Digit Ratio, Testosterone/Cortisol Levels and Hand Grip Power of Handedness among Elite Iranian Basketball Players

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***Abstract*—** Handgrips and finger length are very important in Basketball. Some general predictors proposed for handgrip power but, both hand dimensions and hormonal assessment didn't studied simultaneously among elite basketball athletes. Thus, the aim of this study was to investigate the relationship between various hand dimensions, anthropometrical characteristics and testosterone/cortisol levels among elite Iranian basketball players. For this purpose, 14 elite male players (mean ± SD, weight: 95.85 ± 12.16 kg, height: 197.85 ± 10.78 cm) were participated voluntarily in the present study. Visnapuu method and enzyme-immunoassay kit were used for evaluation of finger parameters and salivary hormones, respectively. Statistical analysis of data showed significant correlation ($p<0.05$) between handgrip power of handedness and most hand dimensions (p1, p2, p3, p4, p5, fs2, fs3, fs4) and also wrist girth, highest forearm girth, two opened arm's length and shoulder width. In addition, there was significant negative correlation between cortisol and handgrip power ($p<0.01$, $r=-0.74$). Thus, anthropometrical characteristics like wrist girth, two opened arm's length and shoulder width which found to have strong correlation with handgrip power could be used as simple predictors for handgrip power in such a sport with handgrip importance.

***Keywords*—** digit ratio, basketball, salivary hormones, handgrip power

I. Introduction

ELITE athletes are the most professional samples in any sport that reached to the higher performance levels via their specific talent or higher levels of training[1]. If these talents could be distinguished, it could lead to better spouting or selection of new athletes in any sport. Many factors could lead to advantage of some athletes over others that some studies related the part of physical differences to testosterone and via its organizational (prenatal) or activation (adult) effects [2] that could be a determining factor among male athletes with different levels. This is a androgenic hormone which has the significant role in muscle mass and positive muscle protein balance via either its anabolic and anti-catabolic effects[3]. In addition, because of the direct relation between muscle mass and power output, this could be a determinant factor in the performance of athletes in sports with many physical contacts such as basketball. Another hormone which is responsible in the protein balance is cortisol. Cortisol is a glucocorticoid which has the known catabolic effect and cause the negative protein balance in the body. In addition, these hormones have a multiple effects on neural development which can affect neural and muscular performance[4]. Many studies investigated the ratio of testosterone and cortisol as markers of physiological stress which can show the status of net protein balance in the body and many of their effect on performance of different samples especially elite athletes[5].

One of the proposed predictors for prenatal testosterone is the ratio of 2nd digit (2D) to the 4th digit or digit ratio (2D:4D). The ratio of index finger to ring finger (2D:4D) is a sexually dimorphic trait which men's tend to have a lower values than women's[6]. It's well known that Homeobox (HOX) gene family affect differentiation in the length of fingers and formation of gonads[7]. Thus, this ratio has been proposed as a marker of prenatal androgen levels which can affect many mental and physical aspects specifically in elite athletes which are in the highest sport levels. Prenatal hormone levels define the measures of digit ratio which prenatal testosterone promotes the growth of fourth digit, while prenatal estrogen promotes the growth of second digit[6]. Some studies reported that the length of fingers are correlated with handgrip power and since the fingers are completely involve until the end of the shot in basketball, their length could affect shot accuracy[8] and thus seems important for players.

There are evidences that showed digit ratio sex differences don't affected by puberty and thus it seems that it's established very early in life[9]. The negative correlation between digit ratio and prenatal testosterone has been reported that is higher in males than females which does not appear to change among the life and via the puberty[10]. Many studies reported the relationship between digit ratio and sex dependent variables like psychological, behavioral, cognitive variables. In addition, many studies reported the negative correlation between digit ratio and the performance of athletes in soccer, skiing, fencing, hockey, martial arts, rugby, running, soccer, squash, swimming and tennis[6, 10-13]. But until now there is not a study among basketball players and especially in elite samples. Athletes need special requirement in any sports to succeed that defining them could help athletes to better train and coaches to better

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select talents and also prepare their athletes[1]. Iran is one of the most powerful countries among the Asia in basketball and thus, this study designed to evaluate the relationship between digit ratio and testosterone/cortisol levels and hand anthropometrical dimensions among players of national basketball team of Iran.

II. Materials and Methods

A. Participants

For this purpose 14 Iranian male national team basketball players (mean ± SD, weight: 95.85 ± 12.16 kg; height: 197.85 ± 10.78 meters; BMI: 24.42 ± 1.53 kg/m^2) had been voluntarily participated in this study which all of them had won the multiple Asian championship medals. For evaluation of finger length parameters, the Visnapuu method was used[8]. In addition, the height and the weight of the athletes were measured using Seca meter and scale (Germany) to the nearest 0.1 cm and 0.1 kg, respectively.

B. Hand dimensions

For evaluating the hand dimensions, the standard Visnapuu et al (2007) method had been used[8]. For this purpose, the subjects sit comfortably on a suitable chair and put their hands on a paper with the fingers open in a full abduction state. Then, the shape of the hand was drawn and 3 categories of hand anthropometric dimensions were measured as showed in figure 1.

The breadth of the shoulder has been evaluated from the acromion process of one side to the same point on the other side of shoulder girdle. In addition, the lower arm and the wrist girth measured in the highest point and wrist of the dominant hand, respectively. The length of two opened arms was measured while participants opened their arms horizontally as much as possible[1].

C. Hand grip power evaluation

The handgrip power of handedness was measured using mechanical hand grip (Yagami, YDM-110D, 5-110kg) three times and the highest reading was recorded as a personal record. For the adequate provision of fingers, the adjustable rod of dynamometer had been adjusted prior to the test according to the subjects' hand size. In addition, for prevention of fatigue, 3-minutes rest was allowed between tests. The test was performed when the hand was in anatomical position and without any flexion in elbow joint[1].

