

UNIVERSITY OF WISCONSIN-LA CROSSE

Graduate Studies

RATING OF PERCEIVED DRIFT DURING STEADY STATE  
TREADMILL EXERCISE

A Manuscript Style Thesis Submitted in Partial Fulfillment of the Requirements for the  
Degree of Master of Science

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College of Science and Allied Health  
Clinical Exercise Physiology


December, 2011

RATING OF PERCEIVED EXERTION DRIFT DURING STEADY STATE  
TREADMILL EXERCISE


By Lee J Walraven

We recommend acceptance of this thesis in partial fulfillment of the candidate's requirements for the degree of Master of Science, Clinical Exercise Physiology


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## ABSTRACT

Walraven, L. J. Rating of perceived exertion drift during steady state treadmill exercise. MS in Clinical Exercise Physiology, December 2011, 43pp. (C. Foster)

The ability to prescribe and monitor exercise can be a difficult task for fitness professionals. Previous studies have shown a drift upward in Rating of Perceived Exertion (RPE) during prolonged exercise. The purpose of this study was to examine the use of the Talk Test (TT) to prescribe exercise and the effect on RPE over a 60 minute trial. Twelve subjects performed three exercise trials at last positive-1 (LP-1), last positive (LP), and equivocal (EQ) intensities, according to incremental TT responses. During each trial heart rate (HR), lactate (HLA), RPE, and TT score were recorded every ten minutes, along with a session RPE score 30 minutes following the exercise trial. HR, HLA, RPE, and TT score were all significantly higher in the EQ trial compared to the LP and LP-1 trials. Session RPE and mean RPE were significantly higher in the EQ trial compared to the LP-1 and LP trials. There was no significant difference between HR, HLA, RPE, session RPE, mean RPE, or TT between the LP-1 and LP trials. This study concluded that exercise can be safely prescribed and monitored using the TT when exercise intensities are prescribed from the LP and LP-1.

## ACKNOWLEDGMENTS

I would like to begin by expressing my sincere thanks to Dr. Carl Foster, my thesis chairperson. Without his intellect and guidance this process would not be possible. His enthusiasm for research showed daily and made the process more gratifying.

Secondly, I would like to thank my thesis committee, Dr Richard Mikat and Russ C. Hendrix. Dr. Mikat's hours spent fixing my errors and helping me analyze the statistical data. Along with Russ whose continued humor helped make this process enjoyable.

Next I would like to thank all of the people that continued to support me through the entire process from my friends to the amazing participants in the LEHP program. The jokes and humor shared between us kept me from becoming overly stressed and kept me grounded throughout my time here.

Lastly, I would like to thank my family. The amount of support they gave me through this process is something they will most likely never truly realize. Allowing me to work through this degree and showing me their continued love will forever be remembered. Their continued support throughout my life is a daily reminder of their love.

## TABLE OF CONTENTS

	PAGE
ABSTRACT.....	iii
ACKNOWLEDGEMENTS.....	iv
LIST OF FIGURES.....	vi
LIST OF APPENDICES.....	vii
INTRODUCTION.....	1
METHODS.....	4
Experimental Approach to the Problem.....	4
Subjects.....	4
Table 1. Subject descriptives by sex and group.....	5
Procedures.....	5
Statistical Analysis.....	6
RESULTS.....	6
DISCUSSION.....	11
PRACTICAL APPLICATIONS.....	13
APPENDICES.....	16

## LIST OF FIGURES

FIGURE		PAGE
1.	Heart rate across time by trial. Heart rates were significantly higher ( $p < .001$ ) during the EQ trial.....	7
2.	Blood lactates across time by trial. Blood lactates were significantly higher ( $p = .018$ ) during the EQ trial.....	8
3.	Talk Test score across time. Talk Test scores were significantly higher ( $p < .001$ ) during the EQ trial.....	8
4.	RPE (Borg-CR10) rating across time. RPE ratings were significantly higher ( $p < .001$ ) during the EQ trial.....	9
5.	Mean RPE compared to Session RPE rating at the end of each trial. There was no significant difference between ratings.....	10
6.	Session RPE after each trial. Session RPE was significantly higher ( $p < .001$ ) for the EQ trial.....	10

## LIST OF APPENDICES

APPENDIX	PAGE
A. Informed Consent.....	17
B. Rating of Perceived Exertion.....	20
C. Pledge of Allegiance.....	22
D. Review of Literature.....	24

## INTRODUCTION

There is currently a world-wide epidemic of obesity which can largely be attributed to sedentary lifestyles. A health professional who works with less-active adults can find prescribing exercise to be challenging. The American College of Sports Medicine (ACSM) recommends an exercise intensity of between 40 and  $\leq 84\%$  of oxygen uptake reserve or heart rate reserve (HRR), or between 64/76 to  $\leq 94\%$  of maximum heart rate ( $HR_{MAX}$ ) (2). To prescribe exercise in this range the fitness professional normally needs some type of graded exercise test to know the maximal level of exercise the person can achieve. However exercise tests are expensive and can sometimes pose a health risk to the participant (which requires the presence qualified health professional at the graded exercise test). These factors can increase the cost of a graded exercise test and can provide a barrier to exercise training.

The ideal approach to solve this problem is to create a subjective method of prescribing exercise that is valid and comparable to objective means of prescribing exercise. Subjective exercise methods may reduce the cost of prescribing exercise and make prescribing exercise easier. Some examples of subjective means of exercise prescription are the Rating of Perceived Exertion (RPE) and the Talk Test (TT). Both have been shown to be valid markers of exercise intensity and have key markers that are comparable to objective measures (9-12). Webster and Aznar et al. (21) discussed the TT and its application in a recent issue of the *ACSM's Health and Fitness Journal*. The journal is read by many health professionals working with the obese and sedentary population thus showing the increasing acceptance of the TT.

