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ORIGINAL RESEARCH

Differences in external game loads are inconsistent and predominantly small between seasons in semi-professional, male rugby league players: a three-year team-based observational study

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Abstract

Background: Although external game loads have been readily examined across acute timeframes within male rugby league seasons, longitudinal analysis between seasons remain limited. Consequently, this study compared game demands during separate seasons in male, rugby league players. **Methods**: One semi-professional team competing in a men's state-level Australian rugby league competition was monitored during all games for three seasons (2022–2024). External load variables were measured with global positioning system devices. Linear mixed-model and Hedge's g_{av} effect sizes were used to compare variables between seasons within the same players (participated in all seasons, n = 6) and within the entire team (participated in any season, n = 33). **Results**: Within-player and team-level analyses revealed playing duration ($p < 0.01$, g_{av} (range) = 0.44–0.63), total distance ($p < 0.05$, g_{av} = 0.33–0.51) and peak speed ($p < 0.01$, g_{av} = 0.35–0.52) were significantly lower, while relative (per min) distance ($p < 0.05$, g_{av} = 0.35–0.52), accelerations ($p < 0.01$, g_{av} = 0.57–0.69) and decelerations ($p < 0.01$, g_{av} = 0.47–0.60) were significantly higher in 2022 compared to other seasons. Non-significant differences were evident between 2023 and 2024 for all variables ($p > 0.05$, g_{av} = 0.03–0.23), except relative high-speed running distance, which was higher in 2024 in team-level analyses ($p = 0.01$, g_{av} = 0.31). **Conclusions**: The increased playing duration, total distance and peak speed, and decreased relative external load variables in 2023–2024 compared to 2022 were mostly small in magnitude, indicating seasonal fluctuations were relatively subtle at player and team levels. These findings suggest practitioners working with semi-professional, male rugby league players could develop long-term plans for upcoming seasons based on typical game data from previous seasons, but plans should be adaptable given the inconsistent and tenuous way loads may vary longitudinally.

Keywords

Training load; Monitoring; Football; Team sport; GPS; Performance; Longitudinal

1. Introduction

Rugby league is a popular global team sport among men, with over 50 member nations recognized by the governing body, International Rugby League [1]. Accordingly, many rugby league competitions have been established in various countries, ranging from recreational to professional levels [2]. Among the higher competitions at semi-professional and professional levels, teams are increasingly employing sport scientists and other performance staff to instill practices that provide a competitive advantage across the season. Data generated from these practices can aid decision-making in evaluation, training, recovery and game management processes for players [3]. Training load monitoring is one such practice that is commonplace among semi-professional and professional rugby league teams [3, 4], representing the demands experienced by players during training and games.

Rugby league practitioners have indicated they monitor the training load among players predominantly to enhance performance, reduce injury risk, enhance fitness and evaluate training plans [3]. In this regard, many rugby league teams implement monitoring approaches to measure player movements and activity to understand what they do in training and games, referred to as the external load [5]. Indeed, external load data can indicate if the prescribed training plan yielded the intended outputs among players, which in turn drives the adaptive training effects [6]. The external load is regularly measured among rugby league teams due to the wide scope of data provided and low burden placed upon players [7], where the most popular monitoring tools are global positioning systems (GPS) [3]. In turn, GPS data can inform player preparation and management strategies across varied timeframes such as implementing within-session adjustments, for daily and seasonal planning and longer-term uses [7].

To date, external load data have been readily reported for semi-professional and professional, male rugby league players across relatively acute periods within seasons [2, 4, 8, 9], with less evidence available examining the longitudinal trends between seasons. Identifying any fluctuations in longitudinal external load could assist in developing plans for upcoming seasons, establishing player profiles and managing players transitioning across career stages [7]. In this regard, understanding seasonal changes in external loads, specifically in games, is particularly important for optimal long-term descriptive and planning applications in practice [6] given variations in coaching staff, tactical approaches, game scheduling, opponent quality, team roster, and player fitness may impact game demands in each season [10]. Variations in external game load variables have been widely explored between seasons in other sports like soccer [10–14], with little data available in rugby league contexts [15–17]. Specifically, Rennie *et al.* [15] reported variable fluctuations in external game demands between three seasons in 124 professional, male rugby league players who were consistently monitored across the 2018–2020 Super League competitions. Similarly, Delves *et al.* [17] reported differences in peak game accelerations and movement speeds across varied epochs in 42 professional, male rugby league players across the 2019–2021 National Rugby League competitions. However, between-season variations in game demands in both of these previous studies were attributed to major rule adjustments between seasons [15, 17], suggesting the reported outcomes are likely indicative of external regulatory factors rather than typical yearly changes. In turn, Evans *et al.* [16] observed increased external load intensities across three seasons in 20 professional, male rugby league players who were consistently monitored across 2012–2014 English Super League competitions. However, these data [16] were measured in a team that was newly promoted to professional competition and are indicative of game contexts over a decade ago.

