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Original Article

Handgrip strength and ball velocity of young male and female handball players

LABRINA TSAKALOU[1], ZACHARO KOTSAMPOUIKIDOU[2], MAGDA PAPA[1],
ILIAS ZAPARTIDIS[1]
[1] School of Physical Education & Sport Science, National and Kapodistrian University of Athens, GREECE
[2]Faculty of English Language and Literature, National and Kapodistrian University of Athens, GREECE

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Abstract:
The aim of the current study was to compare the performance of handgrip strength and ball velocity between boys and girls of two different age groups (12 and 13 years) and consequently investigate the correlation between these two parameters. The sample consisted of 121 adolescent handball players (74 males, 47 females), divided into four groups depending on the age and sex: boys and girls 12- and 13-years old. Stature, body mass, palm width, palm length, ball velocity and handgrip strength were measured. In the 12 years age group, male handball players had significantly longer palm length and performed significantly better than female ones in ball velocity. In the 13-years age group, male handball players were significantly taller, heavier, had longer palm width and palm length, and performed significantly better than female ones in ball velocity and handgrip strength. In the 13-years age group, maximal handgrip strength showed more powerful correlations to those of the 12 year olds, in all the examined variables. After controlling for body mass, the relationship between grip strength and body height was not significant, however ball velocity and hand length were still correlated to grip strength.
Key words: **team handball, hand dynamometry, sex differences, young athletes**

Introduction

Sex and age, have an immediate relevance to the functioning ability of children and adolescents. Their performance in a variety of skills is improved with age, however, as it seems there is a wider overcompensation on the boys' performance than that of the girls Malina et al., 2005. The musculoskeletal development is one of the keys to the basic characteristics during childhood thus; the muscular action determines the functional requirements during childhood that are enforced on other organic systems (Neu et al., 2002). The handgrip is an important measurement of general health and is used as an estimator of the normal function as it is referred to as one of the most accurate clinical methods of estimating children's strength (Groslambert, Nachon & Rouillon, 2002). Moreover, the handgrip of a skilled arm in handball is important for the holding and throw of the ball. On the other hand, the ball's velocity in handball is a significant racing skill and seems to be a distinction between the most and the less successful athletes, especially during developing ages (Zapartidis et al., 2009). The greatest differences, considering sex, regarding the ball throw velocity , seem to appear near the ages of 12-13 years old, with boys increasing significantly their performance in relation to girls after the age of 14 years old (Zapartidis et al., 2011). Especially in young ages, when body height is not yet fully developed, the factors which mostly contribute in ball handling skill, is hand surface and handgrip strength.

A research on Indian students regarding hand strength was conducted (Gandhi et al., 2010). 330 healthy children (males-females) 6-16 years old were measured on body height, mass, body mass index, five skinfolds, and handgrip strength on both hands.

A study on results indicated a considerable correlation on both anthropometric parameters and handgrip strength for both hands. In an effort to define a simple prediction model, 100 athletes were examined (Hewson et al., 2010) using anthropometric characteristics. The research set independent variables as : body height, body mass, length of arm and forearm, wrist and hand circumference. Maximal handgrip strength was set as dependent variable. Results showed strongest correlation reference to hand circumference with handgrip strength and it was clearly predictable (R2-=0.624). A study on influence of basic anthropometric characteristics on handgrip strength was performed by Vinsapuu and Jurimae (2007). A sample of 193 basketball and handball players 10-17yrs old was used. Significant strong correlation between anthropometric characteristics and fingers length with handgrip strength was found from this research. Apostolidis and Zacharakis (2015) used a sample of 106 basketball players 13-14yrs old, to measure the relationship between anthropometric characteristics, handgrip strength and selected technical skills. The research proved strong correlations between all anthropometric parameters and handgrip, whilst average strength correlations were observed between handgrip and the technical

Corresponding Author ILIAS ZAPARTIDIS, E-mail: elzapa@phed.uoa.gr

skills. Gandhi et al., (2010) in the process of studying a sample of 330 males and females 6-16years old, investigated the influence of body height, body mass, body mass index and five skinfolds on handgrip strength of both hands. Their study showed considerable correlation between anthropometric parameters and handgrip strength for both hands. Moreover, Hewson et al. (2010), evaluating a population of 100 subjects, they showed that amongst body height, body mass, arm/forearm length, wrist circumference, the variable with strongest correlation with handgrip strength, was the hand circumference.

