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Impact of Instructions on Accuracy in Exercising Rate of Perceived Exertion (RPE) in Older Adults

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Impact of Instructions on Accuracy in Exercising Rate of Perceived Exertion (RPE) in Older Adults

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Abstract

The purpose of this study was to determine the impact of instruction types and familiarization on the correlations between physiological measures of intensity (HR and VO_2) and RPE. This was done by comparing the Borg (1998) script to a modified script over two sessions. In the first session, participants were given the Borg (1998) script prior to performing the submaximal Balke-Ware protocol on the treadmill. Participants were randomly assigned to a control or treatment group. The same test was performed for the second session and the control group received the same instructions; however, the treatment group was instructed on RPE with the modified script. There were significant differences between groups at session one for the mean correlation of RPE with VO_2, t (13) = 1.365, p = .021, d = 1.625, but not at session two. There were no significant differences from session one to session two for the control group, t (6) = -.497, p = .637, d = 0.285, or the treatment group, t (7) = -1.67, p = .137, d = 0.620, for mean correlations with RPE and VO_2. No significant differences were found between groups at session one, t (14) = – 1.038, p = .70, d = 0.418 or session two, t (14) = .417, p = .189, d = 0.611, for the mean correlation of HR and RPE. No significant differences were found for either the control group, t (6) = -2.121, p = .078, d = 0.836 or the treatment group, t (8) = -.393, p = .705, d = 0.324, between session one and two. Although most of the results were non-significant, a familiarization effect did occur with an increase in correlations from session one to two. The treatment group did show more improvement in the mean correlation of VO_2 and RPE, while the HR and RPE mean correlation showed more improvement in the control group. Instructions may have an effect on the accuracy of RPE in older adults.

Chapter One: Introduction

Background

Rate of Perceived Exertion (RPE) was originally developed by a psychologist named Gunnar A.V. Borg in the 1960s (Borg, 1962; Noble & Robertson, 1997). Borg and Dahlstorm (1960) performed many of the original experiments with male and female adults. The goal for development of the RPE scale was to use a metric system with an absolute zero, applicable for all ages, genders, heritages, and cultures (Borg, 1982). Noble and Robertson (1997) defined perceived physical exertion as one's personal thought of "effort, strain, discomfort, and/or fatigue" during exercise. Measuring the perception of work and fatigue is important to keep track of exercise adaptations and advancements (Borg, 1962). Rate of perceived exertion (RPE) scales are meant to provide a method to monitor exercise intensity in addition to or instead of direct measures of heart rate (HR) or volume of oxygen consumption (VO_2). The aim of the scale was to rank the amount of effort during exercise based on *gestalt* (Borg, 1962). Borg (1962) stated that gestalt is a pattern of sensations from the body interpreting aches, pains, strains, and fatigue to the muscular and pulmonary systems. The complexity of RPE is due to the fact that it involves not only physiology, but psychology as well (Borg, 1998, pp. 2). RPE can also be focused on local areas of the body, like the legs or arms (Borg, 1998, pp. 9).

The RPE scale was meant for measuring exercise intensity for the general population and was initially tested on a cycle ergometer with the ratio scale halving technique (Borg, 1962). The ratio scale halving technique is when the participant starts working at a certain intensity over a specific amount of time, then performs half of both the intensity and time when performing a second bout (Borg, 1962). The ratio scale halving technique did not show whether something was actually fatiguing or not (Borg, 1990), eventually leading Borg to develop the first RPE scale (Borg, 1970). The first official scale of RPE was the 15-point scale ranging from 6 to 20 (Borg, 1970). Creating the 15-point scale was a gradual process that started with a short ranged 7-point scale, which was not enough to gauge fatigue, leading to the 21 point scale that provided too much of a range for participants (Borg, 1998, pp. 29).

The RPE numbers are attached to effort “anchors” that enable people to communicate their exertion levels during exercise, or their extent of pain (Borg, 1990). Borg has developed several perception scales including the 15-point scale ranging from 6 to 20 (Figure 1), the CR-10 Scale (Category Ratio 10 Scale Figure 2), and the 10-point pain scale (Borg, 1970, 1990; Noble & Robertson, 1997). The CR-10 scale differs from the Borg 6-20 scale in that the scale is from 0 to 10, with 10 representing maximal exertion. Borg (1982) noted that the 6-20 scale is equivalent to heart rates ranging from 60 to 200 beats per minute, with six symbolizing 60 beats per minute, denoting no effort or no exertion, being at level with the normal resting heart rate (Borg, 1990). While the CR-10 scale was developed to be simpler and easier for someone to anchor the numbers, it is still linearly related to heart rate (Borg, 1998). In the CR-10 scale, 10 is the maximal perceived exertion known by the person; however, the person may be able to think of an exertion or situation that would be a 12 or 13 (Borg, 1982).