As such, contemporary research is needed to enrich the available evidence concerning seasonal fluctuations in game demands among male rugby league players. Identifying whether and how external game loads fluctuate between seasons may provide useful insight for rugby league practitioners to proactively plan player loading strategies across defined periods within seasons (*e.g.*, macro blocks, weekly cycles, daily plans) [6]. In this regard, if consistent external game loads are observed across seasons, consolidated loading plans may be able to be developed for longitudinal application; however, if varied external game loads occur between seasons, loading plans with greater adaptability for specificity to each season may be necessary. Moreover, contemporary seasonal comparisons in external game loads may allow player profiles to be better established and inform strategies that assist players in progressing throughout their careers within semi-professional rugby league contexts [7]. Accordingly, this study aimed to quantify and compare external game loads between three consecutive seasons in semi-professional, male rugby league players from a single team.

2. Materials and methods

2.1 Participants

Using an observational study design, semi-professional, male rugby league players (Tier 3 in the Participation Classification Framework [18]) from one club competing in a state-based Australian competition were monitored during all games across three consecutive seasons between 2022–2024. Multiple comparisons in game demands were conducted between seasons including: (1) comparisons that only consider the same players who participated in all three examined seasons (within-player comparisons); and (2) comparisons considering players who completed in at least one of the examined seasons (team-level comparisons). Although no definitive standards exist regarding the minimum amount of participation in games (*i.e.*, playing duration) or seasons (*i.e.*, number of games) for inclusion in studies of this nature, we set some practical thresholds to optimize the included sample size while representing a robust representation of the typical game demands encountered. In this regard, players had to register at least 25 min of playing time in a game to provide a sample in this study. Across all seasons combined, 86 total game samples were removed due to players participating <25 min in games, with a further three samples removed for erroneous data being retrieved from devices. Moreover, players had to register at least five samples (games) in a season to be included in analyses for that season, representing at least a quarter of the games played in each season. Although 50 individual players were monitored throughout the three seasons, within-player comparisons between seasons considered only players who met these criteria in all analyzed seasons. Team-level comparisons considered players who met these criteria in at least one of the analyzed seasons without a requirement to participate in multiple seasons [10]. Overall, six players met the criteria across all seasons for inclusion in within-player analysis. For team-level analyses, a further 13 players were included in 2022, 12 players in 2023 and 12 players in 2024. It should be noted that in addition to the six players meeting the inclusion criteria for all seasons, 12 players met these criteria for two seasons, meaning 18 players were included across multiple seasons for team-level analyses. In this regard, there were seven unique players included only in 2022, four unique players included only in 2023, and four unique players included only in 2024, equating to 33 players being recruited for team-level analyses across seasons. Details for players included in the within-player and team-level analyses are separately given in Table 1 (Ref. [2]). Ethical approval was obtained from the Central Queensland University Human Research Ethics Committee for use of the collected data (no: 0000023985).

TABLE 1. Details for players included for analysis in this study.

Detail	Within-player analysis	Team-level analysis		
		2022	2023	2024
Player sample size (count)	6	19	18	18
Game samples (count)	297	285	221	229
Position breakdown (count)	2F, 1B, 3A	10F, 5B, 4A	8F, 5B, 5A	9F, 5B, 4A
Age (yr)	24.0 ± 2.7	23.3 ± 1.7	24.1 ± 2.6	23.9 ± 2.4

Note: F, forwards; B, backs; A, adjustables, as regularly adopted in the literature [2]; age for within-player analyses was averaged across all seasons for the included players; data presented as mean ± standard deviation for age.

