International Journal of Strength and Conditioning

Aziz, R., Jones, M. T., Jagim, A. R., Feit, M. K., Kuhlman, N., Crabill, T., & Fields, J. B. (2023). In-Season Match Demands Of Men's Collegiate Soccer: A Comparison By Half, Position, Match Outcome, Match Location, And Competition Phase. International Journal of Strength and Conditioning
https://doi.org/10.47206/ijsc.v3i1.154

In-Season Match Demands Of Men's Collegiate Soccer: A Comparison By Half, Position, Match Outcome, Match Location, And Competition Phase

Richard Aziz[1], Margaret T. Jones[2,4], Andrew R. Jagim[2,3], Mary Kate Feit[1], Nicholas Kuhlman[1], Thomas Crabill[5], & Jennifer B. Fields[1,2]

[1]Exercise Science and Athletic Training, Springfield College, Springfield, MA, [2]Patriot Performance Laboratory, Frank Pettrone Center for Sports Performance, George Mason University, Fairfax, VA, [3]Sports Medicine Department, Mayo Clinic Health System, La Crosse, WI, [4]Sport, Recreation, and Tourism Management, George Mason University, Fairfax, VA, [5]Physical Education and Health Education, Springfield College, Springfield, MA
Corresponding Author: jfields2@springfieldcollege.edu

ABSTRACT

The purpose of this study was to quantify athlete external workload by half, position, match outcome, match location, and competition phase (e.g., conference vs non-conference) during match play across a men's NCAA DIII soccer season. Throughout the competitive season, 16 soccer players wore a GPS device in 17 matches. Workload metrics collected were: total distance (TD), distance per minute (D/min), distance in speed zones (SZ) 1-5, sprint efforts, sprint distance (SD), top speed, accelerations, player load (PL), and player load per minute (PL/min). TD (4164±1235 m), PL (169±52 AU) D/min (116±20 m/min), PL/min (4.7±0.8 AU), SD (80±55 m), accelerations (32±14), decelerations (35±14), PP (30±10), SZ2 (1520±469 m), and SZ3 (582±222 m) were significantly higher in the 1st half of play. Forwards demonstrated significantly higher top speeds (9.5±2.0 m/s) than midfielders (8.0±1.1 m/s) and defenders (7.7±1.2 m/s). PL (309.45±83.86 AU), D/min (216.82±59.26 m/min), PL/min (8.76±2.26 AU/min), top speed (15.82±3.41 m/s), SZ3 (1059.45±403.27 m) and SZ4 (139.52±75.78 m) were significantly greater in matches that resulted in wins. However, SZ5 (20.59 ± 23 m) was significantly greater during matches that resulted in losses. PL (321.73±93.38 AU), D/min (229.26±74.58 m/min), PL/min (9.24±2.84 AU/min), top speed (16.03±4.43 m/s), SZ2 (2819.48±891.09 m), SZ3 (1130.63±460.09 m), SZ4 (150.33±80.52 m) SZ5 (20.84±22.86 m) were significantly greater during home matches. PL (321.85±88.79 AU), D/min (228.2±64.66 m/min), PL/min (9.16±2.45 AU/min), SZ2 (2850.53±795.83 m), SZ3 (1145.27±456.34 m), and SZ4 (142.49±74.89 m), were significantly greater during nonconference matches. SZ5 (19.23 ± 22.87 m) was significantly greater during conference matches. Match workloads help coaches identify physical demands needed to compete. Tailoring training and monitoring accumulated fatigue will allow coaches to optimize team performance.

Keywords: GPS, athlete monitoring, sport science, external load, football

IUSCA International Universities Strength and Conditioning Association

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

INTRODUCTION

Quantification of physical work performed during training and competition, commonly referred to as external load, is important to consider when designing and implementing programs for athletes. Global positioning systems (GPS) are a viable tool for monitoring and managing athlete loads in order to minimize injury risk and improve sport performance (Bourdon et al., 2017). Further, monitoring athlete external load can be used to manipulate volumes and intensities, inform coaching decisions, optimize recovery, and guide nutritional interventions (Jagim et al., 2020). Soccer is an intermittent, high-intensity sport, in which players are exposed to high volumes (e.g., total distance, player load) and intensities (e.g., high-speed running, sprints, jumps, change of direction, accelerations, and decelerations). External loads achieved during match play may vary depending upon a multitude of factors including: half, playing position, match outcome, match location, competition phase (e.g., conference vs non-conference), score margin, tactical objectives, pacing strategies, and playing time. National Collegiate Athletic Association (NCAA) soccer rules and seasonality structure differ from other levels of competition, therefore, match loads may differ from those reported at the professional level (Jagim et al., 2020). For example, NCAA soccer rules allow for re-entry following substitutions, include two 10-minute overtime periods with a "golden goal" applied, and incorporate clock stoppage for injuries, goals, and card issuance (Andres, 2021). There are also differences in regards to in-season scheduling, where NCAA soccer players can compete in over 25 matches during a 15-week season, with 2 matches per week, compared to European professional soccer players who may play multiple matches per week over a 45-week season (Carling et al., 2012; Lago-Peñas et al., 2011; Ranchordas et al., 2017).

