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Association between External Load and Injury Incidence in Professional and Elite-Youth Football Players

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Abstract
Background: Elite football players are monitored daily to minimize injury risks and maximize performance.
Objectives: The aim of the study was to investigate injury incidence differences between competition and training and differences in key external load indicators during 1-, 2-, 3- or 4-weeks prior to the injury (WPI) with respect to the season average week (SAW).
Methods: Data of 224 unique players of five teams (1st, under-23, under-18, under-17, and under-16) were collected during 3.5 seasons of competition and training resulting in 467 player records in total. Collected data included kinematics from Global Positioning System tracking units (Viper Units, STATSports) and 528 injury incident records. External load was expressed in terms of acceleration counts (ACC), deceleration counts (DEC), total training time (TT), total distance (TD), and distance covered in high-speed zones: 14.4-19.7 km/h (Z4), 19.7-25.1 km/h (Z5), and >25.1 km/h (Z6). Injury incidence was derived as number of injuries per 1000 hours of exposure.
Results: Incidence rate was on average 4-11 times higher during competition than training for all teams except under-16 (incidence rate: 2.5, p=.153). In the 1st Team, external load (i.e. ACC, TT, and TD) were significantly different between 1-, 2-, 3-, and 4-WPI and SAW (p=.041, p=.037, and p=.049 respectively). For ACC and TT, the 3-WPI loads, were significantly higher than during SAW (p=.044 and p=.038, respectively).
Conclusion: These findings can assist professionals and scientists to improve their understanding of the relationship between external load indicators and injury incidence and consequently improve player health and performance.

Keywords: football players, global positioning system, key performance indicators, injury prevention, kinematics, external load.

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INTRODUCTION

To optimize player development and avoid the occurrence of exposure-related injuries, professional football players are continuously monitored by the clubs' medical and coaching staff (Pfirrmann et al., 2016). Consequently, various aspects of the relationship between training exposure and injuries have been investigated extensively with the aim of mitigating injury risk. Initially, the focus was on injury characteristics, such as damaged tissue (muscle, tendon, and ligament), mechanism (contact, non-contact), and incidence (injuries per 1000 hours of exposure) (Ekstrand, 2008; Ekstrand et al., 2011a, 2011b; Hawkins et al., 2001; Pfirrmann et al., 2016; Waldén et al., 2005). Research showed that injury incidence is roughly five times higher during competition than training, therefore emphasizing the importance of distinguishing levels of load for similar exposure (Bowen et al., 2020; Drew & Finch, 2016; Ekstrand, 2008; Ekstrand et al., 2011a, 2011b; Jaspers et al., 2018). Thus, external load during training and competition sessions became of importance in order to avoid the development of injuries (Bowen et al., 2020; Ehrmann et al., 2016; Enright et al., 2020; Jaspers et al., 2018; Nobari et al., 2021; Suarez-Arrones et al., 2020). The next step was to connect injury characteristics and incidence with external load exposure of the players (Drew & Finch, 2016). There has been a constant effort from sport scientists to assess the association between the key performance indicators (KPIs) of external load and injuries (Bowen et al., 2020; Ehrmann et al., 2016; Enright et al., 2020; Jaspers et al., 2018; Nobari et al., 2021; Suarez-Arrones et al., 2020). Unfortunately, many aspects of the relationship between load and injury, such as magnitude and timing, remain unclear.

External load, measured by tracking player kinematics using Global Positioning System (GPS) devices, provides an objective indication of performance and can be defined as the work the athlete has done in terms of movement that is independent of their personal internal characteristics or relative physiological stress (Halson, 2014). The most important parameters, KPIs, are acceleration counts (ACC), deceleration counts (DEC), total time spent (TT) (minutes per session), total distance covered (TD) (meters per session), and distance covered in high speed zones: 14.4-19.7, 19.7-25.1 and >25.1 km/h as zone 4 (Z4), zone 5 (Z5), and zone 6 (Z6), respectively (Malone et al., 2020; Malone et al., 2017). These KPIs have been shown to be significant indicators in previous research that investigated the relationship between external load and injury incidence (Ehrmann et al., 2016; Jaspers et al., 2018; Nobari et al., 2021).