2.2 Game and season details

Only games played during the regular season were included in analyses with pre-season and finals games removed to negate variations in outcomes due to these confounding factors [8]. In turn, key information for each season that could impact game demands [19] are presented in Table 2. Across the monitoring period, players typically completed two primary field-based training sessions each week. The team normally played in one game per week across the regular season and had the same head coach across all seasons that were monitored. Up to three "bye" weeks were scheduled in each season in which no games were played.

2.3 External load monitoring procedures

All players had their external loads monitored during games using Catapult PlayerTek™ GPS devices (PlayerTek™ Pod; Catapult Sports; Melbourne, VIC, Australia; specifications: 10-hz sampling rate; 42 g mass; 84 mm × 42 mm × 21 mm dimensions), which were inserted into customized pockets (positioned between the scapulae that were sewn into playing jerseys) during the pre-game preparation period. Research [20] examining other field-based team sport players supports the validity (mean difference: distance *vs.* manual measurement of distance $\leq$0.01%, $p > 0.05$; peak speed *vs.* speed measured with a radar gun = 0.03%, $p > 0.05$) and retest reliability (coefficient of variation (CV) = 1.1% for total distance to 11.7% for very high-speed running distance $\geq$22 km·h^{-1}) of the devices we used during running and sprinting tasks. All recorded external load data were downloaded from devices following games and processed using proprietary software (PlayerTek™ Cloud; Catapult Sports; version 1.0.32, Melbourne, VIC, Australia).

Game data files for each player were trimmed to include only time when on the field (between the start and end of the game) and exclude any time when substituted out of games and half-time breaks. All games were 80 min in duration (two 40-min halves), excluding any stoppages of the game clock during play. Trimming of all data files was performed using visual inspection of data traces in the proprietary software as previously documented [8] and then exported as Microsoft Excel files (version 16; Microsoft Corporation, Redmond, WA, USA). External load variables recorded from the proprietary software for each game included total distance (m), relative distance (also called average speed) (m·min^{-1}), as well as absolute (m) and relative (m·min^{-1}) distance performing high-speed running (HSR; >18 km·h^{-1}) using a widely accepted speed threshold in rugby league research [2, 3]. Furthermore, on-field duration (min), peak speed (m·s^{-1}), accelerations (count; >1 m·s^{-2}), relative accelerations (count·min^{-1}), decelerations (count; <−1 m·s^{-2}) and relative decelerations (count·min^{-1}) were also measured in each game. These external load variables have been defined in previous rugby league research [4, 8] and were included given they have been recognized as the most important to monitor by practitioners working in rugby league settings [3] and are among the most commonly used by practitioners working in wider field-based team sports [21].

2.4 Statistical analyses

External load data were imported into RStudio (v4.1.3; R Core Team) from Microsoft Excel for cleaning and analyses. Data were arranged in long form with rows representing separate observations and external load variables presented in each column. Differences in external load variables between seasons were assessed with linear mixed-effects models (LMM) where customized script was built using the *lmerTest* package [22], following recommendations in the literature [23]. For analyses, season (n = 3) was entered as a fixed effect, with player entered as a random effect. Histograms and Q-Q plots of the residual values were checked using the *see* [24] and *performance* [25] packages and confirmed normality of the data for each variable. Pairwise comparisons between seasons were performed with Tukey's Honestly Significant Difference tests using the *emmeans* package [26] and via calculation of Hedge's g_{av} effect sizes (with 95% confidence limits) [27, 28]. Effect size magnitudes were interpreted following established descriptors and thresholds [29]: trivial $\leq$0.20; small = 0.20–0.59; moderate = 0.60–1.19; large = 1.20–1.99; or very large $\geq$2.00. Descriptive data for all external load variables were determined as estimated marginal means (with 95% confidence limits) and α was set at <0.05 for statistical significance.

3. Results

Regarding within-player analyses, descriptive data are shown in Table 3 while statistical outcomes for pairwise comparisons between seasons are shown in Fig. 1. LMM revealed significant differences between seasons in all external load variables except absolute and relative HSR distance (trivial-to-small effects) as well as accelerations (trivial-to-small effects). More precisely, playing duration, total distance, and peak speed were significantly lower in 2022 than 2023 and 2024 (small-

TABLE 2. Details for each season analyzed in this study.

