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Original Research Article

A Study of Anthropometric Variables, Back strength and Performance Tests in Inter- University Hockey Players

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ABSTRACT

Introduction: The purpose of the study was to evaluate the anthropometric variables and physical fitness tests in inter-university hockey players, and to find the correlation between these variables. The purposely selected 105 inter-university hockey players aged 18-25 years were collected from various universities of North India. An adequate number of controls (n = 84) were also taken from the same place for comparison.
Methods: A total of seven anthropometric variables i.e. height, weight, BMI, total arm length, % body fat, biceps skinfold, triceps skinfold, and back strength, and two physical performance tests i.e. sit and reach test and Illinois agility test were measured on each subject.
Results: Statistically significant differences ($p \leq 0.009$-0.001) were found in BMI, biceps skinfold, triceps skinfold, % body fat, back strength, sit and reach test and Illinois agility test between hockey players and controls. When sex differences were checked in hockey players, significant differences ($p \leq 0.001$) were found in height, weight, BMI, total arm length, % body fat and back strength. Back strength, sit and reach test and Illinois agility test had significant positive correlations ($p \leq 0.006$-0.001) with height, weight, BMI, total arm length and % body fat in hockey players.
Conclusion: The results of the study showed that there were strong associations between performance tests and anthropometric variables. The findings would be helpful to search the sports talents, administrating training program and minimizing sports specific injuries in the game.

Key words: Inter-university hockey players. Anthropometric variables. Back strength. Performance tests.

INTRODUCTION

Field hockey is an intermittent endurance sport involving short sprinting as well as movement with or without ball. [1] The game is popular both in males and females in many continents of the world, particularly in Europe, Asia, Australia and South Africa. In field hockey, players are to bend forward to the ground for the maximum groundwork and to cover a wider range all around during the game. [2] Tactical skills can be defined as knowledge regarding in game adaptations and decision making activity on the field of play. Such knowledge can be distinguished from the strategy, which refers to choices discussed in advance with the trainers in order to the team to organize itself. [3-5]

Back strength is one of the important characteristics to keep the individuals at bay from pain. Back plays a huge rule in how entire body functions because it attaches to hips, abdominals, chest, shoulders and neck. Optimal function of the human spine requires that it be flexible, yet strong enough to withstand functional loads. The conflicting nature of those requirements may be a contributing factor in spinal dysfunction, [6] particularly for athletes who participate in sports that demand above average flexibility and strength. Some low back injuries in sport are attributable to specific incidents, such as physical contact [7] or training errors, but many have no apparent cause and are classified as overuse injuries. [8] Such is the case in women's field hockey, where there has been a recent increase in reports of low back pain of unknown origin. [9] Execution of most field hockey ball handling skills requires a combination of spinal flexion and rotation, two movements known to increase the work of the back extensor muscles and the spinal compression load. [10] Further, these athletes increase muscle work and spinal loading by running for the majority of the 70-minute game in varying degrees of trunk flexion. Consequently, field hockey athletes place high demands on the back extensor muscles for endurance and eccentric and concentric strength. [11] It has been well establish that specific anthropometric profiles indicate whether the player would be suitable for the competition at the highest level in a specific sport. [12]

Anthropometry involves the external measurement of morphological traits of human beings. It has a widespread and important place in nutritional assessment, and while the literature on anthropometric measurements and its interpretation is enormous, the extent to which measurement error can influence both measurement and interpretation of nutritional status is little considered. [13] It has been suggested that chronic stretching can be lead to increase flexibility, improved muscle or athletic performance, improved running economy, injury prevention, promotion of healing and possibly decreased delayed-onset of muscle soreness. [14] Upper extremity muscle strength and grip strength are primary factors affecting passing accuracy. Grip strength is correlated with the strength of the upper extremity, general strength of the body with some anthropometric measurements. A strong grip is also important for many sports such as: martial arts, wrestling, rock climbing, gymnastics, hockey, tennis, baseball, golf, etc. Not much literature is available regarding the back strength and its correlation with anthropometric variables and performance tests in hockey players, especially in Indian context. Thus the present study was planned.