One method of subjective exercise prescription is the TT (8,11,12). The TT is a method of prescribing exercise based on how comfortably the participant can speak during exercise. The method has been shown to be a valid form of exercise prescription in healthy populations as well as populations with coronary artery disease (CAD) (3,4,11). The participant exercises while reciting a standard paragraph and chooses one of three options: I can speak comfortably; I am unsure; or I cannot speak comfortably. These three markers are then labeled last positive (I can speak comfortably), equivocal (I am unsure), and negative (I cannot speak comfortably) (3,5,8). These options correspond to physiological markers of exercise intensity with last positive (LP) being below ventilatory threshold (VT), equivocal (EQ) corresponding to the (VT), and negative (NEG) corresponding to the respiratory compensation threshold (RCT) (11,17-20). To prescribe exercise for sedentary individuals the last positive-1(LP-1) is typically used. This is the stage before the last stage that the participant was able to speak clearly. LP-1 has been shown to be suitable for exercise prescription (5,12,20). LP-1, LP, and EQ have been shown to correlate well with  $64-94\%HR_{MAX}$ , (15) which is within previously mentioned exercise prescription guidelines (2). Jeanes et al. (15) had participants exercise for 40 minutes based on their TT response. She was then able to show that the exercise prescription had the participant within the ACSM's guidelines for exercise prescription. Since these methods are simple the TT becomes an easy and efficient method to prescribe exercise for the sedentary individual.

Session RPE is another subjective method of prescribing exercise by measuring exercise intensity. Session RPE is a variation of the momentary RPE method. Momentary RPE rates exercise intensity at a specific time and does not measure overall

intensity for the full exercise session. Session RPE is not recorded until approximately 30 minutes after the exercise period has concluded and represents the exertion for the entire bout of exercise (9,10). Session RPE has been shown to be a valid method of monitoring exercise (9,10).

Attempts to show the validity of the session RPE method to quantify training sessions have been the subject of previous studies (10,14). Ozkan et al. (2007) studied the reliability of regulating exercise during a step dance class. The study was designed to have the participants regulate their exercise intensity using the RPE method. The outcome from the study showed that intensity was difficult to regulate using RPE during step dance classes, but was still a reliable method of monitoring exercise intensity (16). Another finding was that RPE drifted upwards as exercise duration increased (16).

Lastly since session RPE is a subjective measure of exercise exertion and based on a participant's perception of intensity it is fundamental to educate participants on RPE and its function in exercise. Research has shown that RPE during moderate intensity exercise is affected by psychological disposition (13). When exercise reaches the high intensity level rating intensity becomes difficult to differentiate between hard, very hard and maximal (13). This is important when prescribing because most of the initial exercise will be in the low to moderate range. Understanding that RPE will be easier to rate at moderate levels of exercise intensity but having the TT to monitor exercise that is based on physiological markers (9,10,17,19) could make the combination of RPE and the TT a valid form of exercise prescription. It was hypothesized that RPE would not drift upwards when the subject exercised at LP-1 and LP.

## **METHODS**

### **Experimental Approach to the Problem**

The purpose of the study was to address the issue of RPE drift during prolonged exercise, while participants are exercising according to TT guidelines of exercise intensity (last positive -1 (LP-1), last positive (LP), and equivocal (EQ)). Along with RPE changes this study also assessed how session RPE was affected by the use of the TT to prescribe exercise.

### **Subjects**

Twelve physically active individuals (Table 1) participated in the study. To determine if a participant was in good health the subject completed a health history questionnaire developed by the ACSM and the American Heart Association (1). Each participant provided written informed consent before participating in the study and the protocol was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects.

Table 1. Subject descriptives (mean±SD) by sex and group.

	Men (n=6)	Women (n=6)	Total (n=12)
Age	22.3 ± 2.5	20.3 ± 1.0	21.3 ± 2.1
Height (cm)	184.15 ± 6.17	168.91 ± 7.32	176.50 ± 10.2
Weight (kg)	82.43 ± 10.05	61.60 ± 4.16	72.0 ± 13.1
VO <sub>2max</sub> (ml/kg/min)	55.40 ± 3.77	46.52 ± 5.16	51.0 ± 6.3
VO <sub>2</sub> (L/min) @ VT	3.00 ± 0.31	2.22 ± 0.38	2.60 ± 0.5
VO <sub>2</sub> (L/min) @ RCT	3.54 ± 0.4	2.56 ± 0.35	3.10 ± 0.6
HR <sub>MAX</sub>	187.2 ± 13.8	189.5 ± 11.1	188.3 ± 12.0
HR @ VT	156.7 ± 5.1	162.3 ± 12.4	159.5 ± 9.5
HR @ RCT	172.0 ± 8.6	175.7 ± 9.7	173.8 ± 9.0

### Procedures

The subjects performed two graded exercise tests on a treadmill to assess exercise capacity and to prescribe exercise intensities. The test used a Modified Balke protocol. The subjects choose a brisk walking pace of either 3.5 or 4.0 mph. During the first graded exercise test respiratory gas exchange was used to measure oxygen uptake (VO<sub>2MAX</sub>) and the VO<sub>2</sub> at VT and RCT (6). Following the first graded exercise test (GXT) the subjects performed a second (GXT) using the TT with the same protocol as the first (GXT). The TT was used to estimate markers of exercise intensity (VT & RCT) according to previous methods (11,17) with at least 48 hours between trials.

Following the graded exercise tests, each subject was prescribed exercise intensities (LP-1, LP, EQ) based on their TT response. Subjects exercised at each prescribed intensity for 60 minutes with at least 48 hours between trials. Each trial began with an incremental warm-up during the first ten minutes to reach the prescribed

intensity. Heart rate (radiotelemetry), blood lactate (Lactate Plus Meter), RPE (Borg CR-10) rating, and TT score(yes=1, yes/no=2, no=3) were analyzed prior to the start of the exercise trial and then during the last minute of each 10 minute increment for each exercise trial. Each subject's session RPE rating was recorded 30 minutes after each trial.

### **Statistical Analysis**

Repeated measures ANOVA was used to compare heart rate, lactate, RPE, and TT score response at rest, 10, 20, 30, 40, 50, and 60 minutes of each training bout. Bonferoni corrected paired t-tests were used to measure significance when justified by ANOVA. Alpha was set at ( $p < .05$ ) for the repeated measures ANOVA and ( $p < .017$ ) for the Bonferoni corrected paired t-test for statistical significance.

## RESULTS

Heart rate, blood lactate, RPE, and TT response was recorded every 10 minutes. Heart rate drift was analyzed for significance during time in trial. Mean resting heart rate was  $80(\pm 11)$  bpm). There was no statistically significant difference in heart rate between the LP-1 and LP trials for time in trial. Heart rate was significantly higher in the EQ trial ( $p < .001$ ) than in the LP-1 and LP time in session (Figure 1).