Detail	Season		
	2022	2023	2024
Total games (count)	19	20	20
Home/away games (count)	11/8	9/11	10/10
Accumulated travel distance (km)[#]	5795	7411	7523
Wins-draws-losses (count)	11-1-7	12-2-6	10-8-2
Ladder position (rank)[‡]	5th	4th	6th
Total points scored	472	511	474
Total points conceded	394	387	452
Aggregated score differential (points)	+78	+124	+22

Note: [#]Travel distance was determined between cities using an online platform (https://www.google.com/maps), with detail on travel mode and duration not accessible for each season; [‡]ladder position was ranked out of 14 teams in 2022 and out of 15 teams in 2023 and 2024.

TABLE 3. Within-player analyses estimated marginal means (95% confidence limits) for external load variables during games across seasons in semi-professional, male rugby league players.

External load variable	Season		
	2022	2023	2024
Playing duration (min)	67.7 (55.4–79.9)	74.6 (62.3–86.9)	76.5 (64.2–88.7)
Total distance (m)	6223 (4865–7580)	6690 (5332–8048)	6857 (5499–8216)
Relative distance ($m \cdot min^{-1}$)	91.8 (87.1–96.6)	89.5 (84.7–94.2)	89.7 (84.9–94.4)
HSR distance (m)	474 (261–687)	486 (273–699)	523 (310–736)
Relative HSR distance ($m \cdot min^{-1}$)	6.85 (4.41–9.29)	6.48 (4.05–8.92)	6.82 (4.38–9.26)
Peak speed ($m \cdot s^{-1}$)	7.66 (7.11–8.21)	7.98 (7.43–8.53)	8.01 (7.46–8.56)
Accelerations (count)	313 (253–374)	327 (267–388)	331 (270–391)
Relative accelerations ($count \cdot min^{-1}$)	4.69 (4.36–5.02)	4.41 (4.08–4.75)	4.36 (4.03–4.69)
Decelerations (count)	301 (242–361)	319 (259–379)	322 (263–382)
Relative decelerations ($count \cdot min^{-1}$)	4.52 (4.17–4.87)	4.30 (3.95–4.66)	4.25 (3.90–4.60)

Note: HSR, high-speed running.

to-moderate effects), with decelerations significantly lower in 2022 than 2024 (small effect). In contrast, relative accelerations and relative decelerations were significantly higher in 2022 than 2023 and 2024 (small-to-moderate effects), while relative distance was significantly higher in 2022 than 2023 (small effect). Non-significant, trivial-to-small differences were evident between 2023 and 2024 for all variables.

For team-level analyses, descriptive data are given in Table 4 and statistical outcomes for pairwise comparisons between seasons are shown in Fig. 1. LMM revealed similar patterns to the within-player analyses with significant differences between seasons in all external load variables except HSR distance, accelerations and decelerations (trivial-to-small effects). In turn, playing duration and total distance were significantly lower in 2022 than 2023 and 2024 (small effects), with peak speed significantly lower in 2022 than 2024 (small effect). Oppositely, relative accelerations and relative decelerations were significantly higher in 2022 than 2023 (small-to-moderate effects). While differences in most variables between 2023 and 2024 were non-significant and trivial in magnitude, relative HSR distance was significantly higher in 2024 than 2023 (small effect).

4. Discussion

This study provides the first known investigation comparing external loads across multiple "typical" seasons in rugby league players, with existing research on this topic encompassing aberrant situations including variations between seasons with pronounced rule changes [15, 17] and the transitioning seasons of a newly promoted team to professional competition [16]. An additional novel aspect of this study was the consideration of within-player analyses encompassing only players who competed in every season as well as team-level analyses where players who competed in any individual season were included. In this regard, each analysis produced similar trends in external load variables across the three seasons that were analyzed, suggesting variations are consistent at the player and team level. In discussing these findings, it should be noted that most effect sizes for pairwise comparisons between seasons in our analyses were trivial-to-small, suggesting that observed

