Relationship between Handgrip Strength, Anthropometric and Body Composition Variables in Different Athletes

Olivia Di Vincenzo[1], Maurizio Marra[1], Delia Morlino[1], Enza Speranza[1], Rosa Sammarco[1], Iolanda Cioffi[1] and Luca Scalfi[2]

[1]*Department of Clinical Medicine and Surgery, Federico II University of Naples, Via S. Pansini 5, 80131, Naples, Italy*

[2]*Department of Public Health, Federico II University of Naples, Via S. Pansini 5, 80131, Naples, Italy*

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Abstract: Handgrip strength (HGS) is a relatively inexpensive, portable and simple functional capacity test which provides information about muscle function. In the field of sport, HGS is largely used as one of the main indicators for testing and monitoring progress in muscle power. This study aimed to evaluate the relation of HGS with both anthropometric and body composition variables in a group of male athletes compared to a control group matched for age, body weight and body mass index. Male athletes aged 17-40 years who train for a minimum of 16/18 hours per week were recruited. Anthropometry, measures of HGS and bioimpedance analysis were performed. HGS and FFM were similar between the two groups, whereas FM in both absolute and percentage values was higher ($p<0.05$) in controls than in athletes. On the other hand, phase angle (PhA) values clearly increased in athletes by 6.1% ($p=0.008$) compared to controls. In athletes FFM showed a very strong correlation with HGS ($r=0.918$, $p=0.000$), whereas in controls body weight gave the best correlation ($r=0.509$). Additionally, multiple regression analysis showed that the main predictor of HGS was FFM in athletes and body weight in controls. Our data suggest that FFM was the main determinant of muscular function in athletes, but not in control subjects.

1 INTRODUCTION

The handgrip strength (HGS) measurement, using a dynamometer, is a relatively inexpensive, portable and simple functional capacity test which provides information about overall muscle function.

It has been widely used for evaluating muscle strength in the general population as well as in subjects with illnesses. Additionally, in sport, it is largely used as one of the main indicators for testing and monitoring progress in muscle power (Cronin 2017).

Strength is important for several sports such as baseball, climbing, boxe, hockey, paddling, swimming, tennis and weightlifting, which require high values of HGS for optimizing performance and potentially preventing injury (Cronin 2017).

The sex- and age-specific reference curves for HGS are well-established in some studies for general populations (Lunaheredia 2005; Schlüssel 2008; Wang 2018), but, to the best of our knowledge, there are no studies that developed reference values for athletes.

So far, few studies have reported strong correlations between HGS and some anthropometric characteristics (Drinkwater 2008; Torres-Unda 2013; Pizzigalli 2017). Surprisingly, the relationship between HGS and both anthropometric and body composition parameters has not been deeply considered.

Bioelectrical impedance analysis (BIA) is a widely used, non-invasive tool for assessing body composition in athletes. Additionally, raw BIA variables, such as phase angle (PhA), have been shown to be significantly associated with muscle strength and physical activity (Moon 2013; Mundstock 2019) and to be increased in athletes compared to general population (Di Vincenzo 2019; Di Vincenzo 2020).

From a sports performance perspective, it may be interesting to understand how HGS relates to anthropometric as well as body composition parameters in different athletes.

Therefore, the aim of this study was to evaluate the relation of HGS with both anthropometric and body composition variables in a group of male athletes compared to a control group.

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2 METHODS

Inclusion criteria of the present study were: male athletes aged 17-40 years who train for a minimum of 16/18 hours per week. Subjects affected by overt metabolic and/or endocrine diseases and/or regularly taking any medications, were excluded. Athletes were compared to healthy subjects matched for age, body weight and Body Mass Index (BMI) who served as control group.

Participants were studied in the morning (8 a.m.), after an overnight fast according to standardized conditions, abstaining from vigorous physical activity for 24 hours before the assessment.

Body weight and stature were measured to the nearest 0.1 kg and 0.5 cm, respectively, using a platform beam scale with a built-in stadiometer (Seca 709; Seca, Hamburg Germany). BMI (kg/m^2) was calculated as body weight (kg) divided by squared stature (m).

BIA was performed at 50 kHz (Human Im Plus II, DS Medica). Measurements were carried out on the nondominant side of the body, in the post-absorptive state, after voiding and with the subject in the supine position for 20 minutes, with a leg opening of 45° from the median line of the body and the upper limbs, 30° apart from the trunk (Kyle 2004). The BIA variables considered were resistance (R), reactance (Xc), and PhA. FFM was estimated using the Sun equation (Sun et al. 2003). Fat mass (FM) was calculated as the difference between body weight and FFM.

Isometric strength of upper limbs was assessed by HGS in both dominant and non-dominant hands with a Jamar dynamometer (JAMAR, Roylan, UK). Subjects performed the test standing with upper limbs by their sides, and they were instructed to squeeze a dynamometer at maximal voluntary isometric contraction. The measurement was repeated three times alternately on both sides (dominant and non-dominant arm) 1 min apart to avoid fatigue. The dominant hand was determined by asking subjects if they were right or left-handed. The mean value was recorded in kilograms (Fess 1992).

