TRAINING LOAD, RECOVERY AND INJURIES IN ELITE RHYTHMIC GYMNASTS DURING MAIN COMPETITIVE PERIODS: A CASE STUDY

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Case study

Abstract

Competitive periods are critical periods where elite rhythmic gymnasts experience higher training loads and insufficient recovery. The aim of this short report is to describe individual training load, recovery and injuries in elite group rhythmic gymnasts during competitive periods. Six gymnasts from the Brazilian senior rhythmic gymnastics group were monitored daily over a 126-day period comprising regular training and four competitions. Training load was measured using the session rating of perceived exertion (session-RPE). Daily load, chronic load, and acute:chronic workload ratio (ACWR) were assessed. The Total Quality Recovery (TQR) scale was used to monitor recovery and a 3-day rolling average (3RA) TQR was also measured. Injuries were diagnosed and reported by the medical staff and their reports were used in the analysis. Descriptive statistics were used. The gymnasts presented distinct daily load, ACWR, and recovery patterns, as well as injuries across the competitive periods. All athletes had rapid increase ("spike") in load. Three athletes were underrecovered more than 60% of the time. Four athletes sustained five injuries during the time of the study (all lower limb overuse injuries, two severe, two mild and one slight). Individual factors such as age and chronic load could moderate how each gymnast responds to training and tolerates spikes in load. Moreover, injuries sustained during competitive periods appear to affect the short and long-term careers of gymnasts, as well as impair training and competition organization of the team.

Keywords: *gymnastics, injury, ACWR, competition.*

INTRODUCTION

Rhythmic gymnastics is an aesthetic sport that demands high technical compliance, and well-developed physical and artistic capacities (Debien et al., 2020; Douda, Toubekis, Avloniti, & Tokmakidis, 2008). Group exercises are performed by five gymnasts at the same time mainly characterized by harmonic collective work (Ávila-Carvalho, Klentrou, & Lebre, 2012). The group competition format requires peak performance during one to four days. Each group presents two different routines in qualification phase and the first eight ranked groups perform these routines again

at the finals. Elite groups involved in international competitions may have five or six events in one season including two or three main competitions (e.g., World Championship, Continental Games/Championship, Olympic Games).

Competitive periods in rhythmic gymnastics are associated with higher training loads, rapid increase ("spikes") in load (Debien et al., 2020), and insufficient recovery (Debien, Miloski, Timoteo, Ferezin, & Bara Filho, 2019). Spikes in load and an imbalance between load and recovery might expose the gymnasts to maladaptation and higher injury risk (Soligard et al., 2016). Moreover, injury sustained in competitive periods prevent athletes from training and performing, thereby impairing their chance of success (Drew, Raysmith, & Charlton, 2017). In a rhythmic gymnastics group, any changes in the starter squad due to injuries during the competitive period may affect the training load of the entire team by causing routine adjustments and more repetitions as each gymnast performs very specific roles in the routines.

In order to achieve peak performance and minimize injury risk, it is essential to manage training load and individual responses to that load. An interesting way to better understand training information from elite level athletes is through case studies. This format is a powerful tool to bridge the gap between science and practice (Halperin, 2018; Ruddock, Boyd, Winter, & Ranchordas, 2019). However, to date no study has analysed individual training load, recovery and injuries among elite level rhythmic gymnasts. Therefore, the aim of this short report is to describe individual training load, recovery and injuries in elite group rhythmic gymnasts during competitive periods.

METHODS

Six gymnasts from the 2015 Brazilian senior rhythmic gymnastics group participated in the current study (Table 1). This group comprised the best-selected gymnasts across the country, which represented Brazil in senior international competitions, including the Pan-American Games and World Championship. The study was approved by the University's Ethics Committee.

