Effects of warm-up intensity on 5 km performance & blood lactate response

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Abstract

The 5 km race has grown increasingly popular and recreational runners are continuously seeking proper warm-up routines for optimal performance. **PURPOSE:** The purpose of the study was to examine the effects of varying warm-up protocols on performance variables during a simulated 5 km race. **METHODS:** Ten male recreational runners ($VO_{2\ max}$: 49.41 ± 6.2 ml/kg/min) participated in a total of three laboratory sessions. The first session consisted of baseline testing where height, weight, body composition, and $VO_{2\ max}$ were evaluated. Following the baseline testing, each subject returned for two trials, with either a high intensity warm-up (HIWU) or moderate intensity warm-up (MIWU). The order of the warm-up protocols were randomized. The HIWU consisted of a 10 min jog at 50% of $vVO_{2\ max}$, followed by 5 min of 30 s intermittent sprints at the individual's $vVO_{2\ max}$. The MIWU protocol consisted of a 15 min jog at 50% of $vVO_{2\ max}$. Following the warm-up, subjects began the 5 km on the treadmill. Blood lactate [La^-] was taken at each km of the run. Heart rate (HR) was also recorded throughout each trial. **RESULTS:** The mean HR was significantly higher throughout the 5 km following the HIWU ($p < 0.05$). There was no significant difference in mean [La^-] or performance time between trials ($p > 0.05$). **CONCLUSION:** In conclusion, the variation in intensity between the two warm-up procedures may not have been large enough to elicit a change in performance time. A higher intensity should increase the metabolic demand which may better prepare runners for the race.

Figure 1. Subject running a 5 km

Introduction

Athletes, at any level, desire to perform at their best (Haff & Triplett, 2016). A proper warm-up initiates glycolytic metabolism. As glycolytic metabolism is initiated with exercise, lactic acid is formed, which dissociates into lactate and hydrogen ions (H^+). In order to efficiently perform, H^+ need to be buffered to prevent acidity (Draoui & Feron, 2011). In addition, the lactate molecule leaves the cell via the lactate shuttle and is repurposed into ATP (Kenney et al., 2015). With the increase in HR during a warm-up, more oxygen (O_2) is available for the working tissues, resulting in greater ATP production (Haff & Triplett, 2016). Theoretically, by increasing these metabolic processes sooner, via a HIWU, the lactate shuttle will work more efficiently and more ATP will be produced overall. This may result in better performance.

Previous researchers have studied the effects of a warm-up in relation to performance (Anderson et al., 2014; Bishop, 2003; Bishop et al., 2001; Ciric et al., 2012). The researchers have shown that a warm-up has elicited significant differences in individuals' VO_2, blood lactate accumulation, and heart rate response, which has improved performance (Anderson et al., 2014; Bishop, 2003; Bishop et al., 2001; Ciric et al., 2012).

Purpose

The purpose of the study was to examine the effects of warm-up intensity on 5 km performance and blood lactate response.

Subjects

Ten male recreational runners participated in the study. The subjects must have run 5-15 mi/week and not be a member of any collegiate track & field or cross country team, or an elite runner.

Descriptive Statistics

Table 1.
Descriptive statistics of the subjects

	M	*± SD*	*n*
Height (cm)	181.76	6.60	10
Weight (kg)	82.55	11.22	10
Body fat (%)	14.88	4.03	10
Age (yrs)	22.70	2.49	10
$VO_{2\ max}$ (ml/kg/min)	49.41	6.19	10

Methods

Each subject participated in 3 testing sessions, each about a week apart. The first session included a series of baseline tests, and the next two included either a HIWU or MIWU, followed by a 5 km run. The order of the warm-up protocols were randomized.

