



THE DIFFERENTIAL EFFECTS OF LADDERMILL VS. TREADMILL MAXIMAL EXERCISE TESTING

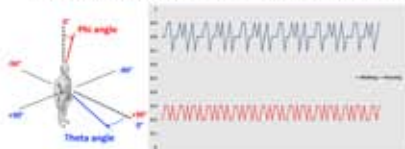
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Abstract

PURPOSE: To examine peak oxygen uptake ($\dot{V}O_{2peak}$) on a Laddermill (LM) compared to a standard treadmill (TM). Concurrently, accelerometry data will be used to examine impact forces that occur during LM and TM exercise. **METHODS:** Standardized graded exercise tests were conducted on a LM and TM in 20 healthy, college-aged (21.3 $\pm$ 1.8y) men (n=10) and women (n=10) in a randomized, cross-over design. Impact forces were obtained by tri-axial accelerometers (lateral, vertical, and sagittal; Bioharness, BH3, Annapolis, MD) on the left side of the body. **RESULTS:** $\dot{V}O_{2peak}$ was significantly lower for LM compared to TM (42.2 $\pm$ 5.5 vs. 46.7 $\pm$ 5.8 ml/kg/min, resp.; $p < 0.001$). Lateral accelerations increased in LM ($p < 0.01$) and sagittal accelerations increased in TM ($p < 0.01$) with an increase in energy expenditure. **CONCLUSIONS:** These results suggest that the impact forces experienced during LM and TM differentially affect $\dot{V}O_2$ consumption and EE. Supported by the Robert and Patricia Hines Endowment in Kinesiology. LM provided by Jacobs Ladder®.

Introduction

- Arm exercise included with lower body exercise has been shown to increase the energy requirement of exercise.
- Additionally, arm exercise increases ventilation, which could increase the perceived intensity of exercise and alter the dynamics of oxygen consumption during submaximal and maximal exercise.
- The impact forces experienced could further raise the energy demand of exercise.
- The purpose of this study is to compare the metabolic effects of a maximal graded exercise test (GXT) on a laddermill (LM) compared to a standard treadmill (TM).



Walking impact ~.2 g
Running impact ~.8 g

Methods

Healthy men and women aged 18-35 years completed a maximal GXT on the TM and LM in a cross-over, counterbalanced, randomized design separated by at least 3 days. Expired gases, blood lactate, and RPE were collected at the end of each stage. During the tests, participants also wore a Bioharness 3.0 (Zephyr, Annapolis, MD) to collect impact force and HR data.

Table 1. Protocol

Time (min)	Treadmill		Laddermill	
	Speed (mph)	Grade (%)	Speed (ft/min)	Grade (%)
3:00	3.0	0.0	60	40
2:00	5.0	2.5	70	40
2:00	5.0	5.0	80	40
2:00	5.0	7.5	90	40
2:00	5.0	10.0	100	40
2:00	5.0	12.5	110	40
2:00	5.0	15.0	120	40



The Jacobs Ladder® (JL) is a non-motorized self-powered laddermill (LM) set at a 40 degree angle. The speed of the ladder mill is controlled by the exerciser via a belt attached to a tension cable that when pulled, releases the brake. Once the exerciser stops moving the tension is reduced and the brake is reengaged.

Table 2. Participant Characteristics

	Male	Female
n	10	10
Age	25.3 $\pm$ 4.4	22.3 $\pm$ 7.1
BMI	25.0 $\pm$ 1.9*	22.0 $\pm$ 1.7

*p value < 0.005



Results

Peak $\dot{V}O_2$ Response

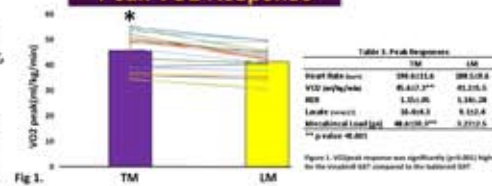


Fig. 1.

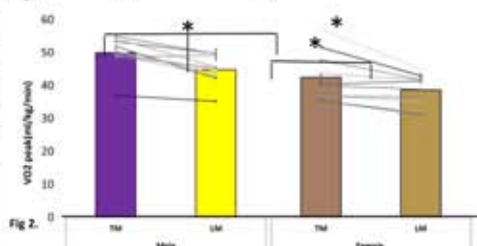
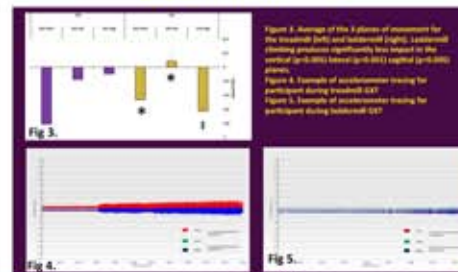


Fig. 2.

Accelerometry



Caloric Expenditure

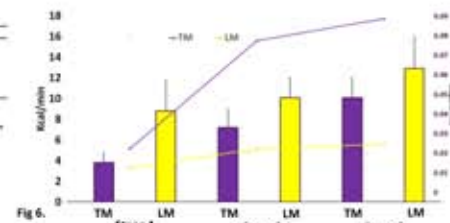


Figure 6. Stage by stage comparison of TM to LM. LM exercise consumed significantly (p-value < 0.001) more calories while resulting in significantly lower impact.



Figure 7. An earlier impact force the laddermill offset significantly (p-value < 0.001) more calories than the treadmill during the walking slow climbing phase.

Conclusion

$\dot{V}O_{2peak}$ was significantly lower in LM compared to TM. LM elicited a greater heart rate response during the early stages when compared to TM ($p < 0.001$). Energy expenditure was significantly greater during each stage of the LM test compared to TM at similar RPE. Impact forces are significantly reduced on the LM while energy expenditure is increased when compared to TM exercise.