Data were collected across 126 days comprising regular training and four competitions. Regular training sessions started with a light warm up, followed by ballet, strength and conditioning, and technical training. Training load was assessed daily using the session rating of perceived exertion (session-RPE) method (Foster et al., 2001). Daily load was obtained by the sum of loads of all training sessions during that day. Acute and chronic loads were calculated by exponentially weighted moving averages (EWMA) using 7 and 28 days for time decays, respectively (Williams, West, Cross, & Stokes, 2017). The acute:chronic workload ratio (ACWR) (Gabbett, 2016) was also measured on a daily basis. This measure describes the size of the current training load (i.e., acute load) in relation to longer-term training load (i.e., chronic load) (Gabbett, 2020). ACWR≥1.3 was considered a "spike" in load (Murray, Gabbett, Townshend, & Blanch, 2017). The Total Quality Recovery (TQR) scale (Kenttä & Hassmén, 1998) was used to monitor recovery before the first training session of each day. A 3-day rolling average (3RA) TQR was calculated. A score of ≥13 (reasonable recovery) indicates a minimally adequate recovery state (Debien et al., 2020; Kenttä & Hassmén, 1998). On days of no training, training load was considered zero and TQR was not collected. Injuries were diagnosed and recorded by the medical staff, which provided individual reports containing body region, injury type, time-loss, date of occurrence, and observations regarding the impact of injuries on competitions and dismissals. All musculoskeletal injuries that required medical attention (Bahr et al., 2020) during the study period were reported and included in our analysis. Injury severity was

classified based on time-loss (number of days that the athlete was unavailable for training and competition) as following: slight (no absence), mild (1 to 7 days), moderate (8 to 28 days), and severe (>28 days) (Bahr et al., 2020). Descriptive statistics were used.

Table 1
Gymnasts' characteristics at the beginning of the season.

	Age (yrs)	Experience in RG (yrs)	Height (m)	Weight (kg)
Athlete 1	26	17	1.64	53
Athlete 2	18	13	1.70	61
Athlete 3	22	12	1.60	50
Athlete 4	20	13	1.67	52
Athlete 5	20	17	1.67	54
Athlete 6	20	17	1.58	48

Note:Yrs- years; RG- rhythmic gymnastics.

RESULTS

Individual training load, recovery, injuries details, and status in competitions are described in Table 2. Figure 1 shows daily load, chronic load, EWMA ACWR, recovery and injuries of each gymnast across 126 days comprising the competitive periods of the season. Figure 2 presents EWMA ACWR in relation to chronic load and 3RA TQR score for each gymnast. Four athletes had five injuries during the time of the study, all of which were lower limb overuse injuries.

DISCUSSION

The aim of this short report was to describe individual training load, recovery and injuries of elite group rhythmic gymnasts during competitive periods. Our results illustrate the importance of individual training load management in this sport in order to minimize the risks of undesired outcomes during competitive periods preceding an Olympic season.

Athletes 1 and 4 sustained severe overuse injuries that resulted in absence from training and competition for several weeks. Athlete 1 was the oldest (26 years) and the only athlete who sustained two different injuries. She presented a few spikes (ACWR≥1.3) in training load at the same time as underrecovery (3RA TQR<13) in the first half of competitive periods (Figure 1A and 1G). Athlete 4 also showed spikes in load before the first main competition, but mainly in conjunction with low chronic load and decreasing recovery during her return to training post-injury (Figure 1D). Despite being starters before their injuries, they were not able to regain this position in the group and were waived at the end of the season. Athletes 2 and 3 presented mild and slight overuse injuries, respectively, which did not affect their position in both main competitions. Athlete 2 lost one day of training (day 49) followed by spikes in load on days 46 to 48. Athlete

3 was injured during the two principal events, however it was a chronic injury that recurrently occurred. This injury required constant treatment despite her ability to maintain full training. In this regards, Figure 2C illustrates how athlete 3 was frequently in a "safe zone" concerning adequate chronic load, recovery, and ACWR. Athletes 5 and 6 had no injuries during the study period and, despite not initially being starters, went to the Olympic Games as starters the following year. It is worth noting that Athlete 5 was underrecovered 74% of the time and athlete 6 had a few spikes in load, possibly when she started to train as a reserve.

High chronic loads are associated with fewer injuries, however, these loads must be progressively increased relative to the athlete's capacity to tolerate load (Gabbett, 2020). Moreover, the training load-injury relationship is moderated by several factors such as age, previous injury, and lifestyle (Gabbett et al., 2019). Previous investigations have found higher training loads, frequent spikes in load, and underrecovery during competitive periods in elite rhythmic gymnasts (Debien et al., 2020). All gymnasts in our study had at least one spike in load, yet each one may have tolerated this change in load differently based upon their age, chronic load, and recovery status. Some spikes occurred that did not result in injury, perhaps indicating that a combination of factors may need to occur for athletes to get injured (i.e., the "perfect storm"). Nevertheless, we highlight that the two athletes who sustained severe injuries also experienced more spikes in load. Both athletes presented spikes in load until competition 2, while athlete 4 also had spikes in load during her return to training, which might explain her inability to regain her position on the team (Gabbett, 2019). Despite the protective nature of high chronic loads, it is important to understand the chronic load of each athlete, the "ceiling" of safety, and the time available to safely reach the required loads for the sport (Gabbett, 2019). Our results reinforce how training load data should not be interpreted in isolation. The context and factors influencing load tolerance on an individual basis must always be taken into consideration in the decision-making process.

