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Original research

Influence of physical qualities on post-match fatigue in rugby league players

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ABSTRACT

Objectives: This study examined the influence of physical qualities on markers of fatigue and muscle damage following rugby league match-play.
Design: Between subjects design.
Methods: Twenty-one male youth rugby league players (age 19.2 ± 0.7 years; height 180.7 ± 5.6 cm; body mass 89.9 ± 10.0 kg) participated in the study. Yo-Yo intermittent recovery test (level 1), 3 repetition maximum back squat and bench press were assessed prior to 2 competitive fixtures. Neuromuscular fatigue (countermovement jump [CMJ] and plyometric push-up [PP]), and blood creatine kinase (CK) were assessed before and after match-play. During match-play, movements were recorded using microtechnology. Players were divided into high- and low-groups based on physical qualities.
Results: High Yo-Yo and squat performance resulted in greater loads during match-play ($p < 0.05$). There were larger reductions in CMJ power in the low Yo-Yo group at both 24 (ES = −1.83), and 48 h post-match (ES = −1.33). Despite greater internal and external match loads, changes in CMJ power were similar between squat groups. There were larger increases in blood CK in the low Yo-Yo group at 24 (73% vs. 176%; ES = 1.50) and 48 h post-match (28% vs. 80%; ES = 1.22). Despite greater contact loads, the high squat group exhibited smaller changes in blood CK post-match (ES = 0.25–0.39).
Conclusions: Post-match fatigue is lower in players with well-developed high-intensity running ability, and lower body strength, despite these players having greater internal and external match loads.

1. Introduction

Rugby league is an intermittent team sport where players repeatedly perform bouts of high-speed running and physical collisions interspersed with periods of low-speed activity.[1] These demands result in increased markers of muscle damage, neuromuscular and perceptual fatigue.[2,3] While generally transient in nature, this fatigue typically persists for 24–48 h after competition, although muscle damage may last for several days.[3] High levels of residual fatigue and markers of muscle damage have the potential to compromise performance through reductions in low- and high-speed movements, as well as tackling proficiency.[4,5]

Understanding and managing the fatigue response to match-play may allow optimal preparation for subsequent performance. While various interventions are often employed to facilitate recovery following match-play, their efficacy is often questioned.[6,7] Currently, it is unclear whether any intrinsic qualities influence the fatigue response observed following competition. Findings from Australian rules football found that across a season, players with higher 6 min run performance showed smaller disturbances in blood creatine kinase (CK) prior to competition.[8] In addition, well-developed physical qualities reduce transient fatigue following physical exertion. In particular, greater aerobic fitness results in smaller decrements in repeated-sprint performance.[9,10] Fitter athletes may experience smaller metabolic disturbances following high-intensity activity, resulting in less acute fatigue.[11] These data suggest that aerobic fitness could reduce residual fatigue and muscle damage following competition.

In addition to aerobic fitness, muscular strength has the potential to influence the fatigue response. Although collisions play a major role in the muscle damage and fatigue response,[2,12] high-speed movements also induce symptoms of fatigue.[2,5,12] Therefore, players who possess greater muscular strength and eccentric strength in particular, may be more suited to dealing with the forces associated with these movements. Indeed, greater strength appears to augment the stretch-shortening cycle, potentially placing less stress on the contractile components of the muscle.[13,14] Byrne et al.[15] suggested that enhancing the stretch-shortening

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cycle capabilities of the muscle may moderate the effects of muscle damage. Therefore, greater muscular strength may limit neuromuscular fatigue and muscle damage following match-play.

The purpose of this study is to assess whether physical qualities influence post-match markers of fatigue in rugby league players. Such information would allow coaches to better manage post-game recovery practices and reduce disruption to training. It is hypothesised that greater high-speed running ability and muscular strength will be associated with reductions in post-game neuromuscular fatigue and markers of muscle damage.

2. Methods

High-intensity intermittent running ability, and upper and lower body muscular strength were assessed in 21 male sub-elite youth rugby league players (age 19.2 ± 0.7 years; height 180.7 ± 5.6 cm; body mass 89.9 ± 10.0 kg). The players were from the same under 20's side of a Queensland Cup team. The Queensland Cup is a feeder competition to the Australian National Rugby League. Neuromuscular fatigue and blood CK were assessed before and after two competitive fixtures separated by 7 days. Prior to the study, players attended an information session outlining experimental procedures. Over the course of the testing period, players were asked to maintain their normal diet. Following each match, players engaged in no physical activity until reporting to training at 48 h post-match. In accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki), informed consent and approval from the Australian Catholic University's ethical review board for human research was obtained.

Within fourteen days prior to the first match of the study, players performed the Yo-Yo intermittent recovery test (IRT) level 1, as well as a 3 repetition maximum (RM) bench press and back squat at the start of two training sessions. Testing sessions were separated by two days. Players were free from injury at the time of testing, and avoided exercise for 48 h prior to each test. On the first night, players performed the Yo-Yo IRT level 1 to assess high-intensity intermittent running ability as described previously.[16] The test was performed on a floodlit grass pitch; players wore studded boots and training kit to complete the test. The typical error of measurement (TE) for this test is 4.9%.[16]

Two days later, upper and lower body muscular strength was assessed using a 3 repetition maximum (RM) bench press and back squat, respectively, using free-weight Olympic bars. Players were given two warm-up sets of increasing loads before attempting to lift their previous 3RM. If successful, after a 3–5 min rest, players increased the load by a minimum of 5 kg until they reached their new 3RM. The tests were conducted using the same procedures outlined by Baker and Nance.[17] The TE for the bench press and back squat was 2.5% and 3.5%, respectively.

