

## Predicting Grip Strength based on Anthropometric Characteristics in Female Junior Volleyball Players

Elaheh Faraji<sup>1</sup>, Fatemeh Sarvari<sup>1\*</sup>, Ahmad Ebrahimi Atri<sup>1</sup>

<sup>1</sup>Faculty of Physical Education and Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran

Received 12 January 2013

Accepted 4 May 2013

### Abstract

**Purpose:** Volleyball is an intermittent sport and as the use of the hand is essential in it, hand morphology and functional properties play an important role in its performance. Also, volleyball requires a sustained level of hand prehensile force to maximize control and performance. Therefore, the aim of the present study was to evaluate the effect of anthropometric characteristics of the upper limb on hand gripe of elite female volleyball players.

**Material and Methods:** 50 volleyball players (age 12-17 years) volunteered to participate in the present study. A series of anthropometric tests were carried out on each participant including forearm length, arm length, wrist Breadth and arm Breadth, forearm circumference and hand span. For grip strength measurement, digital hand dynamometer was used.

**Results:** The results of the stepwise multiple regression analysis about predictors showed that the most important basic anthropometric variable was body height ( $R^2 \times 100 = 31.2\%$ ) and BMI, age and hand span were predictors of maximal hand strength.

**Discussion and Conclusion:** In the present study, results indicated body height and BMI were the most important anthropometric variables in junior females. In the other words, taller volleyball players would have better hand grip strength.

**Key world:** Grip Strength, Anthropometric, Female Volleyball Players, Junior

### Introduction

Volleyball is one of the ball games requiring comprehensive abilities including physical, technical, mental and tactical abilities. As volleyball demands excessive use of the hand, hand morphology and functional properties could be important factors in its successful performance. The hand does not function in isolation, and is dependent on the integrity of the shoulder and elbow complexes to allow the appropriate positioning of the hand in space to complete the desired task [1]. Also, volleyball requires a sustained level of hand prehensile (power grip) force to maximize control and performance [2].

Hand grip strength has often been used as an indicator of overall physical strength and health, and hand performance and function [3]. Several studies, such as Nevill and Holder, Nicolay and

Walker and Sartorio et al explored the influence of anthropometric and body composition variables on handgrip strength in adults and children and stated different results [4,5,6]. Quite naturally, the interest in anthropometric characteristics and body composition of athletes from different competitive sports has increased tremendously over the last decades. All ball games require comprehensive abilities including physical, technical, mental and tactical ones. Among them, physical abilities of the players are more important as these have marked effects on the skill of players and the tactics of the teams because ball games require repeated maximum exertion such as dashing and jumping [7].

In this regards, anthropometric dimensions and morphological characteristics play an important role in determining the success of an athlete. The aim of the present study was to evaluate the effect of anthropometric

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\* Corresponding author E-mail:  
fatemehmfts@yahoo.com

characteristics of the upper limb on hand gripe of elite, female volleyball players.

### Material and Methods

50 volleyball players (age 12-17 years) volunteered to participate in the present study. All of the participants played for their school teams taking part in provincial tournaments. Exclusion criteria were set upon our knowledge of some genetic, psychological, neurological or chronic diseases affecting hand function and anthropometric characteristics. A series of anthropometric tests were carried out on each participant including forearm length (from lateral epicondyle to styloid process of ulna), arm length (from acromion process to olecranon process), forearm circumference (the bulk of muscle), wrist Breadth and arm Breadth, hand span (from the tip of thumb to the tip of the little finger) [3,5].

adigital hand dynamometer (Saehan, company) was used. to measure the grip strength. The participant sat on a chair with the elbow flexed at 90 and the forearm in semi pronation position lying on an arm rest. The participants were asked to squeeze the dynamometer three times with their dominant hand. There was a five-minute rest between the squeezes in order to overcome fatigue.

The best value of the three squeezes was taken into account [5].

Means and standard deviations of the testing trails were used for statistical analysis. Linear Regression was used to assess the influence of predictor variables on the independent variable. The statistical analysis was performed using the SPSS software (version 16).

### Results

Basic anthropometric and body composition variables of the participants are presented in Table1. The mean values of hand grip strength in the participants was 24.3 kg (SD= 6.1).

The results of the stepwise multiple regression analysis regarding the predictors are presented in Table2. The most important basic anthropometric variable was body height ( $R^2= 31.2$ ). Among the basic upper limb anthropometric variables, it was observed that hand span had the greatest influence on the hand grip strength of the individuals ( $R^2= 53.2$ ) followed by age ( $R^2= 45.5$ ), and , BMI ( $R^2= 38.6$ ).