In order to achieve good technical performance, the main training content during competitive periods in rhythmic gymnasts are routine repetitions. Each group routine lasts 150 seconds and includes several jumps, rotations, balances, throws, and catches performed with high intensity effort (Ávila-Carvalho et al., 2012; Douda et al., 2008). Considering one heavy day with two sessions, four hours each (Debien et al., 2020), and a session-RPE score of 10 (maximal) for both sessions would result in a daily load of 4,800 AU. Nonetheless, all gymnasts reached more than this value at least once in our study. In addition, studies have shown that elite rhythmic gymnasts are regularly underrecovered during competitive periods (Debien et al., 2019, 2020). Recovery is essential to promote appropriate adaptation and achieve good performance (Kenttä & Hassmén, 1998; Soligard et al., 2016) however it should be noted that in this study spikes in load, low (or excessively high) chronic load and drops in recovery were not necessarily temporally aligned, and the lag effect for each is likely to be different among athletes. Future studies should focus on understanding the positive and negative effects of such high load in rhythmic gymnastics.

Albeit the pioneer findings, our study presents some limitations. We highlight that is also important to measure and analyse external training load data. However, this is a complex measure in rhythmic gymnastics training and future investigations should focus on quantifying it through repetition counting and wearable technology, for instance. Moreover, studies are needed to establish an accurate threshold of EWMA ACWR in regards to injury risk in elite rhythmic gymnastics.

Table 2
Individual training load, recovery, injuries, and status during each competition of elite group rhythmic gymnasts across competitive periods.

	Training load and recovery				Injuries			Competitions				
	Daily load (AU) Mean (SD) Max Min	Chronic load (AU) Mean (SD) Max Min	EWMA ACWR (%) ≥1.3	3RA TQR (%) <13	Body region	Type	Severity	1 Days 20 and 21	2* Days 68 to 71	3 Days 96 and 97	4* Day 125	Olympic Games* Following season
Athlete 1	1211 (1421) 5400 0	1296 (598) 2426 163	15%	64%	Hip Foot	Tendinopathy Bone stress fracture	Mild Severe	Starter	Starter	Starter	Injured	No
Athlete 2	1233 (1229) 5520 0	1312 (385) 2068 572	11%	65%	Hip	Bursitis	Mild	Starter	Starter	Starter	Starter	No
Athlete 3	1350 (1114) 5160 0	1366 (311) 2162 775	6%	18%	Foot	Tendinopathy	Slight	No	Starter	Starter	Starter	No
Athlete 4	1064 (1376) 5460 0	1166 (612) 2288 279	17%	6%	Lower leg	Bone stress injury	Severe	Starter	Injured	Injured	No	No
Athlete 5	1496 (1245) 4920 0	1559 (365) 2328 928	5%	74%	-	-	-	Reserve	Reserve	Reserve	Reserve	Starter
Athlete 6	1182 (1076) 6150 0	1208 (271) 1795 657	9%	37%	-	-	-	No	Reserve	Starter	Reserve	Starter

Note: AU- arbitrary units; SD- standard deviation; EWMA- exponentially weighted moving averages; ACWR- acute:chronic workload ratio; 3RA TQR- 3-day rolling average Total Quality Recovery score; %- percentage of days in relation to the total measured; Starter- compete in both routines; Reserve- compete in one routine; No- not selected to compete; Injured- unavailable to compete due to injury.

