Are Three Contact Efforts Really Reflective of a Repeated High-Intensity Effort Bout?

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RUNNING HEAD: Three Contact Efforts and Physical Performance

Are three contact efforts really reflective of a repeated high-intensity effort bout?

ABSTRACT

The use of 3 or more efforts (running and contact), separated by short recovery periods, is widely used to define a 'repeated high-intensity effort' (RHIE) bout in rugby league. It has been suggested that due to fatigue, players become less effective following RHIE bouts; however, there is little evidence to support this. This study determined if physical performance is reduced after performing 1, 2, or 3 efforts with minimal recovery. Twelve semi-professional rugby league players (age 24.5 ± 2.9 years) competed in three 'off-side' small-sided games (2 x 10 min halves) with a contact bout performed every 2 min. The rules of each game were identical except for the number of contact efforts performed in each bout. Players performed 1, 2, or 3 x 5 s wrestling bouts in the single-, double- and triple-contact game, respectively. Movement demands of each game were monitored using global positioning system units. From the first to the second half, there were trivial reductions in relative distance during the single-contact game (ES = -0.13 ± 0.12), small reductions during the double-contact game (ES = -0.47 ± 0.24), and moderate reductions during the triple-contact game (ES = -0.74 ± 0.27). The present data show that running intensity is progressively reduced as the number of contact efforts per bout is increased. Targeting defensive players and forcing them to perform two or more consecutive contact efforts is likely to lead to greater reductions in running intensity. Conditioning performing multiple contact efforts whilst maintaining running intensity should therefore be incorporated into training for contact team sports.

KEY WORDS: Tackles; contact sport; pacing; physical demands

INTRODUCTION

Rugby league is a collision sport characterized by periods of high- (e.g. sprinting, tackling, wrestling) and low-intensity (e.g. jogging, walking, standing) activity (12,24). During competition, players typically cover distances of 90-100 $m \cdot min^{-1}$ (12,21,24), including 6-14 $m \cdot min^{-1}$ at high-speeds (12,24). In addition to these running demands, players are also involved in frequent physical collisions involving blunt force trauma as well as wrestling and grappling efforts. Depending on position, players are involved in 24-47 contact efforts during a game at an average frequency of 0.38-1.09 per min (11). However, players are often required to perform contact efforts at a much greater frequency during certain passages of play. Indeed, the frequency of physical contact is twice as high in defence compared with attack (1.9 ± 0.7 vs. 0.8 ± 0.3 per min) (13). These collisions and contact efforts are associated with increased physiological and psychological loads (16), muscle damage (17,22), upper body fatigue (17), and reductions in running performance (18). As such, players are required to maintain a sufficient running intensity whilst regularly performing repeated contact efforts and high-intensity running actions.

Given the high physiological cost associated with performing contact efforts, coaches often use tactics that involve targeting a certain defensive player during a period of play, or over an entire game. This results in the player having to make multiple tackles in quick succession. It is believed that forcing a player to make 3 consecutive tackles, reduces their effectiveness during match-play for a certain length of time (9), most likely due to cumulative fatigue resulting from the repeated contact efforts (16). Early research within the sport of field hockey aimed to quantify the most demanding passages of competition and defined repeated-sprint bouts as 3 or more sprints with less than 21 seconds between each sprint (20). Whilst

this may be adequate for non-contact sports, repeated-sprint bouts overlook the highly demanding contact efforts that are commonplace in rugby league (16), and therefore underestimate the worst-case demands of competition. As such, Austin and colleagues described repeated high-intensity effort (RHIE) bouts (1), which included repeated sprints, and also contact efforts. Specifically, a RHIE bout was defined as 3 or more contact or high-speed running efforts with less than 21 seconds between each effort (1). More recently, with the development of global positioning system (GPS) technology, maximal accelerations have been integrated into the RHIE definition alongside contact and high-speed running efforts (12). The evidence in support of 3 RHIE being important to physical performance outcomes is largely anecdotal (9) and only one study in rugby league has suggested this may be the case (16). The authors noted that players could only maintain sprint performance for 3 efforts (2 sprints and 1 tackle), during a repeated-effort test, before sprint performance was markedly impaired (16). However, only amateur players were examined in this study (16), and players did not perform back-to-back tackles. It may be that 2 back-to-back contact efforts are all that are required to impair performance, and render a player relatively ineffective. In addition, a recent study examining the RHIE demands of elite and semi-elite competition highlighted that the majority of RHIE bouts were comprised of 2 efforts, and semi-elite players performed a greater proportion of 2 effort bouts compared with their elite counterparts (3). As such, it appears that performing 2 efforts within a RHIE bout poses considerable physical demands on players, which may impact on subsequent performance.

