Seasonal Accumulated Workloads in Collegiate Men's Soccer: A Comparison of Starters and Reserves

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[1]Korey Stringer Institute, Department of Kinesiology, Korey Stringer Institute, University of Connecticut, Storrs, Connecticut; [2]IFNH Center for Health & Human Performance, Rutgers University, New Brunswick, New Jersey; [3]Department of Kinesiology and Health, Rutgers University, New Brunswick, New Jersey; [4]Department of Athletics, The Pennsylvania State University, State College, Pennsylvania; [5]Department of Athletics, Northwestern University, Evanston, Illinois; and [6]Department of Athletics, University of Connecticut, Storrs, Connecticut

Abstract

Curtis, RM, Huggins, RA, Benjamin, CL, Sekiguchi, Y, Arent, S, Armwald, B, Pullara, JM, West, CA, and Casa, DJ. Seasonal accumulated workloads in collegiate men's soccer: a comparison of starters and reserves. *J Strength Cond Res* 35(11): 3184–3189, 2021—The purpose of this investigation was to quantify and compare player's season total-, match-, and training-accumulated workload by player status characteristics (i.e., starter vs. reserve) in American collegiate men's soccer. Global positioning system (GPS) and heart rate (HR)-derived workloads were analyzed from 82 collegiate male soccer athletes from 5 separate teams over the 2016 and 2017 seasons. Differences in total physical and physiological workloads (i.e., total distance, accelerations, and weighted HR-zone training impulse [TRIMP] score) as well as workloads over a range of intensity zones were examined using multilevel mixed models, with mean difference (MD) and effect size (ES) reported. Starters accumulated substantially more total distance (MD = 82 km, ES = 1.23), TRIMP (MD = 2,210 au, ES = 0.63), and total accelerations (MD = 6,324 n, ES = 0.66) over the season. Total accumulated distance in all velocity zones (ES [range] = 0.87–1.08), all accelerations zones (ES [range] = 0.54–0.74), and time spent at 70–90% HRmax (ES [range] = 0.60–1.12) was also greater for starters. Reserves accumulated substantially more total distance (MD = 20 km, ES = 0.43) and TRIMP (MD = 1,683 au, ES = 0.79) during training. Although reserves show elevated physical and physiological loads during training compared with starters, there is an imbalance in overall workloads between player roles, with starters incurring substantially more match and total seasonal workloads. These results indicate managing player workloads in soccer requires attention to potential imbalances between players receiving variable match times. Coaches and practitioners in collegiate men's soccer may consider implementing strategies to reduce discrepancies in loading between starters and reserves. Individualized monitoring of training and match workloads may assist in the implementation of more balanced load management programs.

Key Words: technology, player tracking, team sports, global positioning systems, mixed models

Introduction

The tracking of physical and physiological workloads is an ever-evolving, practical tool used to manage fitness, injury risk, and overall player development in high-performance sport. Although coaches and athletes look for ways to amass marginal gains throughout arduous and congested seasons, accounting for accumulated stresses through the alteration of training workload remains the primary modifier available (32). A body of workload literature in soccer has focused on quantifying the demands of both match-play and training. This has led to an inundation of research investigating physical, physiological, and perceptual match workloads in a range of soccer cohorts, including elite men (3,5,11), women (26), and youth (7). Similarly, reports have quantified the training demands of soccer, which have largely been conducted with professional players (1,2,17,27,28). Although professional soccer has received much of the attention in workload research, quantification of loading in other competitive soccer standards is lacking, particularly in American collegiate men's soccer. However, improvements in microtechnology accuracy and cost have spurred an influx in objective workload tracking and thus expanding the ability to quantify workloads at all levels of soccer.

The physical and physiological loads sustained during American collegiate soccer match play have been described (9), with players accumulating 9,367 ± 2,149 m of total distance and 1,700 ± 369 m of high-speed distance (HSD >14.4 km·h^{-1}) (9). In addition, players accumulate ~1,900 accelerations and average 78 ± 8% of their maximum heart rate (HR) during matches (9). Likewise, unpublished investigations on the training demands of American collegiate soccer by our group indicate players average ~4,500 m of total distance, 550 m of HSD (>14.4 km·h^{-1}), and average 65% of HR maximum during a single in-season training session. Research to date has predominantly reported average loads sustained during individual match and training sessions; however, questions remain unanswered regarding the typical accumulated physical loading experience throughout an entire

