ACUTE EFFECTS OF TRAINING ON HURDLE CONFIGURATION DURING SPRINT HURDLE MOTION

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Here we assessed the acute effects of training in hurdle configuration on sprint hurdle motion in five male hurdlers. We compared the hurdlers' motion between the pre- and post-training conditions for three different types of training programs. Our results showed that a short-interval training program was effective in reducing the duration of all four step, particularly that of the 2nd step. On the other hand, a long-interval training program particularly influenced the characteristics of the 3rd step without improving the overall four steps. Thus, a long-approach training was effective in adjusting the ground reaction force in the support phase of the 4th step, necessary to appropriately clear the hurdle.

KEY WORDS: Motion analysis, training, interval.

INTRODUCTION: Faster hurdlers have great speed, power, and coordination abilities. Training exercises to boost coordination usually involve changing the speed and rhythm of the hurdle motion (Bompa, 1999). In general, hurdle manuals recommend changing the hurdle configuration, such as the distance between the hurdles and their height, for effective training; however, not many studies have comprehensively assessed the effect of this type of training programs. Step frequency is expected to increase during hurdle races; therefore, understanding the effects of changing hurdle configuration on sprint hurdle motion, particularly regarding the step frequency, is essential to evaluate the effectiveness of this type of training programs.
Set against this background, we assessed the acute effects of training in hurdle configuration on sprint hurdle motion.

METHODS: Five male hurdlers (Height: 1.77 ± 0.06 m; body mass: 67.4 ± 7.2 kg; PB: 15.44 ± 0.75 s) participated in this study. First, we recorded the athlete's motion between the 3rd and the 4th hurdle prior to specific training in regular hurdle configuration (pre-trial; length from start to 1st hurdle (approach): 13.72 m, length of interval: 9.14 m). Then we recorded the same motion in regular hurdle configuration after three training programs:
1. Short-interval training (SI; length of approach: 13.72 m, length of interval: 8.64 m)
2. Long-interval training (LI; length of approach: 13.72 m, length of interval: 9.64 m)
3. Long-approach training (LA; length of approach: 20 m, length of interval: 9.64 m)
The order of the training programs was randomized per subject. Motions in regular hurdle configuration in pre- and post-trials during four steps (1cycle) were recorded using a high-speed VTR camera (EX-F1, CASIO, Japan). In addition, we used a motion analyzer (Frame-DIAS-II ver.3, DKH, Japan) to digitize the position of 25 body landmarks and calibration marks in the projected images. Next, we calculated the position of the two-dimensional coordinates based on the calibration marks. These data were subsequently smoothed using a butterworth low-pass filter with optimal cut-off frequencies, which were determined using the residual error method proposed by Wells & Winter (1980). Figure 1 shows the classification of the movement phases. We analyzed the following kinematic parameters: the duration of each phase, vertical velocity of the center of gravity (CG), step length, and angular velocity of the thighs. In addition, we assessed whether the differences between the pre- and post-training conditions were statistically significant using a Wilcoxon rank-sum test for paired values ($p < 0.05$).

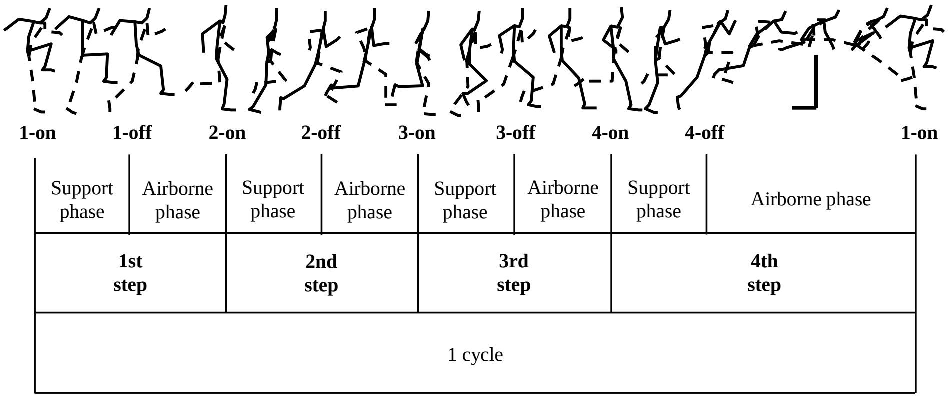

Figure 1 Movement phases during four steps in hurdle motion (1cycle).

RESULTS: Table 1 shows the durations of each phase during 1cycle motion for pre- and post-training conditions (SI, LI, and LA). The durations of 1cycle and the airborne phase in the 2nd step for SI were shorter than those for pre-training condition. The duration of the airborne phase of the 3rd step for LI was shorter than that for pre-training condition. On the other hand, the duration of the airborne phase of the 4th step was shorter after LA than that during pre-training condition. Figure 2 shows the ratio of “step length of each step” to “step length of the 1cycle motion” for pre- and post-training conditions. For SI, this ratio increased during the 4th step compared with the pre-training value, whereas the step length of the 3rd step decreased for LI compared with that of pre-training value.

