

The relationship between generic GPS metrics and training load on injury across two pre-seasons.

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Soccer | Monitoring | Injury

Headline

High-speed running (HSR) and sprint distances (SD) have been observed to be associated with injuries in elite soccer [1]. Exposing players to acute increases in HSR and SD reportedly increases the risk of injury [2]. Furthermore, ‘spikes’ in weekly total distance (TD), accelerations and decelerations have also been demonstrated to be related to higher injury risk [3]. Previous research also suggests that there is a high incidence of injury during training and match play during pre-season [4]. As a result, it is imperative that exposures to different stimulus’ during pre-season is progressive and appropriate in nature [5]. It is important to note the complexity of injuries in sport and the difficulties in assessing the influence of training load on player availability which were set forth by Impellizzeri et al. [18, 19]. The relationship between generic global positioning system (GPS) metrics across pre-seasons and player availability is yet to be investigated in elite soccer in North America.

Aim. The aim of the current study was to investigate the association between GPS metrics (total distance (TD), high-speed running (HSR), sprint distance (SD) and the sum of accelerations and decelerations (AD), training load (sRPE x Time) and injuries in elite soccer players. It is hypothesized that increased volume in some or all of the aforementioned metrics mentioned above will be a factor in more players being unavailable for training and match play due to injury.

Methods

Athletes. Twenty-two (2020) and twenty-six (2021) professional elite soccer players from two squads over two pre-seasons (Mean±SD, age: 25.4±4.5; height: 173.9±14.1; mass: 171.1±13.4; body fat % : 9.0±3.1; Yo-Yo IRTL2, 840±40m) participated in the study. Informed consent was given by the local institution for this study and conforming to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Design. Data was collected across the 2020 and 2021 Major League Soccer pre-season. All outfield players were included in the study which accounted for four positional groups (central defenders (n = 7), full backs (n = 7), central midfielders (n = 10) and forwards (n = 7). All injuries that prevented a player from full team training and match play was recorded. An injury is defined as “any injury that prevents a player from

taking full part in all training and match play activities typically planned for that day for a period of greater than 24 hours from midnight at the end of the day the injury was sustained” [6].

Methodology. In 2020, a five-week pre-season with five pre-season games and twenty-seven training sessions were included. In 2021, a six-week pre-season with four pre-season games and thirty-two training sessions were included. The distance (m) measures of physical performance including TD, HSR (19.8 – 25.2kmhr⁻¹), SD (> 25.2kmhr⁻¹); additionally, the sum of accelerations and decelerations (AD) (> 3m/s² lasting 0.5 seconds) are communicated. These metrics were collected via GPS (Statsports, Northern Ireland). Session rated of perceived exertion (sRPE) scores were taken using

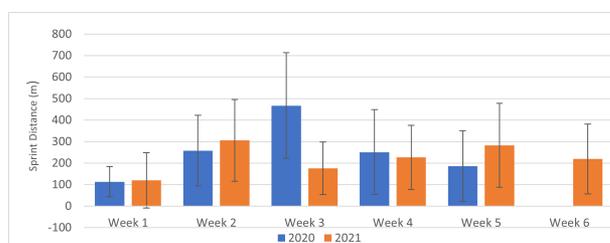


Fig. 1. Comparison of sprint distance (m) across the 2020 2021 pre-season

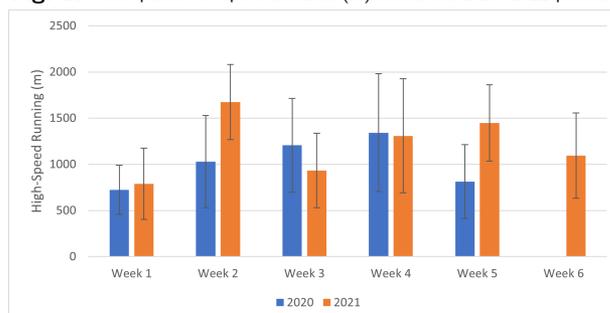


Fig. 2. Comparison of high-speed running (m) across the 2020 2021 pre-season.

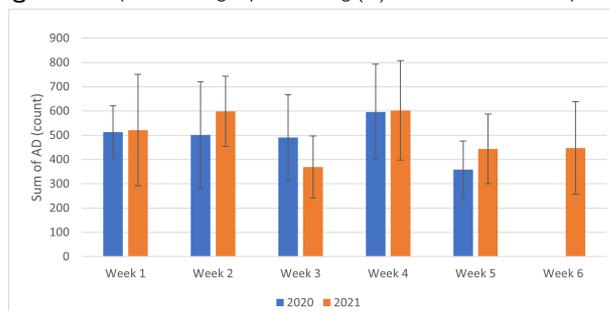


Fig. 3. Comparison of the sum of accelerations decelerations (AD) across 2020 2021 pre-season.

Table 1. The physical characteristics of participants.

Characteristics	2020 (n=28)	2021 (n=32)
Age (years)	25.4±4.5	25.8±3.9
Height (cm)	173.9±14.1	176.6±12.4
Weight (kg)	77.5±5.8	77.5±5.8
Body fat (%)	9.0±3.1	8.2±2.0
Yo-Yo IRTL 2 (m)	852±171	847±183

Table 2. Linear regression of generic GPS metrics and TL with respect to injuries.