MATERIALS AND METHODS

Subjects

The present cross sectional study was based on purposely selected 105 hockey players (65 male and 40 female) aged 18-25 years (mean age = 20.60 ± 1.79 years) were taken from inter-university level competition organized in Amritsar, India. An adequate number of controls (n= 84; 44 males 40 females, mean age = 21.63 ± 2.08 years) were also taken from the same place matching age, sex, socio-economic status, religion, except the playing condition for comparisons. The age of the subjects were recorded from the date of the birth registered in their respective institutes. A written consent was obtained from all the subjects. The data were collected under natural environmental conditions in evening (between 3 pm to 6 pm). The study was approved by the Institutional Ethics Committee.

Anthropometric Measurements

Seven anthropometric variables, such as height, weight, BMI, total arm length, biceps skinfold, triceps skinfold and percent body fat were taken on each subject using the techniques provided by Lohman et al. [15] and were measured in triplicate with the median value used as criterion. The height was recorded during inspiration using a stadiometer (Holtain Ltd., Crymych, Dyfed, UK) to the nearest 0.1 cm. The subject was asked to stand erect on the stadiometer with bare foot. The horizontal bar of the stadiometer was placed on the vertex of the subject and the readings were recorded in centimeters. Weight was measured by digital standing scales (Model DS-410, Seiko, and Tokyo, Japan) to the nearest 0.1 kg. The subject was asked to stand erect on the digital weighing machine with minimum clothing and bare foot. The reading was recorded from the scales of the digital weighing machine in kilograms. BMI was then calculated using the formula weight (kg)/height^2 (m^2). Total arm length was measured by anthropometric rod in vertical position. The subject was asked to stand erect on the horizontal surface stretching as much as possible, arms hanging by the side with finger stretched. The final cross bar was allowed to touch with acromian and the moving bar to the dactylion position lightly. Results were recorded in centimeter. For the measurement of biceps and triceps skinfold, the Harpenden skinfold calliper (British Indicators Ltd, St Albans, Herts) was used. Both the measurements were taken with the subject seated on a stool, on the right side of the body. The sites selected were as follows. (I) Biceps: over the mid-point of the muscle belly with the arm resting supinated and (2) Triceps: over the mid-point of the muscle belly, mid-way between the olecranon and the tip of the acromion, with the upper arm hanging vertically. The skinfold was pinched up firmly between the thumb and forefinger and pulled away slightly from the underlying tissues before applying the calliper. Results were recorded in millimeter. Percent body fat was estimated with the formula given by Durnin and Womersley: [16]

Females (17-68 years) = 1.37 X BMI - 3.47

Males (17-68 years) = 1.34 X BMI - 12.47.

Back Strength Measurement

Back strength was measured by back-leg-chest dynamometer. The subject was positioned with body erect and knees bent so that grasped-hand rests at proper height. Then straightening the knees and lifting the chain of dynamometer, pulling force was applied on handle. The body was inclined forward at an angle of 60 degrees. The strength of the back muscles was recorded on the dial of the dynamometer as best of three trials in kg. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds time interval was maintained between each back strength testing.

Performance Tests

Two performance tests, such as, Illinois agility test and sit and reach test were considered for the present study.

Illinois Agility Test

Illinois agility test was done on a flat non-slip surface using 8 cones, a stopwatch and an assistant. The length of course was 10 meters and the width (distance between the start and finish points) was 5 meters. On an athletic track, 5 lanes were used. 4 cones can be used to mark the start, finish and two turning points. Each cone in center spaced 3.3 meters apart at beginning of the circuit. When counted in sprint as fast as the player can through the circuit following the path indicated. Results were recorded in seconds.

Sit and Reach Test

Sit and reach test was done by sit and reach box. This test was best completed after a substantial amount of warm up was completed in order to ensure the best results as well as being a safety precaution. When a warm up was involved, it was critical that the same warm up was completed each time the test was conducted. To begin this test, the subject sat on the floor with both feet straight out against a box for him/her to press their feet against, making sure their feet were bare, both the knees were pressed down to the floor and their palms were facing downward. The subject was asked to reach as far as they can towards their toes or if they were really flexible over the box. With a ruler, or some sort, the length of which the subject can reach measuring from their toes to their finger-tips was recorded. It should be made sure that both hands were even and one was not reaching further than the other. The subject should not do jerky or quick movements while recording. The distance from their toes to their fingertips was recorded in inches. If their fingers were passed their toes, the results were positive, if the fingers were behind the toes, the results were negative.

