2015

Influence of Directional Loading on the Metabolic Demands of Running in a Lower-limb Positive Pressure Treadmill

Brendan J. Rickert
Sacred Heart University, rickertb@sacredheart.edu

Beau K. Greer
Sacred Heart University, greerb@sacredheart.edu

Matthew F. Moran
Sacred Heart University, moranm@sacredheart.edu

INFLUENCE OF DIRECTIONAL LOADING ON THE METABOLIC DEMANDS OF RUNNING IN A LOWER-LIMB POSITIVE PRESSURE TREADMILL

EXERCISE SCIENCE
SACRED HEART UNIVERSITY

Brendan J. Rickert, Beau K. Greer, Matthew F. Moran
Department of Physical Therapy and Human Movement Science, Sacred Heart University, Fairfield, CT
Contact Information: rickertb@sacredheart.edu

LSAC LIFE AND SPORT ANALYSIS CLINIC

ABSTRACT

No previous scientific investigation has studied the influence of either increasing or decreasing levels of body weight (BW) support on oxygen consumption (VO_2) while running in reduced BW conditions via a differential air pressure (DAP) treadmill. Moran et al. found rate of perceived exertion to be higher at the same BW conditions when moving from high BW support to low BW support but did not quantify the findings with VO_2. **PURPOSE:** The purpose of this study was to both define the physiological changes, if any and perceived efforts, if any, between unloading and loading subjects on DAP treadmill to define loading or unloading order. Specifically, the findings of the study would contribute to our understanding of the potential factors that influence perceived effort. **METHODS:** Fifteen collegiate cross country runners (7M, 8F; 20.4 ± 2.4 yrs; 61.1 ± 12.6 kg) granted informed consent and completed all study procedures. Day one testing was a VO_2 peak test (61.51 ± 14.8 ml/kg/min) run on an Alter-G treadmill (AGTM) (Fremont, CA) at 100% BW. Day two and three testing, counter-balanced, consisted of a 25-min run in which BW was either systematically increased (INC) or decreased (DEC) while velocity was held constant at 70% VO_2 peak. The DEC condition started at 100% BW and decreased 10% to 60% BW. The INC condition started at 60% BW and increased 10% to 100% BW. Each stage lasted 5-min for a total of 25- min. VO_2 (Parvo True One 2400 Metabolic Cart) was collected over the last two-minutes of each stage, as was heart rate (HR; Polar RS 300). Rate of perceived exertion (RPE; Borg Scale) was recorded at the end of each stage. A paired t-test with Bonferroni adjustment was used to analyze the data. Statistics were processed with PASW software Ver. 16.0 (IBM Armonk, NY). **RESULTS:** There were no significant differences between conditions for VO_2 and HR ($p > 0.01$). RPE data at 100% (11.2 INC- 8.4 DEC), 90%(10.4 INC- 8.6 DEC), and 80% (9.1 INC – 8.1 DEC) BW was significant ($P< 0.002$) **CONCLUSION:** From a physiological perspective there were no significant differences in VO_2 or HR at any loading level, but participants perceived a greater demand at the 100% and 90% BW levels during the INC condition. Further research is needed to better understand the psychological differences when INC BW.

INTRODUCTION

Twenty-four to 65% of all runners report a running-related injury (RRI) every year.[2] The AlterG treadmill (AG TM) artificially reduces BW through differential air pressure (DAP) bladder.[1] For rehabilitation purposes, DAP TMs have beneficial outcomes because they reduce ground reaction forces, muscular activity, and metabolic cost.[6,7] The purpose of this study was to investigate the relationship between the level of BW unloading and metabolic demands at the same workloads from increasing and decreasing BW support throughout a training session. In other words, does the direction of unloading influence metabolic demands?

***Figure 1**: AlterG Treadmill*

PARTICIPANTS

Fifteen male and female collegiate cross-country team runners volunteered for this study. All participants were free of lower-extremity injuries for at least six months prior to the study and had a minimum of four years of running experience (Table 1). All experimental procedures were approved by the Sacred Heart University Institutional Review Board. Subjects were informed of the experimental procedures and all granted their informed consent.

