ORIGINAL RESEARCH ARTICLE

Physical profiles of elite male field hockey and soccer players – application to sport-specific tests

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Abstract

Background. The physical demands of field hockey and soccer, based on match analysis, are comparable. As a consequence many exercise scientists and coaches have started to use the same type of field tests for hockey and soccer for the purposes of talent identification and training prescription. The validity of this practice is unknown and the data supporting the similarity of the physical attributes of soccer and hockey players are lacking.

Objectives. To compare the physical attributes of elite South African hockey and soccer players.

Methods. Elite hockey players (*N*=39: 22±3 years; mean ± standard deviation) and soccer players (*N*=37; 24±4 years) completed a set of physical tests including a 10 m and 40 m sprint test, a repeated sprint test (sprint fatigue resistance), a 1RM bench press and a push-up test.

Results. There were no differences in the 10 m (1.8±0.1 s both groups) and 40 m (5.4±0.2 s v. 5.3±0.2 s; hockey v. soccer) sprint times and distance run in the repeated sprint test (754±14 m v. 734±51 m). The hockey players were stronger (82±16 v. 65±13 kg) and did more push-ups (49±12 v. 38±10 push-ups) than the soccer players.

Conclusions. It is acceptable to use the same type of sport-specific tests to measure sprint capacity and sprint fatigue resistance for hockey and soccer players. However, it is questionable whether the normative data derived for upper body strength for soccer players are relevant for hockey players, and *vice versa*.

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Introduction

Field hockey and soccer have both been described as multiple sprint sports[5] consisting of high-intensity sprints that require short bursts of near maximal effort lasting between 5 and 10 seconds.[11,14,25] Match play analysis of competitive soccer has shown that high-intensity efforts occur approximately every 30 seconds for each player,[17] and that the motion activities for elite hockey and soccer players are considered to be similar.[23] Therefore, many exercise scientists and coaches have used the same type of field tests for hockey and soccer for the purposes of talent identification and training prescription.[8,12,17,20] However, the validity of doing this is unknown as data comparing the physical attributes of soccer and hockey players are lacking.

The anthropometric and physiological characteristics of elite male soccer players have been well researched and documented.[4,16,18-20] A database of the physical norms for elite male hockey players was established in 1991.[21] However, since then there have been numerous rule changes in the game and substantial improvements in equipment with the effect of transforming hockey into a faster, more physical and highly technical sport.[2] Although some research has addressed the game of hockey since these rule changes,[3,11] the main focus of research has been directed at elite female hockey players.[2,26] As a result there is a lack of recent research on the physiological characteristics of elite male hockey players, which makes comparison with soccer players difficult.

Therefore, the aim of this study was to establish the physical characteristics of elite South African male hockey and soccer players. The next step was to determine whether the physical characteristics of the hockey and soccer players were sufficiently similar to justify using the same sport-specific tests for talent identification and training prescription.

Materials and methods

Subjects

Thirty-nine elite male field hockey players and 37 soccer players, all playing in their highest respective national leagues, were used in this study. All subjects were tested between 2003 and 2005 at the High Performance Centre of the Sports Science Institute of South Africa. The study was approved by the Ethics and Research Committee of the University of Cape Town. Wherever possible all tests were completed on the same day in the same order as described below:

1. body composition
2. 10 m and 40 m speed
3. repeated sprint test
4. 1RM bench press
5. push ups.

The subjects in both groups were divided into defending, midfield and attacker subgroups.

1. Body composition

Body mass was recorded on a calibrated scale (Seca model 708, Seca, Hamburg, Germany) and recorded to the nearest 0.1 kg. The players were weighed in undergarments and without shoes. The stature of each player was recorded to the nearest mm using a stadiometer (Seca model 708, Seca Germany).

2. 10 m and 40 m speed

The warm-up before this test consisted of a minimum of 10 minutes of self-paced submaximal running, followed by an appropriate stretching regimen and some acceleration sprints for players to familiarise themselves with the intensity of the test. An electronic sprint timer with photo-electric sensors (Newtest Oy, Oulu, Finland) was set at chest height and placed at 10 m and 40 m intervals from the start line. The player was instructed to crouch in the start position, 30 cm from the start line, after which he sprinted maximally for 40 m through the sensors. The player completed two maximal effort runs separated by a recovery period of 5 - 10 minutes. Players wore running shoes without spikes. The fastest 10 m and 40 m times for each player were recorded. The 90% confidence intervals of the typical error were calculated for both hockey and soccer players (A New View of Statistics, www.sportsci.org). Ten and 40 m sprint typical errors were calculated from players at the same level of performance. The 90% confidence intervals for the typical error in the 10 m sprint was very similar between the hockey (0.02 - 0.04 s) and soccer players (0.02 - 0.05 s) and is in accordance with other research.[7] In the 40 m sprint times the typical error was slightly higher in the soccer (0.08 - 0.16 s) compared with hockey players (0.04 - 0.06 s).