Statistical Analysis

Data was analyzed using SPSS (Statistical Package for Social Science) version 20.0. One way analysis of variance was tested for the comparisons of data among inter-university hockey players and controls. Pearson's correlation coefficient test was done to observe the correlations among selected anthropometric variables, back strength and performance tests in the hockey players. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1. One-way ANOVA of selected anthropometric variables, back strength and performance tests in inter-university hockey players and controls

Variables	MHP (n=65)		FHP (n=40)		CM (n=44)		CF (n=40)		F-value	p-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
HT (cm)	167.8	9.33	166.11	8.07	172.13	5.34	159.48	4.62	158.26	<0.001
WT (kg)	62.73	10.08	63.57	9.18	70.88	5.20	55.50	4.78	183.80	<0.001
BMI (kg/m^2)	22.12	1.97	22.99	2.54	23.99	2.36	21.88	2.29	21.46	<0.001
TAL(cm)	74.52	5.60	74.22	1.93	75.26	1.35	73.06	1.84	171.71	<0.001
BSF(mm)	9.14	1.76	6.26	1.36	7.00	1.22	5.45	0.99	63.67	<0.001
TSF (cm)	10.44	2.42	15.72	3.24	13.34	2.26	18.33	1.86	116.90	<0.001
S&RT (cm)	12.88	4.85	1.77	4.63	1.93	5.62	1.60	3.27	84.99	<0.001
IAT (sec.)	17.17	1.97	22.00	1.30	21.14	0.80	22.96	1.05	156.60	<0.001
%BF	17.17	2.63	18.33	3.41	19.68	3.16	16.85	3.07	21.33	<0.001
BS (kg)	85.64	11.37	35.05	12.40	76.57	15.21	21.79	5.26	340.70	<0.001

MHP = male hockey players, FHP = female hockey players, CM = control males, CF = control females, HT = height, WT = weight, BMI = body mass index, TAL = total arm length, BSF = biceps skinfold, TSF = triceps skinfold, S&RT = sit and reach test, IAT = Illinois agility test, %BF = percent body fat, and BS = back strength.

Table 1 showed the one way ANOVA of selected anthropometric variables, back strength and performance tests of inter-university hockey players and controls. One way ANOVA showed significant between-group differences (p<0.001) in all the characteristics studied among these four sets of data.

The correlation coefficients of back strength with selected anthropometric variables and performance tests were examined in inter-university hockey players in table 2. In female hockey players, back strength has significant positive correlations (p<0.026-0.001) with total arm length, biceps and triceps skinfold and percent body fat. In case of combined male and female hockey players, significant positive correlations (p<0.043-0.001) were noted with height, weight, BMI, total arm length, biceps skinfold and percent body fat, and significant negative correlation (p<0.047) was found with Illinois agility test.

Table 2. Correlation coefficients of back strength with selected anthropometric variables and performance tests in inter-university hockey players

Variables	MHP (n=65)		FHP (n=40)		CHP (n=105)	
	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	0.045	0.723	0.433	0.005	0.843	<0.001
WT (kg)	0.059	0.642	0.538	0.001	0.861	<0.001
BMI (kg/m^2)	0.015	0.904	0.349	0.027	0.568	<0.001
TAL (cm)	0.122	0.331	0.672	<0.001	0.877	<0.001
BSF (mm)	0.193	0.123	0.528	<0.001	0.198	<0.043
TSF (mm)	0.102	0.417	0.424	<0.006	0.157	0.110
% BF	0.016	0.902	0.351	<0.026	0.566	<0.001
IAT (sec.)	-0.007	0.953	-0.278	0.083	-0.194	<0.047
S&RT (inches)	-0.212	0.090	-0.028	0.865	-0.126	0.202

CHP = combined hockey players

Table 3 showed the correlation coefficients of sit and reach test with selected anthropometric variables and performance tests in inter-university hockey players. In female hockey players, statistically significant positive correlation (p<0.001) of sit and reach test was found with weight only. In combined male and female hockey players, statistically significant positive correlation ($p<0.001$) was found with weight, whereas statistically significant negative correlation ($p<0.001$) was noted with Illinois agility test.

The correlation coefficients of Illinois agility test with selected anthropometric variables were shown in table 4. No significant correlation was found in any case.

