Original Article

Correlations of anthropometric characteristics with physical fitness tests in Indian professional hockey players

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ABSTRACT

Sharma A, Tripathi V, Koley S. Correlations of anthropometric characteristics with physical fitness tests in Indian professional hockey players. *J. Hum. Sport Exerc.* Vol. 7, No. 3, pp. 698-705, 2012. The purpose of this study was to investigate the correlations of anthropometric characteristics with isotonic strength (handgrip strength), lower limb power, aerobic strength, and skill tests in purposely selected 60 Indian professional male hockey players of different levels players (35 national and 25 state level) aged 18-23 years collected from Ranjit Singh Hockey Academy, Amritsar, Punjab, India. To serve this purpose, three anthropometric characteristics (height, weight and percent body fat), right and left handgrip strength, vertical jump, multi stage fitness test, slalom sprint and dribble tests were performed on each subject. Results indicated statistically significant ($p<0.05$) differences only in lower limb power between Indian national and state level male hockey players. In Indian professional male hockey players, height has significantly positive correlations with weight, right and left handgrip strength, lower limb power and negative correlations with % body fat and dribble test, and body weight has significantly positive correlations with % body fat, right and left handgrip strength, lower limb power and negative correlations with slalom sprint. Significantly positive correlations were noted among the fitness component variables too.
Key words: AEROBIC STRENGTH, SKILL TESTS, ANTHROPOMETRIC CHARACTERISTICS, HANDGRIP STRENGTH, INDIAN PROFESSIONAL MALE HOCKEY PLAYERS, LOWER LEG POWER.

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INTRODUCTION

Field hockey is an intermittent endurance sport involving short sprinting as well as movement with and without ball (Manna et al., 2009). Successful performance in field hockey is influenced by morphological and anthropometric characteristics such as body size and composition, functional parameters (physical capacity) (Scott, 1991; Singh et al., 2010) and fitness (strength, speed, anaerobic and aerobic capacity, agility) (Nikitushkin & Guba, 1998). 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 (Sodhi, 1991) and maximum strain comes over the back muscles as well as abdominal muscles during the entire duration of the game. Estimation of back strength of Indian inter-university male hockey players and significant positive correlations of back strength with height, weight, BMI, hip circumference, % lean body mass and abdominal muscle endurance was reported (Koley et al., 2012). Evaluation of anthropometric, physiological and skill-related tests for talent identification in female field hockey was also reported (Keogh et al., 2003). Anthropometric characteristics and physiological variables were compared too, among the national hockey players of India, Pakistan and Sri Lanka (Singh et al., 2010). Hockey players playing in different positions found to differ on some anthropometric measurements and body cpmposition (Karkare, 2011).

Apart from hockey, reports on anthropometric characteristics and physiological variables were available in handball (Zapartidis et al., 2009; Koley et al., 2011a), Cricket (Koley, 2011; Koley & Yadav, 2009), Basketball (Koley & Singh, 2010; Koley et al., 2011b), Volleyball (Koley & Kaur, 2011; Koley & Singh, 2012; Koley et al., 2010) and softball (Koley & Santhosh, 2011).

Correlations of anthropometric characteristics and physical fitness tests remained less reported, especially in Indian context. To fulfill the lacuna of knowledge, the present study was planned with the hypothesis that there would be significant correlations of anthropometric characteristics studied with the physical fitness components.

MATERIAL AND METHODS

Participants

The present cross-sectional study was based on purposely selected 60 Indian professional male hockey players (35 national and 25 state levels) aged 18-23 years from Ranjit Singh Hockey Academy, Amritsar, Punjab, India. The age of the subjects were recorded from the date of birth registered in their respective records submitted to the authorities. The subjects were divided in such a way that age 18 refers to the individuals aged 17 years and 6 months through 18 years and 5 months and 29 days. A written consent was obtained from the subjects. The data were collected under natural environmental conditions in morning (between 8 AM. to 12 noon) during practice season. The study was approved by the local ethical committee.

Procedures

Anthropometric Measurements

Anthropometric characteristics, viz. height, weight and percent body fat were measured on each subject using standard techniques (Lohmann et al., 1988; Womersly & Durnin, 1977) 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. Percent body fat was calculated with the formula using BMI:
For Males = 1.34 × B.M.I-12.47 (Womersly & Durnin, 1977).

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 three times from both sides of the hands. The maximum value was recorded in kilograms. Anthropometric equipments and handgrip dynamometer were calibrated before each assessment. All subjects were tested after 3 minutes of independent warm-up. Thirty seconds to one minute time interval was maintained between each handgrip strength testing.

Lower limb power
To test the lower limb power the vertical jump test was applied. The hockey player was asked to stand side on to a wall and to reach up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips was marked or recorded. This was called the standing reach height. The player then was asked to stand away from the wall, and to leap vertically as high as possible using both arms and legs to assist in projecting the body upwards. The player was asked to attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height was the score. The best of three attempts was recorded.