The aim of the current study was to compare the performance of handgrip strength and ball velocity between boys and girls of two different age groups (12 and 13 years) and consequently investigate the correlation between these two parameters.

We assume that a) the difference of the performance at the velocity of the throw of the ball and the handgrip between the two sexes will be significantly greater at the age group of 13 years of age and b) there will be a significant positive correlation between handgrip and ball velocity.

Materials and methods

Sample

The sample consisted of 121 adolescent handball players (74 males and 47 females), divided into four groups depending on the age and sex: a) boys 12,56 (12,38 – 12,68 yrs), b) girls 12,50 (12,34 – 12,74 yrs), c) boys 13,47 (13,00 – 13,87 yrs) and d) girls 13,52 (13,14 – 13,89 yrs). Decimal age was calculated as the differences between date of measurement and date of birth. All subjects competed in the highest league according to their age category and had a frequency of 3 training sessions per week. All subjects and their parents were informed about testing procedures and provided their written informed consent to participate in the study.

Measurements and procedure

Testing evaluated body height and body mass, palm width and palm length, handgrip strength and ball throwing velocity. Body height was measured at standing position with the shoulders and heels adjacent to a wall using a height meter (220 Sega, Germany). Body mass was measured using a precision scale (Sega, A model 770, Germany), to the nearest 0,5 kg. Palm width was measured from the fingertip of the thumb to the fingertip of the little finger with all fingers abducted, and palm length from the mid-stylion to dactylion. All length characteristics were measured to the nearest mm. Ball velocity was measured using a radar gun (Sports Radar 3300, Sport Electronics Inc., USA) from a standing position. The height of the gun radar was adjusted to the height of each athlete's throwing arm. The contra-lateral leg of the throwing hand was placed to the front steadily on the ground (penalty throw). All subjects performed 3 throws and the best performance was used. The maximal handgrip strength of the dominant hand was measured using a hand dynamometer (Lafayette Instrument, Co, Indiana). The subjects were standing with the shoulder adducted, the dynamometer was held freely without support. The palm did not flex on the wrist joint (Visnapuu & Jüriäe, 2007). All subjects performed 3 trials with the dominant hand, and the best performance was used. The somatometric features were recorded at the beginning of the trial, during the pre-training exercises. A fifteen minutes pre-training followed, with exercises of general physical preparation, hand-ball throws, and familiarization with the hand dynamometer. All the measurements took place in an indoors gymnasium during evening hours. All the children that showed failure in performing the measurements for any reason were excluded from the process.

Statistics

Statistical analysis consisted of standard descriptive data (mean, min, max), for all athletes. Pearson's correlation coefficients were computed among the six variables of stature, body mass, palm width, palm length, ball velocity and handgrip strength. As handgrip strength is highly correlated to body mass, a partial correlation analysis was then computed among variables after eliminating body mass. Group differences were evaluated using independent sample t – tests. Correlation between handgrip strength and ball velocity was computed to the two age groups without sex distinction.

Results

Descriptive statistics for all variables and differences between boys and girls are presented in Table 1 and Table 2. In the 12-years age group, body height, body mass, palm width, and handgrip strength did not differ between male and female handball players. In the 12 years age group, male handball players had significantly longer palm length *($t = 2.25$, $p = .035$)* and performed significantly better than female ones in ball velocity *($t = 2.29$, $p = .029$)*.

In the 13-years age group, male handball players were significantly taller, *($t = 2.90$, $p = .005$),* heavier *($t = 2.20$, $p = .031$),* had longer palm width *($t = 2.33$, $p = .022$)* and palm length *($t = 4.04$ p □ .001),* and performed significantly better than female ones in ball velocity *($t = 7.78$, p □ .001)* and handgrip strength *($t = 6.83$, p □ .001)*.