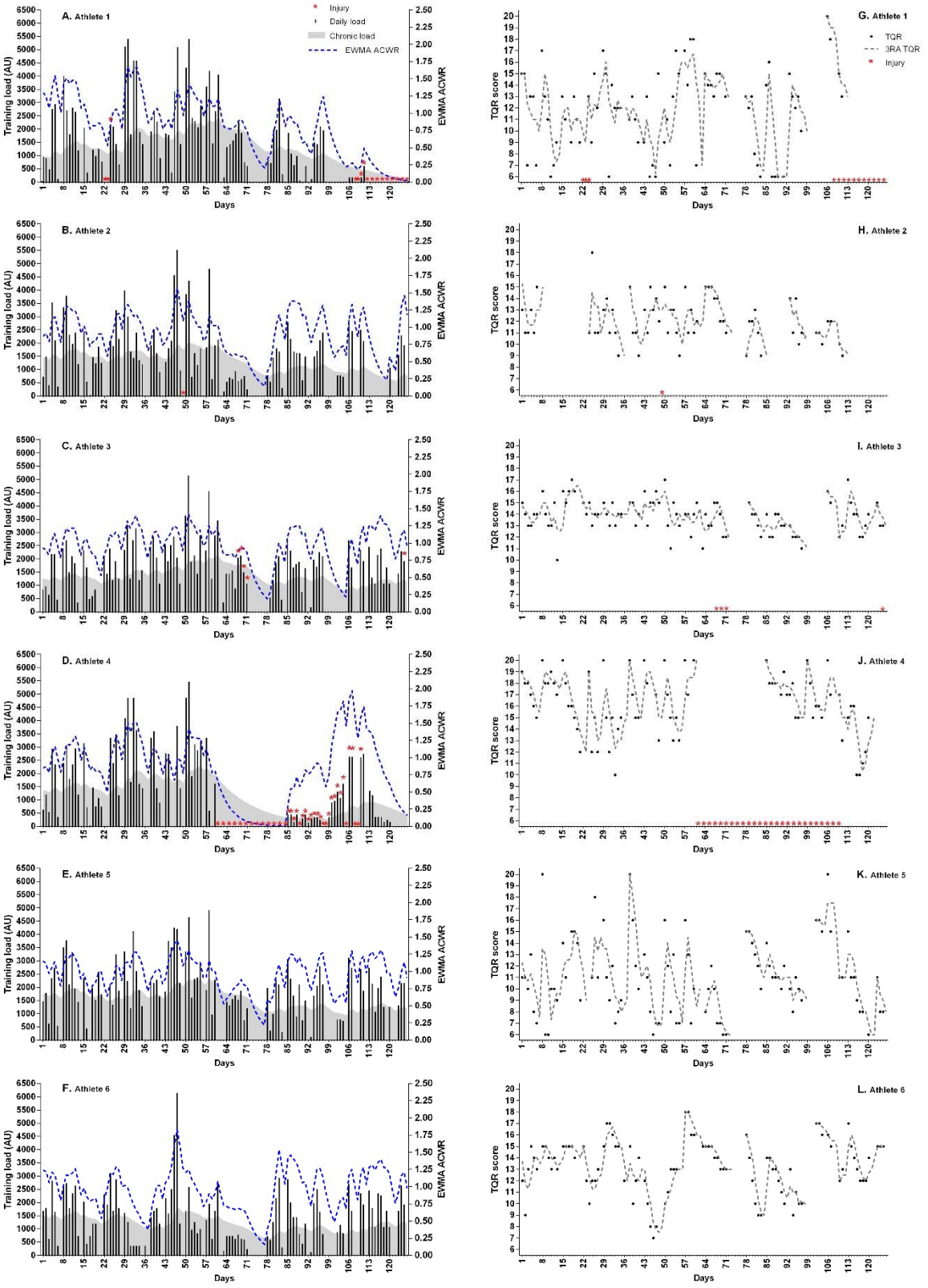

Figure 1. Individual daily load, chronic load, acute:chronic workload ratio, recovery and injuries throughout competitive periods in elite group rhythmic gymnasts.
Note: AU-arbitrary units; EWMA-exponentially weighted moving average; ACWR-acute:chronic workload ratio; TQR-Total Quality Recovery; 3RA-3-day rolling average.