Johnson and Bahamonde (1996) established equations to calculate peak power:

Peak power (in watts) = 78.6 x VJ (cm) + 60.3 x mass (kg) -15.3 x height (cm) -130

Multi Stage Fitness Test (Beep Test)
Aerobic strength of the subjects was tested by the Multi-Stage Fitness Test (MSFT). The test involved continuous running between two lines 20m apart in time to recorded beeps. The subject was asked to stand behind one of the lines facing the second line, and to begin running when instructed by the audio tape. The speed at the start was quite slow. The subject continued running between the two lines, turning when signalled by the recorded beeps. After about one minute, a sound indicated an increase in speed, and the beeps were closer together. The process continued each minute for a single level. If the line was not reached in time for each beep, the subject would run to the line turn and try to catch up with the pace within 2 more 'beeps'. Also, if the line was reached before the beep sounds, the subject would wait until the beep sounds. The test was stopped if the subject failed to reach the line (within 2 meters) for two consecutive ends. The score was calculated over the level and number of shuttles (20 m) reached by the players before they were unable to keep up with the recording. The last completed level was recorded for scoring. The level recorded was converted into VO_2max as per standard technique (Leger & Lambert, 1982).

Slalom sprint (SS) and dribble test (DT)

Based on tests for agility and dribbling skills, the field hockey specific slalom sprint and dribble test (Slalom SDT) was developed to measure field hockey specific slalom sprint and dribble performance (Lemmink et al., 2004). The protocol consisted of a maximal slalom sprint of 30 m while carrying a hockey stick and a maximal slalom dribble of 30 m while dribbling a hockey ball. Twelve cones were placed in a zigzag pattern. Start and finish lines were marked by two cones. The subject was asked to begin the test with both feet behind the starting line, then, upon an auditory signal after a 5 second countdown, the subject ran with a hockey stick around the 12 cones reaching over the finishing line. The protocol of the dribbling portion was identical to the sprinting portion, except that the subject was dribbling a hockey ball. If the subject lost control of the ball—that is, if the subject was more than approximately 2 m away from the cones, the test was repeated. Time was recorded using a stopwatch. Slalom sprint time and slalom dribble time were noted and recorded accurately to within 0.01 seconds.

Statistical Analysis

Standard descriptive statistics (mean±standard deviation) were determined for directly measured and derived variables. Independent t-test was used to compare the two sets of populations. 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 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Descriptive statistics of selected anthropometric characteristics and fitness tests in Indian national and state level male hockey players are shown in Table 1. Statistically significant ($p<0.001$) differences were found only in lower limb power between Indian national and state level male hockey players.

Table 1. *Descriptive statistics of selected anthropometric variables and fitness tests in Indian male state and national level hockey players.*

Variables	**National level players** (n= 35)		**State level players** (n= 25)		**t-value**
	Mean	SD	Mean	SD	
Height (cm)	169.12	5.73	173.27	7.14	1.57
Body weight (kg)	63.94	7.82	65.28	6.37	0.46
Bodyfat %	17.50	3.50	16.69	2.52	0.67
Right handgrip strength (kg)	36.03	4.95	36.65	3.88	1.12
Left handgrip strength (kg)	36.57	4.67	37.77	3.40	0.98
Lower limb power (watts)	3317.34	569.41	3479.24	554.41	160.23*
Aerobic Fitness (ml/kg/min)	45.17	2.18	44.37	1.96	0.56
Slalom sprint (sec)	17.52	1.55	17.51	1.97	0.57
Dribble test (sec)	18.34	1.55	18.43	1.83	0.53

**Significant at 0.001 level*

Correlation matrix of selected anthropometric variables and fitness tests of Indian national and state level male hockey players are shown in Table 2 and 3. Height has significantly positive correlations ($p<0.05$ - 0.01) with WT, RHGS, LHGS, LLP and negative correlations ($p<0.01$) with %BF and DT. Weight has significantly positive correlations ($p<0.05$ - 0.01) with %BF, RHGS, LHGS and LLP, and negative correlations ($p<0.05$) with SS. Whereas, %Bf has significantly negative correlations ($p<0.05$ - 0.01) with LLP, AF, SS and DT. Significantly positive correlations ($p<0.05$ - 0.01) were noted among the fitness component variables too.

