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Research article

Reliability of a contact and non-contact simulated team game circuit

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Abstract
Most team sports are characterised by repeated short maximal sprint efforts interspersed with longer periods of active recovery or rest. Although a variety of testing protocols have been devised to simulate these activity patterns under controlled conditions, a common limitation is the lack of 'body contact' to simulate the tackling efforts seen in contact sports. Therefore, the purpose of this study was to assess the reliability of a simulated team game protocol with and without 'contact'. Eleven male, team-sport athletes (mean ± SD; age 22 ± 2 yr; BMI 23.0 ± 1.7 kg·m^{-2}) completed four separate testing trials; two 'non-contact' trials (NCON) and two 'contact' (CON) trials of a simulated game to determine the reliability of a range of team sport performance indicators including repeated 15-m sprint time, vertical jump height, heart rate response and ratings of perceived exertion (RPE). The team game protocol involved four sets of 15-min of intermittent running around a circuit replicating the movement patterns observed in team sports, either with or without simulated contact. Within-subject reliability of each performance measure was determined by expressing the typical error of measurement as the coefficient of variation, as well as determining intra-class correlations. Both CON and NCON produced reliable results for a variety of team sport performance indicators including repeated 15-m sprint time, vertical jump height, heart rate response and RPE. Repeated sprint and jump performance declined over time throughout the simulated game ($p < 0.05$), while heart rate and RPE increased. There was no difference in these performance measures between CON and NCON protocols. As such, these simulated game protocols provide reliable options for assessing team game performance parameters in response to training or other interventions under controlled conditions.

Key words: Performance, team sports, vertical jump, active recovery, body contact.

Introduction

Most team sports are characterised by short maximal sprint efforts, interspersed with longer periods of active recovery or rest, repeated over a prolonged period of time (Bishop et al., 2001). In an effort to monitor the effect of various interventions on team sport performance under more controlled conditions than a real game situation, a variety of protocols have been devised to simulate the activity patterns of such sports (Bishop and Claudius, 2005; Drust et al., 2000; Glaister et al., 2008; Sirotic and Coutts, 2007). However, a potential limitation of these protocols is the lack of 'body contact' to simulate the tackling, rucking, shepherding (body checking) and collisions that are commonly involved in contact sports. The inclusion of contact in simulated team game protocols may be important given that Australian Rules football players tend to complain of greater soreness post-match as compared to post-training (Dawson et al, 2004b). One possible difference between games and training sessions is the level of body contact and the resulting muscle contusions that commonly occur during a match (Dawson et al., 2005; Takarada, 2003). Likewise, it has been suggested that the direct impact between opposing players accounts for much of the muscle damage observed following competitive rugby matches (Gill et al., 2006). This is supported by positive correlations between the number of tackles during a competitive rugby match and blood markers of muscle damage including peak myoglobin concentration (r = 0.85) and peak creatine kinase activity (r = 0.92; Takarada, 2003). Given that testing and training for team sports should replicate real game activities as closely as possible, protocols are required that incorporate a 'body contact' component. However, there is no data on the reliability of including contact in such protocols. Therefore, the purpose of this study was to assess the reliability of a simulated team game circuit with and without 'contact' to determine whether it may be suitable for monitoring key performance indicators in response to training or other interventions.

Methods

Experimental design

Using a within-subjects experimental design, male team sport athletes attended a grass track (temperature 24 ± 3ºC, humidity 60 ± 1%) on five occasions, first for familiarisation with the simulated team game protocol (both with and without simulated contact), followed by four testing trials; two 'non-contact' (NCON) and two 'contact' (CON) to determine the reliability of a range of performance measures, including repeated sprint speed and vertical jump height, for each. Trials were conducted seven days apart at the same time of day (±1 h) in a randomised crossover design. Participants maintained their normal diet (self-reported) and abstained from training and caffeine in the 48 h prior to each trial.

Subjects

Eleven male, recreational, team-sport athletes (Mean ± SD; age 22 ± 2 yr; body mass 74.4 ± 7.4 kg; height 1.79 ± 0.06 m; BMI 23.0 ± 1.7 kg·m^{-2}) were recruited as participants. They were involved in a range of sports at the time of testing (rugby, hockey and Australian football), but all had previous experience with contact sports. Testing was conducted during the pre-season period to minimise any