Another important aspect of the load-injury relationship is the time prior to injury. Ehrmann et al. (2016), indicated that players covered significantly more meters per minute up to four weeks prior to injury compared to their season average week (SAW). Furthermore, Jaspers et al. (2018) exhibited evidence that the total distance covered and number of decelerations increased the risk of injury to high and harmful respectively, in the 1-, 2-, 3-, and 4-weeks periods prior to injury. Additionally, Nobari et al. (2021) reported an increased level of injury occurrence during the weeks with high values of total distance covered as well as high Z5 and Z6 distances. Nonetheless, contradicting findings suggest that this temporal aspect of the load-injury relationship is not consistent (Bowen et al., 2020; Ehrmann et al., 2016; Enright et al., 2020; Suarez-Arrones et al., 2020). Bowen et al. (2020) demonstrated that the acute-chronic workload ratio (ACWR) had a stronger relationship with injury risk than accumulated loads, supporting the notion that the rapid boost in load is more suggestive of the injury risk than the sum amount of load. Since another study showed contradicting findings for the ACWR, it is unclear on the specific KPIs that are most associated with injuries (Enright et al., 2020). The contradicting results highlight the need for clear evidence regarding the load-injury relationship for professional football players to achieve maximum performance and simultaneously the lowest injury incidence.

Therefore, the primary aim of the current study was to investigate the difference between injury incidence during competition and training. Furthermore, the secondary aim was to establish the differences in key performance indicator values during four periods prior to injury and the SAW values. As per previous research, we expect that the injury incidence is higher during competition than during training sessions. Also, we expect to find higher values in external load KPIs 1-, 2-, 3-, and 4-weeks preceding an injury compared with SAW values.

METHOD

Study Design and Participants

Data of 224 unique male football players were collected over 3.5 seasons from June 1st 2018 to February 1st 2022. A season lasts from June 1st to May 31st, including pre-season and regular season. Five different teams were included, under-16 (U16), under-17 (U17), under-18 (U18), under-23 (U23), and the first team (1st Team), all playing in the first tier of the Netherlands football league system (Eredivisie). Data records were split per season for players that were at the club over multiple seasons resulting in a total of 467 records. Players were designated to one team, which was set at the start of each season, and their respective age was noted. Furthermore, there were 113 players (years as mean ± SD) for the 1st Team (26.5 ± 3.9 years), 114 for U23 (19.5 ± 1.3 years), 81 for U18 (17.5 ± 0.6 years), 82 for U17 (16.1 ± 0.4 years), and 77 for U16 (14.9 ± 0.6 years) for all seasons combined. Participants included 3 goalkeepers, 68 center backs, 94 full backs, 86 defensive midfielders, 59 attacking midfielders, 80 wingers, 63 center forwards, and 14 players with an unknown position on the pitch.

The medical staff noted 528 injury incidents of which 182 were sustained in the 1st Team, 191 for the U23, 66 for the U18, 51 for the U17, and 38 for the U16. These injuries were sustained during training or competition. Regarding injury type, muscle and ligament injuries were the dominant categories. Other injuries were affecting bone, cartilage, laceration, joint, nerve, and tendon. Additional information can be found in the appendix (Appendix Table 1).

It is crucial to state that data collection was impacted as a result of COVID-19 during the 2019-'20 season leaving out one third of all competition games and impacting all training sessions. Moreover, the 2021-'22 season was still ongoing at the time this study took place.

Research Instruments

External load indicators were measured with STATSports' Viper Units (STATSports, Newry, Ireland). The Viper Units, 33×88mm and 48 grams, consist of an 18Hz GPS and Inertial Measurement Unit, 952Hz gyroscope, 952Hz tri-axial accelerometer, and 10Hz magnetometer, and have proven to be a valid and reliable measure for distance and peak speed (Statsports, 2022; Beato et al., 2018). Players wore a harness housing the Viper Units between the shoulder blades at chest level to maximize inter-individual reliability. Data were collected for all outdoor training (individual and team) and competition sessions. All sessions were analyzed afterwards using STATSports Sonra Analysis Software (STATSports, Newry, Ireland) (Statsports, 2022).

Similarly to previous research seven KPIs were measured per session: ACC, DEC, TT, TD, and distance covered in three high speed zones: Z4, Z5, and Z6 (Malone et al., 2020; Malone et al., 2017). Accelerations were counted when a player performed an acceleration of 3 m/s^2 or higher for over 0.5 seconds. Decelerations were counted similarly, whereby the player had to decelerate for more than 3 m/s^2 for over 0.5 seconds. Total training time and total training distance were derived as the cumulative sum of time in seconds and distance covered in meters, respectively. Similarly, distances in the specific speed zones were calculated for ranges 14.4-19.7 km/h, 19.7-25.1 km/h, and over 25.1 km/h for zone 4, zone 5, and zone 6, respectively.