Table 2. *Correlation matrix of selected anthropometric variables and Fitness tests in Indian national level male hockey players.*

	HT	BW	% BF	RHGS	LHGS	LLP	AF	SS	DT
HT	1	0.372**	-0.189	0.219	0.334*	0.243*	0.055	0.110	0.006
BW		1	0.840**	0.222*	0.350*	0.583**	-0.372**	-0.350*	-0.365**
%BF			1	0.100	0.178	-0.483**	-0.349**	-0.451**	-0.399**
RHGS				1	0.801**	0.121	0.166	0.012	0.014
LHGS					1	0.213*	0.194	0.056	0.078
LLP						1	0.292*	0.248*	0.302*
AF							1	0.362*	0.264*
SS								1	0.901**
DT									1

**Significant at 0.05 level, **Significant at 0.01 level, HT = Height, BW = body weight, %BF = Percent body fat, RHGS = Right handgrip strength, LHGS = Left handgrip strength, LLP = Lower limb power, AS = Aerobic fitness, SS= Slalom sprint and DT = Dribble test.*

Table 3. *Correlation matrix of selected anthropometric variables and fitness tests in Indian state level male hockey players.*

	HT	BW	% BF	RHGS	LHGS	LLP	AF	SS	DT
HT	1	0.561**	-0.288*	0.555**	0.533**	0.305*	0.237*	-0.170	-0.271*
BW		1	0.629**	0.296*	0.556**	0.487**	-0.132	-0.321*	0.175
% BF			1	-0.163	0.162	-0.283*	-0.384**	-0.545**	-0.468**
RHGS				1	0.810**	0.182*	0.018	-0.008	-0.097
LHGS					1	0.267	-0.003	0.085	-0.008
LLP						1	0.151	-0.175	0.320**
AF							1	0.538**	0.567**
SS								1	0.922**
DT									1

**Significant at .05 level, **Significant at .01 level, HT = Height, BW = body weight, %BF = Percent body fat, RHGS = Right handgrip strength, LHGS = Left handgrip strength, LLP = Lower limb power, AS = Aerobic fitness, SS= Slalom sprint and DT = Dribble test.*

DISCUSSION

It was reported that a battery of anthropometric and morphological tests could distinguish between players of different ability in the same sport (Keogh, 2003). The same was true for the field hockey (Scott, 1991; Manna et al., 2009; Singh et al., 2010). In fact, 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 m. Therefore, speed, strength and agility are the characteristics that significantly influence performance in the field hockey. So, in the present study, an attempt has been made to investigate the correlations of anthropometric characteristics with physical fitness components in Indian professional male hockey players of different levels.

The findings of the present study indicated significant differences only in lower limb between Indian male national level hockey players and their state level counterparts. No significant differences were found in rest of the parameters between these two sets of Indian professional hockey players. It might be assumed that identical type of exercise and training programs were applied for both these groups of player. Professional hockey players are required to cope up with advanced developments in field hockey, such as the artificial playing surface, new stick material, and the interchange rule which has in turn increased the number of physiological and technical demands on these players (Boyle et al., 1994). Specific type of training programme is required for players as per their playing positions as well as their playing conditions. In the present study statistically significant negative correlations were noted in weight, percent body fat with lower limb power, slalom sprint and dribble test. Therefore anthropometric characteristics can be used as the predictor of performance in hockey.

Field hockey is a high intensity activity sport with a multidirectional nature. The ability to change direction rapidly while maintaining balance without loss of speed-that is, agility-is therefore an important physical fitness component necessary for successful performance in field hockey. Elite field hockey players also need high level of technical skills such as being able to dribble without losing running speed. For a technically good player, dribbling is essentially an automatic process, and the better players distinguish themselves by their running speed while dribbling the ball (Reilly et al., 1986). So, quite naturally, strong correlations would be there among the physical fitness components, viz. slalom sprint, dribble test, aerobic strength and handgrip strength. The findings of the present study also supported the existing knowledge. However, future investigation is required considering more sample size to validate the data.

CONCLUSIONS

It may be concluded from the present study that, off those anthropometric characteristics, weight and percent body fat had statistically significant positive correlations with handgrip strength and lower limb power and negative correlations with slalom sprint, aerobic fitness and dribble test.

CLINICAL IMPLICATIONS

The data presented in the present study carry considerable practical applications. Anthropometric characteristics studied can be used as the predictor of performance in hockey. It should be useful too in future investigation on player selection, talent identification in field hockey and training program development.

