior successful wrestlers have significantly more relative grip strength, pull-ups, oxygen consumption, and peak anaerobic power in upper and lower limbs (15). Finally, a wrestler can earn better results due to high endurance and muscle strength that provides more stability in defense and attack positions (7).

Flexibility is among the most important components of physical fitness (1) and can help prevent from injury (7). It is one of the traditional tests to evaluate wrestlers and has been a persisting parameter in almost all studies focusing on the profile of wrestlers or assessment of wrestlers' performance (3). Alongside other studies (1, 6, 7), our findings showed that higher levels of flexibility (shoulder and-wrist elevation, sit and reach) are associated with higher levels of success in champions. In this context, Mirzaei and colleague (1) reported that trunk-and-neck extension and shoulder-and-wrist elevation tests in 55 kg weight class of Greco-Roman wrestling were lower than the national norms. However, flexibility was higher than the national norm in the sit-and-reach test. Therefore, it is recommended that special attention should be paid

Table 1. Correlation Between Anthropometric Features and Elite Greco-Roman Wrestler's Success

Anthropometric Measurements	Mean ± SD	Correlation Coefficient	P Value
Height (cm)	175 ± 9	0.30	0.13
Weight (kg)	78 ± 15	0.07	0.72
Body mass index (m/kg ²)	25 ± 3	0.24	0.23
Body fat (%)	14 ± 3	-0.42	0.03 ^a
Body fat weight (kg)	11 ± 4	-0.22	0.27
Body muscle (%)	79 ± 3	0.35	0.07
Muscle weight (kg)	62 ± 11	0.18	0.36
Humeral length (cm)	33 ± 3	0.19	0.35
Forearm length (cm)	30 ± 1	0.26	0.19
Femoral length (cm)	42 ± 4	-0.33	0.10
Calf length (cm)	41 ± 4	0.01	0.99
Wrist circumference (cm)	19 ± 1	0.38	0.06
Waist circumference (cm)	82 ± 8	-0.04	0.84
Hip circumference (cm)	98 ± 6	-0.07	0.72
Femoral circumference (cm)	57 ± 5	0.02	0.89
Calf circumference (cm)	38 ± 3	0.14	0.47
Ankle circumference (cm)	24 ± 3	-0.03	0.86
Sitting height (cm)	74 ± 4	-0.08	0.68
Arm span (cm)	181 ± 10	0.61	0.01 ^a

^aIndicates a significant correlation between the two corresponding variables.

Table 2. Correlation Between Physical Fitness Traits and Elite Greco-Roman Wrestlers' Success

Physical Fitness Traits	Mean ± SD	Coefficient Correlation	P Value
Right-hand grip strength (N)	49 ± 9	0.36	0.07
Left-hand grip strength (N)	48 ± 10	0.36	0.07
Dead lift (kg)	167 ± 23	0.86	0.01 ^a
Squat (kg)	148 ± 45	0.42	0.03 ^a
Bench press (kg)	110 ± 28	0.42	0.03 ^a
Maximal oxygen consumption (mL.kg ⁻¹ .min ⁻¹)	50 ± 7	0.78	0.01 ^a
Agility (s)	7.4 ± 0.46	0.37	0.04 ^a
Shoulder and wrist elevation (cm)	24 ± 9	0.7	0.01 ^a
Sit and reach (cm)	33 ± 11	0.7	0.01 ^a
Eye/left hand reaction time (s)	0.51 ± 0.22	-0.53	0.01 ^a
Eye/right hand reaction time (s)	0.47 ± 0.07	-0.12	0.09
Eye/foot reaction time (s)	0.40 ± 0.12	-0.41	0.03 ^a
Ear/left hand reaction time (s)	0.54 ± 0.12	-0.41	0.04 ^a
Ear/right hand reaction time (s)	0.59 ± 0.10	0.37	0.06
Ear/foot reaction time (s)	0.47 ± 0.17	-0.46	0.01 ^a

^aIndicates a significant correlation between the two corresponding variables.

to flexibility exercises of the subject. In addition, it is revealed that the flexibility of elite wrestlers is higher than lower-level wrestlers (7). Therefore, part of success of elite Greco-Roman wrestling may be attributed to higher levels of flexibility.