Previous research in men's professional soccer has demonstrated that physical performance declines in the second half of matches, specifically total distance and high-speed distance (Mohr et al., 2003, 2005). These observed performance decrements may be due to a multitude of physiological changes that occur over the course of a match, including glycogen depletion, increased core temperatures, dehydration (Mohr et al., 2005), pacing strategies, tactical changes, and mental fatigue (Bradley & Noakes, 2013; Paul et al., 2015). The reduction in load across half may also be attributed to score discrepancies and match outcome, such that loads may decrease when teams are winning and increase when teams are losing (Lago-Peñas, 2012). There are also known differences in positional demands as prior research has reported wide defenders and strikers produce the greatest high-speed running, sprinting, and high-intensity acceleration distances, compared to other positions (Abbott et al., 2018; Andrzejewski et al., 2015; Bloomfield et al., 2007; Di Salvo et al., 2007); however, positional workloads may also be affected by tactical formation (Calder & Gabbett, 2022). Match location may also influence external loads, as prior research has shown greater intensity efforts at home matches (Lago-Peñas, 2012; Oliva-Lozano et al., 2021). Lastly, loads may vary across competition phase, with a potential for higher volumes and intensities in conference matches as the level of competition may be greater with more at stake in regard to the outcome. Of importance, match outputs have been observed across a variety of professional levels, and results have shown that lower divisions often covered greater workloads, most likely due to lack of technical and tactical qualities compared to higher divisions (Bradley et al., 2013). Therefore, it is important to quantify match loads throughout a season across distinct levels of NCAA competition, as a collegiate season may provide a unique distribution and magnitude of external loads. In turn, this can help direct the specific programming and recovery needs for male collegiate soccer athletes.

While previous work has quantified match demands of NCAA Division I men's and women's soccer, (Bozzini et al., 2020; Curtis et al., 2018; McFadden et al., 2020), match demands of NCAA Division III (DIII) have not been established despite DIII totaling 410 of the 821 collegiate soccer programs in the United States. Therefore, the purpose of this study was to quantify the athlete external workload by half, position, match outcome, match location, and competition phase (e.g., conference vs non-conference) during match play across a men's NCAA DIII soccer season.

METHODS

Participants

NCAA DIII men's soccer players (n = 16, age range: 18-21 years) classified as "starters", participated. Starters were defined as players who maintained a minimum playing time of 45 minutes per match. Goalkeepers and non-starters were excluded due to relatively low total distances travelled. Soccer athletes were under the direction of the same

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

Certified Strength and Conditioning Specialist® and were following a similar training regimen. All athletes completed a medical history form and were cleared for intercollegiate athletic participation. Risks and benefits were explained to athletes, and an institutionally approved written informed consent form was signed before participation. All procedures involving human subjects were conducted in accordance with the requirements of the Declaration of Helsinki and approved by the Springfield College Institutional Review Board for Human Subjects (IRB #3182021).

Procedures

Athlete external loads were collected over 10 weeks during the 2021 NCAA men's soccer season from "starters." External loads were collected during all in-season matches (n = 17). Information pertaining to match location, outcome and conference status was also recorded and used for later analysis.

External Load

External load was quantified during all matches using 10 Hz GPS/GNSS technology (PlayerTek, Catapult Sports, Melbourne, Australia). Previous work has reported that 10 Hz units provide a valid and reliable estimate of kinematic data with sufficient inter-unit reliability for comparisons between athletes (Johnston et al., 2014; Scott et al., 2016). GPS devices used a minimum of 3 satellites. All devices were activated 30 minutes before training to allow acquisition of satellite signals and synchronization of GPS clock with satellites atomic clock (Maddison & Ni Mhurchu, 2009). To promote reliability, players wore the same unit for each match/training session throughout the season (Buchheit et al., 2014). Devices were worn according to manufacturer guidelines in a supportive harness positioned between the scapulae (Coutts & Duffield, 2010).

External load metrics collected were: total distance (TD) (m), distance per minute (D/min) (m/min), distance in speed zones 1 (SZ1: 0-30% max speed), 2 (SZ2: 30-50% max speed), 3 (SZ3: 50-75% max speed), 4 (SZ4: 75-90% max speed,) and 5 (SZ5: > 90% max speed), sprint distance (SD) (> 5 m/s1), top speed (m/s1), acceleration efforts (> 3 m/s2), deceleration efforts (# > -3 m/s2) player load (PL) (AU) which is calculated as ∑√(instantaneous rate of change in acceleration in all 3 orthogonal planes)), and player load per minute (PL/min). Player load has been shown to be a valid and reliable measurement of total volume accrued during soccer training (Barrett et al., 2014). Additionally, maximal speed was determined for each player during preseason fitness tests and was continuously adjusted throughout the season if a player achieved a new higher speed. The use of individualized speed zones has been shown to provide more useful information regarding player velocity, especially when comparing different playing positions (Sánchez et al., 2017). Additionally, the use of individualized speed zones may be more useful when comparing higher speed zones (SZ4 and SZ5) across playing levels to modify zones based on physical abilites (Bradley & Vescovi, 2015).

Players were categorized by sport-position (forwards (n=3), midfielders (n=6), and defenders (n=7)). After each match, data were downloaded using the proprietary software, which automatically detects and removes any outlier data (Kumar et al., 2022).