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REFERENCES

1. BOYLE PM, MAHONEY CA, WALLACE WFM. The competitive demands of elite male field hockey. *J Sports Med Phys Fitness.* 1994; 34:235-41. [Abstact] [Back to text]
2. JOHNSON DL, BAHAMONDE R. Power output estimate in university athletes. *Journal of strength and Conditioning Research***.** 1996; 10(3):161-166. [Full Text] [Back to text]
3. KARKARE A. Anthropometric measurements and body composition of hockey players with respect to their playing positions. *Indian Streams Research Journal*. 2011; 1:5-8. [Abstract] [Back to text]
4. KEOGH J. Evaluation of anthropometric, physiological and skill-related tests for talent identification in female field hockey. *Journal of Applied Physiology.* 2003; 28(3):397-409. [Abstract] [Back to text]
5. KOLEY S, JHA S, SANDHU JS. Estimation of back strength and its association with selected anthropometric and physical fitness variables in Indian inter-university field hockey players. *The Anthropologist.* 2012; 14(4):359-363. [Back to text]
6. KOLEY S, KAUR SP, SANDHU JS. Correlations of handgrip strength and some anthropometric variables in Indian inter-university female handball players. *Sports Science Review.* 2011a; 20(3-4):57-68. doi:10.2478/v10237-011-0054-3 [Back to text]
7. KOLEY S, KAUR SP. Correlations of handgrip strength with selected hand-arm-anthropometric variables in Indian inter-university female volleyball players. *Asian Journal of Sports Medicine*, 2011; 2(4):220-226. [Abstract] [Back to text]
8. KOLEY S, SANTHOSH KB. Correlations of handgrip strength with selected hand-anthropometric variables in university softball players. *Biomedical human Kinetics*. 2011; 3:91-95. doi:10.2478/v10101-011-0020-7 [Back to text]
9. KOLEY S, SINGH J, KAUR SP. A study of arm-anthropometric profile and handgrip strength in Indian inter-university basketball players. *Serbian Journal of Sports Sciences*. 2011b; 5(1):35-40. [Back to text]
10. KOLEY S, SINGH J, SANDHU JS. Anthropometric and physiological characteristics on Indian inter-university volleyball players. *Journal of Human Sport and Exercise.* 2010; 5(3):389-399. doi:10.4100/jhse.2010.53.09 [Back to text]
11. KOLEY S, SINGH J. Anthropometric and physiological characteristics on Indian inter-university basketball players. *Journal of Physical Education and Sports.* 2010; 28(3):70-76. [Back to text]
12. KOLEY S, SINGH J. Correlations of dominant handgrip strength with some anthropometric and physiological characteristics in Indian inter-university volleyball players. *Human Biology Review.* 2012; 1(1):41-50. [Full Text] [Back to text]
13. KOLEY S, YADAV MK. An association of hand grip strength with some anthropometric variables in Indian cricket players. *Facta Universitatis, Series: Physical Education and Sports.* 2009; 7(2):113-123. [Full Text] [Back to text]
14. KOLEY S. A study of anthropometric profile of Indian inter-university male cricketers. *Journal of Human Sport and Exercise.* 2011; 6(2):427-435. doi:10.4100/jhse.2011.62.23 [Back to text]
15. LEGER LA, MERCIER D, GADOURY C, LAMBERT J. The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Science.* 1988; 6:93-101. doi:10.1080/02640418808729800 [Back to text]

16. LEMMINK KAPM, ELFERINK-GEMSER MT, VISSCHER C. Evaluation of the reliability of two field hockey specific sprint and dribble tests in young field hockey players. *British Journal of Sports Medicine.* 2004; 38:138-142. doi:10.1136/bjsm.2002.001446 [Back to text]
17. LOHMANN TG, ROCHE AF, MARTORELL R. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books, 1988. [Back to text]
18. MANNA I, KHANNA GL, DHARA PC. Training induced changes on physiological and biochemical variables of young Indian field hockey players. *Biology of Sport.* 2009; 26(1):33-43. [Back to text]
19. NIKITUSHKIN VG, GUBA VP. *Methods of selection in team sports*. IKAP Press: Moscow; 1998. [Back to text]
20. REILLY T, BRETHERTON S. Multivariate analysis of fitness of female field hockey players. In: Day JAP (Eds.). *Perspectives in kinanthropometry*. Champaign, IL: Human Kinetics; 1986. Pp. 135-42. [Back to text]
21. SCOTT PA. Morphological characteristics of elite male field hockey players. *Journal of Sports Medicine & Physical Fitness.* 1991; 31:57-61. [Abstract] [Back to text]
22. SINGH M, SINGH MK, SINGH K. Anthropometric measurements, body composition and physical parameters of Indian, Pakistani and Sri Lankan field hockey players. *Serbian Journal of Sports Sciences*. 2010; 4(2):47-52. [Back to text]
23. SODHI HS *Sports Anthropometry*. ANOVA Publications: Mohali; 1991. [Back to text]
24. WOMERSLY J, JUGA D. A comparison of the skinfold method with extent of "overweight" and various weight height relationships in the assessment of obesity. *British Journal of Nutrition.* 1977; 38:71-284. [Back to text]
25. ZAPARTIDIS I, VARELTZIS I, GOUVALI M, KORORO P. Physical fitness and anthropometric characteristics in different levels of young team handball players. *The Open Sports Sciences Journal*. 2009; 2:22-28. doi:10.2174/1875399X00902010022 [Back to text]