3. Repeated sprint

The repeat sprint test, which is used in this study, was the modified 5-m multiple shuttle test (5-m MST) as described by Boddington *et al.*[2] Each subject completed his own specific warm-up for a maximum period of 10 minutes. After this all subjects ran 2 submaximal repeats (125 m) of the 5-m MST which was used as their final warm-up and familiarisation of the protocol. The layout for the test consisted of 6 beacons which were placed 5 m apart in a straight line to cover a total distance of 25 m. Each subject started the test in line with the first beacon, and upon an auditory signal sprinted 5 m to a second beacon, touched the ground adjacent to the beacon with their hand and returned back to the first beacon, touching down on the ground adjacent to the beacon with the hand again. The subject then sprinted 10 m to the third beacon, and back to the first beacon, etc. The player continued back and fourth until an exercise period of 30 seconds had elapsed. No instruction was given as to which hand should touch during each turn. Subjects were instructed to avoid pacing and perform with a maximal effort throughout the whole test. The distance covered by each subject was approximated to the nearest 2.5 m during each 30-second shuttle. The subjects performed 6 repeat bouts of this protocol with a 35-second rest between bouts. The total distance covered in the 6 bouts was recorded.

The 90% confidence intervals of the repeated sprint test were calculated from the data gathered by Boddington *et al.*, which is partially published[2] and was similar in soccer (7 - 19 m) and hockey players (11 - 20 m).

4. 1RM bench press

The player lay supine on a bench with his feet flat on the floor and his hips and shoulders in contact with the bench. Hand spacing was set at approximately 1.5 times the player's biacromial breadth. The player started this test by lowering the bar in a controlled manner to the centre of the chest, touching the chest lightly and then extending upwards until the arms were in a fully locked position.

A light warm-up set of 10 repetitions was performed using a 20 kg weight. This was followed by 6 - 8 repetitions at approximately 30 - 40% of the estimated 1RM, which was based on previous resistance training experience. A 2-minute stretching routine for the shoulders and chest was completed, followed by a further 6 repetitions on the bench press at a weight corresponding to 60% of the estimated 1RM. The player then rested for 3 - 4 minutes before attempting his 1RM. If the 1RM was successful, the player had a 5-minute rest before attempting a bench press using a resistance that had been increased by 2.5% to 5.0%. If the player could not lift the weight the previous successful weight lifted was recorded as his 1RM. The test was scored as the maximum amount of weight (kg) that could be lifted with one repetition. A lift was disqualified if the player lifted his buttocks during the movement, bounced the bar off his chest, extended his arms unevenly, or if the bar was touched by the spotter. 1RM **absolute** bench press was recorded in kilograms (kg), and the 1RM **relative** bench press was calculated as 1RM/(bodyweight$^{0.57}$).[6] No data could be found concerning typical errors in bench press.

5. Push ups

The player began in a prone position with his hands on the floor, thumbs shoulder width apart and elbows fully extended. Keeping the back and body straight, the player descended to the tester's fist, placed on the floor below the player's sternum, and then ascended until the elbows were fully extended. If the player did not adhere to these specifications the repetition was not counted. The test was scored as the number of push ups performed in 1 minute. No data could be found concerning typical errors in push-ups.

Statistics

The data were analysed with STATISTICA (StatSoft, Inc. (2004). STATISTICA (data analysis software system), version 7. www.statsoft.com.). Values are expressed as mean ± standard deviation. The data of the hockey and soccer players were compared using a two-way analysis of variance. Statistical significance was accepted at $p<0.05$. A Tukey post-hoc analysis was used when there was a significant difference between sport (soccer or hockey) and playing position (attackers, midfielders or defenders).

Results

The general descriptive characteristics of the hockey and soccer players are summarised in Table I. Hockey players were significantly taller (F=6.1; p=0.016) and younger (F=9.3 p=0.003) compared with the soccer players. No differences were found between the two sports for body weight and body mass index (BMI).

The 10 m and 40 m sprint times and distance run in the repeat sprint test (5-m MST) were similar for hockey and soccer players (Table II). However, a significant difference was found between the two sports in their 1RM bench test performance (F=24.1; $p<0.001$). The 1RM bench press of the hockey players was 21% higher than that of the soccer players (82±16 v. 65±13 kg, respectively). Even when the 1RM values were corrected for bodyweight[6] hockey players were significantly stronger than soccer players (F=29.6; $p<0.001$). An interaction effect (sport X position) was found for the push ups (F =9.4; $p<0.001$). Further analysis revealed that hockey midfielders and defenders were able to do more push-ups compared with the soccer players playing in these same positions ($p<0.001$ and p=0.009, respectively). No differences were found between the hockey and soccer attackers (p=0.92).