The aim of this study was to compare the influence of 1, 2, or 3 contact efforts in a single bout on running performance during small-sided games. It was hypothesized that as the number of contact efforts increased, so too would the reductions in running performance.

METHODS

Experimental Approach to the Problem

A counter-balanced, cross-over experimental design was used to test our hypothesis. Players were randomly divided into three groups, and played each small-sided game in a counter-balanced fashion over a 10 day period separated by at least 72 hours. GPS microtechnology devices assessed movements during the small-sided games.

Subjects

Thirty-six semi-professional rugby league players from the same rugby league club participated in the study. Twelve of the 36 players (mean ± SD age 24.5 ± 2.9 years; body mass 90.4 ± 7.2 kg) wore GPS units during each game, and these 12 players provided the data for this study. All data were collected during weeks 4 and 5 of the pre-season period, with players free from injury. Over the course of the testing period, players were asked to maintain their normal diet. In accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki), players received an information sheet outlining experimental procedures; written informed consent was obtained from each player. The study was approved by the University's ethical review board for human research.

Small-Sided Games with Contact

The three games were 'off-side' small-sided games, regularly used by rugby league coaches during training. Unlike a regular small-sided rugby game, during 'off-side' games, the ball can be passed in any direction (i.e. to 'off-side' players). Within each of the three groups, players were divided into two teams of 6 players, ensuring an even spread of playing

positions. Each game consisted of two 10 min halves separated by a 2 min rest interval played on a grass training pitch in a standardised (30 m x 70 m) playing area. The 'off-side' game used the same rules as those reported previously (16) and each team was permitted to have three 'plays' while in possession of the ball. A 'play' ended when the player in possession of the ball was touched by a defender with two hands. The ball was turned over when the attacking side had completed three 'plays', or if an error was committed. Every 2 min of each game, players performed a contact bout (eight contact bouts in total), with players allowed 5 s to find a partner. The only difference between the three games was the number of contact efforts in each contact bout. In game 1, players performed a single contact effort each bout (8 in total); game 2 involved two contact efforts each bout (16 in total); game 3 involved 3 contact efforts each bout (24 in total). From a standing position, one step away from their partner, players were asked to perform a single shoulder contact, before being given 5 s to wrestle their partner onto their back. In games 2 and 3 when players performed multiple contacts, each 5 s contact was separated by 2 s of rest. All players received coaching on wrestling techniques as part of their training and were familiar with this contact drill. Similar simulated contacts have shown good reproducibility in rugby league players (16). After each contact period, the game resumed. Other than the number of contact bouts, there was no difference in the rules, verbal encouragement, pitch size, player number, or match duration between games. Due to the varying length of each contact period (single-contact = 10 s [5s to find partner; 1 x 5 s wrestle]; double-contact = 17 s [5s to find partner; 2 x 5 s wrestle; 1 x 2 s rest]; triple-contact = 24 s [5s to find partner; 3 x 5 s wrestle; 2 x 2 s rest]) only active playing time (less the contact periods) was analyzed; distances covered were expressed relative to ball in play time.

Time-Motion Analysis

The GPS units sampled at 10 Hz (Team S4, Catapult Sports, VIC, Australia) and included a 100 Hz tri-axial accelerometer and gyroscope to provide information on collisions. Data were downloaded to a laptop (Acer Aspire 2930, Acer, UK) and subsequently analyzed (Sprint, Version 5.1.1, Catapult Sports, VIC, Australia). Data were categorized into low-speed activity (0-3.5 $m \cdot s^{-1}$), moderate-speed running (3.6-5.0 $m \cdot s^{-1}$) and high-speed running (≥5.1 $m \cdot s^{-1}$) (12). Data were divided into 5 min blocks for analysis in order to determine the changes in running performance during each game. Player Load™ Slow (<2 $m \cdot s^{-1}$) was used to determine the load associated with the non-running components (i.e. physical contact) of the games (4). These units offer valid and reliable estimates of movements common in rugby league (6,23).

Statistical Analyses

The practical meaningfulness of any differences in movement demands between the three games was determined using magnitude based inferences. 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 x the between subject standard deviation. 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 (2). 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 (5). Effect sizes (ES) of 0.20-0.60, 0.61-1.19, and ≥1.20 were considered small, moderate and large respectively (15). Data are reported as means ± 95% confidence intervals (CI).