Table 1. Descriptive statistics and significant differences between boys and girls of the 12 years old group

	Males (n=16)			Females (n=17)		
Age group	mean	min	max	mean	min	max
12,34 - 12,74 yrs	12,56	12,38	12,68	12,50	12,34	12,74
Stature (cm)	158,52	146,00	174,50	159,52	154,00	169,00
Body mass (kg)	53,07	33,80	64,70	55,02	43,00	69,00
Palm width (cm)	20,80	17,60	24,10	20,64	17,10	23,00
Palm length (cm)	17,39*	15,30	18,90	16,62	15,20	18,30
Ball Velocity (km/h)	60,81*	46,00	77,00	55,76	48,00	67,00
Handgrip strength (kg)	29,00	15,00	44,00	25,35	18,00	33,00

**Significantly different from girls, p □ .05*

Table 2. Descriptive statistics and significant differences between boys and girls of the 13 years old group

	Males (n=58)			Females (n=30)		
Age group	mean	min	max	mean	min	max
13,00 - 13,89 yrs	13,47	13,00	13,87	13,52	13,14	13,89
Stature (cm)	167,26*	146,50	182,50	162,74	154,50	179,30
Body mass (kg)	63,41*	39,30	95,70	57,89	44,60	73,70
Palm width (cm)	21,35*	17,70	24,90	20,62	17,30	22,20
Palm length (cm)	18,27**	15,50	20,30	17,30	15,30	19,40
Ball Velocity (km/h)	67,78**	49,00	81,00	55,83	41,00	63,00
Handgrip strength (kg)	39,83**	17,00	56,00	27,37	17,00	40,00

**Significantly different from girls, p □ .05, ** p □ .001*

Table 3. Relationship among handgrip strength and all parameters at the 12 and 13 years old age groups

	12 years		13 years	
Variables	r	p	r	p
Stature	0.40	0.023	0.54	□0.001
Body mass	0.40	0.022	0.49	□0.001
Palm width	0.29	0.107	0.37	□0.001
Palm length	0.59	□0.001	0.69	□0.001
Ball Velocity	0.59	□0.001	0.70	□0.001

Table 4. Relationship among handgrip strength and all parameters using partial correlation where the body mass is controlled

	12 years		13 years	
Variables	r	p	r	p
Stature	0.20	0.269	0.34	0.001
Palm width	0.16	0.367	0.18	0.087
Palm length	0.57	0.001	0.57	□0.001
Ball Velocity	0.50	0.004	0.61	□0.001

In the 12-years age group, maximal handgrip strength of the dominant hand correlated significantly with all variables, except the palm width (Table 3). Interestingly, after controlling for body mass, the relationship between grip strength and body height was not significant, however ball velocity and hand length were still correlated to grip strength but lower (Table 4). Ball velocity was also significantly correlated with body height *(r = 0.62, p □ .001)*, body mass *(r = 0.48, p = .004),* palm width *(r = 0.69, p □ .001)* and palm length *(r = 0.55, p = .001)*. After controlling for body mass, ball velocity was significantly correlated to body height *(r = 0.47, p =.006)*, palm width *(r = 0.64, p □ .001),* and palm length *(r = 0.52, p = .002)*.

In the 13-years age group, maximal handgrip strength showed more powerful correlations to those of the 12 year olds, in all the examined variables (Table 3). However, after controlling for body mass, the relationship was significant, but lower (Table 4). In the 13-years age group ball velocity was also significantly correlated with body height *(r = 0.52, p □ .001)*, body mass *(r = 0.46, p □ .001)*, palm width *(r = 0.31, p = .003)* and palm length *(r = 0.58, p □ .001)*. After controlling for body mass, ball velocity was significantly correlated to body height *(r = 0.34, p =.001)*, and palm length *(r = 0.45, p □ .001)*.

