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Effects of Tactical Periodization on Workload, Physical Fitness, and Well-Being in Professional Rugby Union Players During a Preseason Period

Xiaopan Hu,^{1,2,3} Simon Boisbluche,³ Kilian Philippe,^{3,4} Olivier Maurelli,⁵ Shichang Li,¹ Bo Xu,¹ and Jacques Prioux^{1,2,3}

¹Sino-French Joint Research Center of Sport Science, College of Physical Education and Health, East China Normal University, Shanghai, China; ²Movement, Sport, and Health Sciences Laboratory, Rennes 2 University, Bruz, France; ³Department of Sport Sciences and Physical Education, École Normale Supérieure de Rennes, Bruz, France; ⁴Movement, Balance, Performance, and Health Laboratory, University of Pau and Pays de l'Adour, Tarbes, France; and ⁵Muscle Dynamics and Metabolism Laboratory, University of Montpellier, Montpellier, France

Abstract

Hu, X, Boisbluche, S, Philippe, K, Maurelli, O, Li, S, Xu, B, and Prioux, J. Effects of tactical periodization on workload, physical fitness, and well-being in professional rugby union players during a preseason period. *J Strength Cond Res* 38(1): 105–115, 2024—Tactical periodization (TP) emerged approximately 30 years ago and has recently gained considerable attention in rugby union (RU). It aims to develop specific physical fitness components with 3 acquisition days (strength, endurance, and speed). However, no study has investigated the effects of TP on workload, physical fitness, and well-being across an RU preseason. This study aimed to determine how RU players' workload response to TP focusing on positional differences, observe the influence of a TP preseason training program on aerobic fitness and neuromuscular performance between positions, and analyze the variation of well-being reported by forwards and backs from the 3 acquisition days. Thirty-two male players completed a 6-week TP protocol. External and internal workload variables were recorded through global positioning systems and session rating of perceived exertion (s-RPE) separately. Fitness assessments included Bronco and countermovement jump (CMJ) tests. The sum of well-being indices was measured using the Hooper index. Kruskal-Wallis H tests revealed that the highest values of PlayerLoad slow, PlayerLoad slow percentage, and s-RPE were found on endurance day and the lowest on speed day. Mann-Whitney U tests showed that 15 external workload parameters were higher in backs than forwards for each acquisition day. Small improvements were observed on the Bronco test. No differences were observed in CMJ performance during the preseason period and well-being values between acquisition days. This study provides unique insights into external and internal workload variables during each acquisition day. Furthermore, it highlights TP as an efficient theoretical concept to use in an RU context.

Key Words: team sport, rugby training, assessment, performance

Introduction

The preseason period each year is crucial for physical development in the rugby union (RU) (4). Researching the Super 14 professional rugby team, Argus et al. (2) emphasized the effects of a 4-week preseason high-volume concurrent training regime on the physical conditioning of RU players. In general, an RU preseason period lasts 6–12 weeks. This short period provides limited opportunities to enhance physical conditioning (2). Therefore, the planning and programming during this period must be optimally structured. As part of the efforts to optimize training programs in team sports, coaches and sports scientists use a range of methods, including workload monitoring (4,9), assessment of physical fitness (2,4), and well-being (16,34). Workload is monitored through external and internal workload

measurements (6,34), based on the work performed by the players (e.g., using the global positioning system [GPS]), or their relative physiological and psychological response (e.g., using the rating of perceived exertion [RPE]). Regarding physical fitness, a survey on physical fitness indicated that most strength and conditioning practitioners arrange physical testing in the RU preseason period (19). Common methods include a 10-m sprint for sprint speed, the Bronco test for aerobic capacity, reactive agility for agility, and countermovement jump (CMJ) for muscular power (4,19,26). In addition, tracking the well-being status of players is an accepted practice in elite sports (6). Combining the measurements of these 3 aspects is considered to be helpful in establishing a performance profiling program for the preseason period (2,4,26).

Recently, tactical periodization (TP) has gained considerable attention in the field of RU strength and conditioning (1,35). This approach accounts for a wide array of training factors (i.e., tactical, technical, physical, and psychological) and contains 3 principal training “acquisition” days (i.e., strength, endurance, and speed days) (1,5). The purpose of integrating a TP approach is to categorize workload between 3 acquisition days within a microcycle (small-size training cycles; usually 1 week) (8,20).

Address correspondence to Xiaopan Hu, xiaopan.hu@ens-rennes.fr.

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Given that the TP principles are well-adjusted to team sports, RU coaches adopt some elements of TP in their training strategy (35). However, the popularity of this approach is backed by limited research (1). Although some studies have outlined the potential value of a TP approach in RU (35), none have reported the effects of 3 acquisition days during a preseason training period on workload, physical fitness, and well-being in professional RU players. In addition, there is limited research on the effect of TP training on different positional groups. However, previous studies do indicate substantial differences in the physical fitness and skill performance qualities of rugby players in specific position such as forwards and backs (31,37). Contrasting match demands between these positions also highlights the necessity of individualizing training prescriptions to prepare players for their specific positional roles (27).

A better understanding of the characteristics of workload and variation in well-being perception through 3 acquisition days and differences in the physical fitness of those in various playing positions during the preseason period is necessary to improve the efficiency of TP in the strength and conditioning environment. Therefore, the first aim of this study is to examine the TP approach of an elite RU team during a 6-week preseason phase using external and internal workload measurements. Second, we investigate the effects of TP on the development of running and neuromuscular performance in professional RU players. Finally, the variations of well-being are characterized based on each acquisition day. Although team data are discussed, we focus on a positional analysis. We hypothesized that greater external and internal values would occur on strength and endurance days owing to their high-volume and high-intensity characteristics and that physical fitness would improve after the preseason period. We further hypothesized that well-being indices would serve as useful markers for identifying the effects of workload and that positional differences will exist in these parameters associated with workload and physical fitness.

Methods

Experimental Approach to the Problem

Players returned to training at the rugby club (French second division rugby championship, Pro D2) after a 4-week detraining off-season. The first week back to training was in mid-July, and it was labeled as week 1. Players then began a 6-week preseason training program prescribed by the club (Table 1). Each week's training session is based on the concept of a TP approach. The 3 acquisition days were representative of 3 typical on-field sessions (i.e., strength, 6 times; endurance, 10 times; and speed, 6 times; Tables 1 and 2). The endurance day was arranged twice per week during the first 4 weeks, one of which was used as an alternative for in-season match days. After the fourth week, the Sunday endurance training was replaced by exhibition matches.

During the 6-week preseason period, external workload was monitored during every on-field session using GPS (Vector X7, Catapult Sports, Australia) (4,5). The session rating of perceived exertion (s-RPE) was used to quantify internal workload (4,11), and information on players' well-being status was collected every training day through the Hooper index (HI) (16). Only data included from the main training sessions were considered (Table 1), and data from rehabilitation, recuperation, or exhibition matches were excluded. Fitness tests were selected based on the key physical requirements of the RU. The testing battery included anthropometric (stature and body mass), running (Bronco), and

neuromuscular performance (CMJ) measurements. All performance tests were completed as part of the club's ordinary pre-season training regime and routinely performed by all players.

Subjects

Thirty-two male professional (mean \pm SD; age: 27.4 ± 4.2 years, stature: 187.8 ± 7.6 cm, and body mass: 104.0 ± 16.1 kg) RU players (19 forwards and 13 backs) from the same French National Rugby League team volunteered to participate in this study. Before protocol onset, subjects attended a presentation and received information outlining the experimental procedures. All players were familiar with the monitoring and testing procedures. The Ethics Committee of Rennes University, France approved the study, and the subjects were informed of the benefits and risks of the investigation before signing an institutionally approved informed consent document, indicating their willingness to share the data collected as part of routine practice. Subjects were free to withdraw from the study at any time without penalty.