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season. Seasonal physical loads will likely vary because of discrepancies between players in accumulated match time, suggesting physical performance and biological responses also will concurrently vary. Indeed, previous research has shown decrements in performance tests (i.e., vertical jump and sprint speed) during a season to be more pronounced in starters when compared with reserves in American collegiate soccer (25). Furthermore, discrepancies in match-time have been shown to directly influence aspects of physical fitness (30) and various aspects of technical and tactical skill, thus creating a difficult scenario for those managing player workloads to overcome. Any differences in loading noted between starting and reserve players may aid coaches in individualizing and optimizing on-field training and fitness programs throughout the highly saturated (i.e., ~25 matches in 15 weeks) collegiate soccer season (9).

The purpose of this investigation was to quantify and compare season total-, match-, and training-accumulated loading characteristics by player status (i.e., starter vs. reserve) in American collegiate soccer. In addition, we sought to investigate the magnitude of differences in total distance, counts, and minutes accumulated throughout a range of velocity, acceleration, and relative HR intensity zones, respectively. To the best of our knowledge, this is the first investigation of accumulated loads sustained throughout an American collegiate men's soccer season.

Methods

Experimental Approach to the Problem

This investigation was a prospective cohort study conducted with 5 NCAA Division I men's soccer teams over the full 2016 (1 team) and 2017 (4 teams) soccer seasons (August–November). Workload data are reported for field-based training and match sessions. A total of 6,495 individual player sessions were recorded during the season ($n = 4,593$ training, $n = 1,902$ match). To minimize the effect of inadequate session recording on accumulated totals, players were excluded from the analysis if they recorded <75% of the total number of training sessions or matches of their respective team ($n = 7$) or if they were injured for >2 weeks ($n = 11$). Goalkeepers were also excluded from this analysis ($n = 7$). After exclusion of players due to inadequate recording, injury, or goalkeeper status, a total of 82 players were analyzed. Currently, there is not consensus regarding appropriate classification of starter and reserve soccer players when investigating multiple matches over an entire competitive season. Similar to previous research with professional soccer players, which categorized players by starting status based on the proportion of matches started throughout the season (>60% of matches started) (2), we classified player roles by the combination of total matches started and total seasonal match minutes. This was necessary to account for the frequent substitution strategies often used in NCAA collegiate soccer, whereby a player may not start the match but still receives substantial playing time. Players were considered starters ($n = 48$) if they started in greater than 60% of the total matches in the season and accumulated greater than 60% of the total season's match minutes; all other players were considered reserves ($n = 34$). A total of 5,217 observations (starters = 3,019; reserves = 2,198) were used to create accumulated data for each of the 82 players included in this analysis. Accumulated data sets were created for all sessions combined, match sessions only (starters = 960; reserves = 660), and training sessions only (starters = 2,059; reserves = 1,538).

Subjects

The National Collegiate Athletics Association (NCAA) Division I male collegiate soccer players ($n = 107$; age, 20 ± 2 years; body mass, 77.4 ± 5.1 kg; height, 179.9 ± 6.5 cm; %body fat, 9.9 ± 2.4%; $\dot{V}O_2max$, 53.8 ± 4.1 ml·kg^{-1}·min^{-1}) from 5 separate universities participated in this study. All subjects were medically cleared for physical activity by their respective university's sports medicine department and free of any debilitating musculoskeletal injuries or contraindicated medical conditions. An institutional review board approval was obtained from all institutions with primary oversight and coordination provided by the University of Connecticut (IRB Approval ID: H17-134). All subjects provided written informed consent before the season. When the subject was younger than 18 years of age, parental consent was obtained.

Procedures

HR and GPS player tracking devices (Polar Team Pro; Polar Electro, Bethpage, NY) was used to capture physical and physiological workloads during all training sessions and matches. The 10-Hz GPS player tracking device has reported accuracy and reliability outdoors for 40- and 100-m total distances at 4 separate movement (i.e., walk, jog, run, and sprint) velocities (mean difference [MD] = −1.04 to −2.78 m; coefficient of variation = 1.17–3.16%) and during a team sport simulation circuit (MD = 0.23 m; coefficient of variation = 0.96%) (18). To avoid interunit errors, players wore the same device for each training sessions (6). Players donned the player tracking device before the beginning of the session warm-up and wore it through the end of the last organized training or match event. All on-field session time was recorded for each player including warm-ups, match/training, and cooldowns. After each match or training session was complete, data were uploaded and subsequently exported to Microsoft excel spreadsheets (Microsoft Corporation, Redmond, WA) for analysis.

