



# 2015 NSCA NATIONAL CONFERENCE RESEARCH ABSTRACT SUBMISSION & PRESENTATION GUIDELINES



### General Information

The National Strength and Conditioning Association (NSCA) is pleased to make a call for research abstract submissions for presentation at the 2015 National Conference. Research abstract presentations are an opportunity to present current research findings to researchers and strength and conditioning professionals at the NSCA National Conference. The research abstracts are the largest portion of the scientific programs presented every year at the National Conference. The NSCA encourages all researchers and NSCA students to submit their abstracts for consideration to the 2015 NSCA National Conference. More information and registration for the National Conference can be found online at:

[www.ConferenceAbstracts.com/NSCA2015.htm](http://www.ConferenceAbstracts.com/NSCA2015.htm)

### Submission Deadline

The abstract submission deadline is **Monday, March 2, 2015**.

### Notification

Submitting authors will receive notification of acceptance or rejection of their research abstract by **May 1, 2015**.

### Cost

Abstract submission fee is waived this year thanks to a grant from MusclePharm.

### Presentation Format

Research abstracts can be presented in either a poster or a podium format. Due to a limited number of available podium presentations, all requests for podium presentations cannot be accommodated.

### Presentation Dates

Podium and poster presentations occur on all three days of the conference (Thursday, July 9<sup>th</sup>; Friday, July 10<sup>th</sup>; and Saturday, July 11<sup>th</sup>). Podium presentations typically occur in the morning with poster presentations occurring over lunch.

### Publication of Abstracts

All accepted abstracts will be published in the full conference program book. The abstracts will not appear in the conference notebook. If you require a copy of your abstract for proof of presentation, you must purchase the full conference program book.

Accepted abstracts, that are presented, will be published as an electronic supplement to the *Journal of Strength and Conditioning Research*. The NSCA encourages all research abstract presenters to submit the completed manuscript of their presented research for consideration in the *Journal of Strength and Conditioning Research*.



## Research Abstract Submission Guidelines

- Abstracts may only be submitted online.
- Do not submit abstracts containing data currently in press. In the event that data contained in an accepted abstract is published (paper, electronic, or other format) prior to the National Conference, the abstract will be withdrawn.
- The first author of the research abstract is considered the *primary author* and must present the abstract. However, all authors must approve the abstract prior to submission.
- The *submitting author* is the author who submits the abstract. All correspondence regarding abstract presentation status and presentation type and time will be with the submitting author.
- One person may be the primary author on a maximum of two abstracts (only one may be submitted as a podium presentation).
- All abstract presenters must pay for their conference registration and all other fees associated with travel. Conference registration fee is separate from abstract submission fee.
- For questions, please e-mail the NSCA at [abstracts@nsca.com](mailto:abstracts@nsca.com).

## Subject Categories

There are ten (10) available categories for research abstracts:

1. Biochemistry / Endocrinology
2. Biomechanics / Neuromuscular
3. Body Composition
4. Endurance Training / Cardiorespiratory
5. Fitness / Health
6. Flexibility / Stretching
7. Nutrition / Ergogenic Aids
8. Resistance Training / Periodization
9. Special Populations
10. Speed / Power Development
11. Tactical Strength and Conditioning

## Use of Human and Animal Subjects

All research studies that include data recorded from human participants must comply with the Declaration of Helsinki and the US Department of Health and Human Services Policy for the Protection of Human Research Subjects (US Code, Title 45, Part 46 Protection of Human Subjects). All animal studies must comply with the Public Health Service Policy on Humane Care and Use of Laboratory Animals.

## Abstract Formatting Specifications

- All abstract submissions must be formatted correctly (see examples below) and include original research-based data to allow for a thorough review. Abstracts that do not meet these criteria will not be accepted.
- The body of the abstract cannot exceed 3,500 characters (including spaces) when there is no figure or table included. When there is a figure or table associated with the abstract, the text cannot exceed 3,000 characters (including spaces).