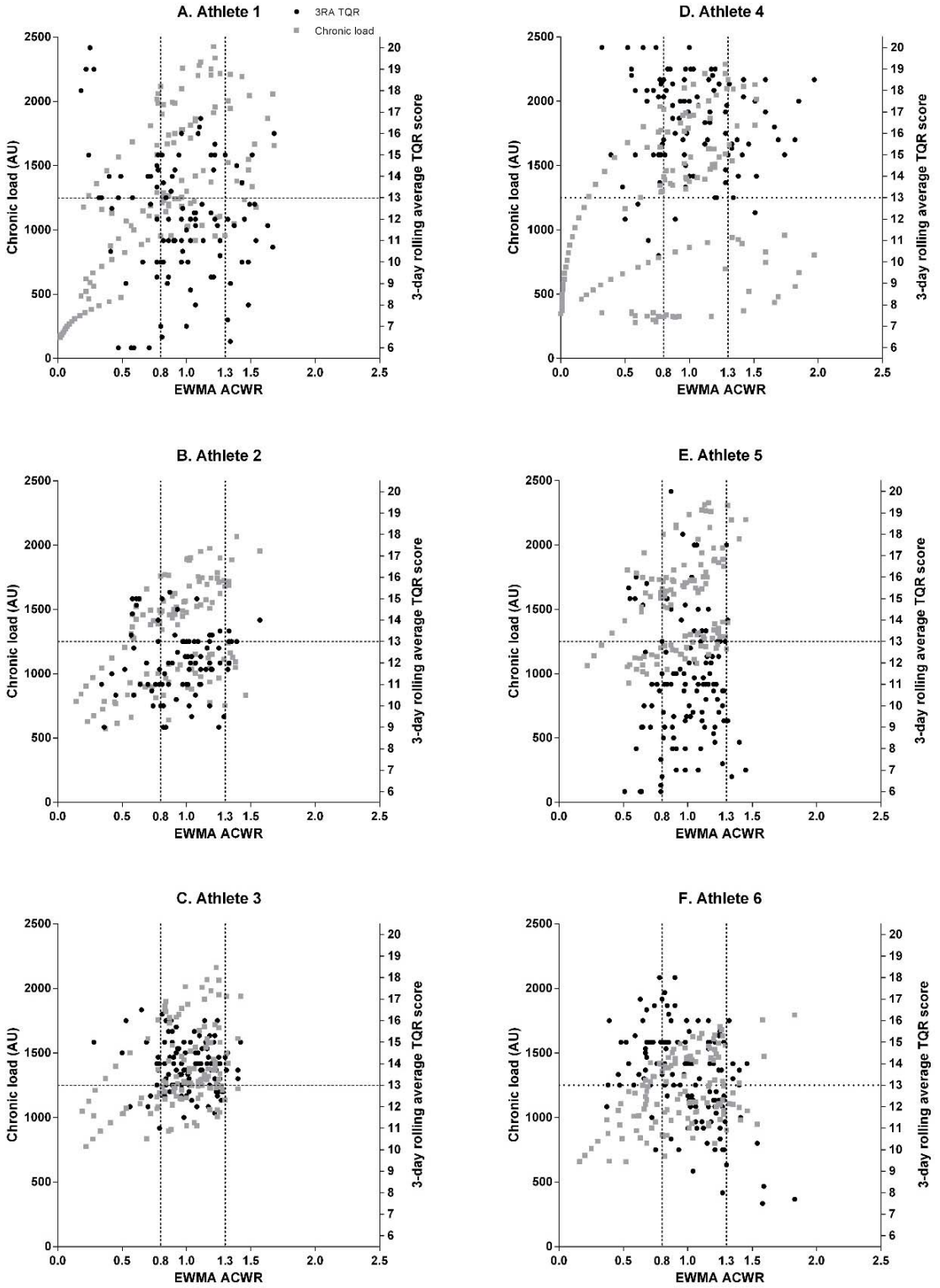

Figure 2. Individual daily acute:chronic workload ratio in relation to chronic load and recovery of elite group rhythmic gymnasts across competitive periods.
Note: AU-arbitrary units; EWMA-exponentially weighted moving average; ACWR-acute:chronic workload ratio; TQR-Total Quality Recovery.

Spikes in load in conjunction with underrecovery and low chronic load in elite group rhythmic gymnastics may represent a large-cost and low-benefit decision for most athletes, especially during the main competitive periods of a pre-Olympic season. Moreover, considering all injuries were lower limb overuse injuries, rhythmic gymnasts may benefit from specific injury prevention programs designed to reduce the risk of these injuries.

In general, coaches want their best athletes fit, fresh, and prepared for the main competitions. However, not all gymnasts can tolerate training load as a starter during competitive periods. Considering that national senior groups practice on a full-time basis, having a larger group of 10 to 12 gymnasts training together would allow the distribution of training load amongst starters and reserves, thereby reducing exposure to spikes in load close to important events.

CONCLUSIONS

Elite group rhythmic gymnasts present different injuries, load, and recovery patterns across competitive periods. Factors such as age and chronic load could moderate how each gymnast responds to training and tolerates spikes in load. Moreover, injuries sustained during competitive periods appear to affect the short and long-term careers of gymnasts, and impair training and competition organization of the team.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest whatsoever.

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