Procedures

Organization of Acquisition Days. All training sessions were designed by the same certified and highly experienced strength and conditioning coach to assist with players' preparation for the upcoming season. The preseason training program included both general (weeks 1–4) and specific (weeks 5–6) preparatory phases (26). Workload was programmed to increase linearly during the general preparation phase before the taper and active recovery strategies were implemented. The volume and frequency of training were reduced during the specific preparation phase, but maintained an average weekly workload higher than the anticipated in-season period. Each acquisition day in a TP program has a broader meaning than the accompanying physiological label. Detailed descriptions of TP including the game model, 3 acquisition days, and methodological principles are described in previous studies (8,23,35).

Strength Day. The strength day focused on neuromuscular stimulation using small-sided games with a few players (e.g., 5 vs. 5 or 4 vs. 3), a small space (e.g., 20×30 m), and a free (oriented/nonoriented/polarized) game orientation (22,35). As a result, the overload acceleration and deceleration efforts were accomplished through confined playing spaces, with contact-focused technical or tactical activities (20). Physical contact is a demanding sport skill and indispensable on strength day (35). In addition to the contact training drills, small-sided games assist players in gaining experience in high amounts of rugby-specific actions (ruck, scrum, maul, line-out, tackling, and ball carrying into contact) concurrently under a competition structure (38).

Endurance Day. The endurance day typically included longer distances through game-play arrangements on larger surfaces (e.g., 50×60 m or full field) with a larger number of players (e.g., 10 vs. 10 or 10 vs. 8) (20). The conditioning session resembled that of the match demands, and the tactical contexts were based on the team's playing styles to stimulate collective interactions. One of the main goals of the preseason training program in the RU is to improve endurance performance. Considering there are no games at the beginning of the preseason period, endurance day was scheduled twice a week during the first 4 weeks for workload accumulation and as an alternative for the match day.

Table 2
Typical sample on-field training sessions in 3 acquisition days.

	Strength	Endurance	Speed
Training goal	High-density efforts to explosive power (acceleration, deceleration, change of direction, etc.)	Exceed average game demands in total volume and relative game speed distance (e.g., high-speed running)	Very high velocity of movement and an excessive speed of decision making
Dominant muscular contraction and metabolism pattern	Strength/aerobic	Endurance/aerobic	Speed/anaerobic
Field size and player number	Small/small	Large/large	Medium/medium to large
Tactics theme and team complexity	Small group tactics/individual with sectorial (moderate complexity)	Small and larger group tactics/sectorial with intersectorial (high complexity)	Larger group tactics/intersectorial (high complexity)
Typical training arrangements	(1) Technical warm-up (ball passing 5 min) (2) Small-sided games (25 min, $r = 3$ min) [5 vs. 5; width \times depth, 20 \times 30 m] (3) Acceleration part (8 min, $r = 2$ min) [sled push 10–20 m; 40% bodyweight; 2 sets \times 5 reps] (4) Skill learning (15 min, $r = 2$ min) (5) Contact training (10 min) [focus on physical confrontation]	(1) Technical warm-up (ball passing 5 min) (2) Position-specific training (10 min \times 2 sets, $r = 1$ min) (3) Collective training (defense technique 10 min \times 2 sets, $r = 2$ min) (4) Contact skill-training (10 min) [focus on skill, ruck, tackle, etc.] (5) Conditioning combat (12 min) [1 vs. 1 wrestling with 10-m sprint running 30 s, $r = 30$ s]	(1) Technical warm-up (ball passing 5 min) (2) Skill learning (12 min, $r = 90$ s) (3) Large-sided games (25 min, $r = 2$ min) [8 vs. 6; width \times depth, 50 \times 60 m] (4) Velocity part (8 min, $r = 90$ s) [15–40 m; 90% individual maximal velocity; 6 times] (5) Collective training (15 min)

stopwatches were within 0.02 seconds (intraclass correlation coefficients [ICCs] = 0.99) (15,36). The typical error of measurement expressed as CV% for the Bronco test in this study was 3.7%.

The player's lower-body explosive power was assessed through a bodyweight vertical CMJ. The CMJ was assessed every Wednesday morning (before the speed day on-field training session) of the second, third, and fourth weeks. Each week included 4 regular TP conditioning sessions (Monday, Wednesday, Thursday, and Saturday). Care was taken to ensure that the CMJ assessments were (a) tested >24 hours after their last strength day contact session, to ensure adequate recovery from the acute effects of training (14,39), and (b) before the speed day on-field training session to exclude the probability of a reduction in lower-body neuromuscular performance after noncontact sessions, focusing on locomotive demands (32). Testing occurred at the same time and place and under the same testing procedures. Jump height was measured on a portable jump mat (Chronojump, Boscosystem, Barcelona, Spain). This open-source jump mat is both reliable and valid for a vertical jump assessment (30). After standing on the contact mat, subjects placed their hands on their hips and descended downward to a self-selected depth before jumping upward for maximum height. Furthermore, they were instructed to keep their legs straight throughout the motion until landing. Two minutes of passive recovery were provided between each attempt (21,25,39). Jumps that did not meet the testing criteria were excluded from the analysis. The height (cm; calculated to the nearest 0.1 cm) of the best performance out of 3 jumps was retained for analyses. The CMJ height has previously demonstrated good reliability (CV% = 5.6%) in team sports (14,25), and the typical error of measurement for 3 CMJ tests in this study was 3.2%.

Psychological Adaptations to the Workload. Psychological adaptations to training stress were measured using the sport version of the HI questionnaire (16). This questionnaire analyzes the athlete's well-being status through perceived sleep quality and quantities of stress, fatigue, and muscle soreness (DOMS), each evaluated according to a 7-point Likert scale (range score 1 [very, very good] to 7 [very, very poor]) (16). Subjects rated the quality of their previous night-sleep, their stress, fatigue, and DOMS in the morning before training. The HI value was then calculated as the total score of these 4 items. The reliability of HI collection

(i.e., repeat collection of 22 training day's recordings by the same researcher) was determined as excellent for the current study with an ICC (95% CIs) of 0.96 (0.94–0.98).

Statistical Analyses

Based on previous studies with an alpha value of 0.05 and power of 0.8 (3,10), a priori power analysis was conducted using G*Power statistical software (version 3.1.9.7; University of Düsseldorf, Düsseldorf, Germany), which recommended the minimum sample size of 28, supporting the present analyses ($n = 32$). The results were expressed as mean \pm SD, with statistical analyses conducted using SPSS (version 27; IBM Inc., Chicago, IL). All data were checked for normality and homogeneity of variance using the Shapiro-Wilk test. Based on the non-normal distribution and associated heterogeneity of the GPS, s-RPE, and HI data, the non-parametric Kruskal-Wallis H with Dunn's post hoc analysis (to test the variance between the 3 acquisition days) and Mann-Whitney U tests (to test the differences between 2 positions) were performed. The ICCs with 95% CIs were calculated to evaluate the reliability of all physical fitness assessments. Differences between the pre-Bronco test and post-Bronco test were determined using a Wilcoxon signed-rank test. Two-way analyses of variance were conducted to compare CMJ across 3 test times and the positional groups to identify interactions between these factors. A Bonferroni adjustment was performed if significant main effects were present. In addition, the magnitude of effects was calculated using the following standardized mean-difference effect size (ES) scores: trivial < 0.2; small 0.2–0.6; moderate 0.6–1.2; large 1.2–2.0; and very large ≥ 2.0 (17), with the level of significance set at $p < 0.05$.