A range of parameters were selected for analysis including total distance covered, distance covered in various velocity zones (VZ), minutes recorded in a range of relative maximum HR zones (HRZ = HR zone), and counts of accelerations in various zones (AZ = acceleration zone). Locomotor data were grouped according to the following VZ: VZ1, 0–7.19 km·h^{-1}; VZ2, 7.20–14.39 km·h^{-1}; VZ3, 14.40–19.79 km·h^{-1}; VZ4, 19.8–25.19 km·h^{-1}, and VZ5, >25.2 km·h^{-1}. Velocity zones were interpreted by using the following categorizations: VZ1 = walk; VZ2 = jog; VZ3 = run; VZ4 = high-speed run (HSR); and VZ5 = sprint. Thresholds for locomotion were selected based on typical ranges specific to men's soccer (1,5,12) and are consistent with the recommendations of Dwyer and Gabbett (13) Acceleration data were grouped based on the following thresholds: AZ1, 0–0.99 m·s^2; AZ2, 1–1.99 m·s^2; AZ3, 2–2.99 m·s^2; and AZ4, >3 m·s^2. Similar acceleration and deceleration thresholds have been used previously in men's soccer (34). Although a range of velocity and acceleration data were observed, it should be noted that measurement accuracy has shown to decrease with higher velocity movements (10,33). In addition to quantification of external loads through velocity and acceleration data, physiological workloads were assessed by recording minutes attained in various zones relative to each athlete's maximum HR (%HRmax). Zones were grouped according to the following %HRmax thresholds: HRZ1, <50%; HRZ 2, 50–59%; HRZ3, 60–69%; HRZ4, 70–79%; HRZ5, 80–89%; and HRZ6, >90%. A weighted training impulse (TRIMP) feature was engineered according to Edward's method (TRIMP) to get a broader representation of HR-based physiological loading over the season (14). Each athlete's maximum HR and estimated maximal oxygen uptake were assessed during their respective team's preseason fitness testing, which consisted of either a repeated sprint test (Yo-Yo

Intermittent Recovery Test or 30–15 Intermittent Fitness Test) or incremental treadmill run to exhaustion by respirometry (TrueOne; Parvo Medics, Sandy, UT).

Statistical Analyses

Multilevel mixed models were used to assess differences between starters and reserves for all dependent variables. Mixed modeling was used for its ability to handle unbalanced fixed factors and to account for repeated measures (8), which occurred with multiple players within multiple teams. To account for between-team variance in accumulated workloads, a multilevel random intercept was set with players nested within their respective team. Mean differences were divided by the between-group standard deviation to determine a standardized effect size (ES). Effect size ± confidence intervals (ES ± 90% confidence interval [CI]) were used to quantify the magnitude of differences. Effect size was interpreted according to the following thresholds: <0.2 = trivial, 0.2–0.6 = small, 0.7–1.1 = moderate, 1.2–2.0 = large, and >2.0 = very large (4). Differences were considered practically important and substantial where there was >75% likelihood of exceeding the smallest important ES value (0.2), and classifications were set at 25–75%, "possibly"; 75–94%, "likely"; 95–99%, "very likely"; and >99%, "almost certainly." When the 90% CI simultaneously crossed positive and negative smallest important ES values, the effect was considered "unclear" (4). Chances of a greater or smaller substantial true difference were expressed quantitatively and calculated using a custom-made Excel spreadsheet (20). Mean, *SD*, and MDs between groups are reported. Statistical analyses and plotting were conducted in R Studio (Version 3.5.2, R Core Team) with the lme4, ggeffect, and ggplot2 packages.

Results

Teams in this investigation played 20 ± 2 matches and completed 48 ± 6 training sessions over the course of 14 ± 1 week. Starters accumulated 79.2 ± 18.8% of the total match minutes and started in 81.6 ± 22.1% of the total matches equating to 15 ± 4 starts during the season. Reserves accumulated 19.6 ± 19.8% of the total match minutes and started in 16.8 ± 21.4% of the total matches equating to 3 ± 4 starts during the season.