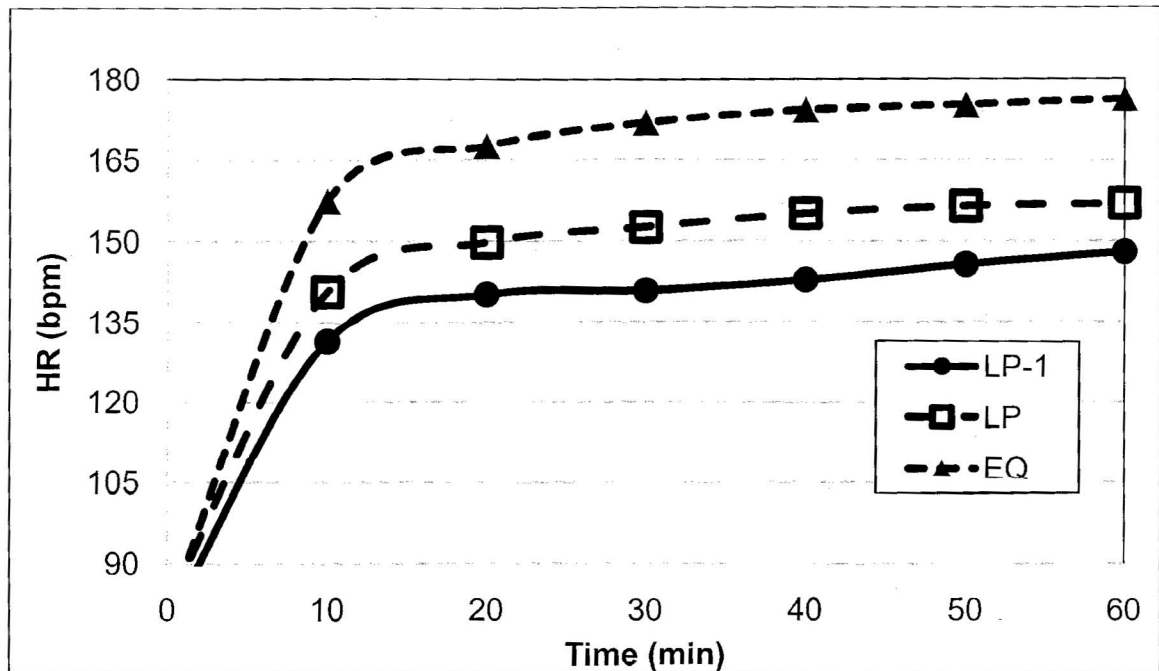


Figure 1. Heart rate across time by trial. Heart rates were significantly higher ( $p < .001$ ) during the EQ trial.

Blood lactate concentration was measured mean resting lactate concentrations was  $1.6 (\pm 0.7)$   $\text{mmol}\cdot\text{L}^{-1}$ ). There was no significant difference in blood lactate between the LP-1 and LP trials when analyzed for time in trial. Lactate was significantly higher in the EQ trial ( $p = .018$ ) than in the LP-1 and LP for time in trial (Figure 2). Talk Test scores were recorded during each 10 minute stage for each trial. There was no difference in TT

scores between LP-1 and LP for time in trial. Talk Test scores were significantly higher in the EQ trial ( $p < .001$ ) than in the LP-1 and LP trials for time in trial (Figure 3).

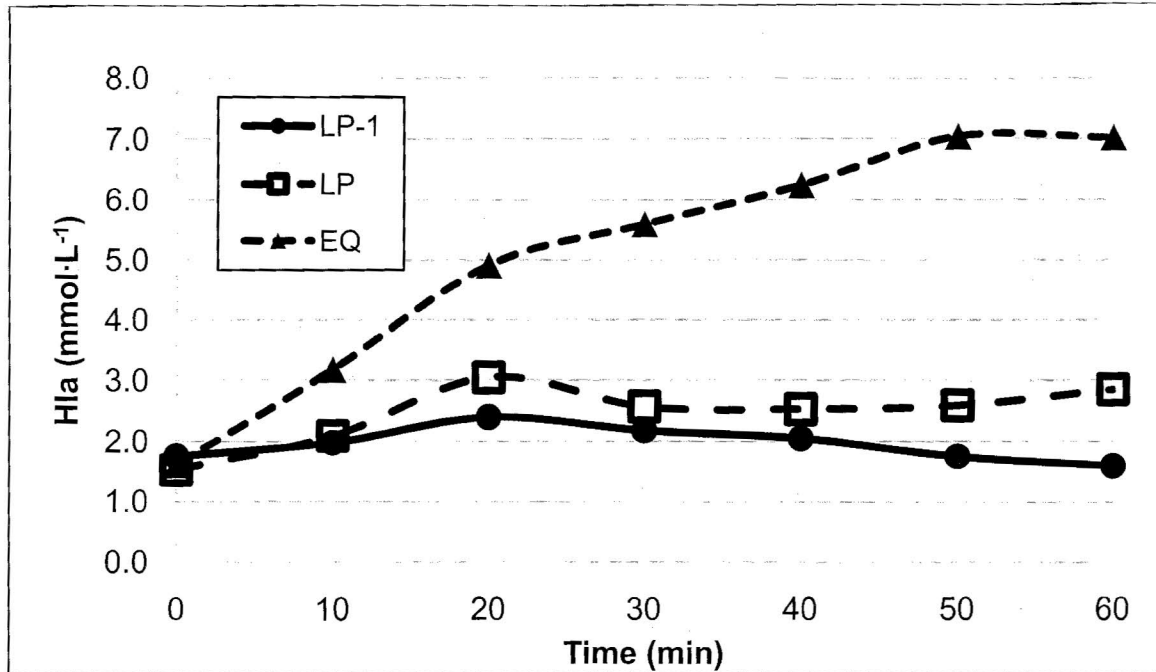


Figure 2. Blood lactates across time by trial. Blood lactates were significantly higher ( $p = .018$ ) during the EQ trial.

