The Interchangeability of Global Positioning System and Semiautomated Video-Based Performance Data During Elite Soccer Match Play

Jamie A. Harley,[1] Ric J. Lovell,[2] Christopher A. Barnes,[3] Matthew D. Portas,[1] and Matthew Weston[1]

[1]Department of Sport & Exercise, Teesside University, Middlesbrough, United Kingdom; [2]Sport, Health & Exercise Science, The University of Hull, Hull, United Kingdom; and [3]West Bromwich Albion Football Club, West Midlands, United Kingdom

Abstract

Harley, JA, Lovell, RJ, Barnes, CA, Portas, MD, and Weston, M. The interchangeability of GPS and semiautomated video-based performance data during elite soccer match play. *J Strength Cond Res* 25(8): 2334–2336, 2011—In elite-level soccer, player motion characteristics are commonly generated from match play and training situations using semiautomated video analysis systems and global positioning system (GPS) technology, respectively. Before such data are used collectively to quantify global player load, it is necessary to understand both the level of agreement and direction of bias between the systems so that specific interventions can be made based on the reported results. The aim of this report was to compare data derived from both systems for physical match performances. Six elite-level soccer players were analyzed during a competitive match using semiautomated video analysis (ProZone® [PZ]) and GPS (MinimaxX) simultaneously. Total distances (TDs), high speed running (HSR), very high speed running (VHSR), sprinting distance (SPR), and high-intensity running distance (HIR; $>4.0\ m\cdot s^{-1}$) were reported in 15-minute match periods. The GPS reported higher values than PZ did for TD (GPS: 1,755.4 ± 245.4 m; PZ: 1,631.3 ± 239.5 m; $p < 0.05$); PZ reported higher values for SPR and HIR than GPS did (SPR: PZ, 34.1 ± 24.0 m; GPS: 20.3 ± 15.8 m; HIR: PZ, 368.1 ± 129.8 m; GPS: 317.0 ± 92.5 m; $p < 0.05$). Caution should be exercised when using match-load (PZ) and training-load (GPS) data interchangeably.

Key Words match analysis, training analysis, team sports

Address correspondence to Jamie A. Harley, jamie.harley@nufc.co.uk.

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Introduction

During elite-level soccer match play, player motion can be quantified using semiautomated video analysis systems. Such systems rely on a series of fixed cameras at club stadia, creating operational problems for use in training environments. One such system, ProZone® (PZ), used by the majority of soccer clubs in the English Premier League, has been reported to be valid for the measurement of mean displacement velocity (typical error as CV <1.3%; [3]), and reliable for the measurement of distances covered during match play (CV ≈ 3.6% [4]).

Recent advances in global positioning system (GPS) devices enable multiple-player tracking with instantaneous feedback, with the technology gaining increasing acceptance as a valid tool for the measurement of athlete motion, which is applicable in the training environment. Five-hertz GPS (MinimaxX, Catapult, Scoresby, Australia) has been reported to be valid (*SEE* = 1.5–2.2%) and reliable (coefficient of variation [CV] 2.2–4.5%) for the measurement of distance covered during soccer-specific activity (7).

Osgnach et al. suggested the use of video analysis (e.g., PZ) for official competitions and GPS for training (6). As such, external work-load data from GPS and PZ can be used collectively to periodize training and to implement training drills that are specific to the movement demands of the game. However, in the absence of a criterion measure of quantifying player work load in professional soccer, information regarding the interchangeability of commonly used measurement systems when used in conjunction is warranted (8). Therefore, the aim of this report was to compare the interchangeability of PZ and GPS as measures of physical match performance during elite-level soccer match play.

Methods

Experimental Approach to the Problem

A method-comparison approach was used to assess the differences in reported variables (total distance [TD], high speed running [HSR], very high speed running [VHSR],

Table 1. Match performances reported by PZ and GPS methods.*

	PZ†	GPS†	d (95% CI)	p
TD	1,631.3 ± 239.5	1,755.4 ± 245.4	0.51 (0.05 to 0.97)	0.031‡
HSR	245.7 ± 89.6	222.6 ± 70.9	0.29 (−0.08 to 0.66)	0.119
VHSR	88.3 ± 45.6	74.1 ± 29.4	0.37 (−0.17 to 0.91)	0.167
SPR	34.1 ± 24.0	20.3 ± 15.8	0.68 (0.12 to 1.20)	0.019‡
HIR	368.1 ± 129.8	317.0 ± 92.5	0.45 (0.04 to 0.86)	0.034‡

*TD = total distance; HSR = high speed running distance; VHSR = very high speed running distance; SPR = sprint distance; HIR = high-intensity running distance; CI = confidence interval.
†Values are given as mean ± *SD* (m).
‡GPS significantly different to PZ ($p < 0.05$).

sprinting distance (SPR), and high-intensity running distance [HIR]) between GPS and PZ. Because GPS and PZ are not commonly used simultaneously during competitive soccer match play (governing body restrictions for the use of GPS at first team level; cost issues and logistical restraints of using PZ at reserve team level), this study uses data from a single competitive reserve team game for which both methods were made available. The game was played toward the end of the competitive season (March 2009) at the Riverside Stadium (Middlesbrough, United Kingdom), at 7 PM in 'cool and drizzling' weather conditions.

Subjects

Six elite-level (outfield) soccer players (mean ± *SD*: age 21.4 ± 1.2 years; height 178.7 ± 5.3 cm; mass 74.2 ± 4.8 kg) from an English FA Premier League club were monitored during a competitive reserve team match. Subjects gave informed consent to participate in the study, and all procedures were approved by the Institutional Review Board.