D. Hormonal assay

Free testosterone and cortisol Levels were measured via a non-invasive saliva sampling which is proposed as a practical and reliable method for determining the free hormone levels[14, 15]. The participants provided a 2 ml saliva sample by passive drool into a 10 ml container, which was stored at -60 ˚C. After thawing and centrifugation (2000 g 6 10 minutes) the saliva samples were assayed in duplicate for free testosterone concentrations using a commercial enzyme-immunoassay kit (IBL, Hamburg) and the manufacturer's instructions. The minimum detection limit for the testosterone assay was 2.0 pg/ml with intra- and inter-assay coefficients of variation (CV) of 2.0–9.8%[16]. Saliva collection, for the resting levels of testosterone and for the first sample in the challenge group, was made between 8.00 am and 9.00 am.

E. Statistical analysis

For statistical analysis of the data, the SPSS software version 19 was used and the normality of data's distribution determined using the Shapiro-Wilk test. In the case of normal distribution, correlation between variables was assessed using Pearson's correlation coefficient; otherwise, the Spearman's correlation coefficient was used. The data are presented as mean ± SD and the significant level was set at $p<0.05$.

III. Results

Descriptive statistics of the variables are presented in table I.

TABLE I
MEAN ± SD OF THE VARIABLES

VARIABLES	MEAN±SD
WEIGHT (KG)	95.85±12.16
HEIGHT (M)	197.85±10.78
BMI (KG/M^2)	24.42±1.53
HAND GRIP POWER (N)	68.05±4.43
DIGIT RATIO (2D:4D)	1.02±0.13
TESTOSTERONE (T) (PG/ML)	77.00±35.33
CORTISOL (C) (PG/ML)	22.03±7.59
T/C	3.13±1.38
FINGER SPAN 1 (FS1) (CM)	14.14±1.74
FINGER SPAN 2 (FS2) (CM)	19.35±2.01
FINGER SPAN 3 (FS3) (CM)	21.82±2.23
FINGER SPAN 4 (FS5) (CM)	23.96±2.00
FINGER PERIMETERS 1 (P1) (CM)	52.35±5.24
FINGER PERIMETERS 2 (P2) (CM)	58.39±5.06
FINGER PERIMETERS 3 (P3) (CM)	51.32±4.28
FINGER PERIMETERS 4 (P4) (CM)	53.28±4.27
FINGER PERIMETERS 5 (P5) (CM)	67.82±5.12

Statistical analysis of the data's showed the significant correlation ($p<0.05$) between handgrip power of handedness with part of examined variables that for handgrip power are discussed in table II. In the case of testosterone levels and testosterone/cortisol ratio, they don't have any correlation with the hand anthropometrical characteristics.

TABLE II
RELATIONSHIP BETWEEN THE HAND ANTHROPOMETRICAL PARAMETERS AND HANDGRIP POWER OF HANDEDNESS

VARIABLES	P VALUE	PEARSON CORRELATION COEFFICIENT
TWO OPENED ARMS	0.027	0.59
SHOULDER WIDTH	0.019	0.62
FOREARM GIRTH	0.005	0.71
WRIST GIRTH	0.043	0.55
IFL	0.022	0.60
MFL	0.010	0.66
RFL	0.010	0.66
LFL	0.006	0.70
P1	0.009	0.67
P2	0.003	0.74
P3	0.007	0.69
P4	0.007	0.68
P5	0.005	0.70
I/R (2D:4D)	0.037	0.58
I/L	0.009	0.67
FS2	0.022	0.60
FS3	0.013	0.64
FS4	0.018	0.62

IV. DISCUSSION

Hand grip power is an important functional capacity that could help performance in many sports[1]. In basketball, handgrips are very common for handling the ball, thus this capacity could be valuable for basketball players. There are few researches that had investigated this factor among elite basketball players[8], which this studies investigated the relationship of some hand dimensions with handgrip power, while we studied its presumable relationship with many hand, arm and shoulder dimensions like lengths, girths, widths in addition to hormonal status with handgrip of athletes.

In the present study we found that 15 factors have an approximately moderate to strong correlation with hand grip power ($0.55<r<0.74$) which the highest correlations were related to P4 and forearm girth (0.74 and 0.71, respectively). Hanger et al (2002), Nicolay et al (2005) and Rashidlamir et al (2011) had found that different finger lengths could be as a predictor for handgrip power which partly supporting the results of present study. The differences found between present study and Rashidlamir et al. (2011) related to the non-significant relationship between handgrip power and finger spans (FS1-FS5). However, Rashidlamir et al (2011) and visnapuu et al (2007) reported the more significant relationship between ring finger and handgrip power that was similar to the present study. In the case of digit ratio, it was not correlated with handgrip power of handedness, testosterone and T/C ratio that supported by the results of Beaton et al. (2011) who don't find the significant correlation between testosterone levels and digit ratio. However, in other results this study had similar results to previous studies.

In addition, this study investigated the handgrip power relationship with more anthropometrical characteristics that this investigation showed the strong relationship among handgrip power and shoulder width, forearm girth, two opened arm's length and wrist girth which could be used as simple predictors for handgrip power. Previously, some studies showed importance of some specific anthropometrical characteristics like two opened arm's length in other sports like fencing[1], but there wasn't any studies in basketball..

Thus, the factors that found to be related with handgrip power could be used in sports such as basketball for founding new talents. However, more studies in the case of investigating elite athletes are needed to fully elucidate these specific characteristics of elite athletes.

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