Statistical Analysis

SPSS version 25.0 (IBM, Armonk, NY) was used for summary statistics. All values are presented as means ± SDs. Normality was assessed and non-normally distributed variables were log transformed for subsequent analyses. A multivariate analysis of variance (MANOVA) assessed differences in external load measures across halves, sport-position, match outcome, match location, and conference status (e.g., in-conference opponent, out-of-conference opponent) ($p < 0.05$). Bonferroni post hoc comparisons were calculated when a significant effect was identified. Partial eta² (η^2) effect sizes were calculated and interpreted as follows: small: 0.01-0.06; moderate: 0.06-0.14; and large: > 0.14.

RESULTS

A summary of external loads by half, sport-position, match outcome, match location, and conference status are presented in Table 1.

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

Table 1. Descriptive Statistics of Match Running Demands and Post Hoc Analysis (mean ± standard deviation)

	TD (m)	PL (AU)	D/min (m/min)	PL/min (AU/min)	SD (m)	Top Speed (m/s)	Accel (# > 3 m/s^2)	Decel (# > -3 m/s^2)	PP (#)	SZ1 (m)	SZ2 (m)	SZ3 (m)	SZ4 (m)	SZ5 (m)
Match (n=17)	7654 ± 2314	308 ± 97	311 ± 91	4.4 ± 0.9	160 ± 93	8.1 ± 1.5	61 ± 28	62 ± 28	54 ± 21	3651 ± 1334	2673 ± 918	1069 ± 458	139 ± 79	19 ± 22
1st half	4164 ± 1235	169 ± 52	116 ± 20	4.7 ± 0.8	80 ± 55	7.8 ± 0.9	32 ± 14	35 ± 14	30 ± 10	1979 ± 717	1520 ± 469	582 ± 222	73 ± 47	9 ± 13
2nd half	3686 ± 1463	151 ± 58	97 ± 29	4.2 ± 1.0	74 ± 58	7.7 ± 1.1	25 ± 14	28 ± 15	25 ± 12	1833 ± 777	1259 ± 534	512 ± 275	70 ± 51	10 ± 14
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	0.101	<0.001	<0.001	<0.001	0.05	0.001	0.005	0.544	0.557
Effect size														
D (n=7)	7743 ± 2519	318 ± 99	202 ± 54	4.1 ± 1.0	155 ± 93	7.7 ± 1.2	64 ± 25	69 ± 28	53 ± 19	3862 ± 1453	2665 ± 898	1083 ± 444	132 ± 76	16 ± 18
M (n=6)	7727 ± 2326	317 ± 93	211 ± 44	4.3 ± 0.8	162 ± 101	8.0 ± 1.1	61 ± 20	66 ± 24	53 ± 22	3740 ± 1192	2778 ± 987	1047 ± 482	139 ± 85	21 ± 27
F (n=3)	7302 ± 1665	286 ± 61	280 ± 91	5.5 ± 1.7	189 ± 79	9.5 ± 2.0	57 ± 23	69 ± 22	59 ± 19	3207 ± 732	2720 ± 614	1186 ± 389	165 ± 70	25 ± 21
p-value	0.441	0.542	0.072	0.177	0.324	<0.001	0.193	0.709	0.664	0.117	0.431	0.244	0.324	0.547
Effect size	0.011	0.008	0.034	0.023	0.015	0.110	0.021	0.005	0.005	0.028	0.011	0.018	0.015	0.008
Win (n=10)	7620 ± 2130	309.45 ± 83.86	216.82 ± 59.26	8.76 ± 2.26	157.35 ± 87.96	15.82 ± 3.41	60.82 ± 21.94	66 ± 23	53.81 ± 19.08	3712.85 ± 1198.65	2688.41 ± 816.40	1059.45 ± 403.27	139.52 ± 75.78	17.81 ± 21.25
Loss (n=70)	8011 ± 2630	261.23 ± 153.11	187.85 ± 111.31	7.58 ± 4.45	174.74 ± 102.52	14.59 ± 5.06	65.8 ± 26.43	72 ± 29	55.91 ± 21.32	3551.66 ± 1386.54	2486.53 ± 1098.86	966.24 ± 595.39	124.59 ± 88.40	20.59 ± 23.00
p-value	0.514	<0.001	<0.001	<0.001	0.701	0.009	0.429	0.535	0.741	0.270	0.050	0.004	0.006	<0.001
Effect size	0.003	0.110	0.092	0.102	0.001	0.044	0.004	0.003	0.001	0.008	0.025	0.053	0.049	0.117

IUSCA
International Universities Strength and Conditioning Association
Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

