

## Current Match-Analysis Techniques' Underestimation of Intense Periods of High-Velocity Running

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**Purpose:** To compare the peak 5-min period of high-velocity running (HiVR) during a soccer match using a predefined vs a rolling time interval. **Methods:** Player movement data were collected from 19 elite Australian soccer players over 11 competitive matches (77 individual match files) using a 5-Hz global-positioning system. Raw velocity data were analyzed to determine the period containing the greatest HiVR distance per match half and the distance covered in the subsequent epoch. Intervals were identified using either a predefined (distance covered in 5 min at every 5-min time point) or rolling (distance covered in 5 min from every time point) method. The percentage difference  $\pm$  90% confidence limits were used to determine differences between methods. **Results:** Predefined periods underestimated peak distance covered by up to 25% and overestimated the subsequent epoch by up to 31% compared with rolling periods. When the distance decrement between the peak and following period was determined, there was up to a 52% greater reduction in running performance using rolling periods than predefined ones. **Conclusions:** It is recommended that researchers use rolling as opposed to predefined periods when determining specific match intervals because they provide a more accurate representation of the HiVR distance covered. This will avoid underestimation of both match running distance and the decrement in running performance after an intense period of play. This may have practical implications for not only researchers but also staff involved in a club setting who use this reduction as evidence of transient fatigue during a match.

**Keywords:** motion analysis, physical performance, soccer, transient fatigue

Current match-analysis techniques allow detailed tracking of player movements during a match. While there are large between-systems differences in the measurement of distances covered,<sup>1</sup> contemporary systems permit researchers to isolate periods of a match for further analysis. The greatest distance covered at a high running velocity in a 5-minute period and the distance covered in the subsequent epoch have been used as an indication of transient fatigue during a match.<sup>2,3</sup> However, these periods are based on predefined 5-minute intervals in match-analysis software. Subsequently, distances during these periods may be underestimated or overestimated.<sup>2</sup> Global-positioning systems (GPS) allow the user to export raw player-movement data that can be analyzed using custom software. Match data can be reanalyzed using a rolling time scale (distance covered after every time point for the next 5-min period) to provide a more accurate report of distances covered for a given interval. The aim of this study was to determine differences in distances covered during intervals of match play when comparing predefined with rolling periods.

### Methods

Player movement was recorded from 19 elite soccer players using 5-Hz GPS (SPI Pro, GPSports, Australia) over 11 games during the 2010–11 Australian A League season (77 individual match files, 154 individual match halves). Raw velocity data were analyzed using a custom spreadsheet. High-velocity ( $\geq 4.17$  m/s) running<sup>3</sup> (HiVR) distance was reported in each half for the 5-minute interval containing the peak distance covered and the distance covered in the following interval.

Two analysis methods were used to determine time periods. The first method (predefined) is commonly used in match-analysis research and isolated match periods using predefined time points (eg, 0–5, 5–10 min). The second method (rolling) calculated distance covered in 5-minute intervals from every time point sampled during each half except when there were less than 5 minutes remaining.

### Statistical Analysis

Data are expressed as mean  $\pm$  SD and effect size (ES)  $\pm$  90% confidence limits (CI). Magnitude of difference was calculated using ES  $\pm$  90% CI and percentage

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difference using a custom spreadsheet. All data were log-transformed to reduce bias due to nonuniformity of error. Effects were characterized for their practical (clinical) significance. ES was assessed using the following criteria: <0.2 trivial, 0.2 to 0.6 small, 0.6 to 1.2 moderate, 1.2 to 2.0 large, and >2.0 very large.<sup>4</sup> Magnitude-based inferences were qualified using quantitative chances assessed qualitatively as <0.5%, most unlikely; 0.5% to 5%, very unlikely; 5% to 25%, unlikely; 25% to 75%, possibly; 75% to 95%, likely; 95% to 99.5%, very likely; and >99.5%, most likely.<sup>4</sup> A substantial difference was accepted when there was more than 75% likelihood that the true value was greater than the smallest worthwhile change.

## Results

Differences in distance covered and distance decrement using each method are shown in Table 1. There was a large decrement in HiVR during the epoch after the peak period in both the first and second halves when using the predefined technique ( $-48\% \pm 9\%$ , ES;  $-2.06$  [ $-2.33$  to  $-1.79$ ] vs  $-56\% \pm 13.8\%$ , ES;  $-2.60$  [ $-3.01$  to  $-2.19$ ], respectively). Similarly, there was a very large decrement when the same intervals were compared during the first and second halves using the rolling technique ( $-69\% \pm 12.4\%$ , ES;  $-3.6$  [ $-3.97$  to  $-3.25$ ] vs  $-75\% \pm 15.5\%$ , ES;  $-4.82$  [ $-5.32$  to  $-4.31$ ], respectively).

## Discussion

This study was the first to investigate the drop in soccer-match performance across selected intervals of play using a rolling analysis. Predefined periods substantially

underestimated the peak distance covered over a 5-minute interval and overestimated the distance covered in the following epoch compared with rolling periods (Table 1). This finding has implications when making inferences on transient fatigue during a match because predefined periods will underestimate the decrement in HiVR after the period of peak distance.

Elite soccer players experience a drop-off in HiVR of ~50% in the epoch after the peak 5-minute period.<sup>2</sup> In this study, the reduction in HiVR was greater when using rolling than predefined periods, so the decrements in elite team-sport players may be even larger than reported.

The decline in running performance after the peak running period may not be solely attributable to fatigue and may be a result of player position, team tactics, or match events. However, research suggesting that this decrement is attributable to transient fatigue is likely to underestimate the magnitude of this decline. Finally, the use of different time periods (eg, 1 or 2 min) may affect results and should be explored in future research.

## Conclusion

Using a predefined analysis to identify peak periods of HiVR during a match can substantially underestimate the true distances covered and subsequent decrement in performance.

## Practical Applications

Practitioners should use a rolling as opposed to a predefined analysis when isolating short periods during a match. This will provide a more accurate representation of the distances covered by players.

**Table 1 Comparison of the Distances Covered (m) Using Predefined and Rolling Time Periods, Mean  $\pm$  SD**

	Predefined distance	Rolling distance	% Difference	Effect size (95% confidence interval)	% Chances of positive/trivial/negative effect
Peak 5-min period					
first half	142 $\pm$ 24	177 $\pm$ 91	25 $\pm$ 3.1	0.69 (0.60 to 0.79) <sup>b</sup>	100/0/0
second half	138 $\pm$ 41	166 $\pm$ 43	20.6 $\pm$ 2.4	0.59 (0.51 to 0.66) <sup>a</sup>	100/0/0
Next 5-min period					
first half	80 $\pm$ 97	64 $\pm$ 65	-24.4 $\pm$ 11.7	-0.48 (-0.68 to -0.29) <sup>a</sup>	0/1/99
second half	72 $\pm$ 39	52 $\pm$ 35	-31.2 $\pm$ 16	-0.50 (-0.69 to -0.30) <sup>a</sup>	0/1/99
Decrement in peak vs next period					
first half	61 $\pm$ 34	113 $\pm$ 42	-52.4 $\pm$ 16.2	-1.83 (-2.19 to -1.46) <sup>c</sup>	0/0/100
second half	67 $\pm$ 44	113 $\pm$ 42	-53.1 $\pm$ 20.4	-1.92 (-2.39 to -1.45) <sup>c</sup>	0/0/100

<sup>a</sup> Small difference (effect size [ES] = 0.2–0.6).

<sup>b</sup> Moderate difference (ES = 0.6–1.2).

<sup>c</sup> Large difference (ES = 1.2–2.0).

## References

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