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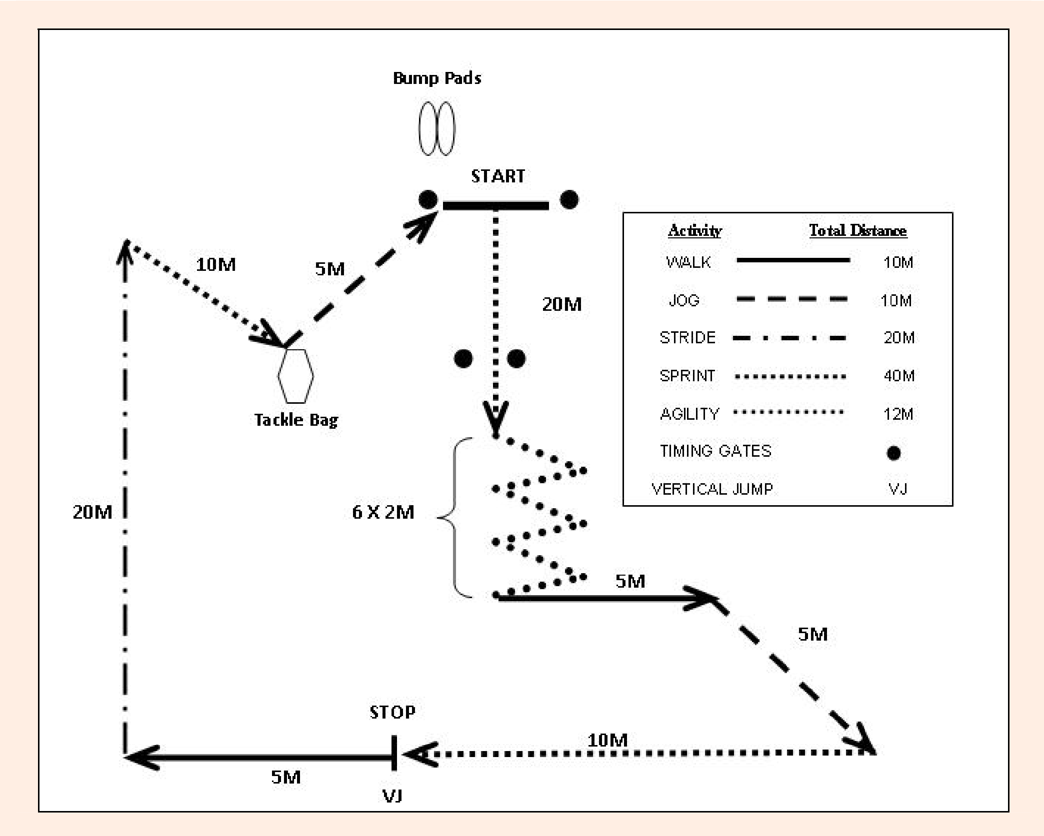

Figure 1. Simulated Team-Game Protocol modified from Bishop et al. (2001) (not to scale). Both CON and NCON involved four sets of 15-min of intermittent running around a circuit replicating the movement patterns observed in team sports, with three maximal sprints, an agility section; walking, jogging, striding and a deceleration to a stop immediately prior to a vertical jump. The only difference between CON and NCON was a tackle bag to be taken to ground every three circuits, together with bump pads to provide three standard contacts to each side of the legs at the end of each set. The circuit was completed in pairs on a staggered start so that one participant could hold the bump pads while the other received the "contact" before swapping. Each circuit took ~50 s; allowing ~10 s rest before the next circuit (on 1 min) with 15 circuits performed per set.

potential influence of competition (and hence body contact) on performance measures. The study was approved by the Human Ethics Committee of The University of Western Australia and written informed consent was obtained prior to testing.

Procedures

All sessions were commenced after jogging six circuits and stretching. The circuit involved a modified version of the simulated team-sport circuit developed by Bishop and colleagues (2001). It involved four sets of 15-min of intermittent running, replicating the movement patterns observed in team sports (Figure 1), with 5 min of rest between sets. This protocol has also been adapted by others for the purpose of replicating team sport games (Ingram et al., 2009; King and Duffield, 2009). The only difference between CON and NCON was a tackle bag to be taken to ground every three circuits (20 tackles in total), together with bump pads to provide three contacts to each side of the legs at the end of each set (12 contacts to each side of the legs in total). With respect to the tackle bag, a target line was marked at the level of the hip on the bag. Participants were then instructed to tackle the bag at this level, following a 10-m maximal sprint run up, bringing it to ground with maximum force. In addition, strong verbal encouragement was provided with each tackle. The circuit was completed in pairs on a staggered start so that the bump pads could be utilised at the end of each period of intermittent running. Here, one participant would kneel in a braced position with the bump pads, while the other was required to run in to receive 3 maximal 'contacts' to each side of the legs, before swapping. The number of contacts provided was based on various time-motion analyses from Australian football (Dawson et al., 2004a), rugby union (Duthie et al., 2005; Takarada, 2003) and rugby league (Sirotic et al., 2009). Each circuit took ~50 s; allowing ~10 s rest before the next circuit (on 1 min) with 15 circuits per set.