Home (n=9)	7935.83 ± 2376.7	321.73 ± 93.38	229.26 ± 74.58	9.24 ± 2.84	171.19 ± 94.41	16.03 ± 4.43	64.9 ± 24.23	70 ± 26	57.03 ± 20.29	3814.53 ± 1329.65	2819.48 ± 891.09	1130.63 ± 460.09	150.33 ± 80.52	20.84 ± 22.86
Away (n=8)	7575.31 ± 2269.33	258.68 ± 130.09	180.79 ± 85.49	7.32 ± 3.46	155.75 ± 92.84	14.64 ± 3.66	60.24 ± 23.13	67 ± 26	51.93 ± 19.25	3477.06 ± 1184.7	2389.03 ± 931.55	909.6 ± 485.68	116.17 ± 77.65	16.67 ± 20.70
p-value	0.473	<0.001	<0.001	<0.001	0.135	0.018	0.793	0.678	0.219	0.109	0.004	<0.001	<0.001	0.001
Effect size	0.003	0.095	0.085	0.087	0.015	0.036	0.000	0.001	0.10	0.017	0.054	0.071	0.078	0.068
NC (n=10)	7970 ± 2210	321.85 ± 88.79	228.2 ± 64.66	9.16 ± 2.45	160.75 ± 88.41	15.69 ± 4.13	63.33 ± 23.04	67 ± 26	56.89 ± 20.56	3814 ± 1299.76	2850.53 ± 795.83	1145.27 ± 456.34	142.49 ± 74.89	18.24 ± 20.41
C (n=7)	7630 ± 2390	272.43 ± 127.72	192.09 ± 90.81	7.79 ± 3.64	165.73 ± 97.28	15.15 ± 4.13	62.25 ± 24.29	70 ± 26	53.14 ± 19.44	3551.4 ± 1246.35	2463.83 ± 984.96	948.83 ± 487.53	128.61 ± 84.17	19.23 ± 22.87
p-value	0.196	0.002	<0.001	0.002	0.895	0.200	0.305	0.188	0.068	0.127	0.002	<0.001	0.034	0.004
Effect size	0.011	0.061	0.069	0.061	0.000	0.011	0.007	0.011	0.022	0.015	0.062	0.071	0.029	0.052

Values are presented in mean ± standard deviation (n = 16)

TD: Total distance (m); PL: Player Load (AU); D/min: Distance per minute (m/min); PL/min: Player Load per minute (AU/min); SD: Sprint Distance (m); Accel: Accelerations (# > 3 m/s^2); Decel: Decelerations (# > -3 m/s^2); PP: Power Plays (#); SZ: speed zone; SZ1: 0-30% max speed, SZ2: 30-50% max speed, SZ3: 50-75% max speed, SZ4: 75-90% max speed, SZ5: > 90% max speed; D: defender; M: midfielder; F: forward; C: conference; NC: non-conference

Halves

Workload differences based on playing period are displayed in Table 1. The results of the multivariate analysis indicated that TD ($p < 0.001$, partial $\eta^2 = 0.12$),), PL ($p = 0.001$, partial $\eta^2 = 0.12$), D/min ($p < 0.001$, partial $\eta^2 = 0.09$), PL/min ($p < 0.001$, partial η2 = 0.11), SD ($p < 0.001$, partial η2 = 0.05), accelerations ($p < 0.001$, partial $\eta^2 = 0.11$), decelerations (p < 0.001, partial $\eta^2 = 0.10$), PP ($p < 0.001$, partial $\eta^2 = 0.08$), and distances in SZ1 (p = 0.05, partial $\eta^2 = 0.01$), SZ2 ($p = 0.001$, partial $\eta^2 = 0.09$), and SZ3 (p=0.005, partial $\eta^2 = 0.05$) were all significantly greater in the first half. No significant differences between halves existed in top speed, SZ4 and SZ5.

Positions

Positional workload differences are displayed in Table 1. The results of the multivariate analysis indicated that forwards demonstrated significantly higher top speeds than midfielders and defenders ($p < 0.001$, partial $\eta^2 = 0.11$). No significant positional differences existed in TD, PL, D/min, PL/min, SD, accelerations, decelerations, PP, and SZ1, SZ2, SZ3, SZ4, and SZ5.

Match Outcome

Differences in workload based on match outcomes are displayed in Table 1. The results of the multivariate analysis indicated that PL ($p < 0.001$, partial $\eta^2 = 0.11$), D/min ($p < 0.001$, partial $\eta^2 = 0.092$), PL/min ($p < 0.001$, partial $\eta^2 = 0.102$), top speed ($p = 0.009$, partial $\eta^2 = 0.044$), SZ3 ($p = 0.004$, partial $\eta^2 =$

IUSCA International Universities Strength and Conditioning Association

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

0.053), SZ4 (p = 0.006, partial η^2 = 0.049) were higher in matches that resulted in wins. However, SZ5 (p < 0.001, partial η^2 = 0.117) was higher in matches that resulted in losses. No significant differences based on match outcome existed in TD, SD, accelerations, decelerations, PP, SZ1, and SZ2.

Match Location

Workload differences based on match location are displayed in Table 1. The results of the multivariate analysis indicated that PL (p<0.001, partial η^2 = 0.095), D/min (p<0.001, partial η^2 = 0.085), PL/min (p<0.001, partial η^2 = 0.087), top speed (p = 0.018, partial η^2 = 0.036), SZ2 (p = 0.004, partial η^2 = 0.054), SZ3 (p<0.001, partial η^2 = 0.071), SZ4 (p<0.001, partial η^2 = 0.078), and SZ5 (p = 0.001, partial η^2 = 0.068) were higher during home matches. No significant differences in match location existed in TD, SD, acceleration, deceleration, PP, and SZ1.

Competition Phase

Workload differences based on competition phase are displayed in Table 1. The results of the multivariate analysis indicated that PL (p = 0.002, partial η^2 = 0.061), D/min (p<0.001, partial η^2 = 0.069), PL/min (p = 0.002, partial η^2 = 0.061), SZ2 (p = 0.002, partial η^2 = 0.062), SZ3 (p<0.001, partial η^2 = 0.071), SZ4 (p = 0.034, partial η^2 = 0.029) were higher during non-conference matches. However, SZ5 (p = 0.004, partial η^2 = 0.052) was greater during conference matches. No significant differences existed between competition phase in TD, SD, top speed, acceleration, decelerations, PP, and SZ1.