## Figures and Tables

- Abstracts can contain either one figure or one table, but not both. Abstracts submitted with more than one figure or table will have both images removed.
- Any figure or table must pertain to the abstract for the purpose of visualizing data and must be referred to in the text of the abstract. Graphs or tables that do not pertain to the abstract will be removed.
- Figures or tables must be concise. It is at the discretion of the NSCA if a graph or table is too big, and if so, it will be removed. Additional text that should be in the abstract may not be substituted in the graph or table.
- The resolution of the figure or table must be adequate for reprinting (i.e., = 150 dpi).
- Including a figure or table does not replace any of the required sections (i.e., Purpose, Methods, Results, etc.).
- No photos or pictures are allowed – only a graph or a table.
- The graph or table must be an image file (.jpg, .gif, .png are accepted). PDF and PowerPoint are not acceptable.

## Required Information

- Abstracts/submissions must contain the following:
  - Title (typed in ALL CAPS) cannot exceed 150 characters (including spaces).
  - Purpose, methods, results, conclusions, and practical applications. Acknowledgements should be included to denote funding sources or conflicts of interest when applicable.
- Abstracts/submissions cannot contain the following:
  - Brand names.
  - Advertising. Research abstracts should be non-biased, free from solicitations, and should not contain demonstrations of products for the purpose of sales.
  - Author(s) degrees (MS, PhD, etc) or credentials (CSCS, FNSCA, etc).
- The following information will be asked during the submission process:
  - All authors' names.
    - If the primary/ presenting author is submitting for award consideration, they must be an NSCA Member (professional or student).
  - All authors' primary institutions/ laboratories (institution/ laboratory name, city, state).
  - All authors' professional mailing address, e-mail address, and phone number.
  - Desired presentation format (i.e., podium, poster, or indifferent).
  - Abstract subject category.
  - If an NSCA Fellow was involved with the research study.
    - If so, the Fellow's NSCA Member number must be provided.
  - If the abstract is being considered for a Student Research Award (see below).



**Example Abstract with Graph or Table  
(2014 Undergraduate Student Outstanding Poster Presentation)**

**BARBELL DEADLIFT TRAINING INCREASES THE RATE OF TORQUE DEVELOPMENT AND VERTICAL JUMP PERFORMANCE IN NOVICES**

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The barbell deadlift is a multi-joint exercise that requires balance, strength, and the coordination of dozens of muscles. No previous studies have examined the effectiveness of barbell deadlift training when performed in the absence of other exercises. **PURPOSE:** The primary purpose of this investigation was to examine the effects of 10 weeks of barbell deadlift training on rapid torque characteristics for the leg extensors and flexors. A secondary aim was to analyze the relationships between training-induced changes in rapid torque and vertical jump performance. **METHODS:** Fifty-four previously untrained subjects (mean  $\pm$  SD age =  $23 \pm 3$  years) participated in this investigation, and were randomly assigned to a training (males,  $n = 17$ ; females,  $n = 17$ ) or control (males,  $n = 9$ ; females,  $n = 11$ ) group. The subjects in the training group were taught how to deadlift, and performed five sets of five repetitions twice per week. Each training session was closely supervised, and 0.45-2.2 kg was added to the barbell during each visit to the laboratory. All subjects performed maximal isometric strength testing of the left leg extensors and flexors, as well as maximal countermovement vertical jumps, before and following the intervention. Torque-time curves were used to calculate rate of torque development (RTD) values at peak and 50 and 200ms from torque onset. **RESULTS:** Barbell deadlift training induced significant pre to post increases of 18.8-49.0% for all rapid torque variables (Table 1). For the subjects in the training group, the largest effect size shown was for RTD at 50ms for the leg flexors (pre =  $199.6 \pm 94.6$ , post =  $297.5 \pm 98.8$   $\text{Nm}\cdot\text{s}^{-1}$  [Cohen's  $d = 1.01$ ]). Vertical jump height increased from  $46.0 \pm 11.3$  to  $49.4 \pm 11.3$  cm (Cohen's  $d = 0.30$ ) for the subjects in the training group, and these changes were correlated to improvements in RTD for the leg flexors ( $r = 0.30-0.37$ ). **CONCLUSIONS:** When performed in the absence of other exercises, 10 weeks of barbell deadlift training enhanced the rapid torque characteristics for both the leg extensors and flexors. Changes in rapid torque were associated with improvements in vertical jump height, suggesting a transfer of adaptations from deadlift training to an explosive, performance-based task. **PRACTICAL APPLICATION:** Since many activities of daily living require the legs, hips, and low back to function together in a coordinated manner during the act of picking up an object from the ground, the functionality of the barbell deadlift has implications for a variety of populations. Strength and conditioning professionals are encouraged to emphasize the barbell deadlift exercise when attempting to design training programs with the intent to develop explosive strength and/or jumping performance in novices.

