Full Title: The effect of a short, practical warm-up protocol on repeated-sprint performance

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The effect of a short, practical warm-up protocol on repeated-sprint performance

ABSTRACT

The aim of our study was to investigate the effect of a short, practical two-phase warm-up on repeated-sprint performance when compared to more traditional warm-up protocols that contain stretching activities. Eleven sub-elite male soccer players completed a warm-up protocol that commenced with 5-min jogging at ~65% of maximal heart rate, followed by either no stretching, static stretching, or dynamic stretching, and then finishing with a task-specific, high-intensity activity. Using a cross-over design the three warm-up protocols were performed in a counterbalanced order with at least 48 h between sessions. Repeated-sprint performance was measured using a repeated-sprint test which consisted of 6 x 40 m maximal sprints interspersed with 20 s recovery. There were trivial differences in mean sprint time (0.2%) and post-test blood lactate (3.1%) between the two-phase warm-up and the three-phase warm-up that included dynamic stretching, whereas the short warm-up had a possibly detrimental effect on fastest sprint time (0.7%). Fastest (-1.1%) and mean (-1.2%) sprint times were quicker, and post-test blood lactates higher (13.2%) following the two-phase warm-up when compared to the three-phase warm-up that included static stretching. When compared to more traditional, three-phase warm-ups that include a bout of stretching, a short, practical two-phase warm-up is an effective means of preparing for subsequent repeated-sprint activity.

Key words: Preparation; Sprints; Repeated-Sprints; Task-specific activity;

INTRODUCTION

Typically, warm-up for team-sport athletes consists of three phases; cardiovascular, stretching, and task-specific activity (5,19,20). However, considering that the warm-up process is often completed under time constraints, unnecessary components of this process should not be included (14). The effectiveness of using a three-phase warm-up protocol has recently been challenged within the scientific literature. Zois et al. (20) reported that a leg-press exercise and small-sided games following five minutes of jogging both improved acute team-sport performance when compared to a traditional three-phase warm-up protocol, suggesting that a two-phase protocol may be adequate provided specific movements patterns are included. Utilising leg press as a mode of warm-up activity in team sports is logistically difficult; whilst the use of small-sided games can be time consuming (~12-min), does not guarantee a homogenous response and can increase injury risk due to player-to-player contact. Therefore alternative protocols may be more practical.

Shorter, more specific warm-up protocols that include a cardiovascular phase followed only by a task specific, high-intensity phase have been reported to improve power output in rowing and cycling, respectively (12,16). Yet to our knowledge the performance benefits of a short, practical two-phase warm-up containing only cardiovascular and high-intensity, task-specific activity remains unexplored in team sports. Consequently, the relevance of a three-phase warm-up protocol in team sports, where further time for technical/ tactical preparation may benefit performance needs to addressed is questionable. Therefore, the aim of our study was to investigate the effect of a two-phase warm-up on repeated-sprint performance in soccer players.

METHODS

Experimental Approach to the Problem

The effect of a short practical two-phase warm-up and two three-phase warm-up protocols on repeated-sprint performance (mean and fastest sprint time) were compared using a post-only crossover design.

Subjects

Eleven sub-elite male soccer players (mean ± SD: age 24 ± 3 years; height 181 ± 5 cm; mass 73.2 ± 4.7 kg; Yo-Yo Intermittent Recovery Test Level 1: 1412 ± 301m) were recruited for this study. The subjects took part in soccer training a minimum of two times per week. Ethical approval from the Teesside University institutional review board and informed consent were obtained prior to the study.

Procedures

The subjects completed the three warm-up protocols in a counter-balanced order with a minimum of 48 hours between each testing session. All testing sessions were completed within a two week period in the preparatory phase of the subjects' season. All tests were conducted at the same time of day to minimize the effects of circadian rhythm on performance. The subjects were asked to prepare for each test in the same manner, avoiding strenuous activity in the 48 hours preceding the test. The warm-up protocols were structured as follows:

1. Cardiovascular phase followed by a task-specific activity;
2. Cardiovascular phase followed by static stretching, followed by a task-specific activity;
3. Cardiovascular phase followed by dynamic stretching, followed by a task-specific activity.

The cardiovascular phase and stretching protocols were adapted from Pearce et al. (13) The cardiovascular phase of warm-up was set at a standardised relative intensity of 65% maximal heart rate (Polar RS400, Polar, Finland). Task-specific activity consisted of two 20 m slalom runs, two 40 m shuttle sprints at 50% and 75% of the subjects' perceived maximal effort respectively, and one maximal 40 m sprint. The perceived intensities were chosen in order to replicate the typical practice used in many soccer specific warm-up protocols. The subjects were given a minimum of 60 s between the warm-up sprints, and as long as they felt necessary to be fully recovered prior to the last sprint which acted as a criterion for the repeated-sprint test. The repeated-sprint test consisted of 6 x 40 m maximal sprints interspersed with 20 s recovery. This test has been demonstrated to be a reliable and valid measure of repeated-sprint performance in elite, sub-elite and amateur soccer players(10). Upon completion of the final sprint the subjects were given 5 min rest before commencing the repeated-sprint test. All subjects were familiarised with the test prior to the testing sessions. Fastest and mean sprint times were measured using single beam light sensitive timing gates (Brower Timing Systems, USA). Blood lactate samples were collected immediately following the conclusion of all tests via a finger-tip capillary sample (Safety lancets, 1.8 mm super, Sarstedt, Leicestershire, UK; Microcuvette's, Microvette CB 300, Sarstedt, Leicestershire, UK) and analysed using an automated blood lactate analyser (YSI 2300, YSI UK ltd, Hampshire, UK).