Results

Effect of Tactical Periodization and Playing Position on Workload

Table 3 presents absolute values for external workload obtained from each acquisition day. PlayerLoad and PlayerLoad slow were higher during the strength ($p < 0.001$, ES = 0.4–0.6) and endurance days ($p < 0.001$, ES = 0.4–0.7) than on the speed day. Of the 3 acquisition days, the strength day had the lowest VHSR distance

($p < 0.001$ to 0.05 , $ES = 0.5$ – 0.6) and HSR intensity ($p < 0.001$, $ES = 0.4$ – 0.5) values. Compared with the endurance day, the strength day had a higher sum of acceleration ($>2 \text{ m}\cdot\text{second}^{-2}$ and $>2.5 \text{ m}\cdot\text{second}^{-2}$) and deceleration ($<-2 \text{ m}\cdot\text{second}^{-2}$ and $<-2.5 \text{ m}\cdot\text{second}^{-2}$) efforts ($p < 0.01$ to 0.05 , $ES = 0.2$ – 0.4), but lower HSR distance ($p < 0.01$, $ES = 0.4$). By contrast, the highest PlayerLoad slow percentage ($p < 0.001$, $ES = 0.4$) and lowest deceleration velocity ($p < 0.001$, $ES = 0.3$ – 0.4) occurred on the endurance day, rather than on the strength day. As designed, the speed day typically contained faster maximum velocity ($p \leq 0.001$, $ES = 0.4$ – 0.5) and acceleration velocity ($p < 0.001$, $ES = 0.3$). On this day, players also achieved the greatest distances at VHSR ($p < 0.001$ to 0.01 , $ES = 0.1$ – 0.6) and SR ($p \leq 0.001$, $ES = 0.1$) and on all intensity parameters in HSR ($p < 0.001$, $ES = 0.5$), VHSR ($p < 0.001$, $ES = 0.2$ – 0.7), and SR ($p \leq 0.001$, $ES = 0.2$ – 0.7) distance per minute. No differences ($p > 0.05$) were found in the total distance, average velocity, and RHIE bouts.

When positions were analyzed separately (Table 4), the backs displayed higher external workload ($p < 0.001$, $ES = 0.6$ – 1.3) than forwards for all indicators except for PlayerLoad-related results. The PlayerLoad-related data indicated that the forwards performed more PlayerLoad than backs on strength day ($p < 0.001$, $ES = 0.9$), but lesser on the endurance and speed days ($p < 0.001$, $ES = 0.4$ – 0.8). There was no difference in PlayerLoad slow ($p = 0.31$ – 0.45) between the forwards and backs, whereas the forwards demonstrated a higher PlayerLoad slow percentage ($p < 0.001$, $ES = 0.8$ – 1.0) than backs on all 3 acquisition days.

Table 4 also illustrates the differences in external workload between the acquisition days in each position. For forwards, our results indicated that the HSR distance (m) and its intensity ($\text{m}\cdot\text{minute}^{-1}$) were lowest on the strength day ($p < 0.05$, $ES = 0.4$ – 0.6). The maximum deceleration velocity and sum of acceleration ($>2 \text{ m}\cdot\text{second}^{-2}$ and $>2.5 \text{ m}\cdot\text{second}^{-2}$) and deceleration ($<-2 \text{ m}\cdot\text{second}^{-2}$ and $<-2.5 \text{ m}\cdot\text{second}^{-2}$) efforts were the lowest ($p < 0.05$, $ES = 0.4$ – 0.5), whereas the PlayerLoad slow percentage was the highest on the endurance day ($p < 0.01$, $ES =$

0.4 – 0.6). On the speed day, the forwards covered the greatest VHSR, SR and their corresponding distance per minute, maximum velocity, and acceleration velocity ($p < 0.05$, $ES = 0.4$ – 0.8). Their RHIE bouts were also higher than on the endurance day ($p < 0.05$, $ES = 0.4$). However, the lowest external workload for PlayerLoad slow was identified on speed day ($p < 0.01$, $ES = 0.5$ – 0.6). Finally, there were no statistically meaningful differences in PlayerLoad, total distance, and average velocity ($p = 0.12$ – 0.97) on the 3 acquisition days for the forwards. For the backs, the sum of acceleration ($>2 \text{ m}\cdot\text{second}^{-2}$) and deceleration ($<-2 \text{ m}\cdot\text{second}^{-2}$) efforts on strength day was greater ($p = 0.03$, $ES = 0.5$) than on speed day. However, VHSR, SR, and 3 high-intensity running distances per minute were lower on the strength day ($p < 0.05$, $ES = 0.4$ – 0.8). The backs had the greatest HSR distance on endurance day ($p < 0.05$, $ES = 0.4$ – 0.6) and covered a greater total distance ($p < 0.01$, $ES = 0.5$) than on speed day. The data for speed day showed peak values for maximum velocity, acceleration, and deceleration velocity ($p < 0.05$, $ES = 0.3$ – 0.5), with the lowest for PlayerLoad and PlayerLoad slow ($p < 0.01$, $ES = 0.6$ – 0.8). Finally, there were no differences between the acquisition days for PlayerLoad slow percentage, average velocity, RHIE bouts, and sum of acceleration ($>2.5 \text{ m}\cdot\text{second}^{-2}$) and deceleration ($<-2.5 \text{ m}\cdot\text{second}^{-2}$) efforts ($p = 0.19$ – 0.71) for the backs.

Figure 1 shows the differences in s-RPE between the acquisition days and positions. All players reported higher ($p < 0.01$, $ES = 0.6$ – 0.7) s-RPE on the strength day (team: 707 ± 161.0 AU; forwards: 737 ± 166.1 AU; and backs: 663 ± 143.2 AU) and endurance day (team: 713 ± 160.7 AU; forwards: 742 ± 160.9 AU; and backs: 671 ± 151.4 AU) than on the speed day (team: 556 ± 296.6 AU; forwards: 577 ± 311.5 AU; and backs: 524 ± 272.2 AU). No differences were found between strength and endurance days ($p = 1.0$). Our results also show that the s-RPE was higher for the forwards than backs on strength ($p < 0.01$, $ES = 0.5$) and endurance days ($p < 0.001$, $ES = 0.4$), whereas there were no differences ($p = 0.07$) between positions on speed day.

Table 3
Mean \pm SD of the external workload parameters for the 3 acquisition days.

