Energy Expenditure During Sub-Maximal Running on a Non-Motorized Treadmill

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Abstract

Non-motorized treadmills are usually used for repeat sprint exercises as the belt speed increases and decreases very quickly in response to the athletes' actions. Historically, non-motorized treadmills have been very large and required the stabilization of participants by either holding onto surrounding objects or wearing a harness during exercise sessions. Recent developments in treadmill design have led to production of the first consumer sized curved non-motorized treadmill. This design features a belt powered by the user and a curved platform that may alter the physiological requirements of running. PURPOSE: To examine the physiological requirements of sub-maximal running on a small curved non-motorized treadmill. METHODS: Experienced distance runners (males=6, females=3) performed an incremental exercise test on a motorized treadmill to determine lactate threshold (LT) and maximal (MAX) values. The subjects then performed four exercise bouts at 50%LT, 65%LT, 80%LT and LT running speeds on both the motorized treadmill (MT) and the curved non-motorized treadmill (CT). Each exercise bout lasted 6 minutes and the order of all exercise bouts was randomized. When the speed was increased, at least 5 minutes of rest occurred between exercise bouts; when the speed was decreased, at least 10 minutes of rest was provided. The rest periods were used to allow the measured variables to return toward baseline values. Heart rate (HR), oxygen uptake variables (VO_2, VE, RR, RER), muscle oxygenation (StO_2), blood lactate (HLa) and ratings of perceived exertion (RPE) were obtained during the last minute of each exercise bout for the incremental test and the comparative runs. A two-way ANOVA with repeated measures was performed, followed by dependent t-tests where appropriate (*P<0.05). RESULTS: All oxygen uptake variables, HR, HLa and RPE were significantly greater for the CT trials than the MT as shown below (mean ± SD).

Variable	Treadmill	50% LT	65% LT	80% LT	LT	MAX
VO_2 (ml·kg·min^{-1})	MT	25.2 ± 8.0	33.9 ± 5.6	41.9 ± 8.4	49.9 ± 9.2	62.2 ± 10.7
	CT	33.4 ± 9.8*	45.9 ± 11.4*	54.6 ± 8.9*	60.2 ± 11.0*	-
HR (bpm)	MT	118 ± 14	130 ± 7	151 ± 9	170 ± 11	195 ± 7
	CT	136 ± 16*	158 ± 15*	175 ± 11*	190 ± 10*	-
HLa (mM)	MT	1.8 ± 0.7	1.7 ± 0.4	2.4 ± 1.1	4.5 ± 1.6	10.3 ± 2.5
	CT	2.3 ± 1.8*	3.6 ± 1.1*	6.8 ± 2.3*	11.1 ± 2.9*	-
RPE (0-10)	MT	0.7 ± 0.5	1.1 ± 1.0	1.9 ± 1.3	4.1 ± 1.6	9.3 ± 1.0
	CT	1.2 ± 0.7*	2.1 ± 1.0*	3.6 ± 0.8*	8.2 ± 1.1*	-
StO_2 (%)	MT	76 ± 19	66 ± 24	57 ± 20	41 ± 21	28.3 ± 20.3
	CT	71 ± 10	52 ±18	34 ± 23*	22 ± 13*	-

DISCUSSION: Even though all subjects were able to run on the CT without the assistance of a harness or holding on, running effort on the non-motorized treadmill was significantly greater than on the motorized treadmill, as indicated by the greater oxygen uptake, HR and HLa. The CT LT workload resulted in efforts very similar to maximal. The increased physical effort while running on the CT could be due to the greater friction inherent on the non-motorized treadmill and/or increased muscle activation as shown by the muscle oxygenation results on the CT. The physiological adaptations that result from this greater effort at the same speed and the effect on exercise performance need to be investigated further. PRACTICAL APPLICATION: The consumer sized non-motorized treadmill can easily be used by athletes without wearing a harness. Energy expenditure is greater on the non-motorized treadmill which may provide an additional training overload if the treadmill is consistently used as a training technique.