Injury records include the date of the first symptoms, a players' respective age, team, position, tissue involved and moment (training or competition). Records were categorized by season and player.

Training and competition sessions preceding an injury were categorized as 1-, 2-, 3-, and 4-weeks prior to injury (WPI) utilizing the date of first symptoms (e.g., 1-WPI were the last 7 days before injury and 2-WPI 8-14 days). Injury free periods were used to calculate the SAW load. Values were normalized to represent a 7-day period similar to the length of the four different WPIs. Additionally, all KPI values were summed to represent a total weekly load for all period types and were normalized with respect to the SAW being the norm. Lastly, injury incidence was calculated as the number of injuries per 1000 hours of exposure to training or competition. Based on changes in data collection, data for 2021-'22 could not be used with respect to training incidence.

Data Analysis

Statistical analysis was performed using the IBM SPSS Statistics 27 software (IBM Corp., Armonk, NY, 2020) (IBM, 2022). Outliers were removed after z-score transformation with exceeding reference values of either -3 or 3 (Lenhard & Lenhard, 2016). Tests for normality of variances, by using the Shapiro-Wilk test and the Levene's Test, did not result in violation for the Homogeneity of Variances.

Our first hypothesis, that injury incidence is higher during competition than training sessions, was tested for each team individually using an Independent-Samples Mann-Whitney U Test. To investigate our secondary aim, that KPI values are higher during the four WPIs than the SAW, a One-Way ANOVA was performed. Subsequently, a Bonferroni post-hoc analysis was executed to investigate differences between WPIs. All data were tested against a confidence interval of 95% and alpha levels were set at .05.

Lastly, Cohen's effect sizes (η^2) were extracted from the ANOVA effect sizes table and interpreted as either no effect (<.01), small effect (≥.01 to <.06), intermediate effect (≥.06 to <.14) or large effect (≥.14) (Cohen, 1988; Lenhard & Lenhard, 2016).

RESULTS AND DISCUSSION

Injury incidence was significantly higher ($p < .050$) in competition compared to training across the 1st Team, U23, U18, and U17 (Table 1). There was no statistical difference between injury incidence during competition and training for the U16 team ($p = .153$).

Table 1. Descriptives of injury incidence during training and competition averaged per team per 1000 hours of exposure.

Team	Number of injuries per 1000 hours of training	Number of injuries per 1000 hours of competition	p-value
1st Team	3.6	24.6	p < 0.001*
U23 Team	10.8	40.8	p = 0.023*
U18 Team	4.8	32.4	p = 0.016*
U17 Team	2.4	26.4	p = 0.023*
U16 Team	3.6	9.6	p = 0.153

In addition, normalized load margins of all KPIs between the different WPI periods and the SAW load were compared (Table 2) and presented in absolute values (Appendix, Table 3). The results indicated significant differences only for the 1st Team, for ACC (111.49 ± 25.83, $p = 0.041$), TT (108.61 ± 20.75, $p = .037$), and TD (107.03 ± 20.13, $p = .049$), respectively. For ACC, TT, and TD there were significant differences in external load margins between the averaged WPI and the SAW (Table 2). These results were supported by small effect sizes ($\eta^2 = .027$, CI: 0.0 – 0.058, $\eta^2 = .026$, CI: 0.0 – 0.057, and $\eta^2 = .027$, CI: 0.0 – 0.055, respectively). Subsequently, the Bonferroni post-hoc analysis revealed that the external load, in terms of ACC (Figure 1) and TT (Figure 2), were significantly higher ($p < .05$) for the 3-WPI period when compared to all other WPIs and SAW.