DISCUSSION

This is the first study to examine match loads in NCAA DIII men's soccer throughout an entire competitive season. The goals of the current study were to provide descriptive and quantifiable information about the physical match loads experienced by NCAA DIII men's soccer players and how they may differ by half, playing position, match location, match outcome, and competition phase. The main findings were that external loads differed for all of the aforementioned parameters.

Previous reports of in-season external loads within collegiate men's soccer are limited. In NCAA DI men soccer players, match TD ranged from 8064 – 9367 m.(current study: ~7654 m), with athletes covering ~287 m of SD (> 5.8 m/sec) (current study: ~160 m), ~930 AU of PL (current study: ~308), and ~121 high acceleration efforts (# > 3 m/s^2) (current study: ~61) (Curtis et al., 2018; Fields et al., 2021; McFadden et al., 2020). Therefore, external loads at the DI level appear to be higher than those of DIII athletes in the current study. However, different GPS systems, in addition to varying sprint and acceleration zone thresholds, were used across studies (Curtis et al. (2018). These differences highlight a limitation in comparing workload between groups using different GPS systems and metrics. These subjective thresholds can potentially result in an under- or over-estimation of sprint distances, depending upon their individual physical attributes and thresholds used (Abbott et al., 2018). Further, the teams previously studied represented a higher division (DI versus DIII), thus the level of competition may influence workloads performed. However, it is important to note the rules of play and clock time are equivocal across the NCAA Division I, II and III levels.

In the current study, TD (+11.5%), PL (+10.7%), D/min (+16.4%), PL/min (+10.6%), accelerations (+22.1%), decelerations (+20%), and distances in SZ2 (+17.2%) and SZ3 (+12%) were higher in the first half of match play (See Table 1). Similar reductions have been observed in professional men's soccer players, where TD, distance/min, PL/min, and medium-high intensity running significantly declined in the second half of match play (Di Salvo et al., 2007; Slater et al., 2018; Strauss et al., 2019). Several possible explanations might provide insight into why these decrements in workload occur, such as the accumulation of physical and mental fatigue (Barros et al., 2007; Di Salvo et al., 2009; Mohr et al., 2003; Rampinini et al., 2008), or if the score is heavily one-sided it may alter exertion levels and tactical strategies (Mohr et al., 2003). While no studies have examined such changes at the DIII level, it may be important to consider these contextual factors, while seeking strategies to attenuate reductions in second half match workloads.

Different activity profiles were evident among playing-position. Forwards (9.5 ± 2 m/s) recorded higher top speeds than midfielders (8.0 ± 1.1 m/s) and defenders (7.7 ± 1.2 m/s) but no differences were observed in the number of sprint efforts or sprint distance across position (See Table 1). These findings differ from previous research in professional soccer players, which reported that forwards are commonly involved in more high-speed running and sprinting activities during match play than other positions (Curtis et al., 2020; Di Salvo et al., 2009; Gonçalves

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

et al., 2018; Reche-Soto et al., 2019). The distinction in positional demands may be attributable to the fact that forwards are required to produce higher speeds in their attempts to win balls and create distance between themselves and the defenders. Additionally, differences in external loads per position may fluctuate depending upon decisions made by players, team dynamics, playing time, or tactical strategies and formations employed by the coach. For instance, if a player is out of position, other players may have to work harder until that player recovers (Dalen et al., 2020). Tactical formation has also been shown to alter positional workloads, as workloads may change based on the configuration of defenders, midfielders, and forwards due to space allotted for each player to cover while attacking, defending, and transitioning (Calder & Gabbett, 2022). Another important consideration is that tactical assignments may vary from player to player, even within the same position from match to match (Carling et al., 2016). While positional data at the collegiate level remains limited, one study investigating five NCAA DI men's soccer teams (n=107) examined positional differences across a full-season and reported no differences in TD or high-speed running (Curtis et al., 2020). Interestingly, in a women's DIII soccer team, forwards covered some of the lowest volumes and intensities when compared to other positions (Jagim et al., 2020). Therefore, it is important to continue to examine differences in match demands across each level of play and between the men's and women's divisions in order to characterize the demands of each position. Additionally, positional classification (i.e., central vs wide players) has also shown to influence the workloads observed between positions (Abbott et al., 2018; Schuth et al., 2016). For example, it has been reported in elite men players that wide defenders tend to cover more TD (11,410 ± 708 m) and sprint distance (402±165 m) than central defenders (TD: 10,627 ± 893 m; sprint distance: 215±100 m (Di Salvo et al., 2007). However, due to the smaller sample size used in the current study, these positional classifications could not be analyzed, but should be considered for future research. Classifying players to these positional groupings may pose a challenge at the collegiate level, as players may re-enter the match into a different position after being substituted (Altmann et al., 2021). Establishing position-specific competition demands will further allow coaches to specialize training sessions to fulfill players' physical needs based on their match demands.

