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Correlations of Back Endurance with Anthropometric Variables and Performance Tests in Indian Elite Male Hockey Players

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ABSTRACT
The purpose of this study was of two-fold: first, to estimate the back endurance of Indian elite male field hockey players and, second, to search the correlation of it with selected anthropometric variables and performance tests. To serve this purpose, a total of ten anthropometric variables, viz. height, weight, BMI, biceps, triceps, subscapular and suprailiac skinfolds, percent body fat, back strength, two performance tests, viz. flexibility measures and tall kneeling and back endurance were measured on purposely selected 80 Indian national level male hockey players aged 16–21 years collected from PAP, Jalandhar, Punjab, India during 2010-2012. The subjects were further divided as per their playing positions, viz. goalkeepers (n=15), center forwards (n=25), center halves (n=20) and full backs (n=20). In results, one way analysis of variance showed statistically significant ($p \leq 0.05$) between-group differences only in body weight among these four sets of players. Significantly positive correlations ($p \leq 0.05$ - 0.01) of back endurance were found with body weight, back strength, flexibility measures and tall kneeling in the Indian male hockey players.
Key Words: *Back strength. Anthropometric variables. Performance tests. Indian elite male hockey players.*

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) (Bale et al. 1986; Fedotova et al. 1990; Mokha and Sidhu 1987; Seluyanov and Sarsaniya 1991; Withers and Roberts 1981; Scott 1991; Singh et al. 2010) and fitness (explosive strength, maximum speed, anaerobic and

aerobic capacity) agility (Bril 1980; Ayrapetyanz and Godik 1991; Nikitushkin and Guba 1998; Volkov and Filin 1983).

Musculoskeletal injuries are more common in athletes (Koplan et al. 1985). Of those, the most disabling injuries are included lumbar spine and lower extremities in them (Biering-Sorensen 1984). Some predisposing factors for those complications are muscular weakness (Biering-Sorensen 1984; Nadler et al. 2000) and poor endurance (Biering-Sorensen 1984; Udermann et al. 2003). Lack of back and hip strength often result low back pain and lower extremity injury (Nadler et.al. 2000). Studies relating to back endurance of field hockey players are less reported. As 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. These back/trunk extensors get fatigued and sore as the game goes on. Although some players may have weakness in their back/trunk extensors, more often this discomfort is related to muscle imbalance. Muscle imbalance in field hockey players may also result in sore or tight hips. The most common muscle imbalance in hockey players is tightness of the hip flexors. Thus, evaluation of back endurance is essential to the hockey players not only for their maximal performance but to avoid the sports specific injuries too.

Though the importance of studying back endurance is immense, literature related to its association with anthropometric variables, back strength and performance tests in field hockey players is scanty, especially in Indian context. So the present study was planned with the objectives to estimate the back endurance of Indian elite male field hockey players and to search any association of it with selected anthropometric variables and performance tests among them.

MATERIALS AND METHODS

Participants

The present cross-sectional study was based on purposely selected 80 Indian national level male hockey players aged 18–25 years (mean age 18.82 years, ± 1.91) from PAP Jalandhar, Punjab, India. The subjects were further divided as per their playing positions, viz. goalkeepers (n=15), center forwards (n=25), center halves (n=20) and full backs (n=20). 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 institutional ethical committee.

Anthropometric Measurements

Ten anthropometric variables, viz. height, weight, BMI, biceps, triceps, subscapular and suprailiac skinfolds, percent body fat, back strength and two performance tests, viz. flexibility measures and tall kneeling, and back endurance, were measured on each subject using standard techniques (Lohmann et al. 1988) 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 weight (kg)/height^2 (m)^2. Four skinfold measurements, viz. biceps, triceps, subscapular and suprailiac were measured with Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm. Percent body fat was assessed with standard formula (Womersely and Durnin 1977) using the four skinfold measurements (biceps, triceps, subscapular and suprailiac). The instruments were calibrated prior to use and all measurements were taken on the subject's right side.

60 – Second back extension endurance test

It is a dynamic strength assessment of the back extensor muscles (Moreland et al. 1997). To perform the test, the subject was positioned prone on a treatment table with the iliac crests at the edge of the table. An assistant manually secured the lower body of the subject to the table at the level of the hip and the mid-calf. Before beginning the test, the subject would rest the upper body on a stool and would place his hands behind the head. The subject was instructed to lift the upper body off the stool. With the spine kept straight, the subject would extend to neutral and then lowered the upper body so the back would flex to 45 degree. The subject would have 60 second to perform as many repetitions as possible. The number of successful repetitions was counted.

Back strength measurement

The back strength was measured using 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 the dynamometer, pulling force was applied on the 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 the 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.

Flexibility measures

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 researcher recorded the distance reached by the player's finger tips in cm. The player performed the test thrice. The researcher then calculated and recorded the average of the three distances and assessed the player's performance.

60 – Second tall kneeling test

It is also a dynamic test to assess the eccentric strength of the illiopsoas and rectus femoris muscles. To perform the test, the subject was instructed to assume a position of tall kneeling, by kneeling on both knees with the trunk aligned directly over the thighs and the arms folded across the chest. Each subject did lean posteriorly until the angle between the lower leg and the thigh reached 70 degree as measured with a standard goniometer. The position of the torso would be marked with the investigator's hand. To begin the test, the subject was instructed to lean back to the hand marker while maintaining a neutral posture and without bending at the waist. The subject would have 60 seconds to perform as many repetitions as possible. The successful repetitions were counted.