**Table 1.** Mean  $\pm$  SD RTD and vertical jump height values, as well as % change and Cohen's  $d$  effect size statistics for the training subjects. There were no mean pre-post changes for the control group ( $P > 0.05$ ).

Muscle Group	Variable	Pre	Post	% Change	Cohen's $d$
Leg Extensors	RTDpeak ( $\text{Nm}\cdot\text{s}^{-1}$ )	$668.9 \pm 337.0$	$835.6 \pm 236.2^*$	25.0	0.57
	RTD50 ( $\text{Nm}\cdot\text{s}^{-1}$ )	$580.8 \pm 284.8$	$737.3 \pm 184.7^*$	26.9	0.65
	RTD200 ( $\text{Nm}\cdot\text{s}^{-1}$ )	$408.1 \pm 185.1$	$501.1 \pm 137.0^*$	22.8	0.57
Leg Flexors	RTDpeak ( $\text{Nm}\cdot\text{s}^{-1}$ )	$305.1 \pm 141.1$	$370.1 \pm 127.2^*$	21.3	0.48
	RTD50 ( $\text{Nm}\cdot\text{s}^{-1}$ )	$199.6 \pm 94.6$	$297.5 \pm 98.8^*$	49.0	1.01
	RTD200 ( $\text{Nm}\cdot\text{s}^{-1}$ )	$208.8 \pm 98.5$	$248.0 \pm 86.3^*$	18.8	0.42
	Vertical Jump Height (cm)	$46.0 \pm 11.3$	$49.4 \pm 11.3^*$	7.4	0.30

\* Denotes statistically significant ( $P < 0.05$ ) pre-post increase



## Podium Abstract Presentation Guidelines

- All podium abstract presentations must be prepared in Microsoft PowerPoint.
- All presenters are asked to bring their presentation (.ppt or .pptx) to the conference on a USB flash/jump drive, CD, or their own personal laptop.
- Presenters are asked to load their presentations onto the laptop (provided by the NSCA) and ensure the presentation displays properly **before 8:30 AM on the day of the presentation**
- All presenters should check in with their session's moderator prior to presenting
  - Moderators are assigned in 1-hour blocks (i.e., 9:00-10:00 AM, 10:00-11:00 AM, and 11:00-12:00 PM). So, for example, those who are scheduled to present between 10:00-11:00 AM should check-in with their moderator before 10:00 AM.
- Podium abstract presentations must be consistent with the contents of the accepted abstract: including an introduction, methods, results, conclusion, and practical applications section.
- Podium presentations are 10-12 minutes in duration with 3-5 minutes of questions from the audience and responses from the presenter.



Example Podium Presentation (Selected Slides)\*  
2014 Doctoral Student Outstanding Podium Presentation

University of Salford  
NANCHESTER

NSCA

## RELATIONSHIPS BETWEEN MEDIAL GASTROCNEMIUS TENDON STIFFNESS AND LOWER LIMB STIFFNESS DURING UNILATERAL HOPPING

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NSCA National Conference  
Thursday 10<sup>th</sup> July 2014

### Introduction

Medial gastrocnemius (MG) tendon stiffness is traditionally measured during maximal voluntary isometric contraction (MVIC) of the plantarflexors (Burgess et al., 2009).

It has been shown to be related to lower limb stiffness (i.e. leg stiffness ( $K_{leg}$ ) and ankle stiffness ( $K_{ankle}$ )), which is quantified during stretch-shortening cycle (SSC) activities (Kubo et al., 2007; Rabit et al., 2008).