Neuromuscular fatigue was assessed immediately before, immediately after, 24 h, and 48 h following both games. Lower and upper body peak power was assessed using a countermovement jump (CMJ) and a plyometric press-up (PP).[5] For the PP, players started in a press-up position with their hands on the force platform in a self-selected position, and arms extended. On the experimenter's signal, players were required to lower their body by flexing the elbows to a self-selected depth before extending the elbows as fast as possible so that their hands left the platform. Both exercises were performed on a force platform (Kistler 9290AD Force Platform, Kistler, USA) interfaced with a laptop (Acer Aspire 2930, Acer, UK) running manufacturer designed software (QuattroJump, Kistler, USA). Previous research has reported TE for CMJ peak power as 2.9%.[18] The TE for PP peak power was 3.5%.

Blood CK was assessed as an indirect marker of muscle damage at the same time points as neuromuscular fatigue. After pre-warming of the hand, a 30 μl sample of blood was taken from a fingertip and analysed using a colorimetric assay procedure (Reflotron, Boehringer Mannheim, Germany). Before each testing session, the instrument was calibrated in accordance with manufacturer recommendations.[2,5] The TE for CK was 3.3%.

Game movements were assessed by GPS microtechnology devices. The GPS units sampled at 10 Hz (Team S4, Firmware 6.88, Catapult Sports, VIC, Australia) and included 100 Hz tri-axial accelerometers, gyroscopes, and magnetometers to provide information on collisions. Data were downloaded to a laptop (Acer Aspire 2930, Acer, UK) and subsequently analysed (Sprint, Version 5, Catapult Sports, VIC, Australia). Data were categorised into low (0–5 m s^{-1}), high (≥5.1 m s^{-1}), and very high-speed (≥7.1 m s^{-1}) movement bands. Repeated high-intensity effort (RHIE) bouts were classified as 3 or more maximal acceleration (≥2.78 m s^{-2}), high-speed, or contact efforts with less than 21 s between each effort.[1] These units have been shown to offer a valid and reliable method of quantifying movements and collisions that are commonplace in rugby league.[19,20] To assess internal load, within 30 min following each game, rating of perceived exertion (RPE [CR-10]) was recorded and multiplied by minutes played.[21]

To control for playing position, players were divided into forwards and backs. A median split, based on fitness test results, was used to further divide the players into high- and low-fitness groups. This ensured there was an even spread of positions between groups. The differences in fatigue, muscle damage and match demands between the high- and low-groups and changes over time were determined using traditional significance testing, and magnitude based inferences. In order to determine changes in neuromuscular function and blood CK and differences between groups, a two-way (group × time) repeated measures ANOVA was used to determine the statistical significance of any differences. To compare differences in match demands between high- and low-fitness groups, independent-samples t-tests were used.

Based on the real-world relevance of the results, magnitude based inferences were used to assess the meaningfulness of any differences. Firstly, the likelihood that changes in the dependent variables were greater than the smallest worthwhile change was calculated as a small effect size of 0.20 × the between subject standard deviation. Based on 90% confidence intervals, the thresholds used for assigning qualitative terms to chances were as follows: <1% almost certainly not; <5% very unlikely; <25% unlikely; <50% possibly not; >50% possibly; >75% likely; >95% very likely; >99% almost certain.[22] The magnitude of difference was considered practically meaningful when the likelihood was ≥75%. Secondly, magnitudes of change in the dependent variables were assessed using Cohen's effect size (ES) statistic ± 95% confidence intervals.[23] Effect sizes (ES) of 0.20–0.60, 0.61–1.19, and >1.20 were considered small, moderate and large, respectively.[24] Data are reported as means ± standard deviation (SD); the significance level was set at $p < 0.05$.

3. Results

Players were divided into high- and low-groups based on Yo-Yo IRT (high: Yo-Yo IRT = 1516 ± 182 m, body mass = 86.9 ± 9.3 kg; low: Yo-Yo IRT = 1196 ± 70 m, body mass = 90.4 ± 10.3 kg); 3RM back squat (high: squat = 145 ± 17 kg, body mass = 87.9 ± 10.1 kg; low: squat = 119 ± 9 kg, body mass = 90.3 ± 9.3 kg); and 3RM bench press (high: bench press = 113 ± 12 kg, body mass = 89.6 ± 19.0; low: bench press = 91.5 ± 3 kg, body mass = 85.6 ± 17.2 kg).

There was no significant difference in playing time between high- and low-groups based on any physical quality. Players with high Yo-Yo IRT covered significantly greater distances at high- ($p = 0.028$; ES = 0.88 ± 0.21) and very high-speeds ($p = 0.023$; ES = 0.91 ± 0.27). Players with high back squat performance