Table 1 Duration of 1cycle, and the support and the airborne phases for each training program.

Variables [mean(SD)]	CT	1st step		2nd step		3rd step		4th step	
		ST	AT	ST	AT	ST	AT	ST	AT
pre	1.28 (0.06)	0.12 (0.02)	0.05 (0.01)	0.16 (0.02)	0.13 (0.01)	0.15 (0.02)	0.08 (0.01)	0.15 (0.01)	0.45 (0.03)
SI	1.25 (0.06)	0.12 (0.01)	0.05 (0.01)	0.15 (0.02)	0.12 (0.01)	0.14 (0.02)	0.07 (0.01)	0.15 (0.01)	0.44 (0.03)
LI	1.29 (0.05)	0.13 (0.01)	0.04 (0.01)	0.16 (0.02)	0.13 (0.02)	0.15 (0.02)	0.07 (0.01)	0.15 (0.02)	0.46 (0.04)
LA	1.25 (0.03)	0.12 (0.01)	0.05 (0.01)	0.16 (0.01)	0.13 (0.02)	0.14 (0.02)	0.07 (0.01)	0.15 (0.01)	0.43 (0.02)
Significant difference	pre > SI	n.s.	n.s.	n.s.	pre > SI	n.s.	pre > LI	n.s.	pre > LA

Unit : [s]

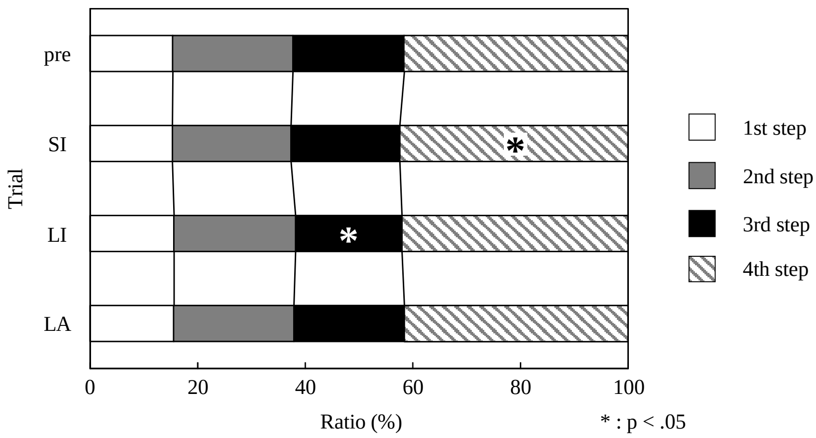

Figure 2 Step length for each step to 1-cycle step length ratio.

Figure 3 shows the changes in vertical velocity of CG for each step for pre- and post-training conditions. Although CG vertical velocity did not significantly differ for pre- and post-training conditions, mean CG vertical velocity during the 4th step was smaller after training than at pre-training condition. Figure 4 shows the average angular velocity patterns of the lead leg thigh during 1cycle motion at pre- and post-training conditions. For SI, the angular velocity of the lead leg thigh during the airborne phase of the 2nd step was smaller than that during pre-training condition.

