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A Comparison of High-Intensity Power Training and Graded Treadmill Exercise

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A COMPARISON OF HIGH-INTENSITY POWER TRAINING AND GRADED TREADMILL EXERCISE

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TITLE: A COMPARISON OF HIGH INTENSITY POWER TRAINING AND GRADED TREADMILL EXERCISE

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The purpose of this study was to investigate acute blood lactate concentration, heart rate, blood pressure, and rating of perceived exertion following two different types of exercise: a high intensity power training exercise test and a graded treadmill exercise test. The hypothesis was that the HIPT exercise test would yield higher levels of blood lactate, heart rate, blood pressure, and RPE, immediately post exercise when compared to a graded treadmill exercise test. Ten college-aged participants with a body mass index <29 kg/m^2, blood pressure <140/90 mmHg, no overt cardiovascular disease, no cardiovascular medications, and no use of tobacco products were included in the study. All participants had a general fitness and training level that allowed them to perform the exercise bouts without any hesitation. Subjects participated in two exercise sessions on separate occasions. A graded treadmill exercise test occurred with the subjects walking on the treadmill until the self-stated desire to stop or until five stages of increased speed and intensity had occurred. In the second meeting, subjects completed a prescribed high-intensity power training exercise test. Heart rate (HR), rating of perceived exertion (RPE), blood pressure (BP), and blood lactate concentration were all obtained before and immediately following each training session, as well as immediately following each stage of the graded treadmill exercise test. Oxygen uptake was obtained during the graded treadmill exercise test.

After both tests were conducted, the high intensity power training exercise test showed a higher percentage of blood lactate concentration at its conclusion when compared to the graded treadmill exercise test with lower final average values BP, HR and RPE. In conclusion HIPT exercise yields higher blood lactate concentrations compared to graded treadmill exercise with a lower blood pressure, heart rate, and perceived exertion.

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INTRODUCTION

For many years, athletic performance has been a topic of research to determine how training sessions should be formatted in order to achieve the highest level of performance. Additionally, the specific measures to be used to quantify outcomes and provide information useful to the athlete has been an area of study. This study investigated acute blood lactate concentration, heart rate, blood pressure, and rating of perceived exertion following two different types of exercise: high intensity power training and a graded treadmill exercise test.

Smith, Sommer, Starkoff, & Devor (2013) reported on significantly improved maximal aerobic capacity (VO_2max) after high intensity power training (HIPT). Their data were scaled to body weight. They reported their study as the first one published that documents changes to maximum oxygen uptake (VO_2 max) or body composition with HIPT. No comparison was measured between HIPT and other types of training in their study.

Alternative training styles are of interest due to the time that can be saved working on endurance and devoted to skill development. This was apparent in a study that compared HIIT with repeated-sprint training (RST) in tennis players (Fernandez-Fernandez, Zimek, Wiewelhove, & Ferrauti, 2012). This study supported conclusions of others that the time-efficient, lower training volume offered by RST enhanced aerobic conditioning as much as HIIT in tennis players. Parameters measured in this study by Fernandez-Fernandez et al. (2012) were oxygen uptake, carbon dioxide production, max velocity at a blood lactate concentration of 4 $mmol \cdot L^{-1}$, and RPE. No information was found in the results or discussion sections related to the RPE assessments.

In a study comparing high-intensity interval training with moderate training among healthy, nonsmoking male university students who engage in some physical activity at least three

times per week, Helgerud, Hoydal, Wang, Karlsen, Berg, & Bjerkass (2007) concluded that intensity and volume of training are not interchangeable. They found that high-aerobic intensity endurance training was significantly more effective than moderate and low-intensity training in the improvement of VO_2max over an 8 week training period. They pointed out that measurement of VO_2max is specific to a given type of activity and that major factors in aerobic performance among different individuals are maximal oxygen uptake, blood-lactate threshold, and work economy (Helgerud et al., 2007).

Bayati, Farzad, Gharakhanlou, & Agha-Alinejad (2011) compared high-intensity interval training with sprint-interval training in healthy, male graduate students who were habitually active but not in a structured training program. Of interest in this study was the fact that both training programs significantly and similarly improved VO_2max in untrained subjects. This has implications for the general population that may not be able to safely adopt sprint-interval training into their routine. They concluded that future research should look at how to combine optimal intensity and volume in a practical, time-efficient manner (Bayati et al., 2011).

