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ASYMMETRICAL HANDGRIP STRENGTH AND BODY COMPOSITION OF CADET WRESTLERS: A PILOT STUDY

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ABSTRACT.

Purpose: to compare the body composition and the maximum of handgrip strength of Venezuelan cadet wrestlers. The sample was of ten wrestlers of Greco-Roman (GR=5; M±SD, age: 16.81±0.34 yrs.-old; weight: 58.76±4.43 kg; height: 167.2±0.31 cm) and Freestyle (FS=5; M±SD, age: 16.35±0.59 yrs.-old; weight: 60.92±3.34 kg; height: 166.7±0.39 cm). **Methods:** the procedure used to estimate the body composition (BC) followed the established standards by the International Society for the Advancement of Kinanthropometry. The handgrip strength (HGS) was measured using the manual dynamometer (Takei), recording the best value of three (3) attempts for both right and left hand. The "t Student" was used to compare GR vs. FS wrestlers and to verify statistical differences between the strength of handgrip (left and right), p ≤0.05 value. **Results:** No effects were observed between GR and FS; the reported values of BC were 12.98±3.08 % for the % body fat and 52.07±3.73 kg for the fat-free mass. The handgrip strength was registered in absolute and relative terms to body weight having as a result for the right hand: (HGS: 49,70±3,53kg.s; 0,83±0,41Kg·kg.s^{-1}) and the left hand (HGS: 43,90±4,07kg.s; 0,74±0,05Kg·kg.s^{-1}). Significant differences were found between the (HGS) of the right hand compared with the left hand (absolute, p ≤0.05; relative, p ≤0.05). **Conclusion:** The differences obtained in the (HGS –asymmetrical) could be due to the predominance of the right hand in relationship with the left hand, or to the actions performed with greater emphasis of the right handed side in this group of wrestlers.
Key words: handgrip strength, body composition, wrestlers.

INTRODUCTION

The early specialization of youth wrestlers and the developing availability of high–level events to younger competitors have led to increased focus on specific adaptations to physical training (Fukuda et al., 2013). Wrestling is one of the sports in which a great level of physical aptitude and an optimal body composition is shown (Demirkan et al., 2015). Specific focus has been given to participants during periods of development in which growth and maturation may demonstrate both threats and opportunities to physical implementation (Capranica & Millard-Stafford, 2011). Since youth, the international competition system with emphasis in competitiveness by weight divisions implies that the body mass of wrestlers must be evaluated during a full training period of wrestling and a few hours before the beginning of an official competition (Alderman et al., 2004).

Therefore, finding the optimal body composition of wrestlers, especially the distribution of the lean and fat component, has been one of the biggest concerns of the technical and scientists related to this sport during the last decades (López-Gullón, 2010). However, the methods used by young athletes to modify body composition can potentially lead to significant health risks including compromised nutritional status, diminished physical performance and impaired growth and development (Berkovich et al., 2016).

Worried about this circumstance, the importance of the body composition in wrestlers has been studied extensively in research, with the usage of several methodological procedures. Among these methodologies, it is important to highlight the study of skin folds (Horswill et al., 1988; Park et al., 1990; Callan et al., 2000; Kramer

et al., 2001; Mirzaei et al., 2009; 2011). As a consequence, it has been demonstrated that the measurements of subcutaneous adipose tissue are very important since previous research has reported a reduction on the physical performance or health due to a high or low percentage of body fat, respectively (Amani et al., 2010; Potteiger et al., 2010).

During a wrestling match, efforts of high intensity are perceived and they are characterized by demanding strength levels and muscular potency both in the upper body and lower body, prevailing a predominance of the production system of the anaerobic energy, and also the isometric component for the technical performance (Horswill, 1992; McGuigan et al., 2006; Vardar et al., 2007; García-Pallarés et al., 2010).

Under these remarks, the isometric strength level is an important agent for the practice of defensive maneuvers in wrestling, both standing and the floor (*par-terre)* position, for that reason, it has been stated that the isometric muscular tensions of handgrip are committed in a combat and during the development of a wrestling tournament (Kraemer et al., 2001; 2004; Barbas et al., 2011). In the same way, this aspect is considered an indicator of the general strength quality, which can determinate the performance of athletes who depend on an appropriate level of lateral symmetrical gripping strength to raise their performance and control and reduce possible injuries (Blackwell et al., 1999).