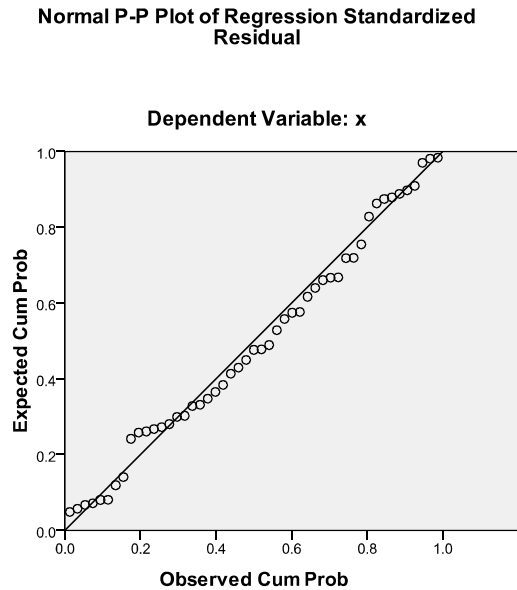
In order to verify these models and to illustrate their ability to predict maximal hand strength, the normal arability plot was drawn. The residuals were normally distributed (Figure.1).

**Table1:** Characteristics and anthropometric data of the participants.

Variables	Mean( range) (n= 50)	Standard Deviation
Age	13.9(year)	1.0
Height	157.1( cm)	6.2
Body mass	51.9 (kg)	10.5
Arm length	32.7(cm)	2.1
Forearm length	24.8(cm)	1.2
Forearm circumference	23.1(cm)	1.8
Arm breadth	6.4(cm)	1.1
Wrist breadth	5.2(cm)	0.6
Hand span	19.1(cm)	1.4
Grip strength	24.3(kg)	6.1

**Table2:** results of linear regression analysis for anthropometric, height, BMI and age and hand span variables

Indicators variables	Multiple R	R <sup>2</sup>	F	SEE	P
Height	0.55	0.31	21.29	5.17	0.00
BMI	0.62	0.38	5.59	4.49	0.02
Age	0.67	0.45	5.71	4.70	0.02
Hand Span	0.73	0.53	7.23	4.41	0.01



**Figure1:** Results on a population of 50. Residual cumulative probability

## Discussion and Conclusion

In this study, the influence of upper limb anthropometric variables on hand grip strength was studied in female, elite junior volleyball players. Our findings showed the influence of age, BMI, height and hand span anthropometric variables on hand grip. Our results were similar to those of Nevill and Holder, who concluded the larger the size of the hand, the greater the hand grip strength [4]. Nicolay and Walker indicated that hand and forearm sizes generally served as better predictors of grip strength as compared to body height and body mass [5]. However, we found that although hand span was a predictor of hand strength, height and body composition were better predicting variables.

Kallman et al. previously claimed that forearm circumference provided the most practical index of maximal grip strength [8]. However, Anakwe et al. recently found that forearm circumference could predict maximal grip strength in men but not in women [9]. Our results did not show the effect of forearm circumference on hand grip strength either confirming the findings of Anakwe, Nicolay and Walker have also stated that in young females, the best single linear measurement to predict grip force was palm width that is almost similar our findings.

Our results also showed age influences on maximal hand strength. Sartorio et al indicated that the increase in hand grip strength with age is

largely dependent on the parallel increase in muscle mass [6] indicating the importance of age factor. In addition, we found that height and BMI were also predictors of hand grip force that is in line with the findings of Semproli et al. who showed that in children, basic anthropometric variables (body height and BMI) had a greater contribution in predicting hand grip strength as compared to the specific anthropometric variables of the hand [10]. Also, Schmidt and Toews stated that body height and body mass affected maximal hand grip [11]., Bassey and Harries also showed that hand grip strength correlated with such anthropometric characteristics as skeletal size in adults [12].

As in volleyball, teams compete by handling the ball above the head, height is considered to be the most important physical attribute., results from the present study indicated that body height and BMI were more important anthropometric variables in junior females. In other words, the taller the volleyball player, the stronger her hand grip. Regarding specific anthropometric variables, hand span was a better predictor of volleyball players' performance. Consequently, taller individuals with larger hands might be more successful in volleyball.

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