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Research Article

Estimation of Handgrip Strength and its Correlations with Selected Anthropometric Variables and Performance Tests in Indian Inter-university Female Field Hockey Players

Abstract

Background: Handgrip strength is used as an indicator of total physical strength which is a prerequisite of physical performances in major competitions in any sport. Field hockey is an endurance sport where physical strength, techniques and tactics are essential. Thus estimation of handgrip strength of female field hockey players is needed to enhance the performances.

Methods: The purpose of this study was of two-fold: first, to estimate the handgrip strength of Indian inter-university female field hockey players and, second, to search the correlations of it with selected anthropometric variables and performance tests. To serve this purpose, a total of five anthropometric variables, viz. height, weight, BMI, percent body fat and upper arm circumference, two performance tests, viz. sit and reach test and vertical jump test, and dominant and non-dominant handgrip strength were measured on purposely selected 121 Indian inter-university female hockey players aged 18–25 years collected from the inter-university competition organized in Guru Nanak Dev University, Amritsar, Punjab, India during March, 2014. The subjects were further divided as per their playing positions, viz. goalkeepers (n=05), strikers (n=67) and defenders (n=49).

Results: In results, one way analysis of variance showed statistically no significant between-group differences among these three sets of players. Significantly positive correlations ($p \leq 0.05 - 0.01$) of dominant handgrip strength were found only with non-dominant handgrip strength in the Indian inter-university female field hockey players.

Conclusions: The study carries immense practical applications and should be useful in future investigation on player selection, talent identification in field hockey and training program development.

Introduction

Grip strength is often used as an indicator of overall physical strength [1,2], hand and forearm muscles performances [3] and as a functional index of nutritional status [4,5], physical performance [6,7]. The power of handgrip is the result of forceful flexion of all finger joints with the maximum voluntary force that the subject is able to exert under normal biokinetic conditions [8,9], which uses several muscles in the hand and the forearm [10].

Handgrip strength is a physiological variable that is

affected by a number of factors including age, gender and body size. Strong correlations between grip strength and various anthropometric traits, (weight, height, hand length etc.) were reported earlier [11–18]. Effect of socio-economic status on handgrip strength were studied by Henneberg et al [19].

Field hockey is an intermittent endurance sport involving short sprinting as well as movement with and without ball [20]. Successful performance in field hockey is influenced by morphological and anthropometric characteristics such as body size and composition, functional parameters (physical capacity) [13,21–26], and fitness (explosive strength, maximum speed,

anaerobic and aerobic capacity), agility[27–30]. Information related to the handgrip strength and its correlations with anthropometric variables and performance tests in female hockey players are limited, especially in Indian context. So the present study was planned.

Materials and Methods

Participants

The present cross-sectional study was based on purposely selected 121 Indian inter-university female hockey players aged 18–25 years (mean age 18.82 years, \pm 1.91) from the inter-university competition organized in Guru Nanak Dev University, Amritsar, Punjab, India in March, 2014. The subjects were further divided as per their playing positions, viz. goalkeepers (n=05), strikers (n=67), and defenders (n=49). The age of the subjects were recorded from the date of birth registered in their respective records submitted to the authorities. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 am to 12 noon). The study was approved by the ethical committee of Guru Nanak Dev University, Amritsar, Punjab, India.

Anthropometric measurements

Five anthropometric variables, viz. height (HT), weight (WT), body mass index (BMI), percent body fat (%BF) and upper arm circumference (UAC), two performance tests, viz. sit and reach test (S&RT) and vertical jump test (VJT), and dominant and non-dominant handgrip strength were measured on each subject using standard techniques [31], and were measured in triplicate with the median value used as the criterion.

The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm. Weight was measured by digital standing scales (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. BMI was then calculated using the formula $\text{weight (kg)}/\text{height}^2 \text{ (m)}^2$. Percent body fat was assessed with standard formula [32], using the four skinfold measurements (biceps, triceps, subscapular and suprailliac). Upper Arm Circumference was measured in vertical position. The measurement was taken at right angle to the axis of the hanging arm where the biceps muscle was most developed. Results were recorded in cms. The instruments were calibrated prior to use and all measurements were taken on the subject's right side.