On the other hand, it is of great importance to emphasize that the term "Cadet" is an official designation of the age group for international competition by the international governing body of wrestling (United World Wresting). Thus, cadet continental championships are held annually for these wrestlers who are between 16 and 17 years old (with the participation in some cases of wrestlers of 15 years old).

Demirkan et al. (2012) made a comparison on the physical and physiological characteristics of Freestyle and Greco-Roman young wrestlers of elite; as a result, they did not find statistically significant differences on the percentage of fat body, with 9.6±5.2% versus 10.7±4.7%, and on isometric hand grip strength, with 54±8.0Kg.s and 49±8.0kg.s for right hand versus 53±7.8kg.s and 48±7.9kg.s for left hand, respectively.

Additionally, Gerodimos and Karatrantou (2013) carried out a study about the reliability of the maximum grip strength test in pre-pubertal and pubertal wrestlers from Trikala, Greek. The individuals were grouped in concordance with their biological age, according to the sexual maturation stages of Tanner, puberty stage: pre-pubertal: (stages 1-2) and pubertal (stages 3-4). As part of the results, they showed statistically significant differences in all of the basic variables recorded (age, body mass, and years of training), pubescent versus pre-pubescent. Furthermore, according to the procedure of the executed tests and the reliability for the maximum grip strength described as an attempt, the best or the average of two and three tries, absolutely all of the trials made for both right and left hand showed a high reliability, with a rank of interclass correlation coefficient of 0.869–0.993 and a rank of technical measurement error (TME) within acceptable limits. So that the manual dynamometry is a reliable method to evaluate the grip strength in young wrestlers.

More recent investigation, made by Arslanoğlu (2015) about Greco-Romans physical profiles of young wrestlers from Turkey, age: 18.61±1.01years old, height: 173.0±8.79cm, body mass: 77.88±18.84kg and sports experience: 8.09±2.7years. In their results, revealed a %BM: 11.04±3.42% and inside the physical parameters, a grip strength: 52.62±9.87kg.s (for the right hand) and 50.89±10.17kg.s (for the left hand). Nevertheless, this study only describes the values of the variables researched, without making comparisons and to determine differences from the results obtained (differences in the values of handgrip strength of the right hand in regard to the left hand).

Based on these statements, a well-established quantitative approach to investigate body composition and manual dynamometry in young wrestlers aged 15-17, values of body fat, handgrip strength in absolute terms and relative to body weight in these subjects. These pratical applications could allow establishing comparisons with other wrestlers of the same age and making adjustments in training programs, avoiding effects of early specialization, as this last component is considered an important aspect to reduce injuries and to develop the domain of actions that require a level of handgrip strength and control during a wrestling match.
Therefore, the purpose of this study was to compare the body composition and the maximum expression of handgrip strength of Venezuelan cadet wrestlers. The results of the investigation will allow adjustments to be made in the preparation of these wrestlers.

METHODS
Subjects
The sample was composed by ten male wrestlers, Greco-Roman (GR=5; M±SD, age: 16.81±0.34 yrs.-old; weight: 58.76±4.43 kg; height: 167.2±0.31 cm) and Freestyle (FS=5; M±SD, age: 16.35±0.59 yrs.-old; weight: 60.92±3.34 kg; height: 166.7±0.39 cm), belonging to the selection of a province of Venezuela (Barinas) in the cadets category, located in the intermediate weight divisions (≤54, 54≤58 and 58≤63kg).

Inclusion criteria: these subjects had at least five (5) years of experience in the sport and performed a daily workout between about 120-150 minutes, at five (5) times per week, being evaluated during a special stage of the annual cycle preparation.

Exclusion criteria: Athletes who could not perform all evaluations, with injuries, chronic problems or who were training with a weekly frequency less than 4 times a week or with experience in the modality less than 5 years.

Testing procedure

The Observatory of Research in Physical Activity and Sport Sciences Review Board, of the Experimental National University of the Western Plains Ezequiel Zamora, approved all procedures conducted during this study. Also, before doing the evaluations, all the subjects and their parents were summoned to explain them the purpose of the study, the potential benefits and risks that could be presented during the development of the investigation, so that was how informed written consent was obtained from both the participants and their parents or guardians.

The tests were carried out at a single moment in agreement with the study design; all measurements took place at the stage of specific preparation of an annual plan of wrestling. It is important to declare, that all subjects were in good physical health and were free of injury or difficulties in the upper extremities, also demonstrating a domain of the right hand (right–hand side) in participants.