Figures 1A–C display accumulated season-long workloads for total distance (km), TRIMP (au), and total accelerations (count), respectively. There was an almost certain large difference in total distance covered during the season (MD = 82 km, ES ± 90% CI = 1.23 ± 0.6), with reserves covering 80% of the total distance of starters. Starters accumulated very likely more TRIMP (MD = 2,210 au, ES = 0.63 ± 0.9) and total accelerations (MD = 6,324 n, ES = 0.66 ± 0.38) during the season. Reserves covered almost certainly less distance during matches, with the difference being very large (MD = 103 km, ES = 2.1 ± 1.0). However, starters showed likely less accumulated distance during training sessions than reserves with the difference being small but substantial (MD = −20 km, ES = −0.43 ± 0.38). Similarly, starters accumulated very likely less TRIMP during training than reserves (MD = 1,662,

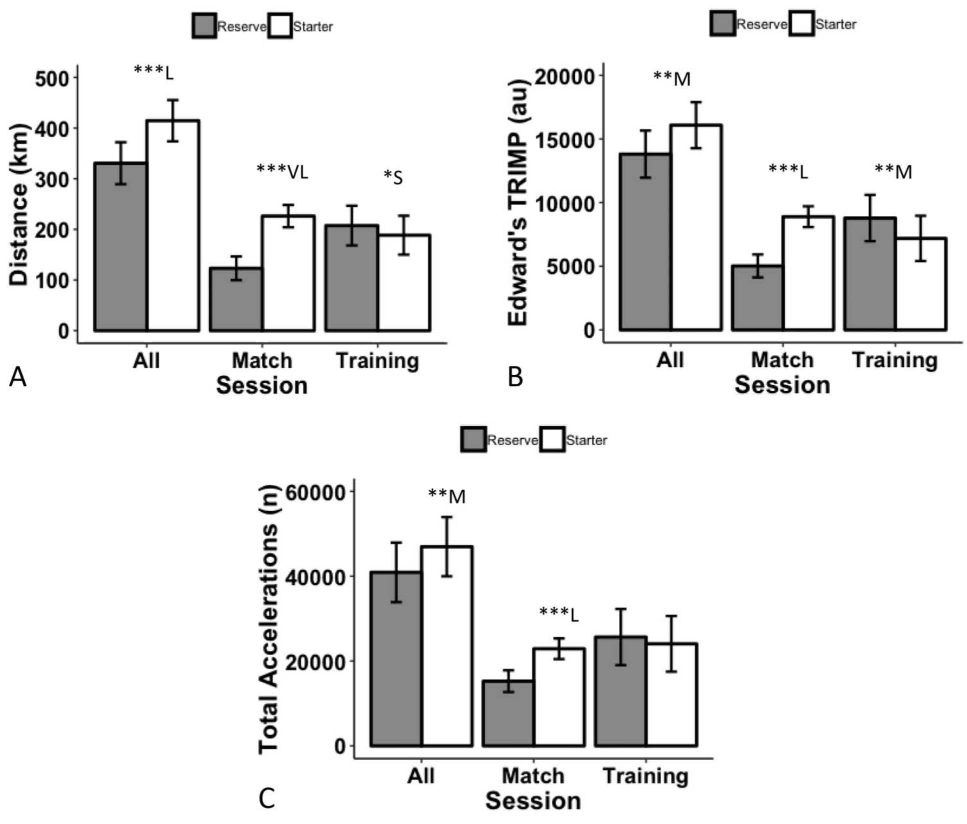

Figure 1. A–C) Accumulated total distance (A), TRIMP (B), and total accelerations (C) by starting status for all, matches only, and training session only. Indicators with markers indicate a difference from reserves. *A likely deviation from smallest meaningful difference; **A very likely deviation from smallest meaningful difference; ***An almost certain deviation from smallest meaningful difference. Effect size abbreviations: S = small, M = moderate, L = large, VL = very large.

ES = −0.79 ± 0.55). There was an almost certain very large difference in accumulated match-day accelerations (MD = 7,639 n, ES = 1.74 ± 0.85). No substantial differences were seen in total accumulated accelerations during training (MD = 1,515 n, ES = −0.2 ± 0.38).