RESULTS

The differences in playing intensities and distance covered in each speed zone are shown in Figure 1. During the first half of each game, there was no difference in relative distance (ES = -0.11 to 0.10), low-speed activity (ES = -0.38 to 0.35), moderate-speed running (ES = -0.20 to 0.24), and high-speed running distance (ES = -0.06 to 0.11) covered. Although not practically meaningful, Player Load™ Slow (Figure 2) was moderately higher in the first half of the triple-contact game compared with the single-contact game (ES = 0.98 ± 1.0; likelihood = possibly, 36%)

FIGURE 1 NEAR HERE

FIGURE 2 NEAR HERE

During the second half of the game, the relative distance covered was lower in the triple-contact game compared with the single-contact game (ES = -0.40 ± 0.24; likelihood = likely, 78%); there was little difference between the single- and the double- (ES = -0.21 ± 0.13), or the double- and triple-contact game (ES = -0.17 ± 0.45). From the first to the second half, there was a trivial reduction in relative distance in the single-contact game (ES = -0.13 ± 0.12; likelihood = possible, 56%), a small reduction in the double-contact game (ES = -0.47 ± 0.24; likelihood = likely, 82%), and a moderate reduction in the triple-contact game (ES = -0.74 ± 0.27; likelihood = likely, 88%). There was a moderate increase in low-speed activity during the second half of the single-contact game (ES = 0.67 ± 0.17; likelihood = likely, 90%), and only trivial decreases in the double- (ES = -0.05 ± 0.14) and the triple-contact game (ES = -0.09 ± 0.12). Low-speed distance during the second half of the single-contact game was moderately greater than during the triple-contact game (ES = 0.71 ± 0.38;

likelihood = possibly, 73%). Whilst there were only small reductions in moderate-speed running in the second half of the single- (ES = -0.37 ± 0.21; likelihood = possibly, 71%) and double-contact games (ES = -0.33 ± 0.22; likelihood = possibly, 69%), there was a moderate reduction in the triple-contact game (ES = -0.74 ± 0.24; likelihood = likely, 92%). High-speed running was maintained between the first and second halves in the double- (ES = -0.16 ± 0.72; likelihood = possibly, 51%) and triple-contact games (ES = -0.09 ± 0.61; likelihood = possibly, 39%), but showed moderate reductions in the single-contact game (ES = -0.78 ± 0.32; likelihood = likely, 91%). Player Load™ Slow (Figure 2) was maintained in the second half of each of the three games (ES = -0.09 to 0.17). Consistent with the first half, Player Load™ Slow was greater in the second half of the triple-contact game, compared with the single-contact game (ES = 0.72 ± 0.38; likelihood = possibly, 27%).

DISCUSSION

The results of this study confirmed our hypothesis and highlight that greater reductions in running intensity occur as the number of contact efforts performed in a single bout increase. In addition, it lends support to the classification of RHIE bouts requiring a minimum of 3 or more efforts. However, it is clear that running intensity reduces progressively as the number of contact efforts increases. It is likely that performing more contact efforts will lead to larger, longer lasting reductions in running performance. Players need to be conditioned appropriately to minimize reductions in running performance whilst affecting multiple contact efforts in quick succession.

In the single-contact game, playing intensity was maintained from the first to the second half, whereas there were small reductions in the double-contact game and moderate reductions in the triple-contact game. These results highlight that when players are required to perform multiple contact efforts in quick succession, reductions in running performance do occur. Although there were small reductions in the double-contact game, the larger reductions observed in the triple-contact game highlight the cost of performing multiple contact efforts. As such, targeting defensive players in attack is likely to be advantageous and could influence match-play in a number of ways. Firstly, fatigue following RHIE exercise causes reductions in tackling technique in rugby league players (8), which in turn can lead to more missed and fewer dominant tackles during match-play (7), potentially increasing the number of points conceded. Secondly, increased fatigue following high-intensity passages of play results in decreases in the number of involvements with the ball and a reduction in the quality of skill execution in the subsequent 5 min period (19). This could have important ramifications if the player who has made numerous consecutive tackles is in a key ball playing position (e.g. half or hooker). With this in mind, at certain times during match-play, coaches may benefit from targeting individual defensive players, forcing them to perform 3 or more consecutive tackles, in order to promote defensive errors and minimize their involvement in any subsequent attack.