Procedures

Before kick-off, players were fitted with 5-Hz GPS units (MinimaxX, Catapult; firmware v. 6.52; weight 67-g, dimensions 50 mm × 18 mm × 88 mm), worn between the shoulder blades in a custommade undergarment. Units were kept stationary under open sky for 20 minutes before kick-off to allow a suitable 'lock-on' to the orbiting satellites. Player motion was also quantified using a computerized, semi-automated video match-analysis image recognition system (PZ [see Bradley et al. (1) for full description]), which was calibrated before kick-off by a trained operator. Postgame match data were divided into 15-minute periods ($n = 36$), with data being excluded if the number of located GPS satellites fell below 4 at any time ($n = 8$) or if the player was substituted before or during a particular 15-minute period ($n = 7$). Data meeting the inclusion criteria ($n = 21$) were analyzed for TD covered (m), and distance covered (m) during HSR (4–5.5 $m \cdot s^{-1}$), VHSR (5.5–7.0 $m \cdot s^{-1}$), and at sprinting pace (SPR [>7.0 $m \cdot s^{-1}$]), using proprietary software (LoganPlus 4.2.3 [GPS]; ProZone MatchViewer [PZ]). High-intensity running (m) was calculated as the sum of HSR, VHSR, and SPR distances. The GPS and PZ data were analyzed blindly by separate analysts who were experienced in the analysis of match data using the relevant systems. Sample frequency for velocity efforts was set at 0.5 seconds using the GPS software in accordance with that used by PZ (4).

Statistical Analyses

Data are presented as mean ± *SD*. Paired-t statistics were calculated for TD, HSR, VHSR, SPR, and HIR between GPS and PZ for each 15-minute period. Effect sizes (Cohen's d) for between-group differences were determined, with values of 0.20, 0.50, and 0.80 representing a small, moderate, and large difference, respectively (2). Data were analyzed using SPSS 16.0 (SPSS Inc, Chicago, IL, USA). Statistical significance was set at $p \leq 0.05$.

Results

For all data meeting, the inclusion criteria, mean ± *SD* located GPS satellites was 7.0 ± 0.4, mean horizontal dilution of precision was 1.8. The GPS reported significantly higher values for TD than for PZ ($p < 0.05$), with a moderate effect size ($d = 0.51$). The GPS reported significantly lower values for SPR and HIR than for PZ ($p < 0.05$), with moderate ($d = 0.68$) and small ($d = 0.45$) effect sizes, respectively. The HSR ($d = 0.29$) and VHSR ($d = 0.37$) reported by GPS and PZ were not significantly different ($p > 0.05$), with both variables displaying small effect sizes (Table 1).

Discussion

The aim of this report was to assess the interchangeability of 20 methods of analyzing player motion, for measures of TD, and distance covered in defined high-intensity speed zones. The findings suggest that TD reported by GPS is higher (~7%) than that reported by PZ, despite the HIR component (>4 $m \cdot s^{-1}$) being reported significantly lower (~14%) by GPS. This implies that low-velocity distance is higher when reported by GPS than

PZ, which is in agreement with the findings of Randers et al. (8). The relative difference in reported TD between methods may simply reflect the measurement error between systems, which may be deemed acceptable for field-based measures of performance, with measurement bias taken into consideration. Furthermore, the small nonsignificant differences for HSR (~9%) and VHSR (~16%) between GPS and PZ could indicate that such data may be used interchangeably. The moderate differences in reported SPR between GPS and PZ (~40%) may indicate that SPR data between methods should not be used interchangeably. In practical terms, a 40% difference in reported SPR between PZ and GPS for 90 minutes of competitive match play could result in absolute differences in SPR ranging from 60 to 138 m, based on mean SPR distances between playing positions reported in the literature (1). In addition, the potential technical error incurred by method interchangeability for the measurement of SPR distance reported in this study (~40%) is similar to the reported short-term variation in match sprint performance reported in the literature (CV% = 38.9 ± 29.9 [5]), further emphasizing the need for caution when comparing SPR values between methods.

Randers et al. (8) compared match performances reported from 4 match-analysis systems including semiautomated video analysis (Amisco, Nice, France) and 5-Hz GPS, reporting significant differences in HIR ($p < 0.001$), with no differences between methods for TD and SPR ($p > 0.05$). The findings of Randers et al. (8) are somewhat conflicting to that of this study, which report significant differences between systems for TD, HIR, and SPR ($p < 0.05$). However, the SPR threshold used in this study (7 $m \cdot s^{-1}$ [25.2 $km \cdot h^{-1}$]) is higher than that applied by Randers et al. (8) (22 $km \cdot h^{-1}$), which is appropriate to the threshold applied by default within the PZ software. Therefore, the use of a different multiple camera system in this study (ProZone) from that of Randers et al. (8) (Amisco) would suggest that the findings of this study would be more applicable to users of the ProZone system.

In elite-level soccer, global player work load can be quantified using data derived from various sources including heart rate (HR), rating of perceived exertion (RPE), GPS, and video analysis (e.g., PZ) measures. Although HR and RPE reflect the internal physiological and perceived cost of the exercise, GPS and PZ provide data on the external load that has brought about the specific internal response. The findings we present in this study aim to act as a primer for sports scientists to understand the relationship of reported data between different measurement systems when interpreting player work-load.

Practical Applications

The implications of the current findings may be important for practitioners in the elite setting who use data derived from ProZone and GPS in the quantification of player loads during training and match play. In particular, comparisons between sprint performance (>7.0 $m \cdot s^{-1}$) in training (GPS) and match play (PZ) should not be drawn directly from the current technology because of large variations in reported data (~40%). In addition, comparisons of TD should be made with the direction of bias in mind (GPS > PZ).

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