Tables 1–3 display zone-specific accumulated workloads for all sessions, match days only, and training days only, respectively. Velocity zones, HRZ, and AZ metrics are displayed in accumulated kilometers, minutes, and counts, respectively. Total accumulated distance in all VZs (ES [range] = 0.87–1.08), all accelerations zones (ES [range] = 0.54–0.74), and time spent at 70–90% HRmax (ES [range] = 0.60–1.12) was greater for starters than reserves. During matches, starters accumulated substantially more minutes above 60% HRmax (ES [range] = 0.85–2.27) and reserves substantially more minutes below 60% HRmax (ES [range] = 0.42–1.78). During training, reserves accumulated substantially more distance jogging (ES = 0.42), running (ES = 0.64), and high-speed running (ES = 0.59) than starters, while also accumulating more minutes >70% HRmax (ES [range] = 0.38–0.93).

Discussion

This study aimed to quantify and profile accumulated season total, match, and training workloads in American collegiate men's soccer, while exploring differences between starters and reserves. This investigation revealed several practically meaningful differences in physical and physiological workloads between starters and reserves in collegiate men's soccer. The main finding of this study was the substantial gap in total accumulated workloads between starters and reserves throughout the American collegiate men's soccer season.

Description of accumulated seasonal workloads in soccer is limited to an investigation by Anderson et al. (2), which quantified the accumulated total, match, and training duration, total distance, and distance covered in high-speed zones (>14.4 km·h^{-1}) in English Premiere League (EPL) players. In comparison with their study, which showed starting status to have no effect on the total volume of workload complete over an EPL season, our investigation found substantial differences between player roles for both total distance, TRIMP, and accelerations in an American collegiate soccer season (Figure 1). As shown in Table 1, distance in a range of locomotor zones, from walking to sprinting, was substantially higher for starters when compared with reserves (ES [range] = 0.87–1.08). Starters also accumulated substantially more total accelerations and acceleration in a full range of intensities throughout the season (ES [range] = 0.54–0.74). The discrepancies between starters and reserves for both physical and physiological loads over the season was due to match loading of starters, which showed large to very large differences between player roles for all distance and AZs.

With a gap in total seasonal workloads between player status evident, it is unclear whether starters were overloaded, reserves were under-loaded, or whether a combination of the 2 were occurring throughout the season. Previous studies have investigated physical and performance responses to a full collegiate men's soccer season by starting status (25,31), with conflicting results being shown. Specifically, Silvestre et al. found no difference in physical and performance characteristics between starters and reserves (25), whereas Kraemer et al. found starters but not reserves to have exacerbated end of season performance decrements (i.e., vertical jump height [−13.8%] and sprint speed [+4.3%]) when compared with preseason values ($p < 0.05$) (31). Although performance responses were not studied here, our results demonstrate a substantial discrepancy exists in physical and physiological accumulated loads between starter and reserve players, with this effect likely owed to the highly saturated season. The saturated NCAA soccer season is of concern for starters as research by Ekstrand et al. (15) indicate periods of match congestion can lead to fatigue, increasing the risk of injury and underperformance during subsequent time periods. With the average match occurrence in American collegiate soccer about every 4 days (9), and

Table 1

Total accumulated workloads in NCAA Division I men's soccer by starting status (mean ± *SD*).*†

Variable	Reserve	Starter	*p*	ES 90% CI	MBI
VZ1 (km)	162 ± 32	196 ± 31	<0.001	1.08 ± 0.53	M§
VZ2 (km)	126 ± 33	159 ± 31	<0.001	1.04 ± 0.50	M§
VZ3 (km)	33 ± 11	44 ± 12	<0.001	0.95 ± 0.46	M§
VZ4 (km)	10 ± 4	14 ± 4	<0.001	0.89 ± 0.43	M§
VZ5 (km)	3 ± 1	4 ± 2	<0.001	0.87 ± 0.42	M§
HRZ1 (min)	2,219 ± 846	1,661 ± 756	0.003	−0.70 ± 0.38	M§
HRZ2 (min)	1,613 ± 356	1,586 ± 355	0.738	−0.08 ± 0.38	NS
HRZ3 (min)	1,273 ± 300	1,366 ± 291	0.165	0.32 ± 0.38	NS
HRZ4 (min)	999 ± 224	1,154 ± 282	0.007	0.60 ± 0.36	S‡
HRZ5 (min)	964 ± 254	1,273 ± 290	<0.001	1.12 ± 0.54	M‡
HRZ6 (min)	586 ± 402	656 ± 377	0.432	0.18 ± 0.38	NS
AZ1 (count)	25,710 ± 5,542	28,670 ± 5,369	0.018	0.54 ± 0.33	S‡
AZ2 (count)	11,882 ± 3,350	14,193 ± 3,057	0.002	0.73 ± 0.38	M‡
AZ3 (count)	2,671 ± 895	3,312 ± 839	0.002	0.74 ± 0.39	M‡
AZ4 (count)	689 ± 262	852 ± 302	0.002	0.57 ± 0.30	S‡