Introduction

Traditional treadmill designs have featured a flat platform and motorized belt for the subject to walk or run on. Non-motorized treadmills have been available but they have been very large, expensive and required the athlete to either wear a harness or to hold on to surrounding objects to stabilize themselves so that they did not go off the front or the back of the treadmill. While these large non-motorized treadmills had their drawbacks, they had their place in exercise training and usually were used for repeat sprint exercises as the treadmill belt speed increased and decreased very quickly in response to the athletes' actions. Recently a non-motorized treadmill has been developed for consumer utilization. The CURVE treadmill (WOODWAY, Waukesha, WI) is a non-motorized belt that allows the subject to vary their speed instantaneously with a curved platform that allows for running without the use of external stabilization. Thus, this design features a belt powered by the user and a curved platform that may alter the physiological requirements of running. Given the differences between the treadmill designs between motorized and non-motorized treadmills, we performed this study to determine the physiological requirement of running on the CURVE treadmill as compared to a standard motorized treadmill.

Purpose

To examine the physiological requirements of sub-maximal running on a small curved non-motorized treadmill as compared to a motorized treadmill.

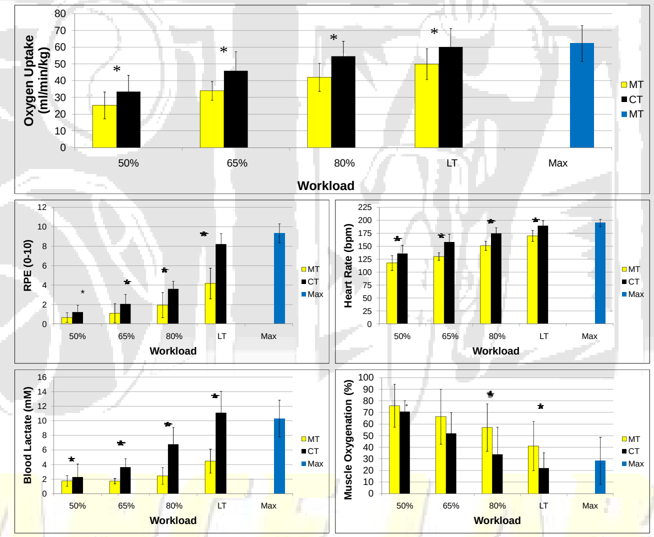
Methods

Subject Characteristics:
- •9 subjects: 6 males, 3 females.
- •College-aged, experienced runners.

Procedures:
- •Submaximal/maximal exercise test
  - •Incremental submaximal treadmill running test to determine lactate threshold (LT) on a motorized treadmill (MT) .
  - •6 minute stages increasing speed by 0.5 mph every stage.
  - •Incline was kept constant at a level grade.
  - •After at least five minutes rest a maximal running test was performed.
- •Exercise testing procedure
  - •Six minute constant speed running tests on the motorized and curved non-motorized (CT) treadmills.
  - •One day consisted of four tests with the participants running at 65 and 80% of LT speed
  - •Other day consisted of 50 and 100% of LT speed.
  - •The order of testing days and tests within each day was randomized with at least 5-10 minutes of recovery allowed between tests.
- •Variables
  - •Heart rate, blood lactate, oxygen consumption, rating of perceived exertion and muscle oxygen saturation values were obtained.

•Statistical procedures
- •Means and standard deviations were calculated on all data.
- •Two-way ANOVA with paired t-tests to determine significance (P<0.05).

Results



All oxygen uptake variables, HR, HLa and RPE were significantly greater for the CT trials than the MT. Similarly, StO_2 was lower for the CT than the MT trials. In addition, the results show that at LT speed the CT elicits physiological values similar to those collected during a max test on the MT.

Discussion

Even though all subjects were able to easily run on the CT, running effort on the non-motorized treadmill was much greater than on the motorized treadmill as indicated by the greater oxygen uptake, HR, HLa, RPE and lower StO_2 values. The CT LT workload resulted in efforts very similar to maximal. The increased physical effort while running on the CT could be due to the greater friction inherent on the non-motorized treadmill and/or increased muscle activation as shown by the muscle oxygenation results on the CT. The physiological adaptations that result from this greater effort at the same speed and the effect on exercise performance need to be further investigated.

Practical Application

The consumer sized non-motorized treadmill can easily be used by athletes without wearing a harness. Energy expenditure is greater on the non-motorized treadmill which may provide an additional training overload if the treadmill is consistently used as a training technique.