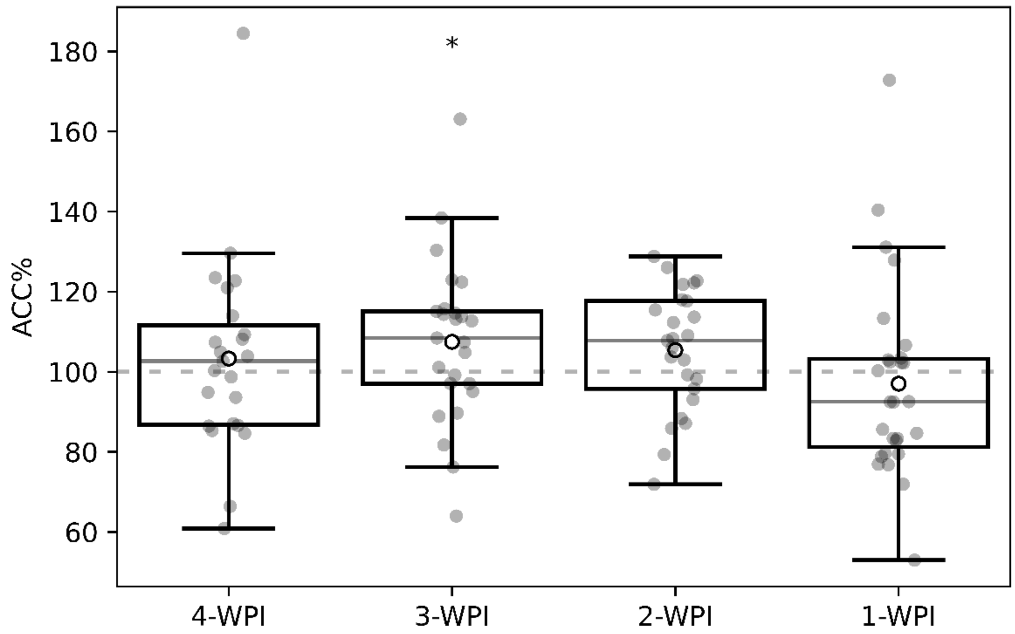

Figure 1. Period overview of normalized load for the 1st Team on total number of accelerations (ACC) during four periods (WPI: Weeks Prior to Injury). An * indicates a significant difference from the seasons average week (100%, dotted line) ($p < .05$).

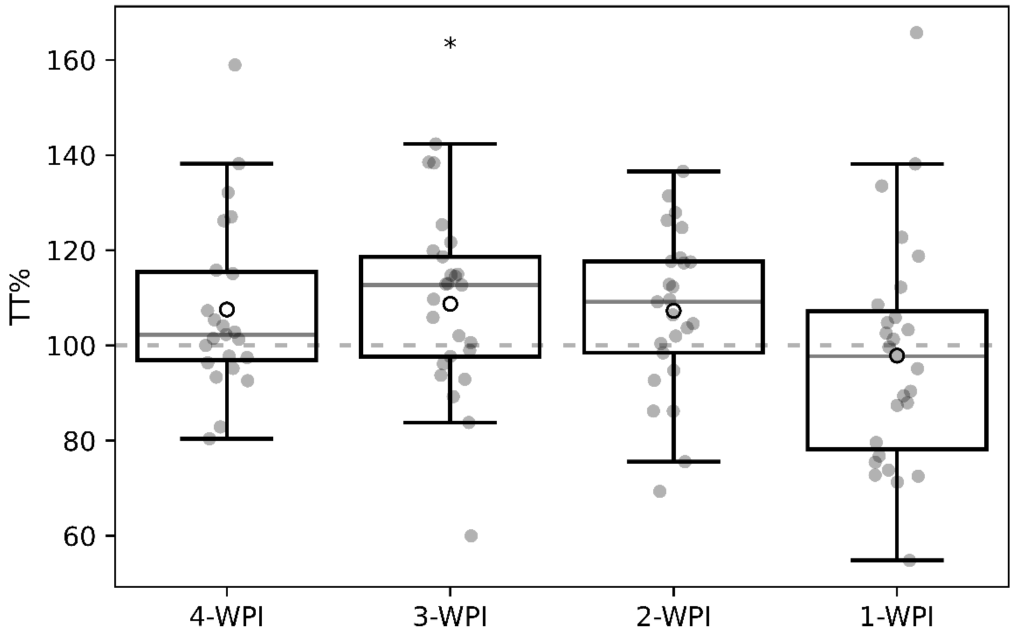

Figure 2. Period overview of normalized load for the 1st Team on total time (TT) spent during four periods (WPI: Weeks Prior to Injury). An * indicates a significant difference from the seasons average week (100%, dotted line) ($p < .05$).