Performance was quantified by timing the initial 15 m of the first sprint in the circuit from a stationary start (SMART SPEED, Fusion Sports, Wales, UK). From this, the best sprint time and mean sprint time were determined. Vertical jump performance was also measured (Yardstick, Swift Performance Equipment, NSW, Australia) to determine the best vertical jump and mean vertical jump in each set. In addition, heart rate (HR; Polar, Finland) and ratings of perceived exertion (RPE) were recorded (Borg, 1982) at the end of each set.

Statistical analyses

Within-subject reliability of performance was determined by expressing the typical error of measurement as the coefficient of variation (CV), along with 90% confidence intervals (CL) and intra-class correlations (ICC) from logtransformed raw data using the online spreadsheet of Hopkins (2000). In addition, differences between protocols (CON and NCON) were assessed using two-way (set x protocol) repeated measures ANOVA, with statistical significance accepted as $p \leq 0.05$. Cohen's d effect sizes were also calculated for this purpose.

Results

The CV between trials for best sprint time was 0.9% (90% CL, 0.7–1.4%; ICC r = 0.97) for CON and 2% (90% CL, 1.4 –3.1%; ICC r = 0.93) for NCON (Table 1). For mean sprint time, the CV was 1.7% (90% CL, 1.3–2.7%; ICC r = 0.89) for CON and 3.7% (90% CL, 2.7–6.0%; ICC r = 0.75) for NCON. There was a main effect of set on both best sprint time ($p < 0.001$) and mean sprint time ($p < 0.001$) within protocols, but no difference between CON and NCON protocols. Small effect sizes were observed for the differences in best sprint time and mean sprint time for CON (0.12 and 0.01 respectively) and NCON (0.21 and 0.36 respectively).

For best vertical jump, the CV between trials was 3.1% (90% CL, 2.3-4.9%; ICC r = 0.97) for CON and 2.7% (90% CL, 2.0-4.3%; ICC r = 0.99) for NCON (Table 1). For mean vertical jump, the CV was 4.1% (90% CL, 3.0-6.4%; ICC r = 0.96) for CON and 4.3% (90% CL, 3.1-6.9%; ICC r = 0.96) for NCON. Best vertical jump was maintained across sets, while mean vertical jump declined ($p = 0.024$); however, there was no difference between CON and NCON. Small effect sizes were observed for the differences in best vertical jump and mean vertical jump for CON (0.00 and 0.37 respectively) and NCON (0.00 and 0.12 respectively).

For heart rate, CV was 1.2% (90% CL, 0.9-1.8%; ICC r = 0.88) for CON and 1.0% (90% CL, 0.7-1.6%; ICC r = 0.97) for NCON (Table 1). Heart rate increased ($p = 0.002$) across sets within both protocols, and there was a significant interaction between protocols and sets ($p < 0.001$), although post hoc analysis failed to reach significance. The CV of RPE was 2.7% (90% CL, 2.0-4.3%; ICC r = 0.86) for CON and 3.4% (90% CL, 2.5-5.5%; ICC r = 0.77) for NCON (Table 1). RPE increased across sets ($p = 0.000$), but was not different between CON and NCON protocols. Similarly, small effect sizes were observed for both HR and RPE in both conditions.

Discussion

The purpose of this study was to evaluate the reliability of both a contact (CON) and non-contact (NCON) version of a simulated game protocol based on a circuit originally developed by Bishop and colleagues (2001). Both CON and NCON produced reliable results for assessing a variety of team sport performance indicators including sprint time, vertical jump height, heart rate response and ratings of perceived exertion. Furthermore, the reliability of CON and NCON is comparable to other team sport simulations. Sirotic and Coutts (2007) reported a CV of 2.0% and 2.7% for total distance and sprint distance covered in their protocol utilising a non-motorised treadmill. Similarly, Bishop and Claudius (2005) reported a CV of 2.5% for mean sprint power output during their cycle ergometer team game simulation. In addition, the RPE during CON and NCON is comparable to that observed by Drust and colleagues (2000) with their soccer-specific protocol, although the heart rate response was higher in the present study compared to previous research (Bishop and Claudius, 2005; Drust et al., 2000; Sirotic and Coutts, 2007).

Of interest, there was no statistical difference in performance measures between CON and NCON. This was surprising given the greater amount of work involved in CON. It is possible that the addition of contact does not acutely impair performance measures, but rather results in a greater decrement in subsequent performance (i.e. after limited recovery 24 or 48 hours later) due to the resulting muscle damage (Gill et al., 2006; Takarada, 2003). Alternatively, it must be acknowledged that the 'contact'

Table 1. Mean (±SD) performance measures during a simulated game protocol with 'contact' (CON) and without 'contact' (NCON) (n=11).