Baseline Testing

- Height (cm)/weight (kg)
- Body composition via the Tanita Body Composition Scale
- $VO_{2\ max}$ via the McConnell Protocol

Figure 2. $VO_{2\ max}$ testing

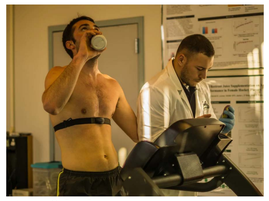

Figure 3. [La^-] assessment

High Intensity Warm-up (HIWU)

- 10 min jog at 50% of $vVO_{2\ max}$
- 5 min intermittent sprints at $vVO_{2\ max}$
  - 30 s at $vVO_{2\ max}$ followed by 30 s at 50% of $vVO_{2\ max}$ for a total of 5 sprints
- 5 min seated rest

Moderate Intensity Warm-up (MIWU)

- 15 min jog at 50% of $vVO_{2\ max}$
- 5 min seated rest

5 km

- Following the given warm-up protocol, each subject began a self-paced 5 km on the treadmill
- HR was recorded throughout each trial
- [La^-] was measured at each km

Results

Blood Lactate

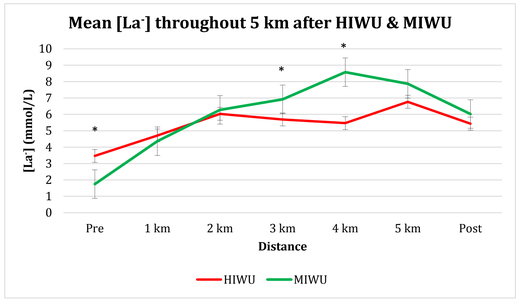

Figure 4. Mean [La^-] throughout 5 km after HIWU & MIWU
There was no significant difference in mean [La^-] throughout the 5 km ($p > 0.05$).
* Indicates significant differences in [La^-] when measured at the time points: pre, 3 km and 4 km ($p < 0.05$).

Heart Rate

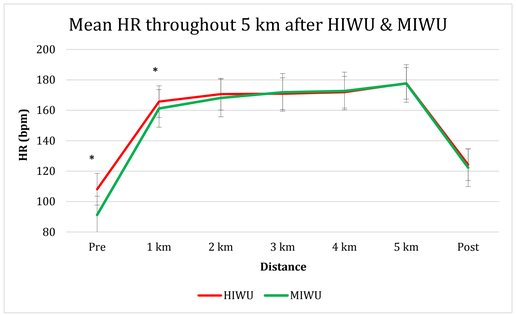

Figure 5. Mean HR throughout 5 km after HIWU & MIWU
There was a significant difference in mean HR throughout 5 km ($p < 0.05$).
* Indicates significant differences in HR when recorded at the time points: pre and 1 km ($p < 0.05$).

Performance

There was no significant difference in performance times between the HIWU (24.76 ± 2.29 min) & MIWU (24.52 ± 2.57 min) ($p > 0.05$).

Table 2.
Mean values for [La^-], HR, and performance time during the 5 km, following the HIWU & MIWU

	HIWU		MIWU	
	M	*± SD*	*M*	*± SD*
[La^-] (mmol/L)	5.37	0.76	5.97	0.78
HR (bpm)	155.60*	3.32	152.10*	4.13
Performance time (min)	24.76	2.29	24.52	2.57

Note. * Indicates significant difference in the mean ($p < 0.05$) (n=10).

Conclusion

In this particular study, the warm-up intensity did not impact performance time. As shown in *Figure 4* and *Figure 5*, there was a difference in physiological response between the two warm-up intensities. This physiological difference, however, was not enough to significantly impact performance time. This is likely due to the intensity of the HIWU not being great enough. As depicted in *Figure 4*, [La^-] levels were higher following the HIWU when measured pre 5 km. However, as the subject continued to run the 5 km, [La^-] levels following the HIWU were significantly lower than the MIWU at 3 km and 4 km. Theoretically, this could indicate that the lactate shuttle was working more efficiently following the HIWU.

Although HR was higher at the beginning of the 5 km following the HIWU, increasing the intensity would elicit a greater physiological response. This in turn would increase O_2 availability and ATP production, which may impact performance (Haff & Triplett, 2016).

Future Considerations

- The high intensity warm-up could be revised by either increasing the number or intensity of the sprints.
- Simulating a 5 km road race on a treadmill in the laboratory setting may impact ecological validity. Researchers should consider field based testing to improve this factor.

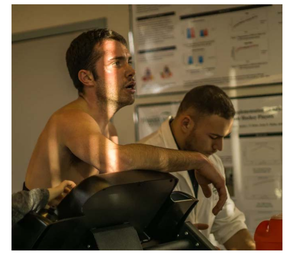

Figure 6. Subject post 5 km

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