Table 2. Mean and standard deviations of all key performance indicators for 1, 2, 3, and 4-weeks prior to injury (WPI) and the average of the weeks prior to injury (Avg.). Acceleration (ACC), deceleration (DEC), total time spent (TT), total distance covered (TD), and distance covered in high speed zones: 14.4-19.7, 19.7-25.1, and >25.1 km/h as zone 4 (Z4), zone 5 (Z5), and zone 6 (Z6), respectively. An * indicates a significant difference from the seasons average week (p < .05).

		ACC%		DEC%		TT%		TD%		Z4%		Z5%		Z6%	
		Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
1st Team	Avg.	111.49*	25.83	111.35	27.75	108.61*	20.75	107.03*	20.13	104.62	24.44	106.00	28.86	108.88	51.79
	1-WPI	108.26	24.80	107.58	26.22	105.75	21.47	103.61	19.77	101.74	21.30	101.96	24.58	106.58	46.48
	2-WPI	113.57	24.60	113.76	25.97	108.97	19.90	107.32	19.47	104.21	24.15	107.67	26.34	104.48	44.18
	3-WPI	114.41*	26.44	115.24	28.89	111.45*	20.83	110.29	19.62	106.10	23.02	109.20	31.74	117.93	56.70
	4-WPI	109.80	27.47	108.88	29.65	108.36	20.78	106.99	21.50	106.57	29.07	105.31	32.30	106.45	58.58
U23	Avg.	109.12	28.84	112.79	30.65	108.75	29.18	107.95	25.55	106.40	28.02	105.12	30.54	105.16	50.49
	1-WPI	110.44	28.36	112.72	30.38	108.31	29.76	107.22	25.00	105.18	28.50	104.93	29.17	96.87	43.41
	2-WPI	105.63	28.27	109.46	31.11	106.71	25.38	106.45	23.89	107.21	30.33	104.60	33.87	105.34	53.46
	3-WPI	111.11	27.99	115.21	32.19	111.05	29.24	108.22	25.57	104.31	24.35	103.49	23.98	114.16	56.96
	4-WPI	109.55	31.49	114.33	29.64	109.36	33.14	110.35	28.65	109.10	28.76	107.57	34.67	106.40	48.46
U18	Avg.	105.17	33.09	104.47	30.60	108.13	28.71	108.49	30.55	112.16	40.36	104.93	52.54	95.37	58.13
	1-WPI	100.42	30.65	100.47	26.28	102.21	25.96	101.57	27.77	101.00	31.56	91.10	39.37	97.74	69.05
	2-WPI	105.59	38.01	104.78	35.23	109.91	33.65	109.21	36.20	111.57	39.50	98.28	50.45	93.35	59.86
	3-WPI	113.85	27.00	111.08	24.29	115.01	24.69	112.50	21.35	112.42	31.24	118.51	73.41	102.46	53.70
	4-WPI	103.95	33.78	104.12	34.26	107.77	27.58	113.56	31.43	128.24	54.93	123.70	48.68	89.67	45.55
U17	Avg.	108.54	32.41	113.29	35.41	104.24	28.11	108.49	28.61	112.29	34.67	111.34	46.83	115.15	77.34
	1-WPI	120.27	36.40	129.20	39.89	118.27	34.88	122.32	31.98	121.79	37.24	124.88	53.96	136.93	89.32
	2-WPI	105.14	33.79	113.89	35.93	104.62	25.27	105.20	25.24	111.20	35.87	100.92	42.50	108.25	69.10
	3-WPI	106.81	36.26	107.17	33.10	102.91	18.52	105.35	27.00	109.14	35.77	104.99	53.88	123.22	92.87
	4-WPI	99.74	20.78	99.06	26.23	88.71	21.67	98.25	25.72	104.84	30.99	111.03	37.10	90.70	54.98
U16	Avg.	111.45	32.74	101.04	31.31	104.03	24.68	107.16	24.64	110.07	31.52	120.60	43.56	118.01	68.16
	1-WPI	109.22	21.89	104.73	28.59	114.22	23.42	115.16	26.14	112.78	40.88	114.05	39.99	104.35	41.25
	2-WPI	104.12	47.17	95.65	42.05	95.94	27.76	99.10	30.24	105.39	32.95	117.88	61.54	114.01	100.48
	3-WPI	116.80	27.06	97.66	20.18	100.59	24.70	107.15	21.83	111.64	24.26	124.79	34.23	112.91	54.67
	4-WPI	118.32	35.59	106.64	35.89	103.52	23.14	105.93	18.85	110.41	28.43	129.14	39.20	149.79	69.94

DISCUSSION

The primary aim of the current study was to investigate the differences in injury incidence between competition and training exposure in professional and elite youth football players over multiple seasons. The secondary aim was to investigate the differences in external load KPIs in the weeks prior to the injury in comparison with a SAW.