Variables	Strength day	Endurance day	Speed day	H	Pairwise comparisons with adjusted p (assessed through Kruskal-Wallis H test)
PlayerLoad (AU)	364.3 \pm 62.1	362.9 \pm 81.1	333.3 \pm 85.9	18.8	Strength and endurance vs. speed ($p < 0.001$)
PlayerLoad slow (AU)	154.9 \pm 25.8	159.6 \pm 34.1	137.5 \pm 33.0	50.0	Strength and endurance vs. speed ($p < 0.001$)
PlayerLoad slow percentage (%)	43.1 \pm 6.5	44.9 \pm 8.3	42.1 \pm 7.2	15.3	Endurance vs. speed ($p < 0.001$)
Total distance (m)	3,201.1 \pm 591.9	3,243.9 \pm 797.2	3,064.3 \pm 800.0	5.7	NS ($p = 0.058$)
HSR distance (m)	438.2 \pm 244.6	564.1 \pm 365.3	516.0 \pm 311.4	11.0	Endurance vs. strength ($p = 0.003$)
VHSR distance (m)	65.4 \pm 78.6	127.0 \pm 165.6	134.6 \pm 135.5	28.6	Speed vs. strength ($p < 0.001$) and endurance ($p = 0.003$); endurance vs. strength ($p = 0.023$)
SR distance (m)	7.4 \pm 16.1	22.1 \pm 46.6	26.8 \pm 45.7	25.4	Speed vs. strength and endurance ($p \leq 0.001$)
HSR per minute ($\text{m}\cdot\text{min}^{-1}$)	8.7 \pm 4.9	11.0 \pm 6.4	11.3 \pm 6.5	20.5	Speed and endurance vs. strength ($p < 0.001$)
VHSR per minute ($\text{m}\cdot\text{min}^{-1}$)	1.3 \pm 1.5	2.4 \pm 2.9	2.9 \pm 2.8	39.0	Speed vs. strength and endurance ($p < 0.001$); endurance vs. strength ($p = 0.009$)
SR per minute ($\text{m}\cdot\text{min}^{-1}$)	0.1 \pm 0.3	0.4 \pm 0.8	0.6 \pm 1.0	27.9	Speed vs. strength and endurance ($p \leq 0.001$)
Average velocity ($\text{m}\cdot\text{min}^{-1}$)	63.4 \pm 12.1	65.8 \pm 12.8	66.6 \pm 13.5	4.8	NS ($p = 0.089$)
Maximum velocity ($\text{km}\cdot\text{h}^{-1}$)	24.1 \pm 2.6	24.3 \pm 3.3	25.4 \pm 2.7	22.8	Speed vs. strength and endurance ($p \leq 0.001$)
RHIE bouts (n)	9.0 \pm 5.6	9.0 \pm 6.2	9.8 \pm 6.4	2.3	NS ($p = 0.310$)
Maximum acceleration velocity ($\text{m}\cdot\text{s}^{-2}$)	3.8 \pm 0.4	3.8 \pm 0.4	3.9 \pm 0.4	23.0	Speed vs. strength and endurance ($p < 0.001$)
Maximum deceleration velocity ($\text{m}\cdot\text{s}^{-2}$)	-4.5 \pm 0.8	-4.2 \pm 0.7	-4.4 \pm 0.8	22.8	Strength and speed vs. endurance ($p < 0.001$)
Sum of acceleration ($>2 \text{ m}\cdot\text{s}^{-2}$) and deceleration ($<-2 \text{ m}\cdot\text{s}^{-2}$) (n)	100.9 \pm 36.7	88.2 \pm 34.3	92.4 \pm 34.3	14.1	Strength vs. endurance ($p = 0.001$)
Sum of acceleration ($>2.5 \text{ m}\cdot\text{s}^{-2}$) and deceleration ($<-2.5 \text{ m}\cdot\text{s}^{-2}$) (n)	53.7 \pm 25.7	47.8 \pm 24.9	50.8 \pm 23.6	7.4	Strength vs. endurance ($p = 0.025$)

AU, arbitrary unit; H = H test statistic; HSR = high-speed running; NS = no significant; RHIE = repeated high-intensity efforts; SR = sprint running; VHSR = very high-speed running.

Table 4**Mean ± SD of the external workload parameters depending on position for the 3 acquisition days.***

Variables	Strength day		Comparison between positions		Endurance day		Comparison between positions		Speed day		Comparison between positions	
	Forwards	Backs	Z	ES	Forwards	Backs	Z	ES	Forwards	Backs	Z	ES
	PlayerLoad (AU)	340.4 ± 56.3	399.2 ± 53.3†	-6.6	0.9	335.1 ± 66.5	403.6 ± 83.6†	-7.3	0.8	320.2 ± 85.3	352.4 ± 83.9†‡§	-2.5
PlayerLoad slow (AU)	154.4 ± 28.9	155.5 ± 20.4	-0.8	NS	161.2 ± 37.3	157.3 ± 28.7	-1.0	NS	139.4 ± 34.0†§	134.6 ± 31.3†§	-1.0	NS
PlayerLoad slow percentage (%)	45.6 ± 6.2	39.3 ± 5.2†	-6.6	1.0	48.4 ± 7.5†	39.8 ± 6.6†	-9.3	1.0	44.4 ± 6.9§	38.8 ± 6.4†	-5.3	0.8
Total distance (m)	2,920.8 ± 548.3	3,610.8 ± 376.0†	-8.5	1.2	2,902.6 ± 570.8	3,742.8 ± 819.5†	-9.0	1.1	2,866.7 ± 783.2	3,353.0 ± 738.4†§	-4.0	0.6
HSR distance (m)	325.8 ± 194.0	602.3 ± 217.2†	-8.0	1.1	409.2 ± 247.9†	790.4 ± 391.0††	-8.5	1.0	420.5 ± 265.7†	655.5 ± 332.7†§	-5.0	0.8
VHSR distance (m)	32.1 ± 47.3	114.0 ± 89.5†	-8.0	1.0	62.7 ± 91.4	220.9 ± 201.4††	-8.2	1.0	92.8 ± 101.1†§	195.7 ± 155.4††	-5.5	0.8
SR distance (m)	2.5 ± 5.8	14.5 ± 22.6†	-6.3	0.7	6.5 ± 16.3	44.8 ± 64.1††	-8.6	0.8	14.9 ± 29.4†§	44.2 ± 58.3††	-5.6	0.6
HSR per minute (m·min ⁻¹)	6.3 ± 3.5	12.1 ± 4.6†	-8.0	1.2	8.0 ± 4.1†	15.3 ± 6.5††	-9.6	1.2	9.1 ± 5.4†	14.6 ± 6.6††	-5.7	0.8
VHSR per minute (m·min ⁻¹)	0.6 ± 0.8	2.3 ± 1.8†	-8.1	1.1	1.2 ± 1.6	4.1 ± 3.5††	-8.6	1.0	1.9 ± 2.1†§	4.3 ± 3.2††	-5.9	0.8
SR per minute (m·min ⁻¹)	0.0 ± 0.1	0.3 ± 0.4†	-6.3	0.7	0.1 ± 0.3	0.8 ± 1.2††	-8.6	0.8	0.3 ± 0.5†§	0.9 ± 1.3††	-5.8	0.7
Average velocity (m·min ⁻¹)	57.5 ± 10.5	71.9 ± 8.8†	-8.5	1.2	59.3 ± 9.7	75.4 ± 10.7†	-11.2	1.3	60.8 ± 11.6	75.1 ± 11.6†	-7.3	1.1
Maximum velocity (km·h ⁻¹)	23.0 ± 2.4	25.7 ± 2.0†	-7.1	1.0	23.0 ± 2.7	26.3 ± 3.1†	-8.9	1.0	24.4 ± 2.4†§	26.8 ± 2.3††	-6.2	0.9
RHIE bouts (n)	6.7 ± 4.6	12.4 ± 5.3†	-6.8	1.0	6.0 ± 3.9	13.4 ± 6.4†	-10.4	1.2	7.8 ± 5.3§	12.8 ± 6.8†	-5.2	0.8
Maximum acceleration velocity (m·s ⁻²)	3.6 ± 0.3	4.0 ± 0.3†	-5.9	0.9	3.6 ± 0.4	4.0 ± 0.4†	-8.5	0.9	3.8 ± 0.4†§	4.1 ± 0.4††	-4.9	0.7
Maximum deceleration velocity (m·s ⁻²)	-4.2 ± 0.7	-4.8 ± 0.7†	-5.8	0.8	-3.9 ± 0.7†	-4.6 ± 0.7††	-8.2	0.9	-4.2 ± 0.7§	-4.8 ± 0.8†§	-6.0	0.8
Sum of acceleration (>2 m·s ⁻²) and deceleration (<-2 m·s ⁻²) (n)	85.9 ± 32.7	122.7 ± 31.0†	-7.0	1.0	70.6 ± 22.5†	114.0 ± 32.3†	-11.1	1.3	83.1 ± 29.9§	105.9 ± 36.1††	-4.5	0.7
Sum of acceleration (>2.5 m·s ⁻²) and deceleration (<-2.5 m·s ⁻²) (n)	42.9 ± 21.2	69.6 ± 23.3†	-7.1	1.0	35.6 ± 16.0†	65.8 ± 24.6†	-10.6	1.2	43.2 ± 19.2§	61.8 ± 25.2†	-5.0	0.8

*ES = effect size; HSR = high-speed running; NS = no significant; RHIE = repeated high-intensity efforts; SR = sprint running; VHSR = very high-speed running; Z = z score.