Estimation of the Body Composition (BC)

The body mass and height were registered as basic variables. Body weight was measured with a digital scale (Electronic XACTA-150, USA); the height was measured using a wall-mounted scale (Holtain Limited, Ukraine), and followed the technique described by Stewart et al. (2011).

The subcutaneous body fat was estimated using the anthropometric technique, taking into consideration the measurement of the thickness of subcutaneous adipose tissue on the right side of the body (triceps skin fold and calf fold), with the clamp type Holtain adipometer. The percentage of fat (%BF) was calculated using the formula developed by Slaughter et al. (1988) and the fat-free mass (FFM) was obtained from the derivation of total weight less fat weight in kilograms (Demirkan et al., 2014; Demirkan, 2015).

It must be stated that all variables were recorded using the protocol which follows the standards set by *The International Society for the Advancement of Kinantropometry [I.S.A.K.]* (Stewart et al., 2011). In addition, measurements were made by an anthropometrist of experience with accreditation level II ISAK.

Measurement of the isometric handgrip strength (HGS)

Before starting the test, the wrestlers were informed about the purpose of it, and they were instructed according to the indications of España-Romero et al. (2010) and Gerodimos and Karatrantou (2013): how they should hold the hand dynamometer to avoid possible bias in the reading of the values obtained, make three (3) tries for each hand (right and left), with one (1) minute rest between trials. The exercised contraction should be gradually and continuously for 2-5 seconds and were encouraged to do their best at the time of testing.

In addition, as standardization of the application of the test, the Alkurdi and Dweiri (2010) protocol was considered, in which the individual in a standing position, with separation of the legs to the same broad shoulders and with the dynamometer trigger adjustment according to the size of the person´s hand evaluated, taking the device and leaving visible hand out the screen, raises his arm, flexing the shoulder and elbow at 90 degrees to the front, begins apprehension of the dynamometer while descending the arm to be extended to one side of the body .Then, he delivers the dynamometer against the evaluator face up to read the value obtained by providing blind measurements to the teenager. The instrument used for measuring this component was an analog manual adjustable grip dynamometer (TKK –*Takei Kiki Kogyo*– model 5101, Japan), with measured values in kilograms.

STATISTICAL ANALYSIS

The Kolmogorov–Smirnov statistical test was used to determine the normal distribution of strength of handgrip variable. Descriptive data are presented as measures of central tendency (average), dispersion measures (standard deviation), range (minimum and maximum) values; Likewise, To verify statistical differences in the strength of hand grip (left and right), the "t Student" test was applied for related samples in order to determine differences in the results of the gripping force of the right hand respecting to his left hand and effect size (ES) was calculated by Cohen's *d*, taking as criterion for all analysis a significance level of *p≤0.05*. Statistical analysis was conducted in the Statistical Package for the Social Sciences (SPSS) version 21.0 for Windows. The graphical representation was performed using Prism Graph v4.4.2 program.

RESULTS

Kolmogorov–Smirnov statistical test was applied as exploration to verify the data normality. It became clear in the process that the values obtained from the maximum expression of isometric grip force from both the right hand and the left come from a normal distribution. Similarly, descriptive statistical values were determined for body composition, the fatty component and fat-free mass, and for the ultimate expression of isometric hand grip force obtained with the dynamometer, exerted by both the right hand and the left, data expressed in absolute terms, kilogram–strength (kg.s) and relative divided by the body weight (kg.s*kg^{-1}).

Taking into consideration the published results, statistically significant difference was found in the gripping force exerted by the right hand compared to the force exerted by the left hand. From the results, you can say analytically that there is a predominance of isometric strength of his right hand compared to his left hand in this sample of wrestlers. The values can be seen in Table 1.

Table 1. Values of body composition and the ultimate expression of isometric hand grip force in a sample of ten (10) fighters.

	M±SD	Mínimum	Máximum	t
BF (%)	12.98±3.08	9.82	17.91	-----
FFM(Kg)	52.07±3.73	47.46	56.79	
ISRH(Kg.s)	49.70±3.53	45	55	6.794
ISLH(Kg.s)	43.90±4.07*	38	50	
ISRH (Kg.s·kg^{-1})	0.83±0.41	0.78	0.90	6.639
ISLH (Kg.s·kg^{-1})	0.74±0.05*	0.66	0.81	

M= *mean*; **SD**= *typical standard deviation*; **BF**= *body fat*; **FFM**= *fat free mass*; **ISRH**= *isometric strength right hand*; **ISLH**= *isometric strength left hand*; **a.-** Absolute grip strength (Kg.s), **b.-** Relative grip strength to body weight (Kg.s·kg^{-1}), *= significance at 0.001.

