

**Changes in metabolic and muscle damage indicators
following a single bout of jump training on stair versus
level**

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Key words: microinjury, plyometric, knee extensor

BACKGROUND: Jump exercises at level can acutely induce delayed onset muscle soreness, loss of maximal voluntary force and vertical jump height [1] due to temporary muscle damage caused by eccentric muscle actions. Immediately after plyometric training oxygen consumption, heart rate, and blood lactate increased in recreationally trained subjects [2]. Though data is available on the acute effects of low intensity stair climb walking [3] and running [4], there is no information about the physiological effects of maximal effort stair-jump training (SJT). As in uphill activities smaller eccentric forces are produced compared with those at level, in the present study we hypothesized that muscle damage indicators are smaller and acute metabolic responses are greater after a single bout of stair-jump exercise, than after jumps at level.

METHODS: Trained males ($n = 8$) executed 100 maximal intensity unilateral jumps in two conditions: on stairs (SJT) with one leg, and at level (L) with the other leg. Maximal isometric torque (MVC) and rate of torque development (RTD) of the quadriceps muscle during knee extension (Multicont II dynamometer), and unilateral vertical jump height (VJ) was determined in the trained leg pre-exercise, immediately post- (IP), 24h and 48h after exercise. Serum creatine kinase (CK) level and delayed onset of muscle soreness (DOMS) of quadriceps and gluteals were evaluated at pre-exercise, 24h and 48h. Blood lactate levels were measured at pre-exercise and at IP. Heart rate (HR) was continuously monitored during exercise sets and rest intervals. All variables were tested with two-way ANOVA of repeated measures (condition $\times$ time).

RESULTS: There was no condition $\times$ time interaction in any of the variables, except DOMS in both muscles. DOMS developed only in the L condition. CK elevated significantly at 24h and was about two-fold greater in L and about three-fold greater in SJT, but magnitude of changes was not different. MVC and RTD declined acutely and remained depressed at 24h, but recovered at 48h in both conditions. VJ height was unaffected in both conditions. Lactate elevated to ~ 8 mmol/l at IP, in both conditions. A non-significant trend ($p = 0.068$) indicated that SJT induces greater HR responses during the rest intervals.

CONCLUSION: Stair and level jumps induced similar heart rate, lactate and CK responses, and similar loss and recovery in muscular performance. We speculate that our participants in the L condition, expecting high stress on muscles during unilateral landings, involuntarily increased the pre-activation level of their muscles. The greater activation may have distributed the workload among fibers that protected the muscles from greater damage, but, on the other hand, increased the metabolic demand. We conclude that vigorous stair-jump training challenges the anaerobic energy system, while this type of training does not compromise power and rapid torque generating ability on the subsequent day, and could be one alternative to prevent delayed onset muscle soreness.

REFERENCES:

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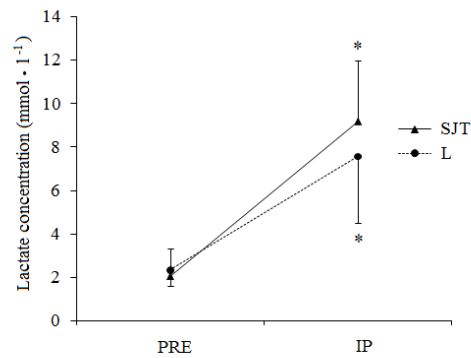


Figure 1

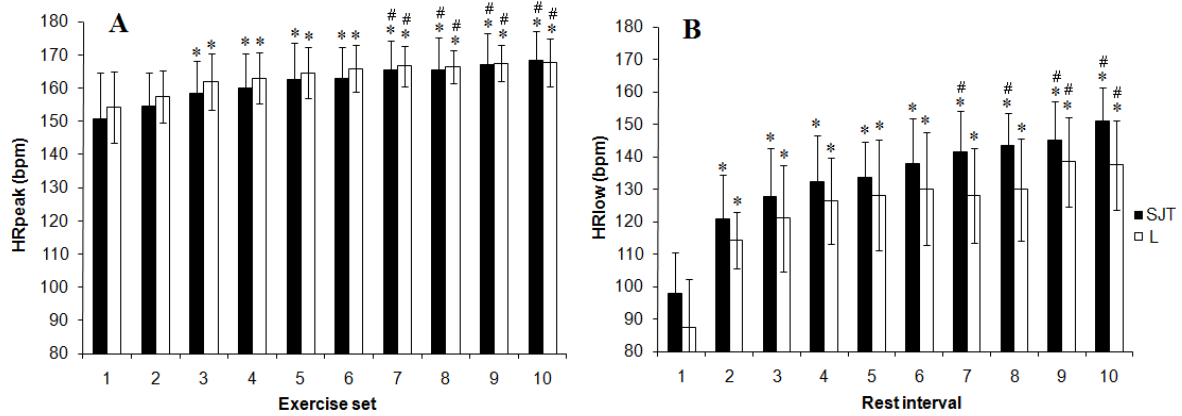


Figure 2

	SJT condition				L condition			
	PRE	IP	24h	48h	PRE	IP	24h	48h
<i>Variables</i>	mean SD	mean SD	mean SD	mean SD	mean SD	mean SD	mean SD	mean SD
MVC (Nm)	349 (42)	322 (28) *	322 (45) *	343 (44)	360 (40)	339 (37) *	323 (43.8) *	338 (55) *
RTD (Nm · ms ⁻¹)	2.16 (0.62)	1.61 (0.52) *	1.92 (0.70)	2.31 (0.61)	2.04 (0.33)	1.54 (0.45) *	2.02 (0.19)	2.03 (0.49)
VJ (cm)	44.0 (8.1)	42.7 (7.4)	42.5 (6.7)	44.0 (7.5)	44.7 (4.1)	44.0 (5.0)	43.0 (4.5)	42.9 (5.7)
CK (IU · l ⁻¹)	154 (43)	-	367 (183) *	281 (183) *	170 (65)	-	612 (415) *	414 (276) *
DOMS _{GL}	0.0 (0.0)	-	0.0 (0.0)	1.4 (3.7)	1.0 (1.9)	-	14.7 (13.2) *	13.0 (12.6) *
DOMS _{QF}	0.1 (0.3)	-	1.1 (2.2)	0.8 (1.3)	0.3 (0.7)	-	4.7 (4.8) *	6.5 (5.1) *

Table 1