†Significant difference between forwards and backs ($p < 0.05$).‡Significantly different from strength day ($p < 0.05$).§Significantly different from endurance day ($p < 0.05$).

Effect of Tactical Periodization and Playing Position on Running, Neuromuscular Performance, and Well-Being Status

Figure 2 depicts the team and individual running time values between the pre-test and post-test. Our results indicated a decrease ($p < 0.01$, $ES = 0.4-0.9$) between the pre-test and post-test for the team (5.2 ± 0.6 vs. 4.9 ± 0.6 minutes), forwards (5.4 ± 0.6 vs. 5.2 ± 0.6 minutes), and backs (4.7 ± 0.3 vs. 4.5 ± 0.2 minutes). The forwards always had slower running times ($p < 0.01$, $ES = 1.1-1.2$) than backs in the pre-test and post-test. The ICCs for the Bronco test were 0.87 (0.18–0.96).

Concerning neuromuscular performance, the backs (range 44.6 ± 4.4 to 46.0 ± 4.5 cm) demonstrated greater vertical jump height ($p < 0.01$, $ES = 1.3-1.5$) than the forwards (range 37.6 ± 5.1 to 38.1 ± 4.8 cm) in each CMJ test time, whereas no difference ($p > 0.05$) was found between test times for the jump height for the team, forwards, and backs (Figure 3). The ICC was 0.94 (0.90–0.97) for the CMJ measurements, indicating high reliability.

Regarding player's well-being status during the preseason period, no differences ($p > 0.05$) in HI values were found between the 3 acquisition days for the team (strength day: 11 ± 3.8 AU; endurance day: 11 ± 4.1 AU; and speed day: 11 ± 3.8 AU), forwards (strength day: 11 ± 4.2 AU; endurance day: 12 ± 4.2 AU; and speed day: 12 ± 4.2 AU), and backs (strength day: 11 ± 3.3 AU; endurance day: 11 ± 3.9 AU; and speed day: 11 ± 3.1 AU). There were also no differences between positions on each acquisition day for the HI variable ($p > 0.05$) (Figure 4).

Discussion

This study assessed the effects of TP on workload, physical fitness, and well-being in professional RU players during a preseason

period while comparing typical acquisition days between positions. The primary findings of this study provide evidence that workload data effectively reflect the characteristics of acquisition days. Furthermore, improvements in running performance were noticeable after the preseason period. By contrast, no significant change was observed in neuromuscular performance. Similarly, well-being status does not differ between 3 acquisition days. Finally, owing to different positional demands and physical fitness characteristics between forwards and backs, the workload characteristics and changes in physical performance observed during the preseason period occurred according to the playing position. All previous results suggest that TP provokes typical workload responses, superior performance outcomes, and maintains well-being status in professional RU players during the preseason period.

In this study, the external workload profile of the on-field training session notably reflected the objective of each acquisition day. As scholars have noted (23,29), the name of the 3 acquisition days needs acceptance, to appreciate its meaning. Each acquisition day was planned to stress different muscles according to the type of subdynamic in the muscular contractions (23,29). For instance, knowing that an optimal strength day should include “acceleration/deceleration strength” activities performed at very high intensities and elevated speeds (5,35), it was not surprising to observe that the team and both positions (forwards and backs) completed the highest sum of acceleration ($>2 \text{ m}\cdot\text{second}^{-2}$) and deceleration ($<-2 \text{ m}\cdot\text{second}^{-2}$) efforts on strength day (Tables 3 and 4). Based on Vachon et al. (38), who found that RU players performed more acceleration and deceleration in aerobic-oriented small-sided games than in speed-oriented small-sided games, the sum of accelerations and decelerations we report for the strength day may offer greater utility in differentiating the physical characteristics associated with different acquisition days. Furthermore, previous evidence suggests that concurrent training with contrasting physical adaptations

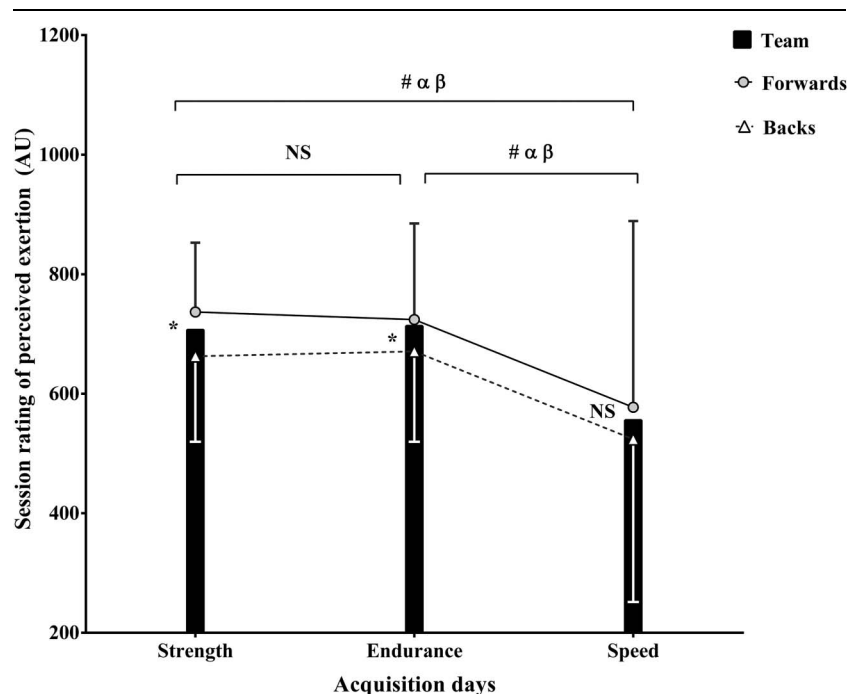


Figure 1. Comparison of session rating of perceived exertion between acquisition days and positions during preseason period (mean \pm SD). Symbols represent significant difference between acquisition day: # team; α forwards; and β backs ($p < 0.05$); *significant difference between forwards and backs ($p < 0.05$); NS, no significant.

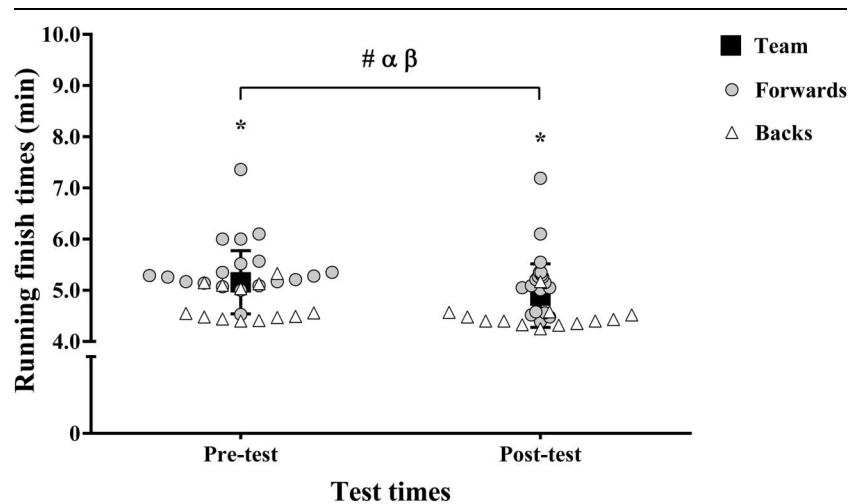


Figure 2. Mean \pm SD and individual values of the Bronco test during preseason period. Symbols represent significant difference between pre-test and post-test for: # team; α forwards; and β backs ($p < 0.05$); *significant difference between forwards and backs ($p < 0.05$).