The definition of a RHIE bout originated from the sport of field hockey (20), and has since been used in rugby league (1,9,10). Despite this, it is unclear whether the use of 3 efforts is indeed valid when defining a RHIE bout in rugby league. It could well be, that a bout involving 2 efforts still reflects a demanding passage of play and results in significant fatigue (14). The present data are in accordance with those of others (16), whereby performing 3 high-intensity efforts in close proximity to one another leads to reductions in running

performance. Whilst players can maintain overall running intensity when performing single contact efforts in a bout, performing double contact efforts results in small reductions in running performance. Previously, research has only focused on RHIE bouts that include 3 or more efforts, with players performing in the region of 8-10 bouts over the course of a game (1,9,10). However, recently it was shown that players perform numerous bouts involving 2 efforts that are physically demanding (3), yet these efforts are not recognized as RHIE bouts in rugby league (14). Moreover, there are greater reductions in the frequency of RHIE bouts involving contact between the first and second halves compared with non-contact RHIE bouts (3), further highlighting the physical performance reductions associated with performing repeated-contact efforts. With this in mind, coaches should condition players so that they are capable of performing RHIE bouts with varying numbers of efforts, durations, and activities. Moreover, it is vital players are physically prepared to perform repeated-contact efforts.

Although there was a greater reduction in overall running intensity as the number of contact efforts increased, there was a difference in the way players either reduced or maintained match intensity between games. In the single-contact game, there was no reduction in overall intensity and this was achieved by increasing low-speed activity whilst there were small and moderate reductions in moderate- and high-speed running, respectively. In the double- and triple-contact games, the reductions in running intensity were primarily brought about through reductions in moderate-speed running, with only small reductions in low-speed activity and high-speed running. Due to the high contact and RHIE demands of rugby league competition (9), and relatively lower running intensities than those of the current games (12), it is possible that players were unaccustomed to the large running component of the single-contact game. As such, players were unable to maintain the initial intensity and reduced high-speed running distance. The increases in low-speed activity in the second half of the single-

contact game could reflect players relying on passes to move the ball, rather than running efforts. Unfortunately, the number of skill involvements was not assessed in the present study. The similar activity profiles in the double- and triple-contact games are not surprising given the repeated contact nature of these two games. The reduction in moderate-speed running and maintenance of high-speed running and Player Load™ Slow are indicative of a pacing strategy whereby players reduce non-essential activities so that the essential high-intensity movements can be maintained (18). Based on this information, it appears that players modify their activity depending on the proportion of contact and running performed. As such, players need to be exposed to the appropriate contact and running demands of competition to obtain sufficient conditioning and allow them to set appropriate pacing strategies during match-play.

This study highlights that increasing the number of contacts in a single bout leads to greater reductions in running intensity. While the findings lend support to the use of 3 efforts to define a RHIE bout, small reductions in running intensity also occur when players are required to perform double contact efforts. Future research should aim to compare the influence of 2, 3, and 4 efforts on both running performance and skill outcomes between different playing standards. In addition, this study only assessed the influence of repeated contact efforts. Future research should investigate the influence high-intensity running efforts and a combination of running and contact efforts have on subsequent game intensity. A limitation of the present study was the use of 'off-side' games as opposed to the 'on-side' nature of rugby league match-play. Future research should assess the influence of RHIE bouts on running performance during 'on-side' games. In addition, due to the stochastic nature of the games, players may have performed high-intensity running efforts immediately

preceding or following the contact bouts which may have led to further decrements in running performance.

PRACTICAL APPLICATIONS

There are a number of practical applications from this study that are useful to rugby league coaching and support staff. Firstly, targeting players in attack, forcing them to perform two or more consecutive contact efforts is likely to lead to greater reductions in running intensity and potentially tackling technique and skill involvements. Although the greatest reductions in running intensity occurred during the triple-contact game, players still need to be prepared for the various contact and running demands of competition. Double effort RHIE bouts are physically demanding for players and such bouts should be incorporated into conditioning drills.

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FIGURE LEGENDS

Figure 1. Relative distance (A), low-speed activity (0-3.5 $m \cdot s^{-1}$) (B), moderate-speed running (3.6-5.0 $m \cdot s^{-1}$) (C), and high-speed running (≥5.1 $m \cdot s^{-1}$) (D) during the first and second half of the single, double, and triple-contact games. * Denotes a moderate effect size difference. Data are presented as means ± SD.

Figure 2. Player Load™ Slow during the first and second half of the single, double, and triple-contact games. * Denotes a moderate effect size difference. Data are presented as means ± SD.

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