Statistical Analysis

Data are presented as the mean ± SD. Data were log transformed and then back transformed to obtain the percent difference between sprint and repeated-sprint performance following the warm-up protocols. This is the appropriate method for quantifying changes in athletic performance (8). In athletic performance research it is not whether there is an effect but how big the effect is and use of the P value alone provides no information about the direction or size of the effect or the range of feasible values (1). Consequently, effect sizes, with uncertainty of the estimates shown as 90% confidence intervals, for the between-protocol differences in fastest, mean and rate of change in sprint time - as calculated by the time-sprint regression slope - and post-test blood lactates were determined using a custom-made spread sheet (9). The threshold value for the smallest worthwhile change in fastest and mean 40-m sprint time was set at 0.5% (10), whereas the rate of change in sprint times and changes in blood lactates were set at 0.2 between-subject standard deviations. Inference was then based on the disposition of the confidence interval for the mean difference to this smallest worthwhile effect; the probability (percent chances) that the true population difference between trials is substantial (beneficial/ detrimental) or trivial was calculated as per the magnitude-based inference approach (1). These percent chances were qualified via probabilistic terms assigned using the following scale: <0.5%, most unlikely or almost certainly not; 0.5–5%, very unlikely; 5–25%, unlikely or probably not; 25–75%, possibly; 75–95%, likely or probably; 95–99.5%, very likely; >99.5%, most likely or almost certainly (8).

RESULTS

Table 1 about here

Table 1 displays the mean duration and heart rate during each phase of the three warm-up protocols, along with repeated-sprint times and post-test blood lactates. Table 2 shows the effects of the warm-up protocols on performance, demonstrating trivial differences in mean sprint time (0.2 ± 1.4%) and post-test blood lactate (3.1%) between the two-phase warm-up and the three-phase warm-up that included dynamic stretching, whereas the shorter warm-up had a possibly detrimental effect on fastest sprint time (0.7%).

Table 2 about here

The short two-phase warm-up had a small but likely beneficial effect on fastest (-1.1 ± 1.4%) and mean (-1.2 ± 1.6%) sprint time, and also post-test blood lactate (13.2 ± 21.6%), when compared to the three-phase warm up that included static stretching. The changes in sprint time across the duration of the repeated-sprint test are displayed in Figure 1.

Figure 1 about here

The time-sprint regression slopes were 0.52 ± 0.22 s for the two-phase warm-up, 0.54 ± 0.22 s for the three-phase warm-up that included static stretching, and 0.52 ± 0.41 s for the three-phase warm-up protocol that included dynamic stretching. The differences between warm-up protocols for the rate of change in sprint time were trivial.

DISCUSSION

The main finding of our study was that a short, practical warm-up protocol containing only cardiovascular and high-intensity, task-specific activity running demonstrated likely improvements in fastest and mean sprint time, respectively when compared to a traditional three-phase warm-up that included static stretching. Furthermore, repeated-sprint performance following the short warm-up was unaffected when compared to the longer warm-up containing a bout of dynamic stretching, although there were possibly detrimental effects on fastest sprint time. The rates of change in repeated-sprint performance were unaffected by warm-up protocol.

Our findings are consistent with recent reports demonstrating that a short duration warm-up can be more effective than longer, more traditional warm-up protocols in preparation for high-intensity activity (12,16,20). The performance benefits observed in our study were supported by substantially higher post-test blood lactates, suggesting a greater glycolytic contribution during the repeated-sprints (17). Many of the proposed benefits of active warm-ups have been attributed to the increased muscle temperatures achieved via active movements of the major muscle groups (3). Whilst we did not measure muscle temperature, the associated ergogenic effects of increased muscle temperature have been widely reported (3,4). Therefore, despite less preparatory activity (~10 min) our short, two-phase warm-up would appear to be of sufficient duration and intensity to elicit muscle temperature-related benefits and is therefore effective preparation for subsequent repeated-sprint activity. Furthermore the use of a shorter warm-up could help to minimize the thermoregulatory strain that is associated with longer warm-ups (12,20). While the short warm-up had a possibly detrimental effect on fastest sprint time when compared to the warm-up that included dynamic stretching, the ecological validity of this finding is questionable as it is the ability to perform repeated-sprints which is of more relevance to physical performance in soccer (10).