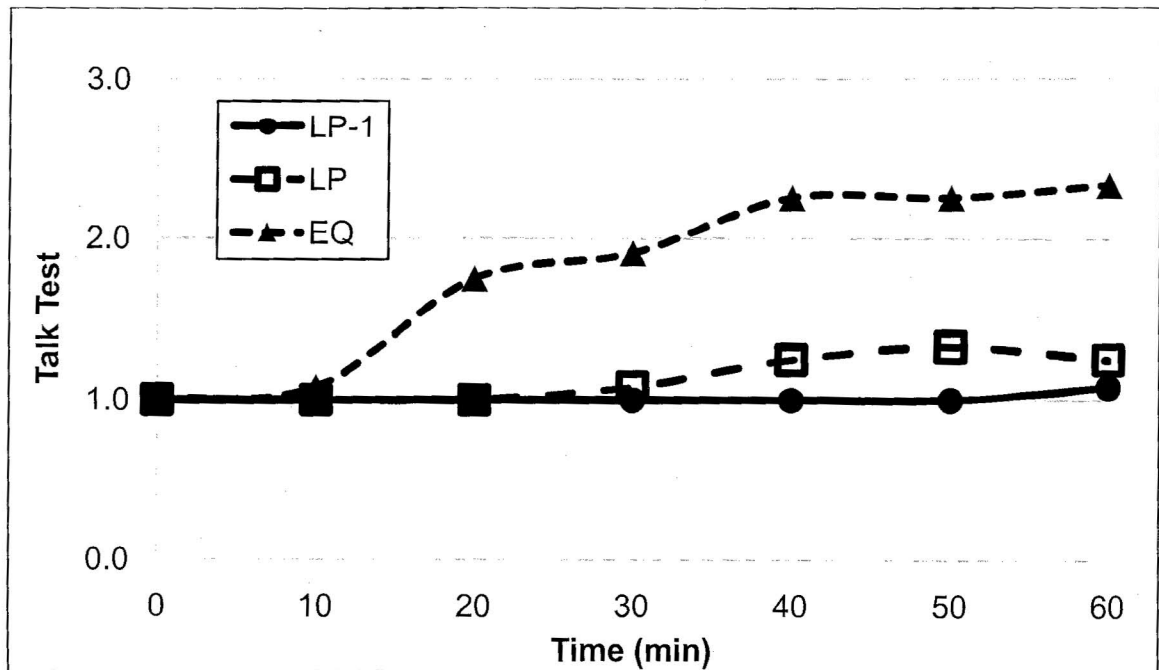


Figure 3. Talk Test score across time. Talk Test scores were significantly higher ( $p < .001$ ) during the EQ trial.

Rating of perceived exertion was measured during each trial was analyzed for significant drift in rating. There was no significant difference in RPE ratings between LP-1 and LP trials along time. RPE ratings were significantly higher in the EQ trial ( $p<.001$ ) than in the LP-1 and LP trials when analyzed for time in trial. (Figure 4). RPE measured during time in trial was computed to give the mean RPE for the entire session. Mean RPE was not significantly different from the session RPE ratings for any of the three intensities. The mean RPE was not significantly different between the LP-1 ( $3.4\pm0.9$ ) and LP ( $4.1\pm1.2$ ) trials. The mean RPE was significantly higher in the EQ trial ( $6.0\pm1.3$ ) ( $p<.001$ ) than in the LP-1 and LP trials (Figure 5 & Figure 6). Session RPE for the LP trial ( $3.8\pm0.8$ ) was not significantly different than the LP-1 trial ( $3.2\pm0.8$ ). Session RPE for the EQ trial ( $6.5\pm2.0$ ) was significantly higher ( $p<.001$ ) than the LP and LP-1 trials (Figure 6).

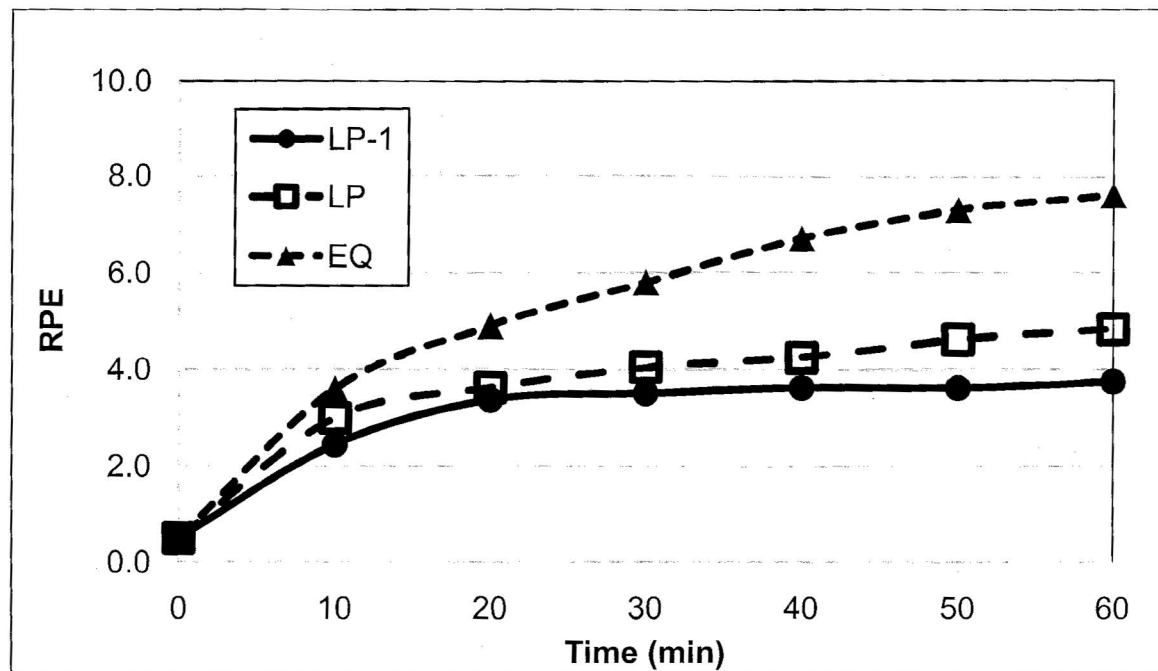


Figure 4. RPE (Borg-CR10) rating across time. RPE ratings were significantly higher ( $p<.001$ ) during the EQ trial.