In the previously mentioned study performed by Smith et al. (2013), marked improvements in body composition and VO_2max were recognized as a result of HIPT. No other parameters were recorded. The aim of the present study was to look at the effect of HIPT on other parameters that can be used to measure athletic performance, including blood lactate accumulation, heart rate, blood pressure, and rating of perceived exertion (RPE). This may be of particular interest to endurance athletes. If HIPT can be an efficient method to improve blood lactate tolerance, more time can be spent with these athletes in the strength and conditioning

setting on recovery and skill acquisition, and less time will need to be spent on training methods that are less efficient.

Purpose

The purpose of this study was to compare the effect of a High Intensity Power Training (HIPT) exercise test and a graded treadmill exercise test on blood lactate accumulation, heart rate, blood pressure, and rating of perceived exertion (RPE) in healthy college-aged males.

Hypothesis

It was hypothesized that the HIPT exercise test would yield higher levels for blood lactate accumulation, heart rate, blood pressure, and RPE immediately post exercise when compared to a graded treadmill exercise test.

METHOD

Participants

Ten male participants were included in this study. Ages ranged from 18 to 29, with the median age of 26. Participants were orally screened for a baseline fitness level and filled out a medical information form. Participants were recruited by the researchers who had a level of fitness to complete the exercises. All participants gave their written informed consent as approved by the Southern Illinois University Human Subjects Committee to participate in this research study.

Dependant Measures

Blood lactate levels were analyzed using the Lactate Plus Blood Lactate Analyzer (Nova Biomedical, Waltham, MA) (Tanner, Fuller, & Ross, 2010). This device uses 10 microliters of whole blood to analyze blood lactate in millimoles (mmol). A lancet was used to prick the finger. The analyzer was held to the finger to draw a drop of blood for analysis. Lancets were disposed of in a sharps container. Rubber gloves were worn by the investigators at all times. A Polar Heart Rate monitor was used to measure all participant heart rates, and a standard blood pressure cuff was used to measure blood pressure. The Borg Scale was used for all participants' ratings of perceived exertion (RPE).

Front squats and pull-ups were conducted as part of the high intensity power training circuit. For pull-ups, a standard pull-up bar was used that was positioned about seven feet above the floor in order to ensure that participants are not using their legs. A standard 45 pound barbell with two 25 pound metal plates was used to perform front squats.

A treadmill was used for the graded treadmill exercise test. Expired gases were collected with a Hans Rudolph mouthpiece (Hans Rudolph, Inc., Shawnee Mission, KS) that was connected to a Parvo Medics oxygen uptake (VO_2) metabolic cart (Parvo Medics, Sandy, UT). This was used to measure VO_2 in ml/kg/min. After each usage, mouthpieces that were used were thoroughly cleaned and sterilized using soap and bleach.

Independent Measures

The high intensity power training (HIPT) circuit was one of two exercise bouts that were completed by participants. This max effort circuit consisted of seven pull-ups, fourteen front squats, and ten push-ups with a hand release at the bottom. Participants were asked to complete the circuit as many times as they could within 12 minutes. The front squats were done with a standard 45 pound barbell with a 25 pound plate on each side, totaling 95 pounds. Participants were simply told to do their best in completing as much of the circuit as they could. Prior to the circuit, participants' initial readings of heart rate, blood pressure, RPE, and blood lactate were measured and recorded. Participants were then given the choice to perform their own warm-up or complete a dynamic warm-up circuit consisting of ankle and hip mobility movements before beginning the circuit. Participants were then timed during the circuit using a stopwatch and were made aware when every two minutes had elapsed. Immediately following the completion of the circuit, participants' heart rate, blood pressure, RPE, and blood lactate were measured and recorded.