The results from the current study demonstrate that PL (309.45 vs 261.23 AU), PL/min (8.76 vs 7.58 AU/min), D/min (216.82 vs 187.85 m/min), top speed (15.82 vs 14.59 m/s), and distances in SZ3 (1059.45 vs 966.24 m) and SZ4 (139.52 vs 124.59 m) were greater in wins (n=10) compared to losses (n=7). However, distances in SZ5 (20.59 vs 17.81 m) were greater in losses (See Table 1). Limited attention has been paid to quantifying differences in loads by match outcome, but preliminary findings have demonstrated that professional soccer players perform significantly fewer high-intensity movement patterns during wins compared to losses (Bloomfield et al., 2005 Lago et al. 2010). This phenomenon suggests that players may assume a ball retention strategy when winning, resulting in a slower pace of play with attenuated speeds (Bloomfield et al., 2005 Lago et al. 2010). On the other hand, when losing, players may try to increase their physical outputs to gain ball possession to improve the likelihood of scoring. Other research found higher external loads in wins, but higher TD and high-speeds running distances in the second half of losses. (Nobari et al., 2021). This may be attributed to a closer score, which may be associated with various motivational implications, amongst other variables.

Match location appeared to influence differences in external loads as current results indicated PL (321.73 vs 258.69 AU), D/min (229.26 vs 180.79 m/min), PL/min (9.24 vs 7.32 AU/min), top speed (16.03 vs 14.64 m/s), and distances in SZs 2-5 (2819.48 vs 2389.03 m, 1130.63 vs 909.6 m, 150.33 vs 116.17 m, and 20.84 vs 16.67 m, respectively) were higher during home matches (n=9) compared to away matches (n=8) (See Table 1). Although data in regard to match location and external loads remain limited, current findings are in support of a prior study showing professional men's soccer players covered greater TD at home matches. (Lago et al., 2009; Zubillaga et al., 2007). Home advantage in soccer is well-known and players may have taken advantage of the familiar crowd, playing surface, absence of travel, pride, and other psychological factors that may result in greater effort and more movement (Pollard, 2008). It is recommended that future studies investigate the effect of match location in collegiate-specific populations.

Lastly, PL (321.85 vs 272.43 AU), distance/min (228.2 vs 192.09 m/min), PL/min (9.16 vs 7.79 AU/min), and distances in SZs 2-4 (2850.53 vs 2463.83 m, 1145.27 vs 948.83 m, and 142.49 vs 128.61 m respectively) were higher during non-conference matches (n=7) than conference matches (n=10), while distances in SZ5 (19.23 vs 18.24 m) were higher during conference matches (See Table 1). These findings align with previous research in NCAA DI women's

IUSCA International Universities Strength and Conditioning Association

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

soccer players, where non-conference matches elicited greater training loads, TDs, and energy expenditures relative to conference play (Bozzini et al., 2020). Of important note, the first four matches of the season were played against non-conference opponents; therefore, it is likely players produced greater workloads because they had not experienced much accumulated fatigue from the upcoming season (Gualtieri et al., 2020). Another explanation for the greater workloads observed in non-conference play man be attributed to the higher frequency of player substitutions as players are competing for a starting spot on the roster (Bozzini et al., 2020). This aggressive play coupled with the potential for higher quality opponents, could potentially lead to the increased external loads observed in non-conference matches. Further exploration of such differences is warranted to ensure athletes are balancing progressive overload and recovery during accumulating in-season demands and conference play (Bozzini et al., 2020).

This study does not come without limitations. First, data was collected from one NCAA Division III men's team in the northeast region and therefore may not be comparable to teams in other divisions or regions. Further, the small sample size (n=16) prevented additional positional classifications (i.e., central vs wide defenders). It's also important to note that tactical decisions including formation and substitutions may have also influenced match demands. Lastly, the current study used Playertek GPS systems, which may differ from other GPS systems in its satellite recruitment and filtering threshold.

This is the first examination of external workload match demands in DIII men's soccer players over the course of an entire season. Our results indicate that external loads were affected by half, position, match outcome, match location, and competition phase. Further research exploring interactions between contextual factors affecting external loads in competitive soccer is warranted. Such contextual variables, which result in changes in workload and performance, may be considered for more appropriate load prescriptions and improved programming for load management and periodization strategies during congested match schedules. Additionally, future research should consider examining accumulated fatigue and fluctuations in workload during training leading up to matches to optimize training without hindering match performance. Coaches may use this information to identify key performance indicators and tailor practice activities that will maximize their technical and physical performance for matches.