Discussion

The first finding of this study was that the mean height and age of the hockey and soccer players were significantly different. However, they only differed by 2 cm and 2 years respectively and therefore it is unlikely that there is any practical relevance in these differences as these values fall within

TABLE I. General descriptive characteristics of the field hockey and soccer players (mean ± standard deviation)

	Hockey				Soccer			
	Attackers (*N*=11)	**Midfielders (*N*=13)**	**Defenders (*N*=15)**	**Total (*N* =39)**	**Attackers (*N*=8)**	**Midfielders (*N*=15)**	**Defenders (*N*=14)**	**Total (*N*=37)**
Age (yrs)	20±2	22±3	22±3	22±3 *	26±4	23±3	25±5	24±4*
Height (cm)	179±3	177±7	179±7	178±6 *	170±6	175±6	179±7	176±7*
Weight (kg)	76±6	73±7	77±15	75±9	69±5	70±8	79±8	73±9
BMI (kg.m^{2})	24±3	23±2	24±2	23±2	24±1	23±2	25±2	24±2

* $p<0.05$

TABLE II. Time(s) for 10 m and 40 m sprint, repeated sprint test (m), bench press (kg) (absolute and relative) and number of push-ups of soccer and hockey attackers, midfielders and defenders (mean ± standard deviation)

	Hockey				Soccer			
	Attackers (*N*=11)	**Midfielders (*N*=13)**	**Defenders (*N*=15)**	**Total (*N*=39)**	**Attackers (*N*=8)**	**Midfielders (*N*=15)**	**Defenders (*N*=14)**	**Total (*N*=37)**
10m sprint (s)	1.78±0.09	1.80±0.07	1.81±0.10	1.8±0.1	1.72±0.09	1.81±0.13	1.73±0.09	1.8±0.1
40m sprint (s)	5.29±0.17	5.39±0.13	5.48±0.30	5.4±0.2	5.27±0.15	5.38±0.25	5.27±0.19	5.3±0.2
Repeat sprint (m)	730±102	778±17	750±48	754±64	748±18	744±32	714±75	734±51
Push-ups	42±9	57±11^{+}	49±11‡	49±12*	46±10	35±11^{+}	35±7‡	38±10*
1RM bench (kg)	83±15	80±16	84±17	82±16*	66±10	62±13	69±14	65±13*
1RM/body mass$^{0.57}$	7.0±1.1	7.0±1.2	7.1±1.2	7.0±1.1*	5.9±0.9	5.5±0.9	5.6±1.0	5.6±0.9*

* $p<0.001$

$^{+}$ $p<0.001$ hockey midfielders v. soccer midfielders

‡ p= 0.009 hockey defenders v. soccer defenders snormal ranges for elite sportsmen playing at this level, as shown in previous studies on hockey[21] and soccer[1,9] players.

The next finding was that the sprint times and repeated sprint distances between elite hockey and soccer players were similar. This supports the findings of previous research on match analysis, which have shown that the motion activities of elite male hockey and soccer players are comparable.[17,23] Therefore, from this context of exercise testing and prescription it is reasonable to assume that the same type of tests can be used in soccer and hockey to measure sprint capability and fatigue resistance. Although this is already generally accepted and recommended by many researchers[8,13,15,24] this is the first paper to show that the sprint times and fatigue resistance of elite soccer and hockey players are indeed similar.

The third finding was that upper body strength and endurance, as measured by 1RM bench press and push-ups respectively, were significantly higher in the hockey players (bench press absolute: 21%; bench press relative: 20% and push-ups: 22% higher in hockey players compared with soccer players). One explanation for the hockey players having a stronger upper body is that the demands of the game require them to wield a stick as part of the game. Another explanation is that the soccer players in this study were not particularly strong. This interpretation is supported by research on two elite Norwegian soccer teams which showed 1RM bench press values of 77±17 (N=15) and 83±13 kg (N=14).[27] These values are comparable with the results that we found in our field hockey players, suggesting that the soccer players in our study were particularly weak. This interpretation will have to be confirmed by further analysis of data of players from different countries. Previous research focusing on talent identification in soccer has emphasised the relevance of upper body strength in soccer for coping with physical aspects of the game and for throwing in,[10,22] lending support to the explanation that the soccer players in this study underperformed in the tests of upper body strength. Until recently there has not been much emphasis on upper body conditioning in soccer players in South Africa as there has been a perception that resistance training will increase the weight of players and therefore decrease their speed (High Performance Centre: personal observation). In contrast, the structures governing hockey in South Africa have launched national high-performance programmes which have included upper body training programmes and minimum requirements of fitness.

In conclusion, this paper shows that it is acceptable to use the same type of sport-specific tests and normative data to measure sprint capacity and sprint fatigue resistance for hockey and soccer players. For the measurement of upper body strength the same type of test can be used although it is questionable whether the normative data derived for soccer players are relevant for hockey players, and *vice versa*.