In a more obvious way, the results obtained are graphically presented from the measuring of the maximum expression of the absolute strength of hand grip and significant differences found in the right hand against the left in this group of wrestlers (ES=1.91), in Figure 1.
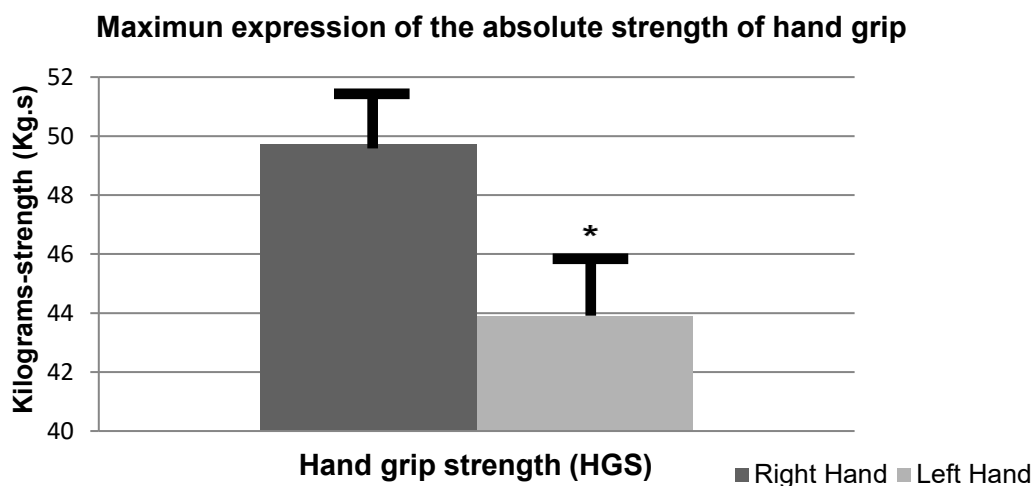

Maximun expression of the absolute strength of hand grip

Figure 1. Differences between the values of grip strength of the right hand in connection with the left hand in the sample of wrestlers
*= significance between right and left hand at 0.001

DISCUSSION
As previously mentioned, the purpose of this study was to describe the body composition and a comparison of the maximum expression of isometric handgrip strength of Venzuelan cadet wrestlers. In contrast to the results, lower values of BF%, higher values of FFM, handgrip strength (HGS) and sports experience (SE),were reported by Demirkan et al. (2014), In Free Style (FS) and Greco-Roman (GR) 15-17 year old style. The results ([FS] % BF: 9.0±4.9; FFM in Kg: 61.3±9.6; HSG in kg.s: 43.9±9.1 for the right hand; 43.4±8.8 for the left hand; SE: 5.7±1.6; [LG] % GC: 8.7±6.4; FFM in Kg: 60.5±11.2; HSG in kg.s: 45.7±9.31 for the right hand; 44.6±9.0 for the left hand; SE in years: 5.7±1.6) not showing statistically significant differences between the wrestlers of both

styles. However, the current study shows manifest statistically significant difference between left and right hands, with a large effect size.

Demirkan et al. (2015) revealed data for fat % lower than found in the present study ([Group A: 15years; B: 16years; C: 17years]% GC A: 6.5±3.6; B: 8.6±5.6; C: 9.5±5.8 vs. 12.98±3.08), a FFM kg (A: 51.9±11.8; B: 60.0±10.3; C: 63.2±9.1 versus 52.07±3.73), one consistent with those published in this research (in years SE SD: 4.5±1.3; B: 5.4±1.5; C: 5.8±1.6, respect 5.6±1.3 compared to) and isometric strength values similar handgrip ([HGS in kg.s] A: 36.4±10.7; B: 43.9±8.4; C: 46.6±8.7 to 49.70±3.53, for the right hand and A: 34.9±10; B: 42.5±7.8; C: 46.4±8.3 vs. 43.90± 4.07 for the left hand). However, they established statistically significant differences between groups regarding the FFM: A ≠ B; A ≠ C, muscle contraction exerted his right hand (A ≠ B, A ≠ C) and left hand (A ≠ B, A ≠ C, B ≠ C). In the current study, subjects were grouped globally for under age range 15-17 as participatory research sample.