Our results provide further evidence for the detrimental effect of static stretching prior to repeated-sprint performance (2,14). The mechanisms responsible for impaired performance following static stretching are not yet fully understood. However, it has been suggested that these mechanisms could involve increased muscle and tendon compliance (18), reduced muscle spindle sensitivity and inhibited neural function (6,11). Also, an impaired physiological response following static stretching cannot be ruled out given that the slower sprint performances were associated with lower post-test blood lactates and the ergogenic effects of increased muscle temperature include increased glycogenolysis, glycolysis and high-energy phosphate degradation (4,7). The findings provide support for existing research advising against the use of static stretching immediately prior to exercise (19)

In summary, the findings of the present study demonstrate that our short, practical two-phase warm-up prior to repeated-sprint activity is equally effective as a longer, three-phase protocol containing dynamic stretching and more effective than a protocol containing static stretching.

PRACTICAL APPLICATIONS

It appears practical for athletes to complete a two-phase warm-up protocol that consists of a cardiovascular phase followed by task-specific activities when preparing for sports dependent on sprint and in particular repeated-sprint performance. Our findings relate also to time-efficiency, as the shorter warm-up would provide more time for the training exercises and tactical preparation prior to competition. The reduced duration may also help athletes to avoid unnecessary increases in thermoregulatory strain during the warm-up, particularly in hot ambient temperatures. Our results also indicate that static stretching should not be used as part of a warm up protocol, but may be best used as part of a post-session/ match flexibility program.

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FIGURE LEGENDS

Figure 1. Sprint times during the repeated-sprint test for a group of sub-elite male soccer players (n = 11) following three warm up conditions warm-up protocols

Table 1 Mean duration and heart rate during each phase of the three warm-up protocols, along with repeated-sprint times and post-test blood lactates in a group of sub-elite male soccer players (n = 11)

Table 2 Effect of the three different warm-up protocols on sprint, repeated-sprint performance and post-repeated-sprint test blood lactates in a group of sub-elite male soccer players (n = 11). *with reference to the smallest worthwhile change.

Table 1 Mean duration and heart rate during each phase of the three warm-up protocols, along with repeated-sprint times and post-test blood lactates in a group of sub-elite male soccer players (n = 11)

	Two-Phase	**Three-Phase with Static Stretching**	**Three-Phase with Dynamic Stretching**
Total Duration (s)	657 ± 57	1295 ± 88	1232 ± 63
Cardiovascular Phase Heart Rate (bpm)	118 ± 5	119 ± 4	119 ± 5
Stretching Phase Heart Rate (bpm)	/	81 ± 9	102 ± 6
Task-Specific Activity Heart Rate (bpm)	130 ± 11	130 ± 8	134 ± 9
Fastest 40 m Sprint (s)	7.21 ± 0.31	7.29 ± 0.29	7.16 ± 0.28
Mean 40 m Sprint (s)	7.51 ± 0.33	7.60 ± 0.29	7.50 ± 0.32
Rate of Change in 40 m Sprint (s)	0.52 ± 0.22	0.54 ± 0.22	0.52 ± 0.41
Post-Test Blood Lactates (mM)	7.89 ± 2.39	7.09 ± 2.66	7.60 ± 2.12

Table 2 Effect of the three different warm-up protocols on sprint, repeated-sprint performance and post-repeated-sprint test blood lactates in a group of sub-elite male soccer players (n = 11). *with reference to the smallest worthwhile change.

Performance measure - Comparison	% Difference (±90%CI)	Effect Size (±90%CI)	Likelihood (%) of the two-phase warm-up being beneficial/ trivial/ detrimental*
Fastest Sprint Time (s)			
Two-phase vs. Three-phase with static stretching	-1.1 ± 1.4	-0.23 ± 0.30	77/ 20/ 3
Two-phase vs. Three-phase with dynamic stretching	0.7 ± 1.6	0.15 ± 0.34	10/ 32 /58
Mean Sprint Time (s)			
Two-phase vs. Three-phase with static stretching	-1.2 ± 1.6	-0.25 ± 0.33	78/ 18/ 4
Two-phase vs. Three-phase with dynamic stretching	0.2 ± 1.4	0.04 ± 0.29	20/ 46/ 35
Change in Sprint Time (s)			
Two-phase vs. Three-phase with static stretching	0.2 ± 1.0	-0.06 ± 0.24	5/ 83/ 12
Two-phase vs. Three-phase with dynamic stretching	0.1 ± 2.6	0.01 ± 0.66	31/ 42/ 28
Post-test Blood Lactates (mM)			
Two-phase vs. Three-phase with static stretching	13.2 ± 21.6	0.31 ± 0.51	67/ 29/ 5
Two-phase vs. Three-phase with dynamic stretching	3.1 ± 22.5	0.11 ± 0.51	34/ 47/ 18