Handgrip strength measurement

The grip strength of both right and left hands was measured using a standard adjustable digital handgrip dynamometer (Takei Scientific Instruments Co., LTD, Japan) at standing position with shoulder adducted and neutrally rotated and elbow in full extension. The dynamometer was held freely without support, not touching the subject's trunk. The position of the hand remained constant without the downward direction. The subjects were asked to put maximum force on the dynamometer thrice from both sides of the hands. The maximum value was recorded in kilograms. The handgrip

dynamometer was calibrated before each assessment. All subjects were tested after 3 minutes of independent warm-up. Except 6 female field hockey players (4.96%), all were right hand dominant.

Sit and reach test

Sit and reach test was used to estimate back and hamstring flexibility. The player performed warm up for 10 minutes and then removed their shoes for test. The researcher secured the ruler to the box top with the tape so that the front edge of the box lined up with the zero-mark on the ruler and the zero-end of the ruler pointed towards the player. The player was asked to sit on the floor with his legs fully extended with the bottom of his bare feet against the box. The player placed one hand on top of the other, slowly bent forward and reached along the top of the ruler as far as possible holding the stretch for two seconds. The distance reached by the player's finger tips in cm was recorded. The player performed the test thrice. The average of the three distances was recorded.

Vertical jump test

The subject was asked for warm up with several easy jumps proceeded with a few minutes rest, which also served the purpose of reviewing the jumping technique of the subject. The subject was told to bend the knees immediately prior to the jump (countermovement technique) which activated the stretch-shortening cycle in the muscles, resulting in greater power production in the legs. While resting, the subject was asked to stand with side toward wall and reach up as high as possible keeping the feet flat on the ground to mark the standing reach height. As and when the subject was ready, with colour on the distal part of his/her third finger (of right hand), he/she was asked to jump up as high as possible using both arms and legs to assist in projecting the body upwards and touch the wall at the highest point of the jump. The subject performed multiple attempts with short rests until a plateau or decrease in performance was observed and the best score was recorded in cms. The "net height" was calculated by subtracting the standing reach height from the jump height in cm.

Statistical analysis

Standard descriptive statistics (mean \pm standard deviation) were determined for directly measured and derived variables. One way analysis of variance was tested for the comparisons of data among Indian inter-university female field hockey players playing position-wise (goal keepers, defenders and strikers), followed by post hoc Bonferroni test. Pearson's correlation coefficients were applied to establish the relationships among the variables measured. Data were analyzed using SPSS (Statistical Package for Social Science) version 20.0. A 5% level of probability was used to indicate statistical significance.

Results

Descriptive statistics of handgrip strength, selected anthropometric variables and performance tests in Indian inter-university female field hockey players were shown in Table 1. One way analysis of variance showed statistically no

significant between-group differences in any case among the three sets of female field hockey players.

Table 2 showed the correlation matrix of handgrip strength, selected anthropometric variables and performance tests in Indian inter-university female hockey players. In the players, significantly positive correlations ($p < 0.01$) of dominant handgrip strength were found only with non-dominant handgrip strength. In the anthropometric variables, significant positive correlations ($p < 0.01$) of height were found with weight and significantly negative correlations with body mass index and % body fat. Similarly, significantly positive correlations ($p < 0.05 - .01$) of weight were found with body mass index, % body fat and vertical jump test. Significantly positive correlations ($p < 0.01$) of body mass index were found with % body fat. Significantly positive correlations ($p < 0.01$) of upper arm circumference were found with sit and reach test.