Trial	SET 1		SET 2		SET 3		SET 4		Mean	
	CON	NCON	CON	NCON	CON	NCON	CON	NCON	CON	NCON
Best Sprint Time (s)*										
T1	2.56 (.13)	2.60 (.19)	2.56 (.14)	2.62 (.21)	2.61 (.14)	2.67 (.22)	2.64 (.14)	2.69 (.21)	2.59 (.13)	2.64 (.20)
T2	2.54 (.13)	2.58 (.19)	2.55 (.12)	2.60 (.19)	2.59 (.11)	2.62 (.18)	2.63 (.14)	2.63 (.17)	2.58 (.12)	2.61 (.18)
Mean Sprint Time (s)*										
T1	2.70 (.14)	2.79 (.22)	2.78 (.15)	2.82 (.21)	2.80 (.17)	2.83 (.22)	2.88 (.18)	2.87 (.23)	2.79 (.15)	2.83 (.21)
T2	2.70 (.14)	2.69 (.17)	2.76 (.14)	2.74 (.20)	2.81 (.14)	2.77 (.21)	2.88 (.17)	2.82 (.21)	2.79 (.14)	2.76 (.19)
Best Vertical Jump (cm)										
T1	46 (7)	47 (10)	45 (8)	45 (10)	45 (9)	46 (11)	44 (8)	46 (11)	45 (8)	46 (10)
T2	46 (7)	45 (8)	45 (8)	46 (10)	43 (8)	47 (10)	44 (9)	47 (10)	45 (8)	46 (9)
Mean Vertical Jump (cm)*										
T1	41 (7)	43 (9)	41 (7)	41 (9)	40 (8)	41 (9)	40 (8)	41 (9)	41 (7)	41 (9)
T2	42 (7)	42 (7)	41 (8)	42 (8)	40 (7)	43 (9)	40 (8)	41 (10)	40 (8)	42 (8)
HR(bpm)* †										
T1	177 (6)	181 (10)	180 (6)	178 (10)	180 (6)	180 (9)	182 (6)	180 (11)	180 (6)	180 (9)
T2	178 (7)	178 (1)	181 (6)	181 (9)	181 (7)	180 (11)	182 (6)	183 (11)	181 (6)	181 (10)
RPE*										
T1	15 (1)	14 (1)	16 (1)	15 (2)	17 (2)	16 (1)	17 (1)	17 (2)	16 (1)	16 (1)
T2	15 (1)	14 (1)	16 (1)	15 (1)	17 (1)	16 (1)	18 (1)	17 (1)	16 (1)	15 (1)

* Indicates significant main effect of sets on performance. † Indicates significant interaction effect of set and trial on performance. HR: Heart Rate, RPE: Rating of Perceived Exertion, T1: trial 1, T2: trial 2.

involved in the current study was simulated. Despite our best efforts to ensure that each tackle was maximal, it is likely that the ‘contact’ experienced with a tackle bag and bump pads may be less physically damaging than actual body-on-body contact. However, true contact is not feasible within the context of a simulated performance test and the current protocol should be preferable to previous protocols used to simulate the activity patterns of team games that have neglected to include any contact component at all. Perhaps future studies could attempt to quantify the degree of impact experienced with simulated (i.e. tackle bags and bump pads) versus actual body-on-body contact. If found to be lacking, the number of simulated contacts in the current protocol could be increased to compensate for any possible reduction in the ‘intensity’ of contact. Nonetheless, both CON and NCON appear reliable for assessing aspects of team sport performance. As such, these tests may provide additional options for assessing team game performance parameters, with the type of test used depending on the specific sport itself and whether ‘contact’ is involved.

Conclusion

A variety of protocols have been devised to simulate the activity patterns of team sports. These protocols may be used by the coach and athlete in training to replicate game demands, or at intervals throughout the season to monitor key performance indicators in response to training or other interventions (i.e. ergogenic aids, dietary manipulations, recovery strategies) under more controlled conditions than a real game situation. The protocol used in the current study is unique in that it includes an aspect of ‘contact’, which has been lacking from previous protocols. Given that testing and training for team sports should replicate real game activities as closely as possible, together with the evidence that the direct impact between opposing players accounts for much of the muscle damage observed following contact sports, our study provides a reliable option for assessing team game performance parameters for both contact and non-contact sports, with the choice of test depending on the specific sport itself and whether contact is involved.

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Key points

- A variety of protocols have been devised to simulate the activity patterns of team sports.
- The protocol used in the current study is unique in that it includes an aspect of ‘contact’, which has been lacking from previous protocols.
- Both the ‘contact’ and ‘non-contact’ protocols tested appear reliable for assessing team game performance parameters
- These protocols provide a reliable option for assessing team game performance parameters for both contact and non-contact sports.

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