This may be due to lower achievable tendon forces (Muraoka et al., 2005) and bad rates (Gentil et al., 2011) during plantarflexion MVIC.

### Purpose

Unilateral hopping performed across a variety of frequencies allows for a range of MG tendon forces and load rates to be achieved (McMahon et al., 2013).

Therefore, the purpose of this study was...

To explore relationships between MG tendon stiffness and lower limb stiffness (i.e.  $K_{leg}$  and  $K_{ankle}$ ) during unilateral hopping.

### Methods

Subjects

10 resistance trained males gave informed consent ( $26.3 \pm 8.5$  years,  $181.9 \pm 4.8$  cm,  $86.4 \pm 10.7$  kg)

Procedures

Three unilateral hopping trials

- At 2.0, 2.5 & 3.0 Hz
- 15 seconds per trial
- Randomised order

Plantarflexion and dorsiflexion MVICs

- Performed after hopping
- Ramped contractions

### Methods

Figure 1: The muscle-tendon model used to determine MG tendon length. (Pukrajaga et al., 2001)

### Results

Table 1 - Comparison of temporal, kinetic and kinematic variables across the three hopping frequencies.

	2.0 Hz	2.5 Hz	3.0 Hz
Flight Time (ms)	207 ± 2.9	20.6 ± 2.9 <sup>a</sup>	21.0 ± 4.1 <sup>ab</sup>
Ground Contact Time (ms)	21.7 ± 1.0	19.4 ± 2.6 <sup>a</sup>	19.0 ± 2.0 <sup>ab</sup>
Ground Contact Time (ms)	21.0 ± 1.3	23.0 ± 1.0 <sup>a</sup>	20.8 ± 1.2 <sup>ab</sup>
Flight Time (ms)	21.0 ± 1.7	17.2 ± 2.2 <sup>a</sup>	1.21 ± 1.6 <sup>ab</sup>
Max Height (cm)	2.2 ± 0.2	1.2 ± 0.4 <sup>a</sup>	1.0 ± 0.2 <sup>ab</sup>
Peak VGRF (N)	1023 ± 20.8	1027 ± 23.2	1020 ± 23.8 <sup>ab</sup>
Peak Leg Compression (Nm)	2.7 ± 0.0	2.8 ± 0.4	4.2 ± 0.4 <sup>ab</sup>
Peak Ankle Moment (Nm)	21.0 ± 3.6	22.8 ± 2.2	1.01 ± 2.4 <sup>ab</sup>
Ankle Angular Displacement (deg)	23.0 ± 2.8	17.3 ± 2.2 <sup>a</sup>	11.0 ± 2.0 <sup>ab</sup>
Ankle Translation Angle (deg)	102.3 ± 4.2	102.3 ± 2.7	102.7 ± 7.3

Each value represents mean ± SD.  
<sup>a</sup> Significant difference ( $p < 0.05$ ) from 2.0 Hz.  
<sup>ab</sup> Significant difference ( $p < 0.05$ ) from 2.5 Hz.

### Results

Figure 2: Mean MG tendon force-elongation relationship at 60-100% peak MG tendon force.

### Conclusions

- MG tendon stiffness showed moderate-high inverse relationships with both  $K_{leg}$  and  $K_{ankle}$ , as measured during functional SSC task (i.e. unilateral hopping).
- There was no correlation between MG tendon stiffness when measured during plantarflexion MVIC and both  $K_{leg}$  and  $K_{ankle}$ .
- Greater MG tendon stiffness was associated with larger tendon forces and higher tendon load rates.