Statistical Analysis

Standard descriptive statistics (mean ± standard deviation) were determined for directly measured and derived variables. One way analysis of variance was tested for the comparisons of data among Indian elite male field hockey players playing position-wise (goal keepers, center halves, center forwards and full backs), 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 17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Descriptive statistics of selected anthropometric characteristics and performance tests in Indian national level hockey players are shown in Table 1. One way analysis of variance showed statistically significant between-group differences ($p < .002$) only in body weight among the four sets of hockey players.

Correlation matrix of back endurance, selected anthropometric variables and performance tests of Indian national level male hockey players (pooled data) are shown in table 2. Significantly positive correlations ($p < .05 - .01$) of back endurance were found with body weight, back strength, flexibility measures and tall kneeling in the players. In most of the anthropometric variables, significant positive correlations were found ($p < .05 - .01$) among themselves.

Table 1. Descriptive statistics of back endurance, selected anthropometric variables and performance tests in Indian national level male hockey players (position-wise)

Variables	**Goalkeepers (n=15)**		**Centre forwards (n=25)**		**Centre halves (n=20)**		**Full backs (n=20)**		**F**	**Sig level**
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**		
BE(rpm)	36.50	3.27	32.93	4.77	34.17	3.61	33.25	5.34	0.882	NS
HT (cm)	171.33	4.46	171.27	5.73	173.75	5.56	170.25	6.98	1.452	NS
WT (kg)	65.00	7.69	59.67	6.15	65.83	8.45	60.00	4.00	3.580	≤.002
BMI (kg/m^2)	22.23	4.26	20.43	3.98	21.37	4.31	20.76	4.22	1.541	NS
BSF (mm)	3.88	1.21	3.64	0.85	3.54	1.02	3.56	1.53	1.905	NS
TSF (mm)	5.95	1.04	5.17	2.01	5.72	4.05	4.78	1.28	0.671	NS
SSSF (mm)	7.10	1.33	6.23	1.68	6.95	2.98	5.79	1.19	0.837	NS
SISF (mm)	8.38	1.69	6.92	2.48	8.07	3.86	8.24	7.94	0.824	NS
% BF	17.92	3.75	14.80	2.66	16.88	4.74	15.35	2.49	2.066	NS
BS (kg)	129.17	13.20	117.67	12.68	124.17	19.52	123	20.69	0.840	NS
FM(cm)	16.42	1.93	14.97	1.70	15.29	1.76	15	2.78	0.521	NS
TK(rpm)	42.67	2.88	38.73	4.31	38.67	5.77	38.67	5.21	1.274	NS

BE = back endurance, HT = height, WT = body weight, BMI = body mass index, BSF = biceps skinfold, TSF = triceps skinfold, SSSF = subscapular skinfold, SISF = suprailiac skinfold, %BF = percent body fat, BS = back strength, FM = flexibility measures and TK = tall kneeling.

Table 2. Correlation matrix of back endurance, selected anthropometric variables and performance tests in national level male hockey players

Variables	BW	BMI	BSF	TSF	SSSF	SISF	%BF	BS	FM	TK	BE
HT	0.156	0.760**	0.063	-0.107	-0.152	0.011	-0.404**	0.262*	-0.112	0.018	0.071
BW		0.794**	0.439**	0.620**	0.742**	0.373*	0.839**	0.315*	-0.008	0.240	0.242*
BMI			0.227	0.314**	0.458**	0.421**	0.542**	0.211	-0.105	0.124	0.133
BSF				0.518**	0.524**	0.145	0.375*	0.257*	-0.236	-0.040	-0.055
TSF					0.838**	0.384*	0.643**	0.124	-0.172	0.218	0.123
SSSF						0.384**	0.775**	0.195	-0.259*	0.087	0.050
SISF							0.339*	-0.022	-0.221	-0.004	-0.097
%BF								0.144	0.038	0.203	0.179
BS									0.134	0.217	0.254*
FM										0.246	0.442**
TK											0.729**

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

DISCUSSION

Athletes with poor back muscle endurance are prone to injury (Latiner et al. 1999). It was also reported that reduced back extensor muscle endurance might be a major risk factor for non-specific low back pain (Biering-Sorensen, 1984, Beckman and Buchanan, 1995). Thus, assessment of back endurance is one of the important preventive measures for sports persons. 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 (Keogh 1999). The same is true for the field hockey (Reilly and Borrie 1992; Reilly et al. 1990; Scott 1991; Manna et al. 2009; Singh et al. 2010).

In the present study, comparisons were made among goalkeepers, center halves, center forwards and full backs of Indian national level male hockey players. One way analysis of variance showed significant differences ($p \leq .05$) only in body weight among these four sets of data (goalkeepers, center forwards, center halves and full backs). No significant differences were found in any other cases. It may be stated form the findings that

not much differences were there among position-wise male hockey players of Indian national level. Significantly positive correlations ($p \leq 0.05$ - 0.01) of back endurance were found with body weight, back strength, flexibility measures and tall kneeling in hockey players. No other anthropometric variables had any association with back endurance, though statistically significant correlations were found among the anthropometric variables themselves (which was obvious). It was reported earlier too, that several anthropometric variables were strongly correlated with back strength in different populations (Roy and Pal 2001). Crystal et al. (2006) also found a close association between back endurance and hip strength in collegiate athletes. The novel part of the study was that, back endurance had strong correlations with the two performance tests studied. The limitations of the study were the small sample size and only male players. In the future study both these limitations will be taken care.

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, except body weight, among these four sets of players, significantly positive correlations ($p \leq .05$) of back endurance were found with body weight, back strength and the two performance tests studied in the Indian male hockey players. 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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