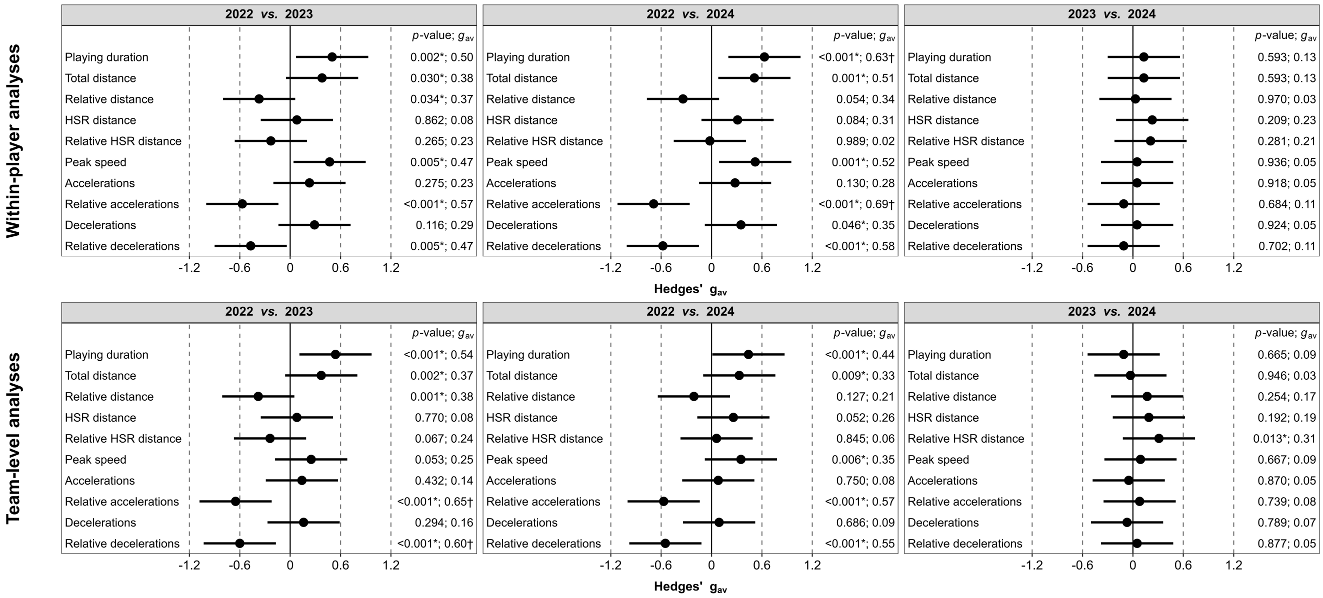

FIGURE 1. Statistical comparisons (*p*-values and Hedge's g_{av} effect size) in external load variables between seasons in semi-professional, male rugby league players. Note: HSR, high-speed running; *indicates statistically significant comparison ($p < 0.05$); †indicates a moderate effect was reached ($g_{av} \geq 0.60$). Circles represent the effect size and lines represent the confidence limits in the visual plots. Effect sizes plotted in a negative direction (left of zero) indicate a higher value was obtained in the earlier season in the comparison.

TABLE 4. Team-level analyses estimated marginal means (95% confidence limits) for external load variables during games across seasons in semi-professional, male rugby league players.

External load variable	Season		
	2022	2023	2024
Playing duration (min)	62.8 (55.5–70.0)	69.7 (62.4–77.0)	68.5 (61.2–75.8)
Total distance (m)	5577 (4943–6212)	5986 (5350–6622)	5948 (5312–6584)
Relative distance (m·min^{-1})	89.0 (87.4–90.6)	86.7 (85.1–88.4)	87.3 (86.1–89.4)
HSR distance (m)	447 (372–522)	458 (383–533)	485 (410–560)
Relative HSR distance (m·min^{-1})	6.88 (6.26–7.50)	6.50 (5.88–7.12)	6.97 (6.35–7.60)
Peak speed (m·s^{-1})	7.71 (7.49–7.92)	7.86 (7.64–8.07)	7.91 (7.69–8.13)
Accelerations (count)	281 (254–309)	289 (262–317)	286 (259–314)
Relative accelerations (count·min^{-1})	4.56 (4.38–4.73)	4.25 (4.07–4.42)	4.28 (4.10–4.46)
Decelerations (count)	275 (248–302)	285 (258–312)	281 (253–308)
Relative decelerations (count·min^{-1})	4.45 (4.28–4.63)	4.17 (4.00–4.35)	4.20 (4.02–4.37)

Note: HSR, high-speed running.

variations were relatively modest in magnitude.