Table 3: Correlation coefficients of sit and reach test with selected anthropometric variables and performance test in inter-university hockey players

Variables	MHP (n=65)		FHP (n=40)		CHP (n=105)	
	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	-0.054	0.671	-0.006	0.973	-0.097	0.324
WT (kg)	0.059	0.642	0.538	<0.001	0.861	<0.001
BMI (kg/m^2)	-0.033	0.791	-0.015	0.925	-0.072	0.467
TAL (cm)	-0.062	0.621	.0011	0.946	-0.092	0.349
BSF (cm)	0.001	0.991	0.008	0.961	0.001	0.993
TSF (cm)	0.109	0.389	-0.147	0.364	-0.072	0.465
% body fat	-0.037	0.772	-0.016	0.921	-0.073	0.461
IAT (sec)	-0.121	0.338	-0.556	0.001	-0.445	<0.001

Table 4. Correlation coefficients of Illinois agility test with selected anthropometric variables in inter-university hockey players

Variables	MHP (n=65)		FHP (n=40)		CHP (n=105)	
	r-value	p-value	r-value	p-value	r-value	p-value
HT (cm)	0.074	0.556	-0.035	0.829	-0.123	0.212
WT (kg)	-0.106	0.402	-0.097	0.554	-0.170	0.083
BMI (kg/m^2)	-0.149	0.237	-0.100	0.539	-0.172	0.080
ToAL (cm)	0.111	0.379	-0.060	0.714	-0.126	0.199
BSF (cm)	0.075	0.552	-0.035	0.828	-0.007	0.942
TSF (cm)	-0.092	0.467	0.113	0.488	0.031	0.750
% BF	-0.149	0.236	-0.096	0.556	-0.169	0.084

DISCUSSION

It is reported that a battery of anthropometric and morphological tests can distinguish between players of different ability in the same sport. [17] The same is true for the hockey too. [18-21] Back strength is a major component of successful performance in almost every activity of daily living. It is vital to the maintenance of upright posture, ambulation, and the accomplishment of simple tasks such as eating and dressing. It is also very essential in various sports. [22] The relationship between the body composition and physical performance changes are also of the great interest to strength and conditioning specialists. Identifying factors such as physical size and structure may result in good performance. [23]

In the present study, significant differences ($p<0.001$) were noted among male and female hockey players and their control counterparts in the entire variables studied (table 1). The results showed higher mean values of back strength in male hockey players (85.64±11.37 kg) and female hockey players (35.05±12.40) players as compared to their respective controls (76.57 ± 15.21kg and 21.79 ± 5.26kg). These values showed, male hockey players have significantly higher mean values for back strength than controls as well as female hockey players, whereas female hockey players have also significantly higher mean values for this trait as compared to control females. Gender predicted 62% of back leg chest strength, whereas the strength variables explained a significant proportion of 87% of the variance. [24] It was showed structural and physiological affinity towards back strength. It was earlier reported too, that several anthropometric variables were strongly correlated with back strength in different population. [25] The literature related to back strength is scanty, especially in the Indian context. [26] In the present study, those anthropometric variables were considered which were not reported earlier for the study of correlation with back strength. According to Bamman et al., [27] anthropometric variables are directly related to muscles. In similar study conducted on Indian field hockey players, back strength was found to be more for the taller players having longer trunk and hand, and with broader chest. It was also more among the players who were heavier, leaner and having bulkier arms. [28]

The physique of an athlete is considered to be an important determinant of the success and in top level sport there would appear to be tendency for individuals to gravitate towards the event to which they are anthropometrically best suited. [29-31] In the present study, strong association was reported between back strength of the hockey players and the selected anthropometric variables and performance tests. When sex differences were analyzed in inter-university hockey players, females had more percent body fat as compared to males, as supported by other studies. [32] Most female athletes carried between 8 to 15 percent of the fat content, and it rises in females than males after the puberty. [33] It is generally accepted that a low relative body fat is desirable for successful performance in almost any sport, as additional body fat adds to the mass of the body without contributing to its force or energy contributing capabilities. [34] The sit and reach test and Illinois agility test had significant correlation only with back strength but not with any of the anthropometric variables studied. More anthropometric variables should be taken into consideration for this purpose in future studies.

CONCLUSION

The back strength was reported to be significantly greater in male and female hockey players than their control counterparts. Even, male hockey players had significantly greater back strength than the female hockey players. Back strength had significant correlations with majority of the anthropometric variables and performance tests studied in Indian hockey players. The data presented in the present 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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