during the same training phase may attenuate gains in muscle mass, strength, and power (12,19). Diverging from concurrent training, the skeletal muscle adaptations associated with exercise training in TP are highly specific to the game model (23). The reduced size of space, number of players, and times with high amounts of RU-specific actions in the small-sided games on the strength day enable performing more acceleration/deceleration strength activities such as changing direction with a sprint to avoid a defender, stopping after physical contact, or maintaining speed while catching a pass (35). Notably, although the strength day had the highest number of acceleration/deceleration activities, the maximum acceleration velocity ($\text{m}\cdot\text{second}^{-2}$) occurred on the speed day. This crucial acquisition day encourages agility learning by simulating game-play

actions (35). In this context, speed day is dedicated to improving maximum velocity, acceleration, and high-intensity running (8,29). As expected, the speed day had higher maximum velocity, VHSR, and SR ($\text{m}\cdot\text{minute}^{-1}$) compared with the strength and endurance days (Tables 3 and 4). These findings highlight the specificity of each acquisition day, which have possibly contributed to the development of sprinting or changing direction over an extended distance required for modern professional RU players (31). However, the mechanisms underpinning how TP speed day training could benefit acceleration are unspecified. Thus, future studies could incorporate electromyography to measure adaptations or compare them with other training protocols (e.g., free sprinting, weights, plyometrics, and resisted sprinting) to ascertain the true utility of

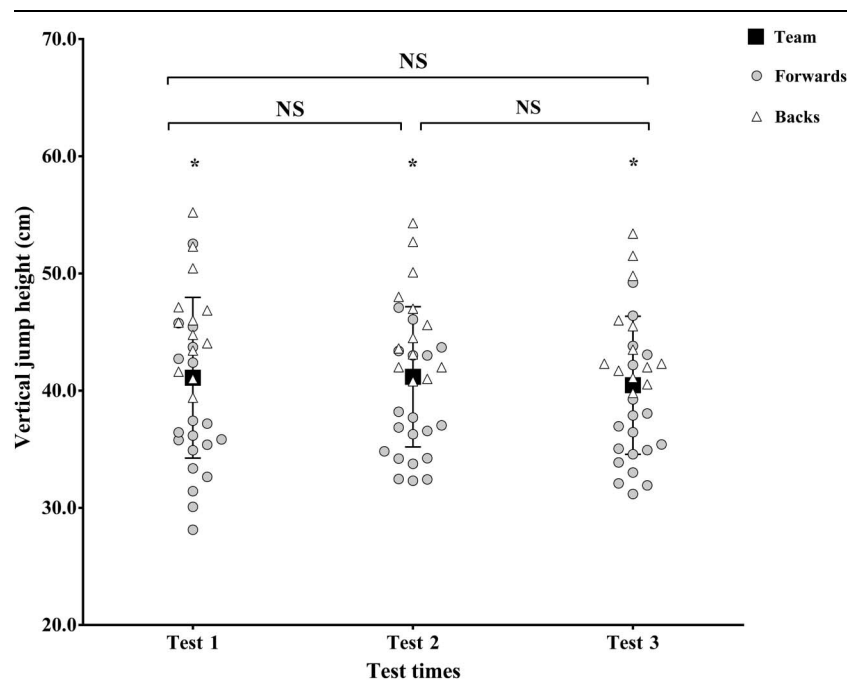


Figure 3. Comparison of the Hooper index between acquisition days and positions during preseason period (mean \pm SD). NS, no significant difference between acquisition days for the team, forwards, and backs and no significant difference in position comparison on each acquisition day ($p > 0.05$).

speed day in TP (21). Previous studies have suggested that the manufacturer-specific parameters of PlayerLoad (accelerations data accumulation from 3 axes) and PlayerLoad slow (all accelerations that occur at $< 2 \text{ m}\cdot\text{second}^{-1}$) can indicate the global and low-velocity physical loads experienced by the player (28,31). Based on this, the PlayerLoad slow percentage seems reliable reflecting the relative contribution of low-speed movements to total PlayerLoad for each player, which is related to collision-based activities (28). Our study demonstrated that more PlayerLoad and PlayerLoad slow were accomplished on strength and endurance days than during speed day (Tables 3 and 4). These findings support existing research (13,22) and show evidence of the different main targets in the training stimulus of each acquisition day. Specifically, the highest PlayerLoad slow and its percentage were covered during endurance days, which could indicate that the greater efforts of low-speed activity, HSR distance, collisions, and RHIE bouts performed on the on-field sessions are attributed to the type of game-based tasks proposed for this day (13,22,35). The PlayerLoad slow experienced by the players in our study was lower than that reported by McLaren et al.'s (27) research in the English RU Championship game (team: $250 \pm 50 \text{ AU}$; forwards: $290 \pm 30 \text{ AU}$; and backs: $230 \pm 40 \text{ AU}$). However, it was similar to the finding of Roe et al. (32) for professional RU academy preseason training (range 108 ± 1.1 to $165 \pm 1.2 \text{ AU}$). Discrepancies between studies may be due to a methodological difference in collecting data on PlayerLoad slow and differences between match and training demands. Specifically, data for all GPS parameters in this study were collected during the ball-in-play time to provide detailed descriptions of the external workload on acquisition days. Possibly, the totality of mechanical stress accumulated at low velocities experienced by players during training was lesser than during the whole match because of excluded inactive training time (e.g., coaching instruction and drinks break). In addition, the differences in PlayerLoad slow between studies could be attributed to different training strategies adopted by each recruited team. Finally, our study showed no differences in the total

distance, average velocity, and RHIE bouts between acquisition days. Contextual aspects of arrangements beyond training, particularly for additional factors including the number of subjects, length of the monitoring period, and absolute velocity threshold rather than the relative percentage of maximal velocity for inclusion in RHIE bouts (12,27), may be possible reasons for no differences.

Regarding playing position, except for PlayerLoad-related data, the backs always achieved higher external workload values than the forwards (Table 4). This may be because of their different positional roles. Backs spent a longer time at greater velocity and on intense running activity, resulting in completing more distance, acceleration, and deceleration (27). Consequently, there was a strong trend for backs to have a higher PlayerLoad than forwards on the endurance and speed days. This trend is also supported by evidence that the PlayerLoad demonstrated moderate to high relationships with distance covered (13). In addition, the backs completed a higher number of RHIE bouts, which were defined as ≥ 3 consecutive high-intensity efforts or impacts occurring within 21 seconds (27). These findings are consistent with those found for the Top 14 professional RU players (37). However, our results demonstrate that the differences in PlayerLoad slow between positions are unclear (Table 4). Similar results were reported by Roe et al. (32), who proposed this might be attributed to the lack of full-contact collisions in training compared with matches. Studies on the PlayerLoad slow percentage in professional RU are lacking, rendering interstudy comparisons difficult. Here, Norris et al. (28) suggested that the ratio of PlayerLoad slow to total PlayerLoad was sufficiently reliable to detect moderate changes in rugby league performance ($\text{CV}\% = 5.6\text{--}10.0\%$). Given the RU positional differences previously presented in the literature by studies using GPS data (4,9,27), we contend that although the PlayerLoad slow did not differ between positions in our study, the number of physical collisions by forwards results in a greater relative contribution of low-velocity physical loads to the total PlayerLoad.