Within-player and team-level analyses both revealed the first monitored season (2022) yielded significantly lower playing durations, total distances and peak speeds compared with later seasons (2023 and 2024), while only within-player analyses demonstrated this trend for decelerations. There are varied reasons that could explain these findings both within the same players who competed across each season and for the entire team across these seasons. For instance, given within-player analyses encompassed players who were rostered with the team across all three monitored seasons, the contributions of these players were likely valued by coaching staff and team management who provided a consistent setting to nurture their progression. Indeed, continuity in the team environment for these players may have helped them establish connections with coaching staff and the club, which has been documented to help players thrive in a team sport environment [30]. Consequently, these players may have developed physically and technically under consistent coaching staff, earning increased playing time during games. In turn, more exposure likely created more opportunities for these players to accrue metreage and decelerations in game scenarios [8]. Moreover, improved development of physical attributes such as maximal sprint speed, repeated-sprint capacity, strength qualities and technical ability, may have contributed to increased speed [31] and deceleration [32] outputs in games across seasons, which was apparent in the within-player analyses.

Alternatively, similar trends in external load variables provided from the team-level analyses suggest wider mechanisms may have also played a part in the seasonal changes documented. In this way, adjustments made by coaching staff due to different tactical plans (*e.g.*, playing style, player selections) being adopted between seasons [33] may have lengthened the game exposure given to some players [16] in 2023 and 2024. For instance, coaches may have given interchange players shorter game exposures, or some players may have sustained injuries, resulting in them participating for <25 min in games with these samples excluded from analyses in this study. In support of this notion, more individual game samples were excluded in 2023 (n = 34) and 2024 (n = 31) compared to 2022 (n = 21) due to players not reaching the minimum threshold for participation in games. Moreover, slightly more forwards being monitored in 2022 (n = 10) compared to later seasons (n = 8–9) (Table 1) may have also contributed to the lower playing duration (and elevated total distance, accelerations, and decelerations per min) in this season based on typical position-specific trends documented in the wider rugby league literature [2]. Tactical adjustments could have also created different game dynamics and sprinting patterns [34] that permitted faster peak speeds during games in 2023 and 2024. Interestingly, the similar trends between seasons observed for within-player and team-level analyses may indicate that roster changes do not exert a notable impact on the typical game demands experienced.

The increased playing durations between seasons for within-player and team-level analyses likely underpin the concomitant reduction in relative (per min) external load variables observed. Established evidence indicates that as bout duration increases during gameplay, average speed decreases in rugby league players [35]. Moreover, research has shown that as longer epochs are monitored during games, movement acceleration decreases in rugby league players [36]. The reduction in movement intensities with greater playing durations may be attributed to various factors like fatigue-related mechanisms and pacing strategies [37]. Consequently, it seems logical that as players participate in games for longer, key relative external load variables (total distance, accelerations and decelerations per min) decrease, as we observed across seasons. Alternatively, some contextual factors noted for the team may offer further potential explanations for these findings (Table 1). For instance, the team experienced substantially more travel distances (~1600–1700 km) in seasons following 2022 (Table 1). These requirements may have predisposed players to travel-related fatigue leading into some games [31], which could have diminished their ability to maintain high movement intensities during play as documented in wider field-based team sports [38, 39]. In addition, more home games were played in 2022 (58%) than other seasons (45–50%), which may have augmented movement intensities during games in this season given rugby league players perceive their confidence and performance to be improved when playing at home compared to playing away [40]. However, it should be noted that between-venue differences (*i.e.*, home *vs.* away) in external game loads have been shown to vary in the rugby league literature [19], meaning external game demands may not be universally linked to any perceived home-field effects.