REFERENCES

1. Abbott, W., Brickley, G., & Smeeton, N. J. (2018). Physical demands of playing position within English Premier League academy soccer.
2. Altmann, S., Forcher, L., Ruf, L., Beavan, A., Groß, T., Lussi, P., Woll, A., & Härtel, S. (2021). Match-related physical performance in professional soccer: Position or player specific? Plos one, 16(9), e0256695.
3. Andres, K. (2021). NCAA Men's and Women's Soccer Rules. National Collegiate Athletic Association.
4. Andrzejewski, M., Chmura, J., Pluta, B., & Konarski, J. M. (2015). Sprinting activities and distance covered by top level Europa league soccer players. International Journal of Sports Science & Coaching, 10(1), 39-50.
5. Barrett, S., Midgley, A., & Lovell, R. (2014). PlayerLoad™: reliability, convergent validity, and influence of unit position during treadmill running. International journal of sports physiology and performance, 9(6), 945-952.
6. Barros, R. M., Misuta, M. S., Menezes, R. P., Figueroa, P. J., Moura, F. A., Cunha, S. A., Anido, R., & Leite, N. J. (2007). Analysis of the distances covered by first division Brazilian soccer players obtained with an automatic tracking method. Journal of Sports Science & Medicine, 6(2), 233.
7. Bloomfield, J., Polman, R., & O'Donoghue, P. (2007). Physical demands of different positions in FA Premier League soccer. Journal of Sports Science & Medicine, 6(1), 63.
8. Bourdon, P. C., Cardinale, M., Murray, A., Gastin, P., Kellmann, M., Varley, M. C., Gabbett, T. J., Coutts, A. J., Burgess, D. J., & Gregson, W. (2017). Monitoring athlete training loads: consensus statement. International journal of sports physiology and performance, 12(s2), S2-161-S162-170.
9. Bozzini, B. N., McFadden, B. A., Walker, A. J., & Arent, S. M. (2020). Varying Demands and Quality of Play Between In-Conference and Out-of-Conference Games in Division I Collegiate Women's Soccer. The Journal of Strength & Conditioning Research, 34(12), 3364-3368.
10. Bradley, P. S., Carling, C., Diaz, A. G., Hood, P., Barnes, C., Ade, J., Boddy, M., Krustrup, P., & Mohr, M. (2013). Match performance and physical capacity of players in the top three competitive standards of English professional soccer. Human movement science, 32(4), 808-821.
11. Bradley, P. S., & Noakes, T. D. (2013). Match running performance fluctuations in elite soccer: indicative of fatigue, pacing or situational influences? Journal of sports sciences, 31(15), 1627-1638.
12. Bradley, P. S., & Vescovi, J. D. (2015). Velocity thresholds for women's soccer matches: Sex specificity dictates high-speed-running and sprinting thresholds—female athletes in motion (FAiM). International

IUSCA International Universities Strength and Conditioning Association

Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

journal of sports physiology and performance, 10(1), 112-116.
13. Buchheit, M., Al Haddad, H., Simpson, B. M., Palazzi, D., Bourdon, P. C., Di Salvo, V., & Mendez-Villanueva, A. (2014). Monitoring accelerations with GPS in football: time to slow down? International journal of sports physiology and performance, 9(3), 442-445.
14. Calder, A., & Gabbett, T. (2022). Influence of Tactical Formation on Average and Peak Demands of Elite Soccer Match-Play. International Journal of Strength and Conditioning, 2(1).
15. Carling, C., Bradley, P., McCall, A., & Dupont, G. (2016). Match-to-match variability in high-speed running activity in a professional soccer team. Journal of sports sciences, 34(24), 2215-2223.
16. Carling, C., Le Gall, F., & Dupont, G. (2012). Are physical performance and injury risk in a professional soccer team in match-play affected over a prolonged period of fixture congestion? International journal of sports medicine, 33(01), 36-42.
17. Coutts, A. J., & Duffield, R. (2010). Validity and reliability of GPS devices for measuring movement demands of team sports. Journal of Science and Medicine in Sport, 13(1), 133-135.
18. Curtis, R. M., Huggins, R. A., Benjamin, C. L., Sekiguchi, Y., Adams, W. M., Arent, S. M., Jain, R., Miller, S. J., Walker, A. J., & Casa, D. J. (2020). Contextual factors influencing external and internal training loads in collegiate men's soccer. The Journal of Strength & Conditioning Research, 34(2), 374-381.
19. Curtis, R. M., Huggins, R. A., Looney, D. P., West, C. A., Fortunati, A., Fontaine, G. J., & Casa, D. J. (2018). Match Demands of National Collegiate Athletic Association Division I Men's Soccer. The Journal of Strength & Conditioning Research, 32(10), 2907-2917. https://doi.org/10.1519/jsc.0000000000002719
20. Dalen, T., Aune, T. K., Hjelde, G. H., Ettema, G., Sandbakk, Ø., & McGhie, D. (2020). Player load in male elite soccer: Comparisons of patterns between matches and positions. Plos one, 15(9), e0239162.
21. Di Salvo, V., Baron, R., Tschan, H., Montero, F. C., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. International journal of sports medicine, 28(03), 222-227.
22. Di Salvo, V., Gregson, W., Atkinson, G., Tordoff, P., & Drust, B. (2009). Analysis of high intensity activity in Premier League soccer. International journal of sports medicine, 30(03), 205-212.
23. Fields, J., Merrigan, J., Feit, M. K., & Jones, M. (2021). Practice Versus Game External Load Measures in Starters and Non-Starters of a Men's Collegiate Soccer Team. International Journal of Strength and Conditioning, 1(1).
24. Gonçalves, B., Coutinho, D., Travassos, B., Folgado, H., Caixinha, P., & Sampaio, J. (2018). Speed synchronization, physical workload and match-to-match performance variation of elite football players. Plos one, 13(7), e0200019.
25. Gualtieri, A., Rampinini, E., Sassi, R., & Beato, M. (2020). Workload monitoring in top-level soccer players during congested fixture periods. International journal of sports medicine, 41(10), 677-681.
26. Jagim, A. R., Murphy, J., Schaefer, A. Q., Askow, A. T., Luedke, J. A., Erickson, J. L., & Jones, M. T. (2020). Match demands of women's collegiate soccer. Sports, 8(6), 87.
27. Johnston, R. J., Watsford, M. L., Kelly, S. J., Pine, M. J., & Spurrs, R. W. (2014). Validity and interunit reliability of 10 Hz and 15 Hz GPS units for assessing athlete movement demands. The Journal of Strength & Conditioning Research, 28(6), 1649-1655.
28. Kumar, P. S., Mohiddin, M., Gemeda, M. T., & Mishra, A. (2022). GPS Receiver Position Estimation and DOP Analysis Using a New Form of the Observation Matrix Approximations. Journal of Sensors, 2022.
29. Lago, C., Casáis, L., Domínguez, E., Lago, J., & Rey, E. (2009). The effect of match location, quality of opposition and match status on work rate in elite soccer. European Journal of Human Movement, 23, 107-121.
30. Lago-Peñas, C. (2012). The role of situational variables in analysing physical performance in soccer. Journal of human kinetics, 35, 89-95. https://doi.org/10.2478/v10078-012-0082-9
31. Lago-Peñas, C., Rey, E., Lago-Ballesteros, J., Casáis, L., & Domínguez, E. (2011). The influence of a congested calendar on physical performance in elite soccer. The Journal of Strength & Conditioning Research, 25(8), 2111-2117.
32. Maddison, R., & Ni Mhurchu, C. (2009). Global positioning system: a new opportunity in physical activity measurement. International Journal of Behavioral Nutrition and Physical Activity, 6(1), 1-8.
33. McFadden, B. A., Walker, A. J., Bozzini, B. N., Sanders, D. J., & Arent, S. M. (2020). Comparison of internal and external training loads in male and female collegiate soccer players during practices vs. games. The Journal of Strength & Conditioning Research, 34(4), 969-974.
34. Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. Journal of sports sciences, 21(7), 519-528.
35. Mohr, M., Krustrup, P., & Bangsbo, J. (2005). Fatigue in soccer: a brief review. Journal of sports sciences, 23(6), 593-599.
36. Nobari, H., Oliveira, R., Brito, J. P., Pérez-Gómez, J., Clemente, F. M., & Ardigò, L. P. (2021). Comparison of running distance variables and body load in competitions based on their results: a full-season study of professional soccer players. International journal of environmental research and public health, 18(4), 2077.
37. Oliva-Lozano, J. M., Rojas-Valverde, D., Gómez-Carmona, C. D., Fortes, V., & Pino-Ortega, J. (2021). Impact of contextual variables on the representative external load profile of Spanish professional soccer match-play: A full season study. European journal of sport science, 21(4), 497-506.
38. Paul, D. J., Bradley, P. S., & Nassis, G. P. (2015). Fac-