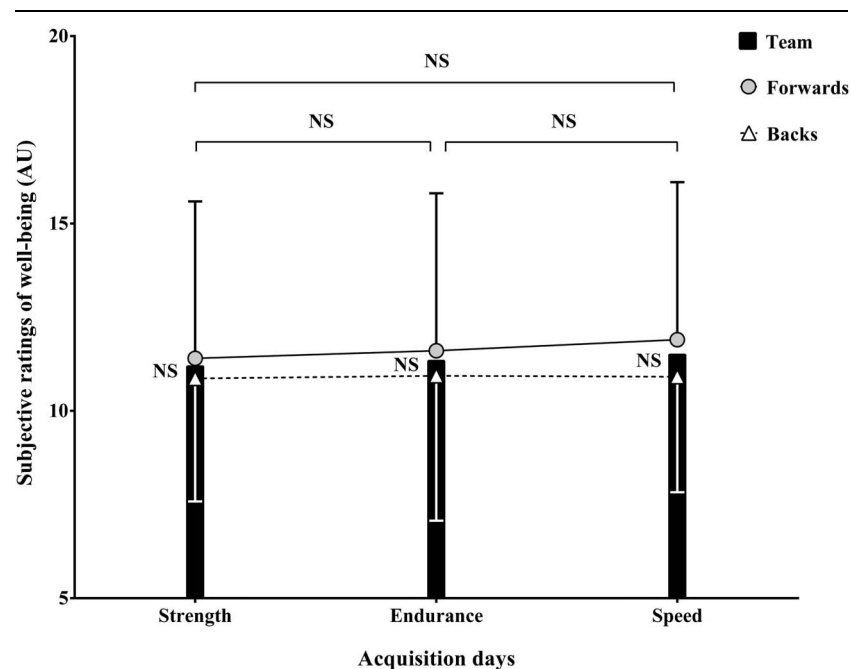


Figure 4. Mean \pm SD and individual values of the countermovement test during preseason period. *Significant difference between forwards and backs on each test ($p < 0.05$); NS, no significant difference between test times for the team, forwards, and backs ($p > 0.05$).

A valid and simplified way to quantify internal workload is using s-RPE (11). Regardless of position, players presented a lower s-RPE on the speed day than on strength and endurance days (Figure 1). This lower s-RPE on speed day may reflect the different activity profiles of acquisition days. It could also represent a clear tapering strategy on the speed day of exhibition game weeks to reduce players' fatigue levels while preserving training-induced adaptations (Table 1). The reduction in workload was achieved by a 74–77% decrease in s-RPE on the 2 speed days (day 34: 226 ± 45.0 AU and day 41: 191 ± 47.1 AU) before the match compared with the previous endurance day. As reported for RU (4) or football (22), tapering is widely used by coaches to unload the players and increase their readiness for the match. By contrast, Buchheit et al. (5) observed no differences in the perceived load between 3 conditioned TP sessions. Thus, possibly, internal workload may depend on the arrangement of different drills and exercises. Other considerations for the inconsistency in internal workload might be factors associated with the type of sport and subjects' playing experience (4). In addition, the results of this study partly confirm that the forwards have higher internal workload than backs (Figure 1). The position's difference in s-RPE on the strength and endurance days could be explained by the fact that the forwards participated in specific scrum and lineout training sessions that exhibited high perceived loads (9). These findings are aligned with those of a previous study on elite RU players, which showed that s-RPE reflects activities related to forwards with relatively static but highly demanding efforts (4). By contrast, there was no difference between player positions on speed day. This result may provide relevant position-specific information to establish TP guidelines for RU. Finally, considering the negative correlations between s-RPE and wellness measures (6), further research is needed to examine the impact of acute s-RPE on well-being status on the following day, related to training adaptations, neuromuscular function, and recovery strategies. From an applied perspective, coaches and scientific staff can use these data to understand the workload required on specific acquisition days and consider periodization from a multidimensional perspective.

Owing to the brief duration of the preseason period, it is crucial to advance training strategies to develop aerobic capacity during this period. In the RU, the Bronco test is widely used to assess aerobic capacity (36). This study showed that both positions reduced Bronco test finish time (Figure 2). These findings highlight the potential function of the TP approach in developing aerobic capacity in professional RU players (36,37). Consistent with Vachon et al. (37), our results showed that backs had better aerobic fitness than forwards. Given that the total sprint time was strongly associated with the Bronco test ($p < 0.01$, $r = 0.90$) and backs' RHIE bouts are composed of a higher proportion of sprints, these results tend to confirm previous observations, indicating the difference in positional roles and playing styles (37). Thus, it seems reasonable to assume that TP training fits the requirements of preparing a player's position-specific physical performance profile.

CMJ monitoring has attracted considerable interest for examining an athlete's neuromuscular status (37). Previous research indicates that RU collisions and increased running intensity reduce neuromuscular performance, which can be monitored through CMJ variables (14,32). However, our study found no decrease in CMJ performance for both positional groups (Figure 3). Horizontal alternation in programming proposed in the TP approach (i.e., the strength, endurance, and speed days) helped in achieving optimal workload that allowed the players to maintain their neuromuscular performance and minimize the accumulation of fatigue throughout the weeks (8,25). Similarly, no increase in CMJ performance was

observed for both positional groups (Figure 3). Research by West et al. (39) and Greg Roe et al. (32) suggested that lower-body neuromuscular functions may be depressed for 24–60 hours after exposure to RU training or match. In this study, the placement of the CMJ test 48 hours after the strength day may not be long enough for positive adaptation to occur (14). From a step pattern viewpoint (21,37), the TP training did not result in significant changes in CMJ height, which may be positive for accelerations since any changes in lower-body power are specific to the sprint step action. Finally, our results showed that the backs had better CMJ height than forwards during CMJ tests. These findings align with those of previous studies that confirmed that the neuromechanical differences between backs and forwards were directly related to position-specific tasks (37).

The physical training program of this study was specifically designed to progressively increase workload during the initial 4 weeks (including the gym session). Several studies have suggested that the HI was sensitive in identifying training stress and has a dose-response relationship with workloads (6,16). Although we observed differences in the external and internal workload (Tables 3 and 4; Figure 1), the overall results indicated no differences in HI values across the preseason period between acquisition days and playing positions (Figure 4). In this study, most responses of overall well-being were lower than 12 points, which is considered below the results reported by Buchheit et al. (6) in elite Australian rules football players. The low accumulated values and variability of well-being indicate that the TP approach did not lead to higher stress or fatigue symptoms in RU players. In fact, players undergo a well-managed and administered training program with the principle of horizontal alternation in specificity, which could have generated morphological adaptations in the muscle fibers necessary to withstand the induced mechanical stress (12).

Despite this study's novelty, we acknowledge its several limitations. It is impossible to control every aspect of a training study involving “real-world” players, especially the drills and exercises. Our results are based on only 1 team during a distinct preseason, making it difficult to generalize these findings. Other contextual factors (e.g., coach, ranking, weather, and so on) also influence our results. Moreover, the players' status also affects the changes observed in the characteristics examined. Future studies should use an experimental design characterizing the external and internal workload among acquisition days during the in-season period. In addition, the TP protocol should be repeated with elite subjects to determine the effects on physical attributes.

Practical Applications

This study showed that a sample of elite male RU players could implement a TP approach to enhance physical performance during a 6-week preseason period. The strength day helps achieve the typical acceleration and deceleration demands. The endurance day may improve high-speed running distance and aerobic capacity. The speed day focuses on maximum velocity and acceleration development. Moreover, based on the findings described in this study, coaches and fitness staff can set specific training goals to fit the distinct functional roles of RU players. It is also recommended that RU coaches implement, during the preseason period, the external and internal workload monitoring as well as physical assessments to monitor the performance of their players. Finally, our data suggest that a TP approach in preseason training programs may be a useful tool for workload management and fitness preparation in RU players.