On the graded treadmill exercise test participants completed a maximum of five stages of increasing intensity on the treadmill. Participants' initial readings for blood lactate, heart rate, blood pressure, and RPE were measured and recorded. The participants were asked to perform a

"light jog" on the treadmill for three minutes as a warm-up. During this initial warm-up period, participants were asked to informally assess initial exercise intensity. If the participant deemed the treadmill speed correlated to a low intensity, then treadmill speed was increased until the participant perceived himself as jogging at a moderate intensity. The speed of the treadmill was then recorded, and the participant would begin his first stage at this speed. The participant was then allowed to stop and catch his breath before being fitted for the oxygen uptake mask. The mask was then attached to the oxygen uptake equipment by a plastic tube. Once the participant signaled he was ready, the mask was put on and the test began.

During each stage the participant ran for three minutes, after which he jumped and straddled the treadmill belt while all data were collected. Dependant measures in between stages included blood lactate, heart rate, blood pressure, and RPE, as well as a recording of the speed and grade of the treadmill of the previous stage. Immediately following data collection the intensity was increased, and the participant jumped back on the treadmill for the next stage whenever he was ready.

Rest periods between stages were one minute to one minute and thirty seconds depending upon how long it took the participant to begin the next stage. Intensity was increased by increasing the speed by 1.5 mph between the first and second stage as well as the second and third stage. The third stage equated to the maximum speed at which participants ran. From that point, intensity was increased by increasing the grade by two degrees before the fourth stage and two more degrees before the fifth stage. Following the completion and data collection for the fifth stage, the oxygen uptake mask was removed from the participant's face, and he was told to engage in a light "cool down" jog whenever he was ready. Following the conclusion of the test,

researchers accessed all oxygen uptake data and recorded VO_2 (mL/kg/min) levels for the participant immediately before the conclusion of each stage.

RESULTS

A summary of both the graded treadmill exercise test and HIPT exercise test results can be found below in Tables 1, 2, and 3. Included in the tables are the average heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and rating of perceived exertion (RPE) for each stage of the graded treadmill exercise test as well as both before and after the HIPT exercise test.

Table 1. Graded Treadmill Exercise Test, Oxygen Uptake & Lactate

Stage	VO2 (ml/kg/min)	% Max VO2	*SD*	HLA (mmol)	% HLA	*SD*
I	31.62	65%	13%	3.05	32%	14%
II	38.36	78%	10%	4.23	42%	12%
III	42.68	89%	10%	6.64	65%	24%
IV	46.58	91%	6%	7.15	69%	13%
V	47.23	99%	2%	10.56	100%	0%

Table 2. Graded Treadmill Exercise Test, Average Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, and RPE

Stage	HR (bpm)	SB (mmHg)	DB (mmHg)	RPE
I	132	148	82	9
II	157	162	82	12
III	165	168	84	15
IV	180	172	84	17
V	184	172	82	19

Table 1 gives the average oxygen uptake, the average percentage of maximum oxygen uptake, the average blood lactate concentration (HLA), and the average percentage of the maximum HLA for each stage of the graded treadmill exercise test. Table 2 includes the average

heart rate (HR), average systolic blood pressure (SB), average diastolic blood pressure (DB), and the average rating of perceived exertion (RPE) for each stage of the test. The average VO_2 gradually increased each consecutive stage from an average of 31.62 ml/kg/min at stage one to an average of 47.23 ml/kg/min at stage five. The average percentage of VO_2max reached gradually increased each consecutive stage from an average of 65% (*SD* = 13%) at stage one to an average of 99% (*SD* = 2%) at stage five. The average HLA gradually increased each consecutive stage from an average of 3.05 mmol at stage one to an average of 10.56 mmol at stage five. The average percentage of maximum HLA reached, gradually increased each consecutive stage from an average of 32% (*SD* = 14%) at stage one to an average of 100% (*SD* = 0%) at stage five.

The average HR gradually increased each consecutive stage from an average of 132 bpm at stage one to an average of 184 bpm at stage five. The average SB gradually increased each consecutive stage from an average of 148 mmHg at stage one to an average of 172 mmHg at stage five. The average DB was consistent between stages, with a maximum value of 84 mmHg at stages three and four and a minimum value of 82 mmHg at stages one, two, and five. The average RPE gradually increased each consecutive stage from an average of 9 at stage one to an average of 19 at stage five.

Table 3. HIPT Exercise Test, Lactate, Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, and RPE.