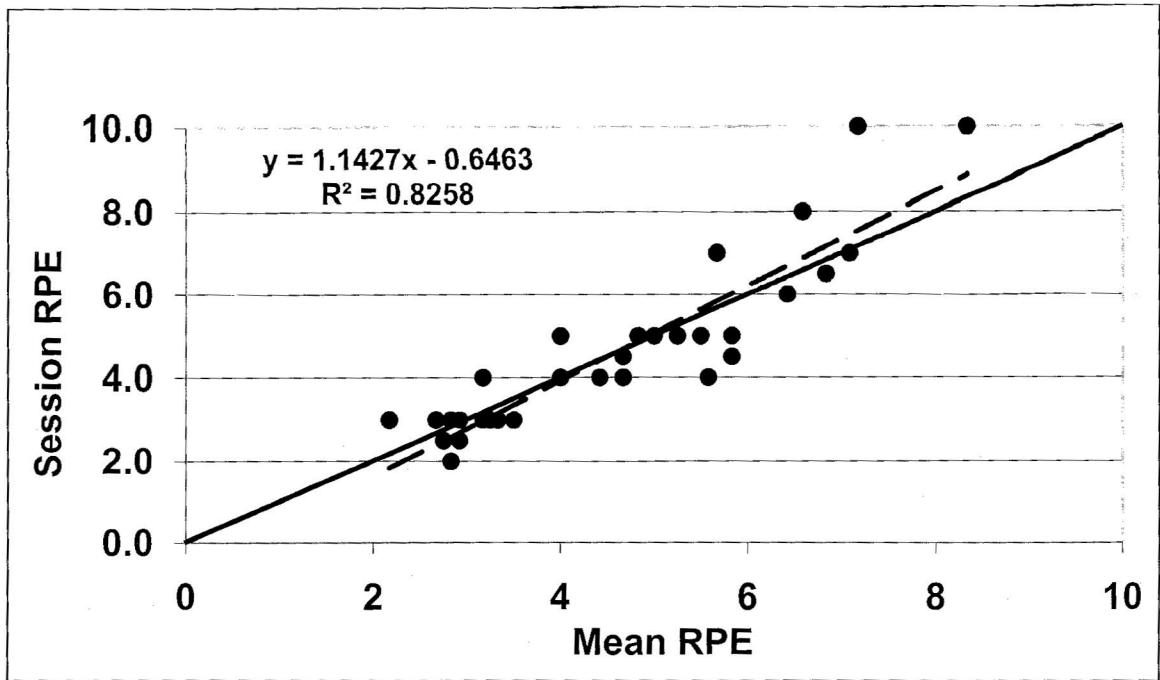


Figure 5. Mean RPE compared to Session RPE rating at the end of each trial. There was no significant difference between ratings.

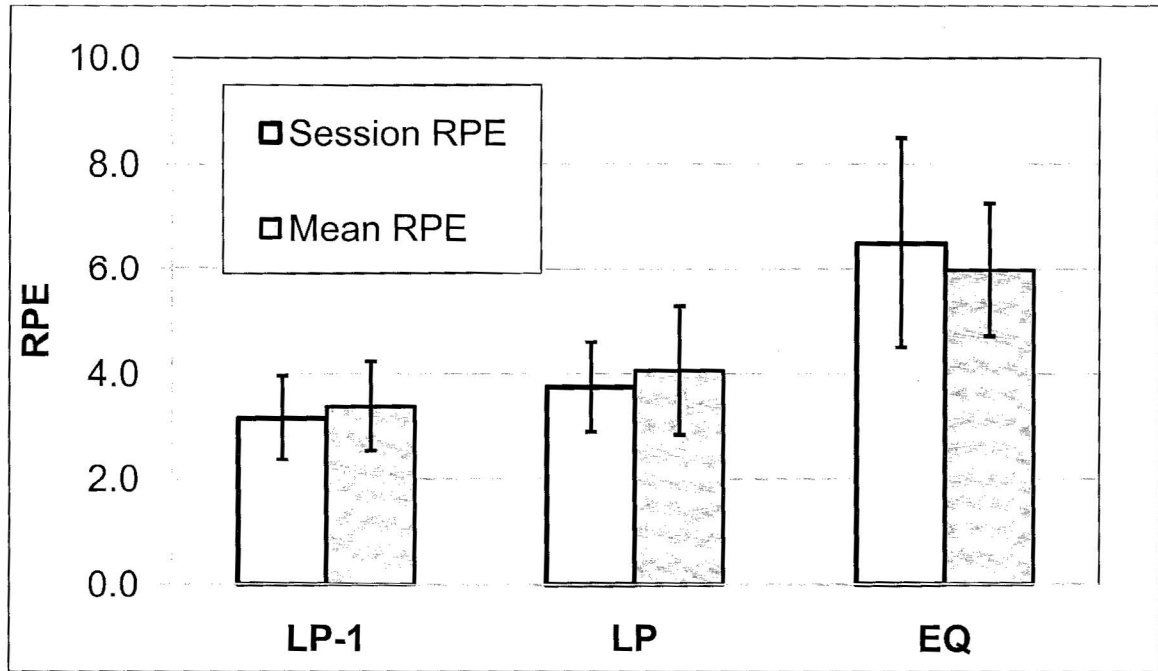


Figure 6. Session RPE after each trial. Session RPE was significantly higher ( $p < .001$ ) for the EQ trial.

## DISCUSSION

Results of the study showed no significant difference between LP-1 and LP trials for HR, blood lactate, session RPE, mean RPE, and TT response. The EQ trial elicited significantly higher HR, session RPE, mean RPE, TT response, and blood lactate than in the LP and LP-1 trials. Thus as long as exercise is prescribed below EQ the exercise prescription should be sufficient to achieve appropriate responses during exercise of up to an hour in duration. Exercise responses changed around 20 minutes into the EQ trial. If the health professional decides to prescribe vigorous exercise from this marker the health professional should limit the session to 20-30 minutes, which would meet ACSM guidelines for vigorous intensity exercise (2).

The findings from this study are consistent with previous findings using the TT (5,11,12). The subjects were able to exercise for an hour while using the intensities prescribed from the TT. The subject's RPE responses were also appropriate and did not show any significant difference between LP-1 and LP trials. There was no significant drift in RPE as noted by Ozkan et al. (16) during the LP-1 and LP trials. There was an upward drift in RPE during the EQ trial after about 20 minutes. While the results of the present study suggest that EQ intensity could possibly be used to prescribe vigorous intensity exercise, further research will be required to validate this practice.

Previous studies (12,15) have demonstrated that exercise prescription were appropriate when set approximately one stage below the LP stage as determined by a graded exercise test. Foster et al. and Jeanes et al. both concluded that exercise needed to

be prescribed from the LP-1 stage to achieve appropriate responses. The current study found that exercise can be prescribed from the LP-1 and LP stage while still obtaining appropriate HR, RPE and TT responses.