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References

- Afonso J, Bessa C, Nikolaidis PT, Teoldo I, Clemente FM. A systematic review of research on tactical periodization: Absence of empirical data, burden of proof, and benefit of doubt. *Hum Mov* 21: 37–43, 2020.
- Argus CK, Gill N, Keogh J, Hopkins WG, Beaven CM. Effects of a short-term pre-season training programme on the body composition and anaerobic performance of professional rugby union players. *J Sports Sci* 28: 679–686, 2010.
- Beck TW. The importance of a priori sample size estimation in strength and conditioning research. *J Strength Cond Res* 27: 2323–2337, 2013.
- Bradley WJ, Cavanagh BP, Douglas W, Donovan TF, Morton JP, Close GL. Quantification of training load, energy intake, and physiological adaptations during a rugby pre-season: A case study from an elite European rugby union squad. *J Strength Cond Res* 29: 534–544, 2015.
- Buchheit M, Lacombe M, Cholley Y, Simpson BM. Neuromuscular responses to conditioned soccer sessions assessed via GPS-embedded accelerometers: Insights into tactical periodization. *Int J Sports Physiol Perform* 13: 577–583, 2018.
- Buchheit M, Racinais S, Bilsborough JC, et al. Monitoring fitness, fatigue and running performance during a pre-season training camp in elite football players. *J Sci Med Sport* 16: 550–555, 2013.
- Clavel P, Leduc C, Morin J-B, et al. Concurrent validity and reliability of sprinting force–velocity profile assessed with GPS devices in elite athletes. *Int J Sports Physiol Perform* 17: 1527–1531, 2022.
- Delgado-Bordonau JL, Mendez-Villanueva A. Tactical periodization: Mourinho's best-kept secret? *Soccer NSCAA J* 7: 28–34, 2012.
- Dubois R, Bru N, Paillard T, et al. Rugby game performances and weekly workload: Using of data mining process to enter in the complexity. *PLoS One* 15: e0228107–e0228121, 2020.
- Faul F, Erdfelder E, Buchner A, Lang A-G. Statistical power analyses using G*power 3.1: Tests for correlation and regression analyses. *Behav Res Methods* 41: 1149–1160, 2009.
- Foster C, Florhaug JA, Franklin J, et al. A new approach to monitoring exercise training. *J Strength Cond Res* 15: 109–115, 2001.
- Fyfe JJ, Bishop DJ, Stepto NK. Interference between concurrent resistance and endurance exercise: Molecular bases and the role of individual training variables. *Sports Med* 44: 743–762, 2014.
- Gabbett TJ. Relationship between accelerometer load, collisions, and repeated high-intensity effort activity in rugby league players. *J Strength Cond Res* 29: 3424–3431, 2015.
- Gathercole R, Sporer B, Stellingwerff T, Sleivert G. Alternative counter-movement-jump analysis to quantify acute neuromuscular fatigue. *Int J Sports Physiol Perform* 10: 84–92, 2015.
- Hetzler RK, Stickley CD, Lundquist KM, Kimura IF. Reliability and accuracy of handheld stopwatches compared with electronic timing in measuring sprint performance. *J Strength Cond Res* 22: 1969–1976, 2008.
- Hooper SL, Mackinnon L, Howard A, Gordon RD, Bachmann AW. Markers for monitoring overtraining and recovery. *Med Sci Sports Exerc* 27: 106–112, 1995.
- Hopkins WG, Marshall SW, Batterham AM, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc* 41: 3–12, 2009.
- Hunter F, Bray J, Towson C, et al. Individualisation of time-motion analysis: A method comparison and case report series. *Int J Sports Med* 36: 41–48, 2014.
- Jones TW, Smith A, Macnaughton LS, French DN. Strength and conditioning and concurrent training practices in elite rugby union. *J Strength Cond Res* 30: 3354–3366, 2016.
- Karlsson UB. *Training/match Load and Physical Performance in an Elite Female Football Team Utilizing a Tactical Periodization Model*. Oslo, Norges: Master's thesis, Norwegian School of Sport Sciences, 2021.
- Lockie RG, Murphy AJ, Schultz AB, Knight TJ, Janse de Jonge XA. The effects of different speed training protocols on sprint acceleration kinematics and muscle strength and power in field sport athletes. *J Strength Cond Res* 26: 1539–1550, 2012.
- Lopategui IG, Paulis JC, Escudero IE. Physical demands and internal response in football sessions according to tactical periodization. *Int J Sports Physiol Perform* 16: 858–864, 2021.
- Mallo J. *Complex Football: From Seirulo's Structured Training to Frade's Tactical Periodization* (2nd ed.). Spain: Topprosoccer S.L., 2020.
- Malone JJ, Lovell R, Varley MC, Coutts AJ. Unpacking the black box: Applications and considerations for using GPS devices in sport. *Int J Sports Physiol Perform* 12: S218–S226, 2017.
- Malone JJ, Murtagh CF, Morgans R, Burgess DJ, Morton JP, Drust B. Countermovement jump performance is not affected during an in-season training microcycle in elite youth soccer players. *J Strength Cond Res* 29: 752–757, 2015.
- McLaren SJ, Smith A, Bartlett JD, Spears IR, Weston M. Differential training loads and individual fitness responses to pre-season in professional rugby union players. *J Sports Sci* 36: 2438–2446, 2018.
- McLaren SJ, Weston M, Smith A, Cramb R, Portas MD. Variability of physical performance and player match loads in professional rugby union. *J Sci Med Sport* 19: 493–497, 2016.
- Norris JP, Highton J, Twist C. The reproducibility and external validity of a modified rugby league movement-simulation protocol for interchange players. *Int J Sports Physiol Perform* 14: 445–450, 2019.
- Pimenta LB. *From Complexity Paradigm to Morphocycle: A Study-Map. UEFA-A Lisenskurs 2013/14*. Nyon, Switzerland: Union of European Football Associations. 2013. pp. 1–45.
- Pueo B, Penichet-Tomas A, Jimenez-Olmedo JM. Reliability and validity of the Chronojump open-source jump mat system. *Biol Sport* 37: 255–259, 2020.
- Read DB, Jones B, Phibbs PJ, et al. Physical demands of representative match-play in adolescent rugby union. *J Strength Cond Res* 31: 1290–1296, 2017.
- Roe G, Darrall-Jones J, Till K, et al. The effect of physical contact on changes in fatigue markers following rugby union field-based training. *Eur J Sport Sci* 17: 647–655, 2017.
- Scott TJ, Black CR, Quinn J, Coutts AJ. Validity and reliability of the session-RPE method for quantifying training in Australian football: A comparison of the CR10 and CR100 scales. *J Strength Cond Res* 27: 270–276, 2013.
- Selmi O, Gonçalves B, Ouergui I, Sampaio J, Bouassida A. Influence of well-being variables and recovery state in physical enjoyment of professional soccer players during small-sided games. *Res Sports Med* 26: 199–210, 2018.
- Tee JC, Ashford M, Piggott D. A tactical periodization approach for rugby union. *Strength Cond J* 40: 1–13, 2018.
- Tece AR, Argus CK, Gill N, Beaven M, Dunican IC, Driller MW. Sleep and performance during a pre-season in elite rugby union athletes. *Int J Environ Res Publ Health* 18: 4612–4613, 2021.
- Vachon A, Berryman N, Mujika I, Paquet J-B, Bosquet L. Fitness determinants of repeated high-intensity effort ability in elite rugby union players. *Int J Sports Physiol Perform* 16: 1103–1110, 2021.
- Vachon A, Berryman N, Mujika I, Paquet J-B, Bosquet L. Preconditioning activities to enhance repeated high-intensity efforts in elite rugby union players. *Int J Sports Physiol Perform* 17: 871–878, 2022.
- West DJ, Finn CV, Cunningham DJ, et al. Neuromuscular function, hormonal, and mood responses to a professional rugby union match. *J Strength Cond Res* 28: 194–200, 2014.