Metric	p value	95% CI Lower	95% CI Upper
Total Distance (m)	0.17	-0.000061	0.000296
High-Speed Running (m)	0.102	-0.000565	0.005198
Sprint Distance (m)	0.023*	0.001574	0.016898
Sum of AD	0.195	-0.004104	0.01745
Training Load (AU)	0.35	-0.00064	0.001607

a modified Borg – CR10 scale [8]. Body composition was assessed using an 8-site ultrasound [16] and an aerobic/anaerobic fitness was assessed using a Yo-Yo IRTL2 [17].

Results

There were 19 injuries across two pre-seasons, 11 in 2020 and 8 in 2021. A total of 191 days were lost through injury, 113 in 2020 and 78 in 2021. The interaction between SD and injury was statically significant (p=0.02; ES = 0.45). The injury results of this interaction can be found in Table 2. Neither TD (p=0.17; ES = 0.19) HSR (p=0.102; ES = 0.03), sum of acceleration and decelerations (p=0.195; ES = 0.179) and training load (p=0.35; ES = 0.09) were statistically significant. Means±SD of the descriptive statistics for all baseline variables is presented in table 1.

Discussion

The purpose of the current study was to investigate the association between generic GPS metrics, training load and injuries in elite soccer players. Nineteen injuries occurred across the two pre-seasons. The key findings of the investigation were that the volume of sprint distance was a potential factor with the occurrence of injury in a soccer pre-season. Therefore, the hypothesis is accepted that increased volume in GPS metrics, particularly the higher velocity metrics will result in more players being unavailable for training and match play due to injury.

The findings of this research coincides’ with previous research which suggests that high volume of sprint distances can be related to injury [1]. Previous research has suggested that “under and over exposures of players to maximal velocity events (represented by a U-shaped curve) increases the risk of injury’ [14]. The current findings are in agreement that the participants in the current study were not adequately exposed

to higher velocity running in the first two weeks of pre-season in 2020 and then experienced a large increase and high volume in sprint distance in the following weeks (Figure 1.)

Sum of AD had low significance (p=0.195) with relation to injury. The accumulated load of AD was higher in the first two weeks of pre-season compared to any other week (Figure 3). It is believed that the periodization scheme is the cause of this training outcome with respect to a higher sum of AD. With respect to training outcomes within soccer, higher absolute and relative AD is associated with playing with fewer number of outfield players within tighter areas [9]. Small sided games (SSG) are a commonly used activity used by coaches which involve playing in tighter areas with less outfield players with respect to match play. SSG results in higher heart rates, RPEs [10] and more soccer actions per minutes (ie. dribbling, passing, tackling) [11], lactate concentrations [12] and larger amounts of change of directions [9]. While SSG presents many benefits, it does not prepare players for certain physical tasks involved in match-play ie. maximal or sub maximal velocity sprinting. Elite soccer players tend to need at least 30 meters to reach maximal velocity sprinting [13]. The low player density within SSG makes it difficult for players to reach maximal or sub maximal sprinting velocity. Therefore, emphasizing the need to train with a wide variety of activities (SSG versus Large sided games) is important for preparing players for the physical demands of match-play.

The participants baseline fitness levels (Yo-Yo intermittent recovery level 2) and average body composition (Body Metrix, ultrasound) had little protective affect against injury. Previous research indicates that invasion sport games players with low aerobic fitness levels have a higher incidence of injury particularly when players are exposed to higher changes in training load [2]. Furthermore, a well-trained aerobic energy system offers a greater protection against injury [15]. These findings re-iterate the importance of off-season programs which help to improve one’s aerobic capacity.

Table 3. The weekly mean±SD GPS metrics across two pre-seasons.

Metric	2020					2021					
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Total Distance (m)	32818±4840	30355±10836	26682±7351	30307±8119	16945±4825	23791±9920	30293±6261	19133±6494	29639±8786	26312±7166	22596±8953
High-speed running (m)	724±266	1029±500	1206±508	1342±638	814±399	88±387	1674±405	932±403	1308±617	1446±413	1093±461
Sprint Distance (m)	113±70	257±164	467±245	250±197	185±164	119±128	305±190	175±122	226±149	282±195	218±162
Sum of AD	512±108	501±219	490±176	596±196	358±117	521±229	598±144	369±128	602±204	443±143	447±190
Training load (AU)	2909±46	3152±16	2628±34	3776±39	3113±43	2145±703	2435±454	1503±210	1833±432	1113±415	1555±420

Practical applications

- High volumes of SD may have an impact on injuries during pre-season. It is imperative that coaches gradually and systematically progress players into these actions as they are critical components of match play.
- A mixed model of general and game specific periodization which involves improving volume of soccer actions before intensity may be the most appropriate way of preparing players for match play.

Limitations

- The current study fails to account for the multi-factorial nature of injury.
- The difference in the number of training sessions, games and number of weeks between the 2020 and 2021 pre-seasons.

Dataset

Dataset available upon request via email to the author.

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