*CI = confidence interval; NS = not substantial (trivial or unclear); ES = effect size; S = small; M = moderate; L = large; VL = very large.
†Velocity Zone Abbreviations: VZ1 (walk), 0–7.19 km·h^{-1}; VZ2 (jog), 7.20–14.39 km·h^{-1}; VZ3 (run), 14.40–19.79 km·h^{-1}; VZ4 (high-speed run), 19.8–25.19 km·h^{-1}, and VZ5 (sprint), >25.2 km·h^{-1}. Heart Rate Zone Abbreviations: HRZ1, <50%; HRZ2, 50–59%; HRZ3, 60–69%; HRZ4, 70–79%; HRZ5, 80–89%; and HRZ6, >90%. Acceleration Zone Abbreviations: AZ1, 0–0.99 m·s^2; AZ2, 1–1.99 m·s^2; AZ3, 2–2.99 m·s^2; and AZ4, >3 m·s^2.
‡A very likely deviation from smallest meaningful difference.
§An almost certain deviation from smallest meaningful difference.

Table 2

Accumulated match-day workloads in NCAA Division I men's soccer by starting status (mean ± *SD*).*†

Variable	Reserve	Starter	*p*	ES	MBI
VZ1 (km)	63 ± 17	103 ± 20	<0.001	2.16 ± 1.05	VL‖
VZ2 (km)	44 ± 24	87 ± 21	<0.001	1.79 ± 0.87	L‖
VZ3 (km)	13 ± 9	27 ± 9	<0.001	1.56 ± 0.76	L‖
VZ4 (km)	4 ± 3	8 ± 3	<0.001	1.57 ± 0.76	L‖
VZ5 (km)	1 ± 1	2 ± 1	<0.001	1.26 ± 0.61	L‖
HRZ1 (min)	1,397 ± 629	583 ± 282	<0.001	−1.78 ± 0.86	L‖
HRZ2 (min)	785 ± 257	697 ± 173	0.091	−0.42 ± 0.4	S‡
HRZ3 (min)	445 ± 159	561 ± 118	<0.001	0.85 ± 0.41	M§
HRZ4 (min)	308 ± 110	534 ± 193	<0.001	1.38 ± 0.67	L‖
HRZ5 (min)	293 ± 171	769 ± 233	<0.001	2.27 ± 1.10	VL‖
HRZ6 (min)	253 ± 243	482 ± 286	<0.001	0.85 ± 0.41	M§
AZ1 (count)	10,097 ± 2,315	13,717 ± 2,510	<0.001	1.49 ± 0.72	L‖
AZ2 (count)	4,126 ± 1,488	7,030 ± 1,599	<0.001	1.87 ± 0.91	L‖
AZ3 (count)	848 ± 457	1,692 ± 461	<0.001	1.84 ± 0.89	L‖
AZ4 (count)	204 ± 116	434 ± 156	<0.001	1.63 ± 0.79	L‖

*NS = not substantial (trivial or unclear); ES = effect size; S = small; M = moderate; L = large; VL = very large; MBI = magnitude-based inference.
†Velocity Zone Abbreviations: VZ1 (walk), 0–7.19 km·h^{-1}; VZ2 (jog), 7.20–14.39 km·h^{-1}; VZ3 (run), 14.40–19.79 km·h^{-1}; VZ4 (high-speed run), 19.8–25.19 km·h^{-1}, and VZ5 (sprint), >25.2 km·h^{-1}. Heart Rate Zone Abbreviations: HRZ1, <50%; HRZ2, 50–59%; HRZ3, 60–69%; HRZ4, 70–79%; HRZ5, 80–89%; and HRZ6, >90%. Acceleration Zone Abbreviations: AZ1, 0–0.99 m·s^2; AZ2, 1–1.99 m·s^2; AZ3, 2–2.99 m·s^2; and AZ4, >3 m·s^2.
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‖An almost certain deviation from smallest meaningful difference.