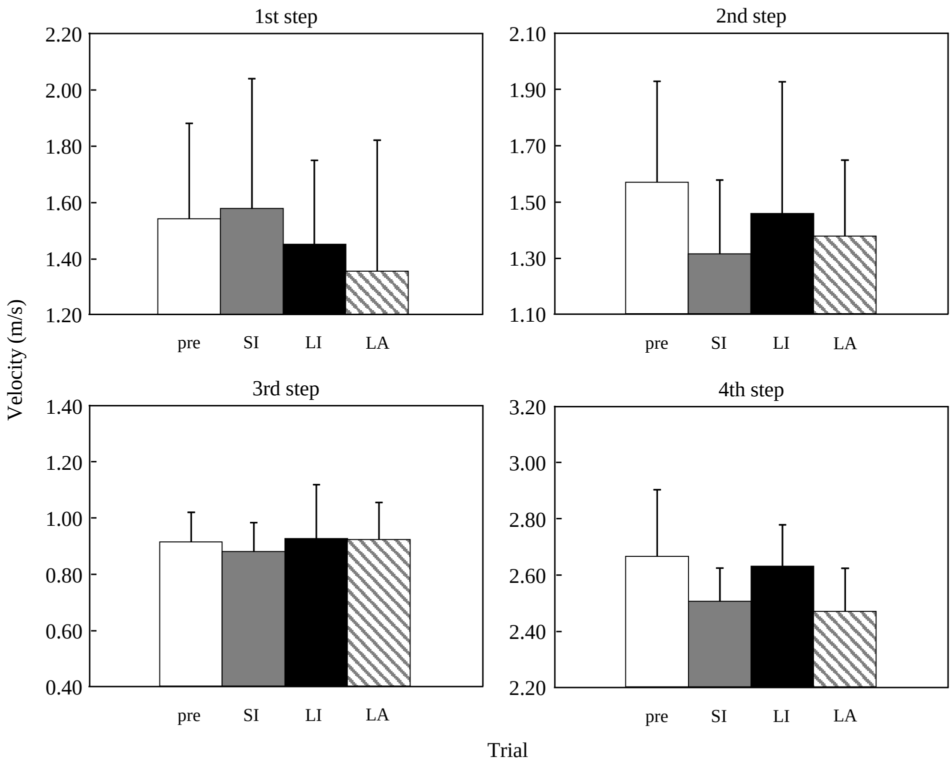

Figure 3 Changes in vertical velocity of CG for each step.

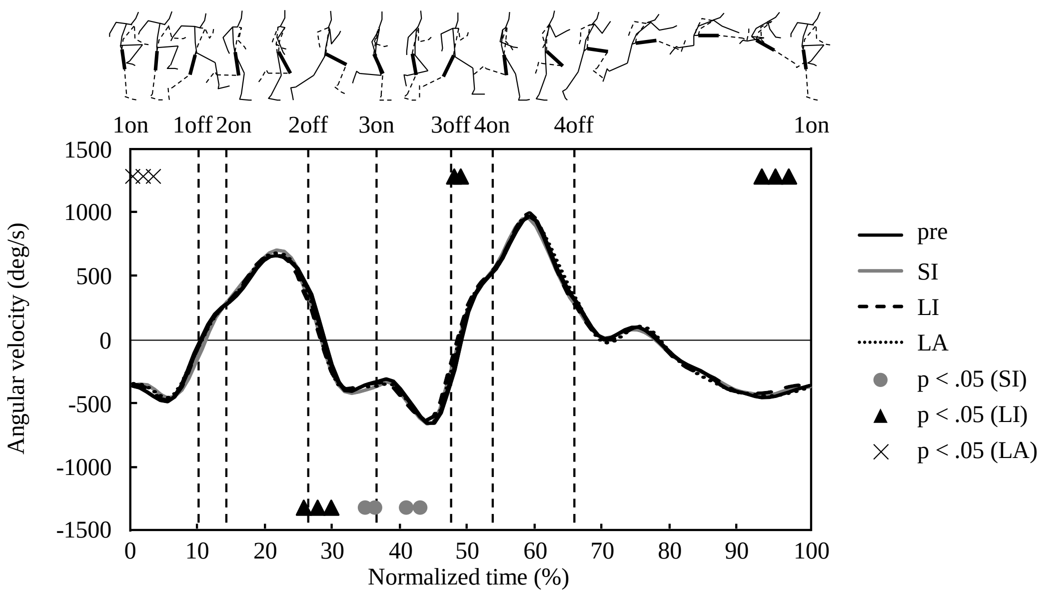

Figure 4 Average angular velocity patterns of the lead leg thigh during 1cycle motion.

DISCUSSION:

1. Short-interval training effect: 1cycle duration decreased due to a reduction in the duration of the airborne phase of the 2nd step. A shorter airborne phase during this step is achieved by active landing with the lead leg. These results are similar to those previously reported by Shibayama et al. (2011), who discussed the characteristics common to fast hurdlers. Thus, short-interval training arises as effective in reducing the duration of a full cycle, particularly by influencing the 2nd step.

2. Long-interval training effect: Although 1cycle duration did not significantly differ between the pre- and post- training conditions for this program, the mean duration decreased following LI training. In addition, the duration of the airborne phase of the 3rd step decreased. The main reason is the increase in the ratio of step length in 1st step and 2nd step. In general, it is important to keep the distance between the take-off point and the hurdle in a constant range. As a result, LI training alters the characteristics of the 3rd step without significantly improving a 1cycle motion.

3. Long-approach training effect: The duration of the airborne phase of the 4th step decreased due to small changes in CG vertical velocity during the support phase of this step. However, the duration of the support phase in this step did not significantly differ between the pre- and post-training conditions. The change in momentum is directly related to the impulse obtained during the support phase; consequently, LA training is effective in adjusting the ground reaction force during the support phase of the 4th step to clear the hurdle successfully.

CONCLUSION: Our results suggested that short-interval training was the most appropriate to reduce the duration of a 1cycle motion. In addition, long-approach training appeared effective in improving the take-off motion when approaching the hurdle. Long-interval training was not suitable for improving a 1cycle motion.

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