Table 1: Participant data

Height (m)	**1.75 ± 0.16**
Mass (kg)	61.1 ± 12.6
Age (years)	20.4 ± 2.4
Running Experience (years)	8.6 ± 3.1
Self-Reported Running Miles Per Week	49 ± 16

EXPERIMENTAL METHODS

All subjects wore their own training shoes and did not run on their respective testing day. Day one testing was VO_2 Peak test in which subjects ran at 100% BW on the AG TM. On days 2 and 3, in a counter-balanced research design, a 25-min run was portioned into five continuous 5-minute segments at 100%, 90%, 80%, 70%, and 60% of BW. The direction of unloading started at 100% and worked down to 60% on one day (**DEC**) and increased from 60% to 100% on the other testing day (**INC**). Running speed was determined from Day 1 testing in which subjects were running at a velocity (vVO_2) of 70% of their peak VO_2. All metabolic measurements were collected by a Parvo Metabolic Cart. Participants were not blinded to the direction of unloading.

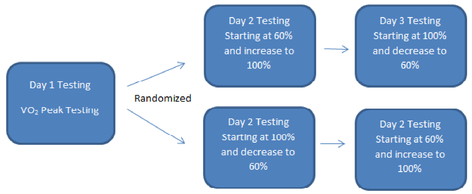

***Figure 2**: Days of participant testing*

Condition: DEC

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
BW %	100%	90%	80%	70%	60%
Duration (Min)	5	5	5	5	5

Condition: INC

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
BW %	60%	70%	80%	90%	100%
Duration (Min)	5	5	5	5	5

Table 2: Testing Protocol - Left Table Decreasing (DEC) BW. Right Table Increasing (INC) BW

RESULTS

A paired t-test with Bonferroni adjustment was used to analyze the data. There were no significant differences in VO_2 , energy expenditure, or HR between BW loading direction ($p > 0.05$). RPE data at 100% BW (INC: 11.2; DEC: 8.4), 90% BW (INC: 10.4; DEC: 8.6), and 80% BW (INC: 9.1; DEC 8.1) was significantly different ($P< 0.002$) but not different at 60% or 70% BW.

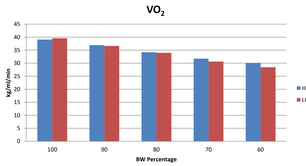

Figure 3: Mean VO_2

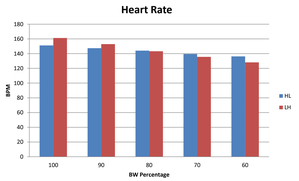

Figure 4: Mean Heart Rate

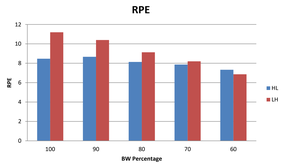

Figure 5: Mean Rate of Perceived Excertion

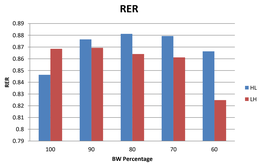

Figure 6: Mean Respiratory Exchange Ratio

CONCLUSIONS

From a previously investigated study, it was found that RPE was greater when BW loading increased, which these results enhance[5]. However the purpose of this study was to investigate physiological changes, which were not observed. It can be hypothesized that though there are no physiological changes, psychological factors must be considered when prescribing a rehabilitation protocol for the AG TM.

PRACTICAL APPLICATION

The AG TM is a new tool in performance enhancement and rehabilitation. Clinicians should consider the direction of loading when working with injured runners. Though there seems to be no difference in oxygen consumption, RPE is lower when decreasing BW.

REFERENCES

1. Alter-G. Alter-G Anti-Gravity Treadmill. Freemont, CA. 2012. Available at: http://www.alter-g.com/
2. Mizrahi J, Verbitsky O, Isakove E. Fatigue-related loading imbalance on the shank in running: a possible factor in stress fractures. *Annals of Biomedical Engineering*. 2000 28.463-469.
3. Derrick TR, Hamill J, Caldwell GE. Energy absorption of impacts during running at various stride lenghs. *Medicine & Science in Sports & Exercise*. January 1998. 30(1) 128-135.
4. ACSM's Guidelines for Exercise Testing and Prescription: Eight Edition. 2010. China.
5. Moran, MF, Rickert BJ: Effect of Body Weight Support on Spatiotemporal Running Mechanics. *Presented at ACSM Annual Meeting, San Francisco*, May 2012.
6. Cavanagh PR and Lafortune MA. Ground reaction forces in distance running. *Journal of Biomechanics*. 1980. Vol. 13, 397-406.
7. Figueroa MA, Manning J, Escamilla P. Physiological Responses to the AlterG Anti-Gavity Treadmill. *International Journal of Applied Science and Technology.*2011. Vol 1; 6.

ACKNOWLEDGMENTS

Thank you to Dr. Anna Greer for statistical analysis assistance and Caroline Bertram for assistance during data collection.

Presented at the 2015 American College of Sports Medicine National Conference
San Diego, California