Statistical Analysis

Results are reported as mean±standard deviations (SD), unless otherwise specified. Significance was defined as $p < 0.05$. The Student's unpaired t-test was used to analyse differences between groups. Linear correlation was applied for evaluating associations between variables. Multivariate linear regression analysis was performed to assess the main predictors of HGS. The model used the following variables: age, body weight, stature, BMI, FFM, FM. Statistical analyses were performed using IBM SPSS (version 20).

3 RESULTS

Fifty-three male athletes practicing different sport specialties were selected for this study and compared to sixty-three age-, sex- and weight-matched healthy male controls. Subject's characteristics are summarized in Table 1.

Table 1: Subject's characteristics.

	Athletes (n =53)	**Controls** (n =63)
Age (years)	26.7±9.7	24.6±5.8
Weight (kg)	71.8±12.7	73.1±10.6
Stature (cm)	176±7	175±6
BMI (kg/m^2)	23.1±3.0	23.8±2.8

Data are reported as mean±standard deviation; BMI=body mass index.

In Table 2 are reported body composition and PhA data of the two groups. HGS was slightly higher in athletes than in controls but the difference was not statistically significant. According to BIA analysis, FFM was similar between the two groups, whereas controls showed higher values for both absolute and percentage FM ($p<0.05$) compared to athletes. While, PhA values were higher by 6.1% ($p=0.008$) in athletes than in controls.

Table 2: Handgrip strength, body composition and bioelectrical impedance phase angle variables.

	Athletes (n =53)	**Controls** (n =63)
HGS (kg)	37.1±7.0	35.7±9.0
FFM (kg)	61.4±9.0	60.4±7.5
FM (kg)	10.6±4.5	13.0±5.5*
FM (%)	14.1±4.2	17.1±5.5*
PhA (degrees)	7.70±0.74	7.26±0.91*

Data are reported as mean±standard deviation; HGS=handgrip strength; FFM=fat-free mass; FM=fat mass; PhA=phase angle.
* $p>0.05$.

Pearson's correlation coefficients assessed the association of HGS with both anthropometric and body composition variables, and they are shown in Table 3. We found that in athletes both anthropometric and body composition variables were significantly associated with HGS, except for PhA. The strongest correlation was found between HGS and FFM (r=0.918, p=0.000) as shown in Figure 1. In controls, HGS was correlated with all anthropometric variables (p<0.05). While, among body composition variables, HGS was directly associated with FFM and FM, but not with FM% and PhA.

Table 3: Pearson's correlation for the association of handgrip strength with both anthropometric and body composition variables.

	Athletes		Controls	
	r	**p**	**r**	**p**
Age	0.171	0.222	0.294	0.020
Weight	0.910	0.000	0.509	0.000
Stature	0.660	0.000	0.372	0.003
BMI	0.832	0.000	0.423	0.001
FFM	0.918	0.000	0.304	0.016
FM	0.712	0.000	0.224	0.080
FM%	0.528	0.000	0.176	0.171
PhA	0.214	0.123	0.061	0.636

BMI=body mass index; HGS=handgrip strength; FFM=fat-free mass; FM=fat mass; PhA=phase angle.

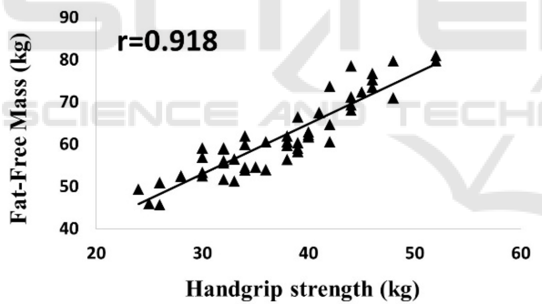

Figure 1: Linear correlation between handgrip strength and fat-free mass in male athletes.

Finally, multiple regression analysis was performed to assess the main determinant of HGS for both groups. The only predictors of HGS were FFM (β=0.910) and body weight (β=0.509) for athletes and controls, respectively.

4 DISCUSSION

This study aimed to evaluate the relationship between HGS, anthropometric and body composition variables in a group of male athletes compared to a control group.

Our results showed that HGS was higher in athletes than in controls, but the difference was not statistically significant. Additionally, we found that PhA, a BIA parameter considered as promising marker of muscle quality, was higher in athletes than in control subject, in accordance with literature results (Marra 2018a; Marra 2018b; Di Vincenzo 2019; Di Vincenzo 2019; Di Vincenzo 2020).

Overall most of parameters considered were positively related to HGS in both groups. However, multiple regression analysis showed that the only predictors of HGS were body weight for controls and FFM for athletes. The latter might be related to a different quality of muscle mass.

In conclusion our study showed that FFM was the main determinant of muscular function in athletes, but not in control subjects. Further evaluations are needed to verify the relation between HGS and body composition variables in athletes.

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