The data for the EQ trial had a larger difference between session RPE and mean RPE values compared to the LP-1 and LP trials. The session RPE vs. mean RPE difference could have been due to the training status of the subjects. Subjects in the study were a mix of recreationally active and college athletes. The session RPE values may have been lower for the athletes and other highly trained subjects in this study as these persons are more likely to be accustomed to long practice sessions. Even with a high blood lactate and elevated HR at the end of a session, athletes tended to perceive the session to be less strenuous than did their less trained counterparts. The small difference in RPE between LP-1 and LP trials demonstrates that exercise prescribed from these two markers is suitable for a wide population and therefore should be suitable for the sedentary person. Both trained and recreationally active subjects scored these two intensities between “moderate” and “somewhat hard” on the Borg-CR scale. Thus LP-1 and LP appear to be appropriate for the fitness professional to prescribe exercise for up to one hour in duration.

This study used a walking protocol with some of the subjects walking at a high grade (above 15%) for an hour. This could have affected the data depending on the types of training the subjects had engaged in prior to the study, such as hill training. Future studies using the TT to prescribe exercise while running or on a bike instead of walking would be of interest, especially to see if the RPE score had any significant change between LP-1 and LP trials.

## **PRACTICAL APPLICATIONS**

Results from this study show that the TT can be used to prescribe exercise for individuals interested in performing moderate intensity training for up to an hour. The fitness professional should use the LP-1 and LP intensities to prescribe exercise. If the client is interested in doing vigorous training the EQ stage may be a good choice. Because RPE, HR, blood lactate, and TT response didn't drastically deviate until around 20 minutes, this system would comply with ACSM guidelines for vigorous intensity (2). Future studies would be needed to address this issue

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APPENDIX A  
INFORMED CONSENT

**Protocol Title:** Rating of Perceived Exertion Drift During Steady State Treadmill Exercise

**Principal Investigator:** Lee J Walraven, HFS  
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(605) 691-3595

**Emergency Contact:** Dr. Carl Foster  
133 Mitchell Hall  
University of Wisconsin-La Crosse  
608-785-8687

- **Purpose and Procedure**

- The purpose of this study is to determine the effect increased duration of exercise has on session RPE.
- My participation will involve 5 different exercise sessions. All of which could be very tiring to me. These will involve two graded exercise tests, and 3 subsequent tests at 3 different levels of intensity (light, medium, hard). Each test will last roughly 60 minutes.
- The total time requirement is 5 hours over a 3-4 week period.
- Testing will take place in room 225 Mitchell Hall, UW-L.
- During all tests I will be wearing a heart rate monitor, strapped around my chest, to monitor my heart rate. I will also be asked how hard I am exercising at various times while exercising, along with having my finger pricked to draw droplets of blood.

- **Potential Risk**

- I may experience muscle soreness and substantial fatigue, along with finger soreness from the finger prick.
- Individuals trained in CPR, Advanced Cardiac Life Support and First Aid will be in the laboratory, and the test will be terminated if complications occur.
- The risk of serious or life-threatening complications for healthy individuals like me is near zero.

- **Right & Confidentiality**

- My participation is voluntary.
- I can withdraw from the study at any time for any reason without penalty.
- The results of this study may be published in scientific literature or presented at professional meetings using grouped data only.
- All Information will be kept confidential through the use of number codes.
- My data will not be linked with personally identifiable information.

- **Possible Benefits**

- I may benefit by understanding my fitness level and why I become tired with long exercise sessions.

Questions regarding study procedures may be directed to Student AJ (608-796-1234) the principal investigator (Lee Walraven) or the study advisor Dr. Carl Foster, Department of Exercise and Sports Science, UW-L (608-785-8687). Questions regarding the protection of human subjects may be addressed to the UW-La Crosse Institutional Review Board for the Protection of Human Subjects, (608-785-8124 or [irb@uwlax.edu](mailto:irb@uwlax.edu)).

Participant \_\_\_\_\_ Date \_\_\_\_\_

Researcher \_\_\_\_\_ Date \_\_\_\_\_

APPENDIX B

RATING OF PERCEIVED EXERTION

BORG-CR10 Rating of Perceived Exertion

0	No Effort
0.5	Standing at Rest
1	Very Light
2	Light
3	Moderate
4	Somewhat Hard
5	Hard
6	
7	Very Hard
8	
9	
10	Maximal Effort

APPENDIX C

PLEDGE OF ALLEGIANCE

“Pledge of Allegiance”

“I pledge allegiance to the flag of the United States of America and to the Republic for which it stands, one Nation under God, indivisible with liberty and justice for all.”

APPENDIX D  
REVIEW OF LITERATURE

## **Introduction**

Today's world sees an ever increasing epidemic of obese and sedentary individuals. The health professional who works with this group of people can find it challenging to prescribe exercise. The American College of Sports Medicine (ACSM) recommends an exercise intensity corresponding to 40%/50% to 85% of oxygen uptake reserve or heart rate reserve (HRR), or 64%/70% to 94% of maximum heart rate (MaxHR) (1). The key to exercise prescription is prescribing exercise so the individual is exercising in the 40-85% of HRR or 64-94%MaxHR zone. To prescribe exercise in this range the health professional needs some type of graded exercise test to know the maximal level of exercise the person can achieve. However exercise tests are increasingly expensive and can sometimes pose a health risk to the person (which requires even more health practitioners at the graded exercise test). These factors increase the cost of a graded exercise test and can make the obese and sedentary individual less likely to exercise.

The ideal approach is to create a subjective method of prescribing exercise that is valid and comparable to objective means of prescribing exercise. Subjective exercise methods reduce the cost of prescribing exercise and make prescribing exercise easier. Some examples of subjective means of exercise prescription are the rating of perceived exertion (RPE) and the Talk Test (TT). Both have been shown to be valid and have key markers that are comparable to objective measures (7-10,12). Webster and Aznar et al. (2008) discussed the TT and its application in a recent issue of the *ACSM's Health and Fitness Journal* (20). The journal is read by many health professionals working with the obese and sedentary population, and thus shows the increasing acceptance of the TT.

This study will address the issue of RPE drift during the later parts of prolonged exercise, while participants are exercising according to TT guidelines of exercise intensity (last positive -1, last positive, and equivocal). The intent is through better understanding of the TT and RPE the health professional can safely prescribe exercise to sedentary individuals.