The importance of both reaction time and agility for success of an athlete in top-level competitions is well acknowledged among the wrestling coaches (1). In this con-

text, the results of the visual reaction time and agility test in the current study showed a significant correlation with elite Greco-Roman wrestler's success. In fact, having high levels of agility and reaction time can dramatically help wrestlers to use their techniques rapidly against opponents' movements. Collectively, this advantage contributed to the speed with which the subjects performed their techniques in both attack and defense.

Table 3. Correlation of Lung Capacities and Elite Greco-Roman Wrestler's Success

Lung Capacity Parameters	Mean \pm SD	Coefficient Correlation	P Value
Inspiratory vital capacity (IVC)	3.4 \pm 0.64	0.001	0.99
Inspiratory reserve volume (IRV)	2.3 \pm 0.66	0.58	0.01 ^a
Expiratory reserve volume (ERV)	1.04 \pm 0.48	-0.23	0.26
Tidal volume (VT)	0.98 \pm 0.52	0.43	0.02 ^a
Functional vital capacity (FVC)	4.40 \pm 0.67	0.55	0.01 ^a
Forced expiratory volume (s) (FEV1)	4.04 \pm 0.62	0.88	0.01 ^a
Peak expiratory flow (PEF)	7.42 \pm 1.79	0.36	0.07
Forced inspiratory flow (FIF)	5.38 \pm 1.72	-0.07	0.73
Maximal voluntary ventilation (MVV)	163 \pm 23	0.87	0.01 ^a

^aIndicates a significant correlation between the two corresponding variables.

Aerobic capacity is proposed as one of the most important physical factors to achieve good results in wrestling competitions (7). Our results showed that higher levels of endurance (VO_2 max) are associated with higher levels of success in champions. The VO_2 max value calculated in the current study was lower than the values reported by others (50 versus 60 mL.kg⁻¹.min⁻¹) (7). This difference may partially be explained by comparing the testing protocol employed in this study. Although our findings showed positive relation between VO_2 max and successes in competition, it should be reminded that changes in wrestling rules may decrease the contribution of the aerobic system (compared to the anaerobic system) for energy production during wrestling in future competitions.

For the first time, we showed significant and positive correlations between lung capacity and success of elite Greco-Roman wrestlers. In this context, Durmic and colleague in a cross-sectional study on 470 male elite athletes have indicated that chronic endurance physical activity leads to adaptive changes in VC, FVC and FEV1 parameters (16). Moreover, it has been demonstrated that endurance combined with resistance exercise training has a greater effect on VC, FVC, FEF than mere endurance or resistance training (17). In fact, Greco-Roman wrestling is a sport with an endurance-resistance nature that influences respiratory parameters involved in success. In reality, these correlations may be due to high levels of strength and endurance of the respiratory muscles and low levels of airway resistance (18).

5.1. Conclusion

Collectively, according to our findings, physical fitness traits and lung capacity have a greater potential than anthropometric characteristics in the prediction of Greco-Roman wrestler's success in championship levels. Thus, talent identification programs for Greco-Roman wrestlers should place greater emphasis on the physical fitness traits and lung capacity than anthropometric measurements. In

other words, during the scouting process, more attention should be paid to the physical fitness traits and lung capacity aspects of junior athletes. Finally, experienced coaches can focus more on physical fitness traits and lung capacity to maximize the possibility of success in Greco-Roman wrestling competitions.

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Footnote

Authors' Contribution: Authors were involved in the data collection, data analysis and the drafting of the manuscript. Also, authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

Ethical Considerations: The subjects and coaches were informed in detail about test procedures, possible risks, and benefits of the results. They signed an informed consent statement in adherence with the human subject's guidelines of Iran's National Olympic Committee Research Center. They were tested in the exercise physiology laboratory of Shahid Chamran University of Ahvaz (Iran) on three consecutive days.

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