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References

1. Bloomfield J, Polman R, Butterly R, O'Donoghue P. Analysis of age, stature, body mass, BMI and quality of elite soccer players from 4 European leagues. *J Sports Med Phys Fitness* 2005; 45: 58-67.
2. Boddington MK, Lambert MI, St Clair Gibson A, Noakes TD. Reliability of a 5-m multiple shuttle test. *J Sports Sci* 2001; 19: 223-8.
3. Boyle PM, Mahoney CA, Wallace WF. The competitive demands of elite male field hockey. *J Sports Med Phys Fitness* 1994; 34: 235-41.
4. Chamari K, Hachana Y, Ahmed YB, *et al.* Field and laboratory testing in young elite soccer players. *Br J Sports Med* 2004; 38: 191-6.
5. Dawson B, Fitzsimons M, Ward D. The relationship of repeated sprint ability to aerobic power and performance measures of anaerobic work capacity and power. *Aust J Sci Med Sport* 1993; 88-93.
6. Dooman CS, Vanderburgh PM. Allometric modeling of the bench press and squat: Who Is the strongest regardless of body mass? *J Strength Cond Res 2000; 14: 32-6.*
7. Duthie GM, Pyne DB, Ross AA, Livingstone SG, Hooper SL. The reliability of ten-meter sprint time using different starting techniques. J Strength *Cond Res 2006; 20: 246-51.*
8. Elferink-Gemser MT, Visscher C, Lemmink KA, Mulder TW. Relation between multidimensional performance characteristics and level of performance in talented youth field hockey players. *J Sports Sci* 2004; 22: 1053-63.
9. Eniseler N. Heart rate and blood lactate concentrations as predictors of physiological load on elite soccer players during various soccer training activities. *J Strength Cond Res* 2005; 19: 799-804.
10. Hoff J. Training and testing physical capacities for elite soccer players. *J Sports Sci* 2005; 23: 573-82.
11. Lakomy J, Haydon DT. The effects of enforced, rapid deceleration on performance in a multiple sprint test. *J Strength Cond Res* 2004; 18: 579-83.
12. Lemmink KA, Verheijen R, Visscher C. The discriminative power of the Interval Shuttle Run Test and the Maximal Multistage Shuttle Run Test for playing level of soccer. *J Sports Med Phys Fitness* 2004; 44: 233-9.
13. Lemmink KA, Visscher C, Lambert MI, Lamberts RP. The interval shuttle run test for intermittent sport players: evaluation of reliability. *J Strength Cond Res* 2004; 18: 821-7.
14. Mayhew S, Wenger H. Time-motion analysis of professional soccer. *Journal of Human Movement Studies* 1985; 11: 49-52.
15. Nicholas CW, Nuttall FE, Williams C. The Loughborough Intermittent Shuttle Test: a field test that simulates the activity pattern of soccer. *J Sports Sci* 2000; 18: 97-104.
16. Reilly T, Bangsbo J, Franks A. Anthropometric and physiological predispositions for elite soccer. *J Sports Sci* 2000; 18: 669-83.
17. Reilly T, Borrie A. Physiology applied to field hockey. *Sports Med* 1992; 14: 10-26.
18. Reilly T, Doran D. Science and Gaelic football: a review. *J Sports Sci* 2001; 19: 181-93.
19. Reilly T, Gilbourne D. Science and football: a review of applied research in the football codes. *J Sports Sci* 2003; 21: 693-705.
20. Reilly T, Williams AM, Nevill A, Franks A. A multidisciplinary approach to talent identification in soccer. *J Sports Sci* 2000; 18: 695-702.
21. Scott PA. Morphological characteristics of elite male field hockey players. *J Sports Med Phys Fitness* 1991; 31: 57-61.
22. Shephard RJ. Biology and medicine of soccer: an update. *J Sports Sci* 1999; 17: 757-86.
23. Spencer M, Lawrence S, Rechichi C, Bishop D, Dawson B, Goodman C. Time-motion analysis of elite field hockey, with special reference to repeated-sprint activity. *J Sports Sci* 2004; 22: 843-50.
24. Sunderland C, Nevill ME. High-intensity intermittent running and field hockey skill performance in the heat. *J Sports Sci* 2005; 23: 531-40.
25. Tumilty D. Physiological characteristics of elite soccer players. *Sports Med* 1993; 16: 80-96.
26. Wassmer DJ, Mookerjee S. A descriptive profile of elite U.S. women's collegiate field hockey players. *J Sports Med Phys Fitness* 2002; 42: 165-71.
27. Wisloff U, Helgerud J, Hoff J. Strength and endurance of elite soccer players. *Med Sci Sports Exerc* 1998; 30: 462-7.