### **Talk Test**

One method of subjective exercise prescription is the TT (8,10). The method has shown to be a valid form of prescription (2,3,10). The TT is a method of prescribing exercise based on how well the participant can speak during exercise. The participant exercises and reads a standard paragraph. After each stage of the test the participant reads the paragraph and chooses one of three options; I can speak comfortably; I am unsure that I can speak comfortably; or I cannot speak comfortably. These three options are based on physiological markers of exercise intensity (10,16,18). These three markers are then labeled last positive (I can speak comfortably), equivocal (I am unsure), and negative (I cannot speak comfortably) (2,5,7). The markers that are of importance for exercise are last positive (LP) and equivocal (EQ). To prescribe exercise from these markers we use the last positive-1(LP-1), which is the stage before the last stage that the participant can speak clearly along with the last positive stage, and then the equivocal stage (10). These three markers have been shown to be suitable for exercise prescription (5,10,18). Since these methods are simple the TT becomes an easy and efficient method to prescribe exercise for the sedentary individual. The health professional only requires a treadmill, heart rate monitor, and a standard paragraph to be able to determine the participant's training intensity.

For a new technique such as the Talk Test to be an accepted means of prescribing exercise they must be tested in various ways to show that the test has validity and reproducibility. Dehart-Beverly et al. (2002) showed the TT defined valid physiological markers of exercise intensity. In her study she had 28 healthy volunteers exercise and use the “Rainbow Passage” as the standard paragraph. Subjects who could speak comfortably were at or below ventilatory threshold (7). From her study she concluded that the TT may be a valid subjective form of measuring exercise intensity. A limitation to her study was that her exercise stages were 2 min stages. To determine ventilatory threshold the stages are usually shorter. The study also used the “Rainbow Passage” which is a 101 word passage. This passage is used in speech pathology, but was found to be too long to be efficient in TT analysis (7). Later studies used the Pledge of Allegiance as the standard paragraph (2,3). The Pledge of Allegiance has been shown to be effective for use during the Talk Test. The Pledge of Allegiance is also known by most people so it does not usually need to be read from a board. The ability to talk comfortably relies on the subject being able to speak at a comfortable pace therefore memorization of the passage reduces variance in how comfortable it is for the person to talk.

Exercise intensity was also a subject of interest when Recalde et al. (2002) did a study with ten participants (17). Recalde followed a similar experiment protocol as Dehart-Beverly but used well-trained subjects instead of apparently healthy students. He tested participants for markers of ventilatory threshold. When the participant could speak comfortably they were below ventilatory threshold (17). When the subjects were unsure if they could speak comfortably they were at the ventilatory threshold (17). Ventilatory threshold is of interest because this is at approximately 80-85% Max HR (16,18,19).

Dehart-Beverly and Recalde used healthy individuals in their studies and therefore showed that the TT is valid in the healthy population.

Other attempts have been made to validate the relationship between ability to talk and the ventilatory threshold. Foster et al. (2008) showed the relationship by training and detraining subjects (9). For purposes of de-training Foster used subjects that donated blood recently and thereby reducing their red blood cell count and therefore reducing their oxygen carrying capacity. When the subject donated blood their ventilatory threshold (VT) went down, as would be expected. Their ability to talk at a given intensity was also diminished (9). When the subjects were given time to for recovery, thus increasing their hemoglobin count, the intensity at which both equivocal and VT stage was achieved also increased. The back and forth movement of the VT correlates well with the TT showing a robust relationship between the two variables (9).

For an exercise procedure to be accepted it must be tested in various populations.

Previous studies have shown that when subjects were speaking they were below ventilatory threshold (7,17,18). These studies used apparently healthy individuals, and so the question becomes can the TT be reproduced in subjects who have their disease controlled by medical intervention? Voelker et al. (2002) used subjects that had their cardiovascular disease (CVD) controlled by medication (19). Her use of the TT in patients with CVD shows that the TT has wide reproducibility. Therefore the TT is valid in individuals that are apparently healthy and individuals that have their CVD controlled by medication. Studies on the TT have also shown to be able to define when the subject was below exertional ischemia (3). Cannon et al. (2004), used patients with known cardiac disease. The subjects exercised and were monitored for EKG changes. The

important findings in the study were that the equivocal stage of the TT preceded ischemic changes on the EKG. From the study we can conclude that when participants are still able to speak they are also below the threshold for exertional ischemia (3). This is especially important when prescribing exercise in individuals with known health issues. It is important to prescribe exercise that is of high enough intensity to incorporate the overload principal. But exercise prescription should also be able to keep the participant below intensities that will produce ischemic situations.

The TT has been shown to be valid in subjects who are apparently healthy and have their disease controlled via medical intervention, but these studies used a treadmill as the mode of exercise. To show reproducibility the TT needed to be shown to be valid when using multiple modalities. Czaplicki et al. (5) tested the TT when subjects were exercising on a treadmill and on a dual-action bike (Schwinn, Airdyne). Czaplicki showed that the TT is valid on both modalities. When the subjects could speak comfortably on both the treadmill and the dual-action bike the subjects were exercising at 50-85% of their MaxHR, which is recommended by the ACSM for exercise prescription (1). Other attempts to show the validity on multiple modalities were done by Persinger et al. (16). She took subjects and exercised them on both a treadmill and a cycle ergometer. The results of her study again showed the cross-over of the TT among various modalities. Patients who could exercise on a treadmill and speak comfortably did not have significantly different values for %VO<sub>2</sub> peak, %VO<sub>2</sub> reserve, %HR peak, nor %HRR than that of the patients when exercising on a cycle ergometer, thus showing the TT was well correlated between exercise modalities (16).

Studies have shown that the TT can be used in apparently healthy individuals and individuals with medically controlled diseases (3,7,20). Other studies have shown the reproducibility of the TT in various exercise modalities (5,16). Brawner et al. used patients with known CAD and tested the use of the TT when done on a treadmill and the track. Brawner showed the use of the TT not only valid in subjects with medically controlled disease but also when using multiple modalities. Brawner showed that when using the TT patients could exercise on the treadmill in the target heart rate. Brawner then took the test further and showed the correlation to walking on a track. The patients walked on a track and were monitored for their ability to talk. The subjects that could still talk comfortably were exercising in their target heart rate zone, 40-85% HRR. The reproducibility of the TT is important here because patients with CAD, the elderly, and obese tend not to prefer to exercise on a treadmill. The treadmill can be intimidating for some and walking on a track allows the patient to quickly start and stop their exercise without trying to manipulate the machine.