### Practical Applications

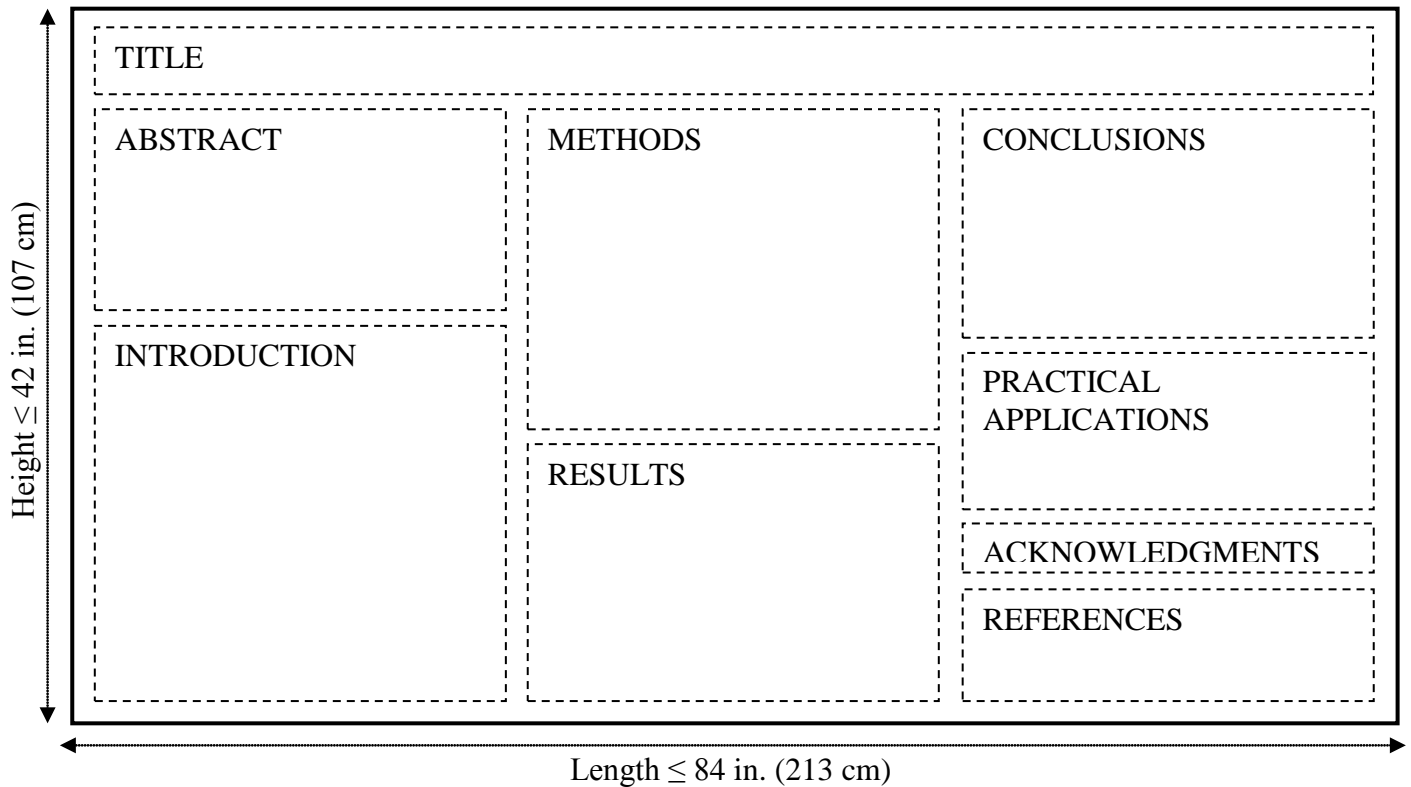
- The relationships observed in the present study, highlight the importance of quantifying MG tendon stiffness during the performance of the task for which lower limb stiffness has been determined.
- This would lead to more accurate interpretation of results derived from lower limb muscle-tendon research and thus, in turn, better application to performance, rehabilitation and training.

\*Due to space limitations, this example contains selected slides from a larger presentation.



## Poster Abstract Presentation Guidelines

- All poster presentations should be printed on one uniform poster sheet with dimensions not exceeding 42 × 84 in. (107 × 213 cm). Unless otherwise noted, the poster boards on which the posters are hung are 48 × 96 in. (122 × 244 cm).
- Presenters are required to supply their own thumb tacks by which to hang their posters.
- Poster abstract presentations must be consistent with the contents of the accepted abstract: including an introduction, methods, results, conclusion, and practical applications section.
- The Research Committee recommends the following layout as a general guideline for all poster presentations:







Example Poster Presentation (2014 Doctoral Student Outstanding Poster Presentation)