As part of the analysis of the result, a functional motor asymmetry is evidenced for the hand grip strength on the right side with respect to the left side (ie failure to demonstrate symmetrical manual grip strength) observed in this group of wrestlers. On average, subjects showed asymmetry for grip strength, exhibiting slightly higher values of right hand grip strength, which are only statistically significant with respect to the left hand. Further, based on the trend, all subjects reported that the right hand was their dominant side.

Kapoor (2011) documented handgrip strength values in 60 young wrestlers matched for age, group 1 (G1: 11-15 years), group 2 (G2: 16-20 years) and Group 3 (G3: 21-26 years). From the results he revealed statistically significant differences between groups regarding grip strength obtained both right hand and left ([HGS in kg.s] right hand G1: 27.64±6.72; G2: 36.68±5.23; G3: 41.63±3.22; for the left hand G1: 25.68±6.51; G2: 35.27±7.15; G3: 39.50 ±4.38. The findings published in this investigation are higher than those obtained by Kapoor in each age group. On the other hand, a study accomplished by Terbizan and Seljevold (1996) showed an increase in the grip strength in a group of older fighters due to the increase in muscle mass compared to the younger fighter group (G1 <G2, G3).

In accordance with the above, similar values in grip strength were published by Bayraktar et al. (2012) in a sample of wrestlers FW and GR cadet category, determining statistically significant differences between groups ([HGS in kg.s] right hand FW: 41.19±9.39; GR: 44.68±9.90; these results show a balance of grip strength manifestation in this sample of wrestlers FS and GR. In this research, statistical differences were found in the force exerted by the right hand (dominant) with respect to the left hand; this could be due to the predominance of right or performing actions with greater emphasis on the right-hand side in this group of wrestlers.

To let people know, this is the first study which reports grip strength values in relative terms to body mass, so the discussion is based on the result of the absolute strength. Taking into account previous studies in which the discussion of this research was generated, it is noted that the synergistic action of the flexor and extensor muscles and the interaction of the muscle groups that exert maximum manual isometric tension, is an important factor for the manifestation of force resulting grip.

Therefore, the findings of this study show that handgrip strength is an important component to make various grips in wrestling and define control over an opponent so, in training programs specific actions should be included to improve isometric grip strength; its evaluation over a whole macrocycle preparation will allow to observe the changes as performance characteristics of this muscular action and also confirm the predominance or balance of the level of strength of the upper extremities, which allow to make adjustments in the training process.

It is important to note, that differences presented in the discussion regarding the results of previous studies could be due to the protocol and the type of instrument used, the dominant hand, the time of evaluation, physical condition of the subject, among others. On the other hand, a thorough review allows us to demonstrate that variables such as age, body mass, muscle mass, the level of biological maturation and training experience can influence the ultimate expression of isometric hand grip force exerted in healthy subjects and athletes(Terbizan & Seljevold, 1996; Kapoor, 2011; Bayraktar et al., 2012; Gerodimos and Karatrantou, 2013; Arslanoğlu, 2015).

CONCLUSIONS
The group of Cadets wrestlers evaluated for body composition, showed higher values of % fat and a lower FFM than those reported in the literature, in samples of similar studies in chronological age, and training experience, indifferent to the training stage in which these subjects were evaluated.

Regarding the ultimate expression of isometric handgrip strength, similar values were reported in other studies in the same age wrestlers and sporting experience. However, statistically significant differences obtained in this study on the values of handgrip strength, could be due to the predominance of the right hand compared with

the left hand or carrying out actions in training where they usually rely more emphasis on the right-hand side of this group of wrestlers.

PRACTICAL APPLICATIONS
Anthropometric characteristics can easily describe the physical subjects, so, some anthropometric variables can be used to estimate body composition in wrestlers. This aspect is very useful to provide necessary information about the lean and fat component of the wrestlers, and it also provides information regarding the specific weight division in which a wrestler must compete without affecting its performance.

Reliable measurement of maximal isometric handgrip strength, in wrestling, can be used as an indicator to confirm the predominance or balance of strength of the upper limb or right side against the left, as a means to estimate the level of grip strength and raise their performance in training monitoring, as well as for prevention and rehabilitation of injuries in wrestling.

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CONFLICT OF INTERESTS
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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