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Automated End of Sprint Detection for Force-Velocity-Power Analysis with GPS/GNSS Systems

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Abstract : Sprint-derived horizontal force-velocity-power (FVP) profiles can be developed with adequate validity and reliability with satellite (GPS/GNSS) systems. However, FVP metrics are sensitive to small nuances in data processing procedures such that minor differences in defining the onset and end of the sprint could result in different FVP metric outcomes. Furthermore, in team-sports, there is a requirement for rapid analysis and feedback of results from multiple athletes, therefore developing standardized and automated methods to improve the speed, efficiency and reliability of this process are warranted. Thus, the purpose of this study was to compare different methods of sprint end detection on the development of FVP profiles from 10Hz GPS/GNSS data through goodness-of-fit and intertrial reliability statistics. Seventeen national team female soccer players participated in the FVP protocol which consisted of 2x40m maximal sprints performed towards the end of a soccer specific warm-up in a training session (1020 hPa, wind = 0, temperature = 30°C) on an open grass field. Each player wore a 10Hz Catapult system unit (Vector S7, Catapult Innovations) inserted in a vest in a pouch between the scapulae. All data were analyzed following common procedures. Variables computed and assessed were the model parameters, estimated maximal sprint speed (MSS) and the acceleration constant τ, in addition to horizontal relative force (F_0), velocity at zero (V_0), and relative mechanical power (Pmax). The onset of the sprints was standardized with an acceleration threshold of 0.1 m/s^2. The sprint end detection methods were: 1. Time when peak velocity (MSS) was achieved (zero acceleration), 2. Time after peak velocity drops by -0.4 m/s, 3. Time after peak velocity drops by -0.6 m/s, and 4. When the integrated distance from the GPS/GNSS signal achieves 40-m. Goodness-of-fit of each sprint end detection method was determined using the residual sum of squares (RSS) to demonstrate the error of the FVP modeling with the sprint data from the GPS/GNSS system. Inter-trial reliability (from 2 trials) was assessed utilizing intraclass correlation coefficients (ICC). For goodness-of-fit results, the end detection technique that used the time when peak velocity was achieved (zero acceleration) had the lowest RSS values, followed by -0.4 and -0.6 velocity decay, and 40-m end had the highest RSS values. For intertrial reliability, the end of sprint detection techniques that were defined as the time at (method 1) or shortly after (method 2 and 3) when MSS was achieved had very large to near perfect ICC and the time at the 40 m integrated distance (method 4) had large to very large ICCs. Peak velocity was reached at 29.52 ± 4.02-m. Therefore, sport scientists should implement end of sprint detection either when peak velocity is determined or shortly after to improve goodness of fit to achieve reliable between trial FVP profile metrics. Although, more robust processing and modeling procedures should be developed in future research to improve sprint model fitting. This protocol was seamlessly integrated into the usual training which shows promise for sprint monitoring in the field with this technology.

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