SUSTAINABILITY, PHYSIOLOGICAL, AND PERCEPTUAL RESPONSES AT THE CRITICAL HEART RATE DURING TREADMILL RUNNING

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Abstract

The mathematical model used to estimate critical power (CP) has been applied to heart rate (HR) measurement during cycle ergometry to derive a fatigue threshold called the critical heart rate (CHR). Theoretically, the CHR represents the maximal HR that can be sustained for an extended period of time without fatigue (FATIGUE). This study examined the time to exhaustion (T\_ex) as well as metabolic (V\_O2max, anaerobic work capacity, EMG AMP and EMG mean power frequency (MPF)), and perceptual (rating of perceived exertion, RPE) responses to constant HR treadmill running at the CHR. METABOLISM: Thirteen moderately trained runners (mean ± SD age: 23.7 ± 3.3 yr) performed an incremental treadmill test to exhaustion for the determination of the HR\_CR, V\_O2max and V\_O2max%peak as well as the velocity associated with V\_O2max (v\_VO2max). On separate days, 4 constant velocity runs (V = 80%, 85%, 90%, 95%) to exhaustion were performed. The total number of heartbeats was plotted against the time to exhaustion (T\_ex) for each of the 4 constant velocity runs. The V\_O2max, EMG AMP, EMG MPF, and RPE responses as well as changes in velocity were recorded during constant runs at the CHR that were performed to exhaustion to terminate at 60 min. The relationship for V\_O2max, HR, RPE, EMG AMP, EMG MPF, and velocity versus time were examined using polynomial regression models (third and quadratic) at an alpha level of p < 0.05. RESULTS: During the CHR runs (V = 80% v\_VO2max), the velocity was constant within 3.2 ± 0.7 min (1.8 ± 1.0 m/s) and 7 of the 11 subjects terminated exercise for 60 min (T\_ex = 80.17 ± 22.07 min). The polynomial regression analyses for the mean responses during the constant runs at CHR indicated there was no change in HR (r^2 = 0.02), but moderate decreases in velocity (R^2 = 0.52) and V\_O2max (R^2 = 0.79), large increases in EMG AMP (r^2 = 0.82) and RPE (r^2 = 0.88), and no change in EMG MPF (r^2 = 0.01). CONCLUSIONS: This study indicated that average CHR represented a sustainable maximum of 30 to 60 min running intensity. During fatigue constant HR running, V\_O2max responses tended velocity, but were dissociated from HR and EMG AMP, which remained stable, as well as EMG MPF, which remained stable. The decrease in V\_O2max throughout the run at a constant HR suggested that fatigue was not related to O2 availability. The increase in EMG AMP likely reflected the fatigue-induced recruitment of additional motor units and increase in firing rate (1). It is possible that the non-significant change in the frequency domain was the result of a balance between factors that tend to increase EMG MPF (i.e., increases in muscle temperature and recruitment of additional motor units) and those that tend to decrease EMG MPF (i.e., the fatigue-induced reduction in activation conduction velocity due to the accumulation of metabolites and ions). PRACTICAL APPLICATIONS: The results of the present study indicated that EMG AMP and RPE responses, but not V\_O2max or EMG MPF could be used as indicators of fatigue during constant HR running. In addition, the current findings suggested that a threshold based on the response of a physiological parameter, such as HR, could be used to estimate the highest sustainable exercise intensity, and would provide a useful intensity for fitness assessment and training purposes. ACKNOWLEDGEMENTS: This study was funded by the 2013 National Strength and Conditioning Association Doctoral Student Research Grant.

Introduction

The critical power (CP) and critical velocity (CV) tests relate the amount of work accomplished for work limit (Wlim) or total distance covered (TD), respectively, and the time to exhaustion or time limit (T\_ex) from a series of four or five constant velocity runs with decreasing velocities (V) ranging from 0.75 to 1.25 times the CV (2,3). The slope of the Wlim versus T\_ex relationship of the CP test and the slope of the TD versus T\_ex relationship of the CV test (4,5). Theoretically, CP and CV represent the asymptote of the power output or velocity versus duration relationship for cycle ergometry and treadmill running, respectively, and can be maintained for an extended period of time (i.e., 30-60 min) without exhaustion (4). Although CP and CV are expressed as a power output or velocity, they are characterized by specific physiological responses (i.e., V\_O2max and blood lactate). For example, it has been suggested (6) that CP represents the highest exercise intensity where V\_O2max and blood lactate each steady state values and has been used to determine the heavy from severe exercise intensity domain (Steeles (6)) have shown, however, that constant exercise at CP and CV resulted in progressive increases in metabolic parameters and/or recruitment of additional motor units (7) and were similarly domains.