Discussion

Hockey is a short-distance sport where running means mostly sprinting, and the sprinting-distances vary from only a few meters to not more than 50 or 60 meters. Therefore,

quickness, explosive strength and agility are the characteristics that significantly influence performance in the field hockey. It is reported that a battery of anthropometric and morphological tests can distinguish between players of different ability in the same sport [33]. The same is true for the field hockey [13,20,26,34,35]. As handgrip strength is considered as the total body strength [2], it is essential to estimate the handgrip strength of the female field hockey players and to identify the factors affecting on this trait.

In the present study, comparisons were made among goalkeepers, strikers and defenders of Indian inter-university female field hockey players. One way analysis of variance showed no significant differences in any case. It may be stated from the findings that not much differences were there among position-wise Indian female field hockey players, may be due to structural and physiological, as well as the training program affinity among them. Significantly positive correlations ($p \leq 0.05 - 0.01$) of dominant handgrip strength were found only with non-dominant handgrip strength in female field hockey players. No other anthropometric variables had any association with handgrip strength, though statistically significant correlations were found among the anthropometric variables themselves (which was obvious). The findings of the present study did not follow the same line of the earlier findings of Koley and Singh [15], Koley and Yadav [14] and Koley et al. [16], where they had found strong positive correlations of dominant right handgrip strength and selected anthropometric variables in various populations. The present data may differ from other studies may be due to gene pool and environmental factors including socio-economic status and nutrition of the female field hockey players. The noble part of the this study was that, the position-wise analysis of the Indian female field hockey players. Not many references are available in this regard, especially in Indian socio-cultural context. The limitations of the study were the small sample size and only female players. Age in which the athletes begin their sport activity should also have been included in the study, as handgrip strength depends upon the sport experience of the athletes. In the future study all these limitations will be taken into consideration.

Conclusion

It may be concluded from the present study that, though no significant between-group differences were found in any of the anthropometric variables and performance tests, among these three sets of players, significantly positive correlations ($p \leq 0.05$) of handgrip strength were found only with non-dominant handgrip strength. The data presented in the study carry immense practical applications and should be useful in future investigation on player selection, talent identification in field hockey and training program development.

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Table 1: Descriptive statistics of handgrip strength, selected anthropometric variables and performance tests in Indian inter-university female hockey players (position-wise)

Variables	Goalkeepers (n=05)		Strikers (n=67)		Defenders (n=49)		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD		
Height (cm)	157.98	6.48	157.14	5.34	157.14	5.34	0.16	0.854
Weight (kg)	50.80	4.32	53.30	3.91	53.30	3.91	1.26	0.288
Body Mass Index (kg/m ²)	20.36	1.42	21.59	1.31	21.59	1.31	2.15	0.122
%Body fat	24.42	1.95	26.11	1.80	26.11	1.80	2.15	0.122
Upper arm circumference (cm)	23.20	0.83	22.77	2.07	22.77	2.07	0.62	0.539
Sit & reach test (cm)	17.40	6.66	14.09	5.55	14.09	5.55	1.97	0.144
Vertical jump (cm)	32.00	7.45	25.88	5.13	25.88	5.13	2.69	0.072
Dominant grip strength (kg)	24.66	6.38	24.36	4.42	24.36	4.42	1.05	0.354
Non-dominant grip strength (kg)	25.18	5.91	22.40	4.88	22.40	4.88	0.71	0.493

Table 2: Correlation matrix of dominant handgrip strength, selected anthropometric variables and performance tests in inter-university female hockey players

	HT	WT	BMI	%BF	UAC	S&RT	VJ	DHGS	NDHGS
HT	1	0.614**	-0.465**	-0.469**	0.077	-0.085	0.077	-0.095	-0.067
WT		1	0.409**	0.411**	0.137	0.010	0.012*	0.026	0.020
BMI			1	1.000**	0.070	0.076	-0.089	0.132	0.082
%BF				1	0.070	0.076	-0.089	0.132	0.082
UAC					1	0.205*	0.130	0.111	0.073
S&RT						1	-0.028	0.069	-0.037
VJ							1	0.047	0.157
DHGS								1	0.724**
NDHGS									1

*Significant at 0.05 level (2 tailed); **Significant at 0.01 level (2 tailed)

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