PERFORMANCE ANALYSIS IN SOCCER: APPLICATIONS OF PLAYER TRACKING TECHNOLOGY

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Abstract

The aim of this thesis was threefold, firstly, to compare current player tracking technology in a single game of soccer. Secondly, to investigate the running requirements of elite women’s soccer, in particular the use and application of athlete tracking devices. Finally, how can game style be quantified and defined.

Study One compared four different match analysis systems commonly used in both research and applied settings: video-based time-motion analysis, a semi-automated multiple camera based system, and two commercially available Global Positioning System (GPS) based player tracking systems at 1 Hertz (Hz) and 5 Hz respectively. A comparison was made between each of the systems when recording the same game. Total distance covered during the match for the four systems ranged from 10 830 ± 770 m (semi-automated multiple camera based system) to 9 510 ± 740m (video-based time-motion analysis). At running speeds categorised as high-intensity running (>15 km·h⁻¹), the semi-automated multiple camera based system reported the highest distance of 2 650 ± 530 m with video-based time-motion analysis reporting the least amount of distance covered with 1 610 ± 370 m. At speeds considered to be sprinting (>20 km·h⁻¹), the video-based time-motion analysis reported the highest value (420 ± 170 m) and 1 Hz GPS units the lowest value (230 ± 160 m). These results demonstrate there are differences in the determination of the absolute distances, and that comparison of results between match analysis systems should be made with caution. Currently, there is no criterion measure for these match analysis methods and as such it was not possible to determine if one system was more accurate than another.

Study Two provided an opportunity to apply player-tracking technology (GPS) to measure activity profiles and determine the physical demands of Australian international level women soccer players. In four international women’s soccer games, data was collected on a total of 15 Australian women soccer players using a 5 Hz GPS based athlete tracking device. Results indicated that Australian women soccer players covered 9 140 ± 1 030 m during 90 min of play. The total distance covered by Australian women was less than the 10 300 m reportedly covered by
female soccer players in the Danish First Division. However, there was no apparent
difference in the estimated $VO_{2max}$, as measured by multi-stage shuttle tests, between
these studies. This study suggests that contextual information, including the “game
style” of both the team and opposition may influence physical performance in
games.

*Study Three* examined the effect the level of the opposition had on the physical output
of Australian women soccer players. In total, 58 game files from 5 Hz athlete-tracking
devices from 13 international matches were collected. These files were analysed to
examine relationships between physical demands, represented by total distance
covered, high intensity running (HIR) and distances covered sprinting, and the level
of the opposition, as represented by the Fédération Internationale de Football
Association (FIFA) ranking at the time of the match. Higher-ranking opponents
elicited less high-speed running and greater low-speed activity compared to playing
teams of similar or lower ranking. The results are important to coaches and
practitioners in the preparation of players for international competition, and showed
that the differing physical demands required were dependent on the level of the
opponents. The results also highlighted the need for continued research in the area of
integrating contextual information in team sports and demonstrated that soccer can
be described as having dynamic and interactive systems. The influence of playing
strategy, tactics and subsequently the overall game style was highlighted as playing
a significant part in the physical demands of the players.

*Study Four* explored the concept of game style in field sports such as soccer. The aim
of this study was to provide an applied framework with suggested metrics for use by
coaches, media, practitioners and sports scientists. Based on the findings of *Studies 1-
3* and a systematic review of the relevant literature, a theoretical framework was
developed to better understand how a team’s game style could be quantified. Soccer
games can be broken into key moments of play, and for each of these moments we
categorised metrics that provide insight to success or otherwise, to help quantify and
measure different methods of playing styles. This study highlights that to date, there
had been no clear definition of game style in team sports and as such a novel
A definition of game style is proposed that can be used by coaches, sport scientists, performance analysts, media and general public.

Studies 1-3 outline four common methods of measuring the physical demands in soccer: video based time motion analysis, GPS at 1 Hz and at 5 Hz and semi-automated multiple camera based systems. As there are no semi-automated multiple camera based systems available in Australia, primarily due to cost and logistical reasons, GPS is widely accepted for use in team sports in tracking player movements in training and competition environments. This research identified that, although there are some limitations, GPS player-tracking technology may be a valuable tool in assessing running demands in soccer players and subsequently contribute to our understanding of game style. The results of the research undertaken also reinforce the differences between methods used to analyse player movement patterns in field sports such as soccer and demonstrate that the results from different systems such as GPS based athlete tracking devices and semi-automated multiple camera based systems cannot be used interchangeably. Indeed, the magnitude of measurement differences between methods suggests that significant measurement error is evident. This was apparent even when the same technologies are used which measure at different sampling rates, such as GPS systems using either 1 Hz or 5 Hz frequencies of measurement. It was also recognised that other factors influence how team sport athletes behave within an interactive system. These factors included the strength of the opposition and their style of play. In turn, these can impact the physical demands of players that change from game to game, and even within games depending on these contextual features. Finally, the concept of what is game style and how it might be measured was examined. Game style was defined as "the characteristic playing pattern demonstrated by a team during games. It will be regularly repeated in specific situational contexts such that measurement of variables reflecting game style will be relatively stable. Variables of importance are player and ball movements, interaction of players, and will generally involve elements of speed, time and space (location)".
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Abbreviations

GENERAL

CI         confidence intervals
CV         coefficient of variation
DOP        dilution of precision
ES         effect size
FI         fatigue index
FIFA       Fédération Internationale de Football Association
g         grams
GPS        global positioning system
HDOP       horizontal dilution of position
Hz         hertz
km         kilometres
km·h⁻¹      kilometres per hour
m          metres
m·s⁻¹       metres per second
min        minutes
mm         millimetres
SD         standard deviation
SEE        standard error of the estimate
$\dot{V}O_{2max}$   maximum oxygen consumption
y          years
Structure of the Thesis

This thesis is presented as a thesis by publication; hence the results components of the thesis have been written as a compilation of (stand-alone) papers arranged into chapters (Chapters 3-6). All four of the papers have been either published and/or submitted for publication in peer-reviewed journals. Declarations of author contributions accompany each of these papers. The components of the thesis include:

Chapter 1: A general introduction including the aims and significance of the thesis, the research questions, and the research context.

Chapter 2: A review of the literature to identify and discuss match and performance analysis methods in soccer, as well as, concepts on principles of play and methodologies used to describe play.

Chapter 3-6: Studies 1-4 in peer-reviewed journal publication format

Chapter 7: Discussion and Conclusions. General discussion, summary and practical applications are presented along with implications for future research.
Publications

The following publications are presented in support of this thesis by publication:


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