Recently, Middle et al. (8) proposed that the CP model, applied to a physiological parameter such as HR, would provide a better estimation of the highest sustainable steady state intensity. Therefore, Middle et al. (8) developed a HR model to the CP test (called the critical heart rate (CHR) test). For this test, four exercise, constant power output rates were performed and the total number of heartbeats (HR\_tot) was calculated for each power output. The HR\_tot was plotted against the time to exhaustion (T\_ex) and the slope of the line was CHR. Thus, CHR represented a physiological intensity that, theoretically, could be sustained for an extended period of time (9).

Although the mathematical model used to estimate CP has been applied to HR measurements during cycle ergometry (9) to derive the CHR, no previous studies have applied a physiological parameter to the CV model during treadmill running. It is possible that using a threshold based on a physiological response (such as HR) would provide a better estimate of a sustainable running intensity (9) that results in physiological responses that differ from those of exercise performed at a constant work rate (5,9). Therefore, the purpose of this study was to examine the time to exhaustion (T\_ex) as well as metabolic (V\_O2max, anaerobic work capacity, electromyographic amplitude, EMG AMP and EMG mean power frequency (MPF)), and perceptual (rating of perceived exertion, RPE) responses to constant treadmill running at the CHR.

Methods

Thirteen moderately trained runners (7 males and 6 females; mean ± SD age = 23.7 ± 3.3 yr, height = 173 ± 9 cm, weight = 72 ± 11 kg) were recruited for this study. This study was approved by the University Institutional Review Board for Human Subjects and all subjects completed a health history questionnaire and signed a written informed consent document before testing.

Incremental treadmill test: Eighteen subjects were collected and analyzed during the incremental treadmill test using a calibrated treadmill (Ludox 4400; American College of Sports Medicine, St. Louis, MO). The V\_O2max was expressed as 20 x average HR. The HR was recorded with a Polar Heart Rate Monitor that was synchronized with the metabolic cart and expressed as 20 x average HR. The EMG signals were recorded from a wireless bipolar surface electrode configuration (2,3) on each electrode connected to the system (12). The V\_O2max was defined as the highest 20 x average V\_O2max recorded during the test. The velocity was plotted against V\_O2max and the regression equation used to determine the v\_VO2max. The HR\_CR was defined as the 20 x average HR value associated with v\_VO2max and the HR\_CR was defined as the RPE taken at the end of the 1st full min completed during the test. The EMG AMP and MPF were the 10 x average associated with v\_VO2max.

Constant velocity runs: Runners randomly ordered treadmill runs at velocities ranging from 70-100% of the v\_VO2max were performed on separate days and HR values were continuously measured and recorded as 5 x averages. For each velocity, the total number of heartbeats (HR\_tot) was calculated as the product of the average HR (8 runs) and time to exhaustion (T\_ex). For each velocity, the HR\_tot was plotted as a function of the T\_ex. The CHR was defined as the slope coefficient of the regression line between HR\_tot and T\_ex (Figure 1).

Statistical Analysis: Each variable (V\_O2max, HR, EMG AMP, EMG MPF, and RPE) recorded during the constant HR runs was normalized as a percentage of the values of V\_O2max and time was normalized as a percentage of T\_ex. Elevator data points (80, 85, 90, 95, 100, 105, 110, 115, 120, and 125% of V\_O2max) were used for all analyses. The relationships for the normalized V\_O2max, HR, EMG AMP, EMG MPF, and RPE versus constant time were examined using polynomial regression models (third and quadratic) at an alpha level of p < 0.05.