Our first hypothesis, that injury incidence is higher during competition than training sessions, was confirmed for the majority of the teams, showing an increased risk of injury during competition than training. More specifically, the number of injuries that occurred during competition were, on average, more than five times higher than the injuries that occurred during training, with over 30 injuries per 1000 hours of competition exposure and less than 6 injuries per 1000 hours of training exposure. Similar findings were found by

Ekstrand et al. (2008) and Bowen et al. (2020) which corroborate that injuries are roughly five times more likely to occur during competition than training. For the U16 players this increased risk of injury was not proven, however, the cause presumably resides in insufficient statistical power rather than the group's characteristics. Further research is needed to establish the increased risk of injuries in all age groups.

Our second hypothesis, that KPI values are higher during the four WPIs than the SAW, was confirmed for the total number of ACC, TT, and TD in the 1st Team. These KPIs are associated with explosive actions as they represent increasing changes of velocity and total intensity in terms of time and distance, respectively. While these KPIs were the most important factors for injury incidence for the 1st Team, no significant differences were found for the other teams and KPIs. A possible explanation to why these mechanisms only appear in 1st Team players is that the staff coverage was at least twice as high for the 1st Team, which may have resulted in better data quality and quantity for these players. Conclusively, the results provided insights that an increasing external load can increase injury rates.

The post-hoc analysis showed that the external load, in terms of ACC and TT, were significantly higher in the 3-WPI compared to the SAW. Although other KPIs did not show significant differences, interesting findings can be highlighted. In particular, the total number of decelerations (DEC) closely followed the margins of ACC. In a similar study by Ehrmann et al. (2016), with fewer participants and recorded seasons, it has been reported that external load was higher in the period prior to injury compared to season average, but only in terms of distance covered per minute (Ehrmann et al., 2016). However, in contrast with the current study's findings, they were not able to prove this relationship for ACC and TT (Ehrmann et al., 2016). Additionally, the current study's findings are in line with the findings of Nobari et al. (2021), which stated that the average injury incidents were significantly higher in the weeks that total distance, high-speed distance, sprint distance, and repeated sprints were higher.

Regarding DEC, Jaspers et al. (2018) exhibited evidence about increased injury risk due to the harmful effect of 1-, 2-, 3-, and 4-weeks values. Regarding TD, the harmful effect of high 1-week, 2-week, 3-week, and medium 2-week, was identified (Jaspers et al., 2018). Thereafter, the findings from the current study, came partially to an alignment with Jaspers et al. (2018) as, although not significant, DEC was higher for 3-WPI compared to the SAW value, which. This suggests that DEC might be of value in terms of injury indication.

This study had several strengths. First, the current study followed a large group of elite professional (youth) football players over multiple years. More specific, the data had a large sample size, a wide range of age, time of recording, player positions (Appendix, Table 2), and reliable and valid measurement techniques (Beato et al., 2018). Furthermore, the current study focused on external workload with specific KPIs that are widely used and relatively easy to implement in daily practice. As modern football practitioners continuously improve in their understanding of training load and data, this research could lead to understandable insights that could aid daily practice. For example, monitoring KPI values to identify relatively high external loads could allow for a timely intervention and thus prevent injury.

While this study has its strong points, it is not without limitations. Since injury incidence could be affected by additional factors, such as sleep, nutrition, previous injuries, hydration, psychological state, and physiological factors (Hägglund, Waldén, Magnusson, et al., 2013), a more holistic view needs to be considered. In those lines, including data on internal workload in addition to external workload would improve the evidence-based association between workload and injuries (Piggott, 2008). Also, data quantity was suboptimal for the youth teams due to less support being available leading to misuse of equipment compared to the 1st Team, as demonstrated in the lower statistical power for the U16 team. Lastly, four studies that presented the relationships of specific KPIs with injury incidence showed small to large effect sizes (Bowen et al., 2020; Ehrmann et al., 2016; Jaspers et al., 2018; Nobari et al., 2021). In those lines, the current study found small, yet significant, effect sizes, demonstrating the importance of these relationships.