Table 3
Accumulated training workloads in NCAA Division I men's soccer by starting status (mean ± *SD*).*†

Variable	Reserve	Starter	p	ES	MBI
VZ1 (km)	100 ± 28	93 ± 24	0.297	−0.27 ± 0.43	NS
VZ2 (km)	82 ± 23	73 ± 20	0.048	−0.42 ± 0.35	S‡
VZ3 (km)	20 ± 6	17 ± 5	0.006	−0.64 ± 0.38	S§
VZ4 (km)	6 ± 2	5 ± 2	0.014	−0.59 ± 0.39	S‡
VZ5 (km)	2 ± 1	2 ± 1	0.688	0.09 ± 0.37	NS
HRZ1 (min)	822 ± 498	1,078 ± 663	0.05	0.43 ± 0.36	S‡
HRZ2 (min)	829 ± 271	889 ± 296	0.342	0.21 ± 0.37	NS
HRZ3 (min)	828 ± 237	805 ± 217	0.665	−0.10 ± 0.39	NS
HRZ4 (min)	690 ± 190	620 ± 182	0.098	−0.38 ± 0.38	S‡
HRZ5 (min)	671 ± 244	504 ± 164	0.001	−0.83 ± 0.40	M§
HRZ6 (min)	333 ± 233	173 ± 112	<0.001	−0.93 ± 0.45	M‖
AZ1 (count)	15,612 ± 4,783	14,953 ± 4,576	0.533	−0.14 ± 0.38	NS
AZ2 (count)	7,757 ± 2,681	7,163 ± 2,150	0.289	−0.25 ± 0.39	NS
AZ3 (count)	1,823 ± 694	1,620 ± 514	0.154	−0.34 ± 0.39	NS
AZ4 (count)	485 ± 218	419 ± 187	0.162	−0.33 ± 0.39	NS

*NS = not substantial (trivial or unclear); ES = effect size; S = small, M = moderate, L = large, VL = very large.
†Velocity Zone Abbreviations: VZ1 (walk), 0–7.19 $km\cdot h^{-1}$; VZ2 (jog), 7.20–14.39 $km\cdot h^{-1}$; VZ3 (run), 14.40–19.79 $km\cdot h^{-1}$; VZ4 (high-speed run), 19.8–25.19 $km\cdot h^{-1}$, and VZ5 (sprint), >25.2 $km\cdot h^{-1}$. Heart Rate Zone Abbreviations: HRZ1, <50%; HRZ2, 50–59%; HRZ3, 60–69%; HRZ4, 70–79%; HRZ5, 80–89%; and HRZ6, >90%. Acceleration Zone Abbreviations: AZ1, 0–0.99 $m\cdot s^2$; AZ2, 1–1.99 $m\cdot s^2$; AZ3, 2–2.99 $m\cdot s^2$; and AZ4, >3 $m\cdot s^2$.
‡A likely deviation from smallest meaningful difference.
§A very likely deviation from smallest meaningful difference.
‖An almost certain deviation from smallest meaningful difference.

sometimes 2 or less days between matches, there is a pervasive precedence placed preparing for the next match, with time off for athletes sacrificed. This is habitually different than the practices of professional soccer leagues, where it is standard for players to have 1–2 days off (i.e., recovery days) after each match (1). The congested schedule in American collegiate soccer presents a conundrum in which there is little time off for starters and concurrently limited time to implement physical loading strategies for reserves between matches. With match congestion being associated with injury risk and underperformance (15) as well as previous research indicating collegiate male starters experience performance decrements end of season but not reserves (31), consideration must be given to the potential of starters being at risk for nonfunctional overreaching and underperformance (24) throughout the NCAA collegiate soccer season. Although this study clearly shows that reserves are not receiving the same physical and physiological load over the collegiate soccer season as starters, caution should be used in concluding reserve's loads should mirror those of starters. Similarly, caution should be used in encouraging too much recovery time for starters because reduced loads may negatively impact conditioning status over the season. Likely, a combined approach is needed whereby reserves receive increased physical and physiological loading during the season and starters receive increased recovery time, when appropriate. Future research is warranted to determine the effect of the NCAA soccer season on injury and performance characteristics in starter and reserve players. Evaluating physical and physiological responses to a collegiate soccer season is necessary to guiding efficacious load management programs (21,24) and would assist in determining whether increased recovery time for starters, increased loading of reserves, or a combination of the two methods is warranted during a collegiate soccer season.