Results: The mean ± SD and range of peak values for each variable (V\_O2max, v\_VO2max, HR\_max, AMP\_max, MPF\_max, and RPE\_max) for the incremental test are included in Table 1. The T\_ex and velocities for the constant velocity runs used to generate the CHR values ranged from 1:09 to 2:25 min and 70-100% v\_VO2max, respectively. The r^2 values for the HR vs. T\_ex relationship ranged from 0.999-1.000. The mean CHR occurred at 173 ± 8 beats/min and represented a mean of 0.1 ± 0.1% of HR\_max.

During the CHR run, the subjects reached the selected HR within 3:24 ± 6.77 min (1.16 m/s) and the T\_ex was 80.17 ± 22.07 min (Table 2). The mean percent change (%Δ) from the time CHR was reached to the end of the run for V\_O2max, HR, EMG AMP, EMG MPF, and RPE were -14.1%, -23.1%, -2.9%, 14.3%, 23.1%, 1.9%, and 21.2%, respectively. The polynomial regression analyses for the mean responses during the constant runs at CHR indicated there was no change in HR, but moderate decreases in velocity and V\_O2max. There was also change, there were large increases in RPE and EMG AMP, but no change in EMG MPF (Figure 2).

Conclusions: A sustainable heart of constant exercise has been operationally defined by T\_ex values of 30 to 60 min (4,11). In the present study, the T\_ex values at CHR reflected the time that subjects were able to maintain the selected HR. The mean findings showed that all but 1 of the 11 subjects completed at least 30 min, and 7 subjects completed the 60 min work limit (T\_ex = 60.97 ± 22.07 min). This study indicated that on average, CHR represented a sustainable maximum of 30 to 60 min running intensity. During the CHR runs, V\_O2max decreased velocity, but were dissociated from HR and EMG AMP, which remained stable, as well as EMG MPF and RPE, which increased. The decrease in V\_O2max throughout the run at a constant HR suggested that fatigue was not related to O2 availability. The increase in EMG AMP likely reflected the fatigue-induced recruitment of additional motor units and increase in firing rate (1). It is possible that the non-significant change in the frequency domain was the result of a balance between factors that tend to increase EMG MPF (i.e., increases in muscle temperature and recruitment of additional motor units) and those that tend to decrease EMG MPF (i.e., the fatigue-induced reduction in activation conduction velocity due to the accumulation of metabolites and ions).

Practical Applications: Exercise prescription for aerobic training programs are often based on HR (10), which is linearly related to V\_O2max during incremental exercise. Currently, the American College of Sports Medicine (ACSM) (12) recommends vigorous (77-93% HR\_max or 64-90% V\_O2max) aerobic exercise for 30 to 60 min to provide the greatest stimulus to improve cardiovascular fitness. During the constant HR runs in the present study, however, V\_O2max was dissociated from HR and decreased 14% throughout the run. Thus, exercise prescribed as a percentage of HR\_max may not result in V\_O2max response within the vigorous intensity range for the duration of the work limit. Therefore, the actual HR should be prescribed at a relative intensity that is high enough to maintain the V\_O2max within the desired range, but low enough to be sustained for at least 30 min. In the present study, the V\_O2max (70-100% v\_VO2max) during the run at the CHR (91 ± 3.3% HR\_max) were within the most associated with vigorous intensity exercise (64-90% V\_O2max) and could be maintained for 30 to 60 min. These findings indicated that the CHR model may provide a useful threshold for prescribing vigorous intensity exercise to improve cardiovascular fitness among previously trained individuals (12). The advantage of prescribing exercise intensity based on the CHR, rather than a percentage-based HR, may be that the CHR is determined from individual HR responses to continuous exercise. Thus, the CHR provides a HR that is high enough to maintain a vigorous intensity V\_O2max, but low enough to be sustained for at least 30 min for each individual.

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2. Was the introduction / literature review sufficient and relevant?
3. Was the study well designed?
  - a. Was the purpose clearly stated?
  - b. Did the methodology address the research question?
  - c. Were the statistical procedures appropriate?
  - d. Were the conclusions valid based on the results of the study?
4. What was the scientific impact of the research?
5. How well did the student *bridge the gap* with the practical application section?