



Application of GPS technology to create activity profiles of youth international field hockey players in competitive match-play

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DOI: 10.26524/1428

ABSTRACT:

Purpose: The purpose of this project was to utilise global-positioning system (GPS) technology to understand the physical demands of youth international field hockey. **Methods:** Sixteen male field hockey players (age 17.1 ± 0.6 y, stature 165 ± 11 cm, body mass 63.3 ± 6.6 kg, estimated VO_{2max} , 52.6 ± 5.3 ml/kg/min) were investigated while competing in 6 matches at the 2011 Boy's Under-18 Asia Cup. Each player wore a GPS unit during competition to track his movement. These movements were classified as either low-speed activity (<4.17 m/s) or high-speed activity (>4.17 m/s). Positional differences were analysed using magnitude-based Cohen's effect size with modified qualitative descriptors. **Results:** Forwards covered the most distance per minute across total distance, low-speed activity and high-speed activity in the 6 youth international field hockey matches. For high-speed activity there was a "Large" difference between the Defenders and Midfielders and a "Very Large" difference between the Defenders and Forwards. **Conclusion:** In youth international field hockey, Forwards cover the greatest amount of distance and carry out the most high-speed activity, while Defenders perform the least amount of high-speed activity. This suggests that these playing positions are sufficiently different to warrant specialised positional training.

Keywords: GPS, Activity Profiles, Field Hockey, Youth Athletes.

Introduction

Field hockey is a team invasion sport played between two teams of 11 players, including 1 goalkeeper, where unlimited rolling substitutions are permitted. Time-motion analysis is common in the study of field hockey. Video of matches is observed and player movement is subjectively classified into pre-defined categories, such as Standing, Walking, Jogging, Striding and Sprinting [1]. Such analysis helps coaches gain an improved understanding of the physical and physiological demands placed on their players [2]. Recent advancements in global positioning system (GPS) technology have improved the accuracy of analysis. An assessment of the use of GPS units for measuring athlete movement, found the technology to be valid for the measurement of distance covered and peak speeds [3]. The major advantages that GPS has over video-based time-motion analysis are that the data can be generated in real-time and is more precise [4]. In addition, the use of GPS technology removes the subjectivity of classifying player movement, such as the transition between Striding and Sprinting which can be difficult to visually assess.



To date, GPS technology has facilitated a number of detailed time-motion analyses of field hockey [5,6,7]. However, most of this current research has focused on senior field hockey, meaning the demands on youth field hockey remain unknown. As the increase in physical challenge is a major obstacle in the progression of youth athletes in team sports [8], it is important to understand the physical differences between youth and senior level competition and design training plans to bridge this gap. The primary purpose of the current project is to utilise GPS technology to understand the physical demands of youth international field hockey.

Methods

Sixteen male hockey players (age 17.1 ± 0.6 y, stature 165 ± 11 cm, body mass 63.3 ± 6.6 kg, estimated VO_{2max} , 52.6 ± 5.3 ml/kg/min) were investigated while competing for Singapore at the 2011 Boy's Under-18 Asia Cup. The goalkeepers were excluded from the study. Ethical clearance was granted by the National Institute of Education Ethics Committee and informed consent was given by the coach who was acting as legal guardian of the team members. The 6 matches were played over 9 days with 2 rest days between matches 2 and 3 and 1 rest day between matches 4 and 5. Matches 5 and 6 started at 1530 h with all other matches starting at 1900 h.

During the matches each player wore a GPS unit (Catapult Innovations, Scoresby, Australia) located between the scapulas in a purpose built harness. The sample rate of 5 Hz was used for the data collection. The movement classifications used were the same as in a recent study of senior international field hockey [7], with low-speed activity (LSA) being movement at less than 4.17 m/s and high-speed activity (HSA) being movement at more than 4.17 m/s.

The differences between playing positions were analysed using magnitude-based Cohen's [9] effect size (ES) with modified qualitative descriptors [10]. Effect sizes were assessed using these criteria: <0.20 = trivial, 0.20 to 0.60 = small, >0.60 to 1.20 = moderate, >1.20 to 2.00 = large, and >2.00 = very large. Ninety per cent confidence limits ($\pm 90\%$ CL) were calculated to indicate the precision of the estimate of observed effects.

Results

Forwards covered the most distance per minute across total distance, low-speed activity and high-speed activity. For total distance there was a "Large" difference between the Defenders and Forwards. For low-speed activity there were "Small" differences between all playing positions. For high-speed activity there was a "Large" difference between the Defenders and Midfielders and a "Very Large" difference between the Defenders and Forwards.



Table 1. Metres per minute at various speeds by playing position in youth international field hockey.

	Mean \pm SD			Effect Sizes \pm 90% CL		
	Defenders (n = 6)	Midfielders (n = 4)	Forwards (n = 6)	Def vs. Mid	Def vs. Fwd	Mid vs. Fwd
Total (m.min ⁻¹)	104.5 \pm 3.3	108.1 \pm 13.3	113.1 \pm 6.8	0.37; \pm 1.27	1.62; \pm 0.87	0.48; \pm 1.22
LSA (m.min ⁻¹)	90.7 \pm 3	88.5 \pm 10.4	92.1 \pm 5.5	0.28; \pm 1.56	0.32; \pm 1.28	0.43; \pm 1.24
HSA (m.min ⁻¹)	13.9 \pm 2.2	19.6 \pm 3.5	21 \pm 3.6	1.96; \pm 0.79	2.43; \pm 0.7	0.41; \pm 1.25

Discussion

The results from this project demonstrate that in youth international field hockey Forwards cover more distance compared to Defenders or Midfielders (Table 1). This is consistent with studies of senior international field hockey players [7]. The amount of low-speed activity (<4.17 m/s) was relatively similar between the playing positions, but the amount of high-speed activity (>4.17 m/s) differed greatly between the Defenders and the other playing positions. Again, this is comparable to the results of studies of senior international field hockey players [6]. This suggests that the physical requirements of different playing positions in youth field hockey are sufficiently different to warrant specialised positional training. These results also point to similarities in the activity profiles of youth field hockey and youth soccer, where significant differences in the amount of high-intensity activity were found between Defenders and other outfield players [11].