In agreement with investigations of EPL players (2), reserves in the current study accumulated more total distance in training when compared with starters (Figure 1). In addition, reserves in the current study accumulated substantially more internal loading (i.e., TRIMP) during training than starters. Although there were no significant differences in accumulated HSR distance during EPL training (2), we found collegiate soccer reserves accumulate substantially more distance jogging, running, and high-speed running than starters during training. Although high-speed loading was elevated for reserves over starters during training, the magnitude of difference was too small (ES [range] = 0.42–0.64) to effectively reduce the discrepancy in seasonal total accumulated physical loads between player roles. As noted previously, coaches and athletes must consider strategies to minimizing the substantial gap in loads between players of different starting status. In addition to increased recovery time for overloaded starters, this may include increasing training efforts for those receiving suboptimal match time, such as the addition of on- or off-ball conditioning (22) or small-sided games (19) in the weekly training cycle of reserves (30).

Although seasonal-accumulated TRIMP was substantially different between starters and reserves, discrepancies in relative HR characteristics between groups varied by the intensity zone (Table 1). Specifically, starters accumulated substantially less time below 50% HRmax and more time in intensities of 70–90% HRmax than reserves during the season. This is to be expected, given previous investigations finding American collegiate soccer players average 78 ± 8% HRmax during matches (9). Given this, reserve players are receiving substantially less match-specific loading throughout the American collegiate soccer season. This may have important implications for on-field performance because high-intensity loading plays an important role in maintaining soccer-specific fitness. As discussed by Iaia et al., (22) improved cardiovascular fitness promotes increases in the capacity to deliver blood to working muscles, and these positive physiological adaptations have implications on important aspects of soccer such as sustaining intense movement and recovery from high-intensity bouts. This is meaningful for performance aspects in soccer because players with improved fitness have shown to cover more distance (6.4%) and more distance at high speeds (22.8%) during a match (23). Further research is needed to explore fitness changes throughout an American collegiate soccer season between player roles and their relationship with accumulated workloads. Nevertheless, the importance of high-intensity physical and physiological loading in promoting positive biological adaptations, such as increased level aerobic fitness and running economy, should not be undervalued by coaches (30).

Although improvements in aerobic fitness and running economy are important for sustaining high work rates, soccer specificity should be considered when designing conditioning programs, particularly during the in-season (22). As noted in this study, there were also practically meaningful discrepancies in a range of low-high accelerations between starters and reserves, suggesting conditioning strategies should include soccer-specific movements. Research has investigated differences between continuous running and other soccer-specific training, such as repeated sprint or small-sided games, and found the latter to be more beneficial in developing soccer-specific abilities (16). Although only physical loads were explored in this study, it should be acknowledged that because of reduced match times, technical and tactical skills are likely being suboptimally trained for reserves over the season as well. This presents a strong rationale for coaches to implement "on-ball" training, which not only requires greater energy expenditure than "off-ball" training (29) but also mimics the technical demands of match play (22).

In conclusion, our results indicate a substantial gap exists in total accumulated workloads between starters and reserves throughout the American collegiate men's soccer season. Starters accumulated substantially more total physical (i.e., total distance and accelerations) and physiological (i.e., TRIMP) workloads over the season. In addition, total distance and accelerations over a range of intensity zones were higher for starter than reserve players. Although reserves accumulated small to moderately higher physical and physiological loading during training compared with starters, the seasonal imbalance remained substantial due to loads incurred in matches for starters during the season.

Practical Applications

Our results indicate managing player workloads in soccer requires attention to potential imbalances between players receiving variable match times. In addition, we present novel seasonal accumulated total, match, and training workloads, which may be used to guide American collegiate men's soccer load management practices by player status (i.e., starter and reserve). Coaches and practitioners in collegiate men's soccer may consider various strategies to overcome workload imbalances such as the integration of sessions targeting increased physical and physiological loading of reserve players. Methods available to reduce differences in seasonal physical and physiological loading may include, but are not limited to, match-specific conditioning (i.e., soccer-specific repeated interval training) and "on" ball training (i.e., small-sided games), with the latter being preferable for enhancing technical skill. Before the implementation of any strategy, biological and performance characteristics should be used to guide recovery practices and additional load interventions.

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