Although changes in game durations and contextual factors across seasons may also explain the significantly reduced relative HSR distance in 2023 compared to 2024 within team-level analyses, HSR metrics (along with total accelerations and decelerations) were less prone to fluctuations between seasons than other variables. These findings align with previous research exploring variations in external game loads in professional, male rugby league players across three seasons [15]. Specifically, Rennie *et al.* [15] observed relatively stable absolute and relative HSR distances between seasons spanning from 2018–2020, despite notable rule changes being enforced in each season including reduced interchanges, the introduction of a shot-clock, administering the golden point rule (extra play if scores are tied upon game completion) and COVID-related changes. These findings are somewhat surprising given a relatively high game-to-game variability (CV = 14%) has been observed for HSR distance in professional, male rugby league competition [41]. However, our results combined with those reported previously [15] suggest this game-level variation in HSR may be diluted (and similarly encountered) across entire seasons, reinforcing the importance of considering data relative to defined periods of interest in practice (*e.g.*, seasonal, monthly, weekly, daily) [6].

While external load variables were somewhat different during games in 2022 compared to other seasons, relatively consistent game data were obtained in 2023 and 2024. Consequently, our findings suggest the extent of seasonal fluctuations in external game loads may vary between years, which aligns with results reported in professional, male rugby league players [15, 16], as well as in wider field-based team sports like soccer [12] and Australian rules football [33]. Indeed, exploration of three regular seasons is certainly a limitation of our study, especially given research in soccer has shown pronounced increases in external load variables during games across five or more seasons [11–13]. Consequently, further temporal analyses of seasonal variations spanning longer timeframes are warranted in rugby league players to understand whether external game loads typically remain consistent, vary in orderly ways, or undulate sporadically between seasons.

Other limitations should also be acknowledged when interpreting the results of our study. For instance, we adopted a sole focus on monitoring external load variables. Accordingly, internal load variables were not examined yet are typically monitored alongside external load [3] and crucial in understanding the responses occurring in players to drive adaptations as part of the training process [5]. Likewise, technical and tactical aspects of play were not recorded, which could help explain the patterns in external load variables observed between seasons. Further research is therefore encouraged by building on these initial analyses exploring a wider range of variables for greater understanding on this topic. Moreover, we examined a single team of semi-professional, male players, encompassing 33 players for the team-level analyses and six players for the within-player analyses. Accordingly, this relatively low sample size limits the generalizability of the provided outcomes, which may not be indicative of other teams within this competition, or wider competitions such as professional, female, or youth teams given the varied tactical approaches, roster makeups, player fitness levels [35] and game demands [42] that may exist between these populations. Therefore, further research is recommended to explore this topic in other rugby league populations. In this regard, the limited sample we recruited in each season also prohibited analyses according to positional groups (*i.e.*, backs, forwards and adjustables), which have been shown to experience specific game demands [2] and produce distinct trends across seasons in rugby league [15] and soccer [10]. Consequently, we encourage more work expanding beyond a single team-based approach to provide evidence on this topic specific to playing positions as well as other rugby league populations.

From a practical perspective, our findings suggest that rugby league practitioners working with semi-professional teams may establish typical game load benchmarks for their players using acquired data, which could aid the development of long-term seasonal plans. However, adaptability and adjustments in these plans are likely needed over shorter cycles given fluctuations in the typical game demands experienced may be inconsistent from year to year. Moreover, the relatively small magnitude of changes in game demands we predominantly observed between seasons may be attributed to variations in game exposures between seasons among the monitored players. This finding reinforces that rugby league practitioners should pay particular attention to playing durations—which is recognized as a fundamental indicator of training volume across sports [43]—when managing the external loads they accrue across games throughout the season. A novel outcome of our study in the similar trends observed for within-player analyses (six players who participated in all three seasons) and team-level analyses (33 players who participated in at least one season) suggests that roster changes between seasons may not overtly impact the typical external game loads encountered.

5. Conclusions

This three-season study showed external loads experienced during games varied somewhat between particular seasons, but not others, at player and team levels within a male semi-professional rugby league team context. Specifically, significantly longer game durations, greater total distances and faster peak speeds, along with significantly reduced relative variables (total distance, accelerations and decelerations per min) were observed in the 2023 and 2024 seasons compared to the 2022 season. In contrast, similar external game loads were apparent between 2023 and 2024. Moreover, most pairwise comparisons were trivial-to-small in magnitude, suggesting seasonal fluctuations in external game loads were subtle.

AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

ATS, TMD and NE—designed the research study. JP and TMD—performed the research. NE—analyzed the data. ATS—wrote the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Central Queensland University Human Research Ethics Committee for use of the collected data (no: 0000023985). The rugby league club consented to the research team to have retrospective access to the collected data for this study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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