The TT has had numerous studies to support its validity (2,3,5,7,9,10). Attempts to modify the TT have been an area for Norman et al. (13,14). Norman has tried to take the theory behind the TT and produce what is called the Counting Talk Test. This method takes into account how long the person can count (1 one-thousand, 2 one-thousand, 3 one-thousand...) after a deep inspiration (13). The person takes a deep inspiration and exhales counting as long as he/she can until full exhalation. The useful tool that the Counting Talk Test gives is that there is a useful equation to predict %MaxHR ( $\frac{\# \text{ during exercise}}{\# \text{ pre-exercise}} \times 100 = \% \text{MaxHR}$ )(13). The equation allows the health professional and the subject exercising a simple method. The limitation to the

method is that there are many variables in the equation. The subject has to take the same deep inspiration each time; has to speak at the same rate; and incorporates arithmetic. The TT is simple and only-relies on the subject being able to speak comfortably, slightly comfortable, or can't speak comfortably (7,16,17). The purpose of a subjective measure of exercise intensity is based on the central idea of simplicity. The easier/simpler the method the better the subjective measure is for measuring intensity.

### **Rating of Perceived Exertion**

RPE is another form of using subjective methods to prescribe exercise and to measure exercise intensity. One form of RPE is session RPE, which tries to quantify the whole exercise session. RPE looks at instantaneous intensity and does not measure overall/global intensity for the full exercise duration. RPE asks the question of intensity while the participant is exercising. Session RPE is not measured until approximately 30 minutes after the exercise period (8,12). Waiting 30 minutes after the exercise session gives a global rating of perceived exertion and therefore, provides a better rating of how intense the subject exercised during the period. Session RPE has been shown to be a valid method of monitoring exercise (6,8,12). Can RPE correlate well when the TT is used to prescribe the training intensity bout and how will session RPE be affected? Session RPE has been studied to determine if it can quantify exercise sessions. Foster et al. (2001) used session RPE to measure how intense the subjects exercised during cycling (steady state) and basketball practice (non-steady state) (8). The importance of the study was that session RPE was valid for quantifying both exercise protocols (8). A limitation to the study was that the subjects were different for the 2-part study that is one group of subjects cycled and a completely different group of subjects participated in basketball

practice. In support of Foster et al. (8) and session RPE was a study done by Day et al. (6). In her study she used resistance training to study the validity of session RPE. Day found that session RPE was a valid form of monitoring resistance training intensity. Day et al. supports Foster's study on basketball practice and cycling because not only did she support the validity of session RPE she also used the same subjects for all three intensities, which was a limitation in Foster's study. To follow up on Foster and Day, Herman et al. (12) used treadmill exercise at three different intensities. The subjects randomly performed different bouts of exercise and were asked for their RPE. Herman et al. also found that RPE was a valid method of quantifying an exercise session. Herman transferred RPE to aerobic exercise on a treadmill and cycle ergometer. Comparisons were made to physiological markers (%VO<sub>2</sub>, %HRMax, etc...) and showed significance. Herman et al. concluded that RPE was a valid method for monitoring exercise, but not as accurate as objective methods of monitoring exercise, as would be expected. A subjective method of monitoring exercise has the limitation that the values will not be as accurate or precise as objective methods, but subjective methods do not need to be as precise as objective measures. A subjective method is preferred because of the simplicity behind the method. Simplicity equates to a decreased cost which makes exercise prescription easier and more affordable.

Attempts to show the validity of the session RPE method to quantify training bouts has been a matter of previous studies (12, 15). Ozkan et al. (15) studied the reliability of regulating exercise during a step dance class. The study was designed to have the participants regulate their exercise intensity using the RPE method. The outcome from the study showed that intensity was difficult to regulate using RPE during

step dance classes, but was still a reliable method of monitoring exercise intensity. The participant was able to determine how hard they worked according to RPE, but could not regulate how much they exerted during the class.

Another finding in Ozkan et al. (15) was that RPE drifted upwards in the participants as exercise duration increased. The drift in RPE showed that RPE could not regulate exercise, because lactic acid and heart rate both decreased in the last stages. For RPE to regulate exercise their RPE score should have gone down too. The drift in RPE was an interesting outcome and something that will be studied during this study. Other studies on RPE did not note this drift in RPE score (8,12). This becomes an interesting outcome because neither Foster et al. (8) nor Herman et al. (12) extended their exercise protocols past 30 minutes. The studies used a 30 minute steady state exercise protocol to study the effects on RPE. Ozkan et al. (15) extended the exercise bout to 45 minutes and thus found an upward drift in RPE at the later stages of the bout. Extending the exercise bout up to 60 minutes would be interesting to see how the RPE score drifted. As exercise is extended the participant will see a cardiovascular drift. The subject's stroke volume will go down and their heart will compensate for the downward drift in stroke volume by increasing heart rate (4). The cardiac drift tends to occur early on in the exercise bout around 10-15 minutes (4), so why is there a drift in the later parts of longer duration exercise? Better understanding of how RPE is affected by extended periods of exercise is important in the process of validation. An exercise prescription method needs to be fully understood to show that the method is safe and effective.

Lastly since RPE is a subjective means of exercise prescription and based on the person's perception of intensity it is fundamental to discuss research done in the area of

psychology. Research has shown that RPE is affected by psychological disposition at moderate intensities (11). When exercise reaches the high intensity level there is little to no difference in rating (11), or in other words when exercise increases in intensity everyone rates the exercise as hard. This is important because when prescribing exercise to the obese/sedentary individual most of the initial exercise will be in the low to moderate range. Understanding that RPE will be affected at moderate levels of exercise intensity but having the TT to monitor exercise that is based on physiological markers (9,16,18) could make the combination of RPE and TT a valid form of exercise prescription.

### **Conclusion**

The purpose of this study is to evaluate the changes in rating of perceived exertion in participants with an increase in exercise duration. I further hypothesize that as the exercise bout increases in duration the RPE will increase without an increase in intensity. Exercise prescription is a difficult process when an exercise test and other objective methods of prescribing exercise are expensive. The nation sees an increasing epidemic in obesity and much of this can be attributed to the sedentary lifestyle we as a nation live. One method to decrease the obesity level in the United States is an increase in exercise. Many people do not feel comfortable or safe to exercise because of their sedentary behavior. Thus the problem now becomes an issue for the health professional to address. The problem can be handled effectively with an exercise prescription. The exercise prescription gives the participant comfort knowing they are not exercising too hard or at a point that will cause injury or harm. Objective means for prescription are expensive, while subjective methods are inexpensive. The Talk Test is a valid method of exercise

prescription and has been shown to be reliable (2,3,5,7,9,10,16-19). Rating of Perceived Exertion is also a reliable method for monitoring exercise intensity (6,8,12,15). Further examination of how the Talk Test, RPE, and session RPE interact with each other will make their use safe and effective for the health professional.

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