	[HLA] (mmol)	% HLA	*SD*	HR (bpm)	SB (mmHg)	DB (mmHg)	RPE
Pre	2.31	16%	12%	74	124	73	6
Post	12.99	131%	47%	168	156	76	17.6

Table 3 includes the average blood lactate concentration and the average percentage of the graded treadmill exercise test's maximum HLA reached for before and after the HIPT exercise test. Table 3 also includes the average heart rate (HR), average systolic blood pressure (SB), average diastolic blood pressure (DB), and the average rating of perceived exertion (RPE) for both before and after the test. The average HLA increased from an average of 2.31 mmol before the test to an average of 12.99 mmol after the test. The average percentage of the graded treadmill exercise test's maximum HLA percentage increased from an average of 16% (*SD* = 12%) before the test to an average of 131% (*SD* = 47%) after the test. The average HR increased from an average of 74 bpm before the test to an average of 168 bpm after the test. The average SB increased from an average of 124 mmHg before the test to an average of 156 mmHg after the test. The average DB increased from an average of 73 mmHg before the test to an average of 76 mmHg after the test. The average RPE increased from a baseline average of 6 before the test to an average of 17.6 after the test.

Every average measure other than HLA was higher following the conclusion of the graded treadmill exercise test compared to the HIPT exercise test. HLA was 10.56 mmol at the conclusion of the graded treadmill exercise test and 12.99 mmol at the conclusion of the HIPT exercise test.

DISCUSSION

The purpose of this study was to compare a High Intensity Power Training exercise test and a graded treadmill exercise test on blood lactate accumulation, heart rate, blood pressure, and rating of perceived exertion in healthy college-aged males. It was hypothesized that the HIPT exercise test would cause an elevated blood lactate accumulation as well as a higher average heart rate, blood pressure, and RPE than the graded treadmill exercise test.

The results showed a higher blood lactate accumulation (%HLA) immediately following the HIPT exercise test (131%, *SD* = 47%) when compared to the final stage of the graded treadmill test. The large standard deviation with regard to the HIPT exercise test is likely due to a lack of experience with that type of training when compared to the graded treadmill test. Participants with more experience in HIPT training were likely more comfortable exerting themselves than participants with less experience, leading to a wider post-test HLA range when compared to the treadmill test. Heart rate, systolic blood pressure, and diastolic blood pressure were lower after the HIPT exercise than after the graded treadmill exercise test. It would be expected for heart rate, systolic blood pressure, and diastolic blood pressure to be higher post HIPT exercise test because of the resistance exercise. The measured response was likely lower than expected in this study due to a lack of participant experience with HIPT training.

In the study performed by Smith et al. (2013), a 10 week HIPT program significantly improved VO_2max and body composition. This was the first investigation to show that these benefits can be derived from HIPT. Smith et al. (2013) found that body fat decreased by 3.7 % following the 10 week HIPT program. The present study aimed to investigate additional exercise response measures following acute HIPT. Blood Lactate, systolic and diastolic BP, and

heart rate were investigated after acute HIPT exercise. With an increased percentage of HLA and lower cardiovascular response found immediately following the HIPT exercise test when compared to the graded treadmill test, it can be inferred that HIPT will cause a heightened long-term training response when the goal is to increase blood lactate tolerance with reduced cardiovascular strain. Future research should extend this observation to a 10 week training program to assess adaptation to HIPT.

In conclusion, the original hypothesis stated that the HIPT exercise test would yield higher levels for blood lactate accumulation, heart rate, blood pressure, and RPE, immediately post exercise when compared to a graded treadmill exercise test. The hypothesis was true only for HLA though not for any of the other dependant measures. Future studies should look at multiple individuals that have a high degree of experience with HIPT and possibly different HIPT circuits for comparison of results. Based on the results seen of the present study, it can be predicted that HIPT leads to an increased HLA with a lower cardiovascular stress.

Conditioning has always been a difficult but essential piece to high level performance. Though, often considered very difficult, it is necessary to devote a substantial amount of time to condition to perform at one's peak. Endurance athletes such as swimmers and mid-distance runners that draw a large amount or energy from fast glycolysis when competing could draw a large benefit from more efficient methods of metabolic conditioning. This information could be valuable to these athletes in order to obtain maximal efficiency in their training regimes. If less of their valuable training time is spent on conditioning, more time can be allocated toward other important components of training such as technique development and skill acquisition.

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