Future research should focus on improving data quality and statistical power by including information of internal workload, ensuring sufficient support during measurements, and monitor players over multiple seasons, which could lead to establishing current and other load-injury relationships with larger effect sizes. Furthermore, potential intervention strategies should be investigated, preferably in a randomized controlled trial. For example, to reduce injury risk, volume of KPIs could be tapered ahead of competition while intensity is kept at the same level. Then, sudden load spikes caused by competition should be reduced and the player should be at a lower risk of overuse. However, another strategy would be to stimulate the player's workload capacity by gradually increasing the external load while implementing additional recovery strategies to lower the risk of injury. Thus, the suggested intervention strategies focus on smoothing the current workload when the risk of an injury is high and increase the player's workload capacity while the risk of an injury is low.

CONCLUSION

This research helped to further understand injury incidences in elite professional (youth) football players. As the injury rate in competition is 3.8 to 11 times as high compared to training more caution or prevention interventions are needed to reduce the injury rate. One possible way to do this is to focus on external load parameters. As these parameters tend to show specific trends before injury occurrence this research could be used to further improve existing injury prevention frameworks. More specifically, for the 1st Team, in the week's prior injury, explosive actions and changes of velocity, as well as total intensity in terms of time and distance, need to be closely monitored to reduce injury risk. A potential intervention strategy would be to taper the volume of KPIs before competition while maintaining the overall intensity level, thereby smoothening the workload and minimize the player's risk of overuse. These assessments and interventions could already be made three weeks prior to injury for total training time and acceleration counts. This research could provide insights to supporting staff and help them to achieve a more efficient allocation of the workload during training scheduling by reaching maximum performance while minimizing the injury incidence for their players. More specifically, sudden spikes in training workload can increase the risk of injury and it is recommended to gradually increase the load over time to reduce this risk. However, the initial spike of training workload may cause minor complaints in players, leading to the risk of actual injury. Therefore, a potential approach to prevent this is to reduce the training workload for a period and then gradually increase it while implementing additional recovery strategies. Alternatively, keeping the player at the initial spike in training load and focusing on extra recovery strategies may also be effective in preventing injury.

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CONFLICT OF INTEREST

The authors hereby declare that this research is free from conflicts of interest with any party.

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Appendix

Table 1. Injuries per Team per Tissue Injured.

Team	Tissue Injured								
	Bone	*Cartilage*	*Joint*	*Laceration*	*Ligament*	*Muscle*	*Nerve*	*Tendon*	*Total*
U16	3	0	1	1	3	15	4	8	**38**
U17	2	0	0	0	15	23	4	2	**51**
U18	5	0	3	0	12	23	8	4	**66**
Jong	3	3	6	4	38	74	12	21	**191**
1st Team	6	2	7	3	47	74	15	11	**182**
Total	19	5	17	8	115	209	43	46	**528**

Table 2. Injuries per Team per Position. Goalkeeper (GK), Center Back (CB), Full Back (FB), Defensive Midfielder (DM), Attacking Midfielder (AM), Winger (W), Center Forward (CF), and Missing Position (MP).

Team	Position								
	GK	*CB*	*FB*	*DM*	*AM*	*W*	*CF*	*MP*	*Total*
U16	0	6	9	7	8	4	3	1	**38**
U17	0	6	13	7	7	6	10	2	**51**
U18	0	14	18	10	7	6	11	0	**66**
Jong	2	48	42	30	22	25	22	0	**191**
1st Team	1	38	24	28	37	26	28	0	**182**
Total	3	112	106	82	81	67	74	3	**528**

Table 3. Mean and standard deviations of all key performance indicators for 1, 2, 3, 4 –Weeks Prior to Injury (WPI) and the average of the weeks prior to injury (Avg.). Acceleration counts (ACC), deceleration counts (DEC), total time spent (TT) (minutes per session), total distance covered (TD) (meters per session) and distance covered in high speed zones: 14.4-19.7, 19.7-25.1 and >25.1 km/h as zone 4 (Z4), zone 5 (Z5), and zone 6 (Z6), respectively. An * indicates a significant difference from a seasons average week ($p < .05$).