The validity of the results from this project is high due to the relatively large sample of players at a high-level youth international competition. However, a limitation with the use of GPS technology is that absolute velocity is used to demarcate the thresholds between the low- and high-intensity movements. This is not ideal as players of different fitness levels will have different intensity requirements to perform the same absolute velocity. This is particularly problematic when comparing players of different age groups. One solution is to verify the GPS data with video-based time-motion analysis [5]. Another solution, advocated in a recent case study [12], is to use results from lab-based tests to individualised thresholds for analysis of GPS data. In future research, similar approaches could be adopted to better understand the demands of youth international field hockey.

Due to the intermittent nature of physical intensity in field hockey, GPS technology is an important tool to benchmark the frequency and duration of high-speed activity in competition and use these benchmarks in the design of training plans to better prepare youth players. Understanding the high-speed activities is especially important as these activities will likely correspond to the most important parts of the match, such as goal-scoring opportunities. It has been suggested that as many as seven sprints of 4 s with less than 21 s recovery may be required in training to replicate the potential demands of senior field hockey competition [1].



The data obtained from this GPS analysis can complement other specific tests that assess the performance capabilities of youth hockey players. A lab-based protocol has recently been developed to assess the intermittent high-intensity running capabilities of youth professional soccer players and was found to be a valid measure of match performance [13]. Due to similarities in the intermittent nature of both soccer and field hockey, this protocol could be modified to assess the intermittent high-intensity running capabilities of youth field hockey players. A combination of data from GPS analysis and results from such lab-based tests would provide benchmarks for youth players to work towards and give coaches important information on the intensity requirements of training sessions.

Conclusion

The results of this project suggest that in youth international field hockey, Forwards cover the greatest amount of distance and carry out the most high-speed activity. It was also found that Defenders performed the least amount of high-speed activity compared to Midfielders and Forwards, suggesting that these playing positions are sufficiently different to warrant specialised positional training. A limitation of the use of GPS technology is that absolute velocity is used to demarcate the thresholds between the low- and high-intensity movements, which is not ideal when comparing players of different fitness levels. Potential solutions to this issue are to verify the GPS data with video-based time-motion analysis or use results from lab-based tests to produce individualised thresholds for each player.

References

1. M. Spencer, S. Lawrence, C. Rechichi, D. Bishop, B. Dawson, and C. Goodman, Time-motion analysis of elite field hockey, with special reference to repeated-sprint activity, *Journal of Sports Sciences*, 22 (2004) 843-850.
2. P. G. O'Donoghue, Time-motion analysis, (2008) In M.D. Hughes, and I. Franks, (Eds.), *The Essentials of Performance Analysis: An Introduction*. London: Routledge.
3. R.J. Johnston, M.L. Watsford, M.J. Pine, R.W. Spurrs, and D. Sporri, Assessment of 5 Hz and 10 Hz GPS units for measuring athlete movement demands, *International Journal of Performance Analysis in Sport*, 13(1) (2013) 262-274.
4. C. Carling, T. Reilly, and A.M. Williams (2009). Performance Assessment for Field Sports, *Journal of Sports Science and Medicine*, 8 (2009) 152.
5. J. Lythe, and A. E. Kilding, Physical demands and physiological responses during elite field hockey, *International Journal of Sports Medicine*, 32 (2011) 523-538.
6. D. H. Jennings, S. J. Cormack, A.J. Coutts, and R.J. Aughey, International field hockey players perform more high-speed running than national level counterparts, *Journal of Strength and Conditioning Research*, 26 (2012) 947-952.
7. D.H. Jennings, S.J. Cormack, A.J. Coutts, and R.J. Aughey, GPS analysis of an international field hockey tournament, *International Journal of Sports Physiology and Performance*, 7 (2012) 224-231.
8. J. Finn, and J. McKenna, Coping with academy-to-first-team transitions in elite English male team sports: the coaches' perspective, *International Journal of Sports Science and Coaching*, 5 (2010) 257-79.
9. J. Cohen (1988) *Statistical Power Analysis for the Behavioral Sciences* (2nd Ed.) Elsevier Inc.
10. W. G. Hopkins, Measures of reliability in sports medicine and science, *Sports Medicine*, 30 (2000) 1-15
11. M. Buchheit, A. Mendez-Villanueva, B. M.



- Simpson, and P. C. Bourdon, Match Running Performance and Fitness in Youth Soccer, *International Journal of Sports Medicine*, 31 (2010) 818-825.
12. R. Lovell, and G. Abt, Individualization of time-motion analysis: A case-cohort example, *International Journal of Sports Physiology and Performance*, 8 (2013) 456-458.
13. S. Mukherjee, and M. Chia, The NIE intermittent high-intensity running test: A reliable and valid test for assessment of soccer-specific fitness, *International Journal of Sports Science and Coaching*, 8 (2013) 77-88.