IUSCA International Universities Strength and Conditioning Association
Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).

tors affecting match running performance of elite soccer players: shedding some light on the complexity. International journal of sports physiology and performance, 10(4), 516-519.
39. Pollard, R. (2008). Home advantage in football: A current review of an unsolved puzzle. The open sports sciences journal, 1(1).
40. Rampinini, E., Impellizzeri, F. M., Castagna, C., Azzalin, A., & Wisløff, U. (2008). Effect of match-related fatigue on short-passing ability in young soccer players. Medicine and science in sports and exercise, 40(5), 934-942.
41. Ranchordas, M. K., Dawson, J. T., & Russell, M. (2017). Practical nutritional recovery strategies for elite soccer players when limited time separates repeated matches. Journal of the International Society of Sports Nutrition, 14(1), 35.
42. Reche-Soto, P., Cardona-Nieto, D., Diaz-Suarez, A., Bastida-Castillo, A., Gomez-Carmona, C., Garcia-Rubio, J., & Pino-Ortega, J. (2019). Player load and metabolic power dynamics as load quantifiers in soccer. Journal of human kinetics, 69(1), 259-269.
43. Sánchez, F. J. N., Bendala, F. J. T., Vázquez, M. Á. C., & Moreno-Arrones, L. J. S. (2017). Individualized speed threshold to analyze the game running demands in soccer players using GPS technology. Retos: nuevas tendencias en educación física, deporte y recreación(32), 130-133.
44. Schuth, G., Carr, G., Barnes, C., Carling, C., & Bradley, P. (2016). Positional interchanges influence the physical and technical match performance variables of elite soccer players. Journal of sports sciences, 34(6), 501-508.
45. Scott, M. T. U., Scott, T. J., & Kelly, V. G. (2016). The Validity and Reliability of Global Positioning Systems in Team Sport: A Brief Review. The Journal of Strength & Conditioning Research, 30(5), 1470-1490. https://doi.org/10.1519/jsc.0000000000001221
46. Slater, L. V., Baker, R., Weltman, A. L., Hertel, J., Saliba, S. A., & Hart, J. M. (2018). Activity monitoring in men's college soccer: a single season longitudinal study. Research in Sports Medicine, 26(2), 178-190.
47. Strauss, A., Sparks, M., & Pienaar, C. (2019). The use of GPS analysis to quantify the internal and external match demands of semi-elite level female soccer players during a tournament. Journal of Sports Science & Medicine, 18(1), 73.
48. Zubillaga, A., Gorospe, G., Mendo, A., & VillaSenor, A. (2007). Match analysis of 2005-06 champions league final with Amisco system. J Sports Sci Med, 6(10), 20.

IUSCA International Universities Strength and Conditioning Association
Copyright: © 2023 by the authors. Licensee IUSCA, London, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/).