Discussion

The period of adolescence is characterized by a rapid body development due to the effect of hormones. The natural changes in the process of development take place earlier at girls than boys (Kovač et al., 2003). During the current study, the 12 year old girls were in cardinal numbers and heavier than the boys but showed a shorter palm length. After the age of 13 years old the boys outmatch the girls significantly in physical height, body mass, the span and the length of the palm. The ball velocity differs significantly for the boys in both age groups, whilst the handgrip is significantly stronger only at 13 year old boys than that of the girls, even though in cardinal numbers the 12 year old boys outmatch the girls of their age group. Malina et al., (2010) did not find significant differences between the 12 year old girls and boys athletes in velocity and handgrip. It is generally accepted that up to the age of 12, the difference in performance between boys and girls are relatively small but increase near the age of 13 years old (Malina et al., 2010; Malina et al., 2005; Zapartidis et al., 2011). The velocity of the ball throw appears to be a strong agent of differentiation of performance for the boys even under the age of 12 years old. A recent research, that 33 boys and 41 girl were studied with an average of 12, 5 years of age, with the same athletic experience, showed that whilst the girls presented similar results to the length without impetus, the 30 meters velocity and the aerobic skill to the boys, however they lacked significantly in the velocity of the ball throw compares to the boys (Zapartidis et al., 2011). During adolescence, the development rate of the muscular mass of the boys is double to the girls' for the upper limbs and only slightly larger for the lower limbs (Beunen & Malina, 1988). The throwing capacity either as a distance or a velocity throws is correlated to the sex in all age groups with the boys outmatching the girls (Roberton & Konczak, 2001). An earlier study (Morris et al., 1982), indicated that boys-girls differences in throwing distance were pronounced across the entire age range presented, even as young as 3 years of age. The handgrip during young ages increases linearly year over year, with the greatest increase demonstrated after the 13 years of age (Häger-Ross & Rösblad, 2002). According to Visnapuu and Jurimae (2007), the greatest increase in handgrip strength demonstrated at the age of 14-15 years. This is probably associated with a rapid increase in body height and body mass at this age. Mean results in our male handball players for both age groups, are slightly better than those reported for handball and basketball Estonian athletes of the same age (Visnapuu & Jurimae, 2007), and much better than the general norm referred to these ages (Häger-Ross & Rösblad, 2002). These differences in maximal handgrip strength must be due to the practice of handball activities that require hand strength for catching and throwing the ball.

The handgrip presented a significantly positive correlation with all the variables in both groups with the exception of the palm span in 12 year old children. However, the highest correlations appeared at the age group of 13 years of age, with the ball velocity presenting the greatest correlation. It appears that the increase rate of body mass, as long as the hyper secretion of the male hormone (testosterone) that take place near the age of 13-14 years old, contribute as much to maximizing the differences between male and female as to the correlation of handgrip and ball velocity at this age. Previous studies (Häger-Ross & Rösblad, 2002; Vaz, Hunsberger & Diffey, 2002) have demonstrated that several anthropometric attributes such as body height, body mass and palm length, combined together affect the handgrip positively, during developing ages. In the study of Visnapuu and Jurimae (2007), body height was the most significant parameter for 10 and 11 years old subjects, predicting maximal handgrip strength, instead, at the age of 12 and 13 years old, body mass was the significant parameter that determined maximal handgrip strength. Apostolidis and Zacharakis (2015), also confirmed the strong influence of body height and hand surface on handgrip strength.

Conclusion

In the present study, the sample was composed of elite young male and female handball players, who have the same training demands in terms of frequency and training load. We found considerable differences in maximal handgrip strength between young male and female handball players only at the age of 13 years. In contrast, boys performed significantly better than girls in ball throwing velocity at both age groups, indicating that throwing motor ability is a big difference between the sexes.

Our results also suggest that young handball players who are taller and have greater body mass and longer palm length have an advantage to perform better in handgrip strength and ball velocity. Handgrip strength had strong correlation with ball velocity even when controlling the body mass. The notably positive correlation of the handgrip strength and the ball velocity with the body height and palm length, confirms the importance of these parameters to handball. Increased length is important for a stable ball grip and accordingly for a proper throwing technique.

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