		Avg. ACC (#)		Avg. DEC (#)		Avg. TT (min)		Avg. TD (m)		Avg. Z4 (m)		Avg. Z5 (m)		Avg. Z6 (m)	
		Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Ist Team	Avg.	261.71*	64.54	231.51	62.85	360.95*	61.22	25771.02*	4714.01	3102.17	812.27	1053.99	338.44	199.06	118.47
	1-WPI	254.16	67.54	222.67	62.47	350.15	63.72	24820.04	4438.43	3002.00	667.63	1018.29	301.13	193.23	111.07
	2-WPI	266.27	57.06	236.71	60.56	361.93	55.25	25826.07	4224.78	3106.80	851.02	1074.98	316.74	193.59	112.26
	3-WPI	266.21*	67.40	237.43	67.16	369.27*	66.21	26591.55	4891.21	3180.66	816.58	1080.24	343.25	211.20	118.16
	4-WPI	260.46	66.03	229.48	61.14	362.83	58.62	25877.43	5185.12	3122.75	908.76	1043.47	391.61	198.29	133.33
Jong	Avg.	215.85	67.41	208.27	63.46	356.65	101.68	24181.45	6272.82	2720.76	896.28	917.53	376.54	222.64	139.20
	1-WPI	219.64	72.06	210.26	68.54	353.51	108.86	23856.22	6346.28	2686.36	881.69	914.99	382.12	206.18	134.59
	2-WPI	206.31	62.96	198.79	57.33	349.45	88.43	23758.14	6008.63	2712.48	918.00	884.75	342.27	219.41	139.25
	3-WPI	220.34	63.83	213.41	62.58	362.38	89.05	24273.11	5691.30	2655.95	761.51	913.89	329.38	243.39	138.05
	4-WPI	217.69	71.09	211.67	65.55	363.28	119.92	24994.08	7125.42	2838.66	1025.75	962.60	453.36	226.44	147.90
O18	Avg.	166.59	77.31	153.18	63.07	262.82	99.06	18110.81	5587.81	2248.97	838.94	756.65	337.94	163.02	118.53
	1-WPI	161.55	72.39	154.32	65.20	258.01	94.77	17661.05	5989.33	2098.49	819.49	685.04	338.29	156.49	127.14
	2-WPI	152.73	69.04	144.13	54.41	245.12	103.16	16920.39	5183.35	2163.09	614.22	677.07	274.25	153.07	120.79
	3-WPI	206.77	91.19	179.47	76.37	311.32	90.83	20973.95	5061.08	2393.43	912.09	888.97	368.82	195.94	121.42
	4-WPI	163.38	81.03	144.93	61.53	258.82	100.87	18337.37	5726.79	2478.04	1100.69	876.94	367.62	161.42	106.13
O17	Avg.	173.96	62.48	159.63	59.25	284.61	88.98	20062.98	5637.53	2261.26	771.36	713.46	316.27	137.65	108.19
	1-WPI	188.14	73.97	174.45	67.68	316.41	99.56	22278.24	6115.41	2464.59	937.08	804.81	415.13	166.45	137.50
	2-WPI	172.30	64.91	163.77	62.98	290.98	80.43	19749.18	5279.68	2236.88	775.49	642.13	280.39	117.07	88.21
	3-WPI	170.52	42.09	149.05	39.18	288.46	61.79	19515.84	4162.05	2140.85	663.52	621.85	212.10	122.63	74.27
	4-WPI	161.90	62.62	146.54	59.96	238.58	92.05	18241.58	6151.51	2143.66	666.11	749.86	281.07	136.55	114.51
O16	Avg.	191.27	82.43	164.55	68.67	283.67	88.22	21146.99	6522.35	2384.71	944.19	771.26	349.62	111.80	76.36
	1-WPI	208.78	72.62	189.28	68.91	335.50	108.47	24333.39	8153.13	2541.73	1014.18	764.26	278.45	109.28	79.29
	2-WPI	175.93	70.26	148.93	63.28	262.63	67.50	19793.34	4954.85	2234.70	808.28	756.80	457.65	112.37	99.22
	3-WPI	169.54	77.07	141.25	64.53	236.84	72.17	18494.68	5601.53	2234.85	956.82	746.86	358.38	102.45	56.63
	4-WPI	210.82	121.97	175.48	82.20	288.61	71.01	21266.61	6106.03	2524.05	1173.27	829.49	363.63	125.71	75.93