Borg (1962) developed the 21-point category ratio scale prior to the 15- and 10-point scales. This scale showed promise for inter-individual validity, but there was a nonlinear relationship between ratings and amount of work (Borg, 1962). The 21-point scale, like the 15-point scale, had verbal anchors tied to certain numbers to associate exertion (Borg, 1962); however, the 21-point scale was found not to increase with physiological demands (Borg, 1962). Thus the 15-point scale was developed and found to have a higher correlation with HR (Borg, 1970). The scale was validated through (a) heart beats, (b) breathing rate, (c) power, and (d) work rate (Borg, 1962, 1970). Borg further modified the scale in 1985 by changing the level 6 to ‘No exertion at all’ and 7 to ‘Extremely light’ (Borg, 1998 pp. 30). Noble and Robertson (1997) stated that the scales Borg developed were found to have moderate to strong validity and test-retest reliability through many studies.

Significance

Older adults are defined as those who are at or above the age of 65 years (Administration on Aging [AOA], 2016). In 2015, 900 million adults were aged 60 and older, and 125 million were over the age of 80 years throughout the world (World Health Organization [WHO], 2015). In 2013, the United States had 44.7 million (14.1% of the population) older Americans, equal to one out of every seven Americans (AOA, 2016). Projections predict that by 2050 the population of older adults will almost double (WHO, 2016). This indicates there is increasing importance to support and take care of the growing population of older individuals.

The National Council on Aging (NCOA, 2016) stated that 80% of older adults have at least one chronic disease, and 68% have at least two (NCOA, 2016). Out of the 83.6 million American adults with cardiovascular disease, almost 50% (42.2 million) of them are older adults (American Heart Association & American Stroke Association [AHA & ASA], 2013). In a study researching the barriers to high-quality care, from the physicians’ viewpoint, 36% primary care and 27% of specialty physicians reported a lack of adequate time with patients (Demelloe & Deshpande, 2011). Patients in the older adult population may not be told how to exercise from their doctors because their doctors do not have the time to explain the recommendation to exercise. Older adults, especially those with chronic disease, may not know what moderate intensity exercise feels like or should feel like, or how to monitor it when starting an exercise program prescribed by their doctors. Borg (1998, pp. 29) talked about the impact of an unclear exercise prescription to a patient post-myocardial infarction. Simply being told “exercise at moderate intensity,” is not clear enough for someone to know exactly what to feel when instructed to work at certain intensities (Borg, 1998, pp. 29).

Rehabilitation is a commonly prescribed method of exercise, whether it is physical therapy, cardiac or pulmonary rehabilitation, or other similar programs. In 2010, a study of 5% of those with Medicare showed that 30,161 older adults attended at least one session of cardiac rehabilitation over a five-year span (Curtis, Hammill, Schulman & Whellan, 2010). RPE is utilized in cardiac rehabilitation as a way to measure intensity in those that are taking beta-blockers or other medications that affect HR (Chen, Huang, Ting & Tsai, 2015). Prior to starting rehabilitation programs, a graded exercise test is performed on the individual to create an exercise prescription for their rehabilitation, often RPE and VO_2 are utilized (Aamot, Forbord, Karlsen & Stoylen, 2014; Chen et al., 2015). Chen et al. (2015) found that those taking beta-blockers had higher RPE during exercise and lower HR during recovery compared to their counterparts. The lower HR during recovery is due to medication causing the HR to be lowered; however, the perceived effort during exercise was higher (Chen et al., 2015). Additionally, a study found that when self-regulating intensity in cardiac patients, the RPE exercise session had a significantly lower mean peak HR than the self-regulation by HR exercise session (Aamot, Forbord, Karlsen & Stoylen, 2014). This could be that the perception was higher than the actual workload shown with HR (Aamot et al., 2014). Supporting Aamot et al. (2014) a study by Borg and Dahlstrom (1962) showed that a heart disease patient reported having a higher RPE than what the HR suggested. The differences between HR and RPE could be from the diseased condition or the ability to accurately identify exertion with a number.

Risk of Perception. It is crucial for older adults to accurately perceive their exertion levels because overexertion can increase the chance of injury (Little, Raina, Stathokostas, Theuo & Vandervoort, 2013; Raina, Stathokostas, Theuo & Vandervoort, 2012). Borg (1998, pp. 15-16) stated that 5-10% of adults can have problems applying the instructions of RPE. In a study, twelve of 18 injured participants at a community-dwelling fitness facility reported the cause of injuries were from overexertion or overuse (Raina et al., 2012). Older adults that can accurately perceive their exertion could reduce the possibility of overexerting themselves during exercise avoiding related injury. Johnson and Phipps (2006) surveyed 100 adult females finding that 86% of them preferred using perceived exertion during exercise, but only 16% were familiar with the RPE scale. So, whether an older adult is using RPE as a scale to measure exertion or not, there is a moderate to strong probability that they are using perception of exertion to measure intensity. Additionally, a systematic review of 15 studies concluded that strain injuries were commonly from overexertion in older adults (Little et al., 2013). Accurately perceiving the exertion level during exercise or physical activity is important to decrease the chance of under-exertion or overexertion.

The difference between the signal of fatigue and the *dangerous strain* from the body is important to understand (Borg, 1998, pp. 3). Dangerous strain is the gestalt or sensation signaling problems in the body like disease or injury (Borg, 1998, pp. 3). Interpreting angina as exercise-related fatigue could be a life or death misinterpretation, so it is vital to know the perceptual difference of disease strain and fatigue. With good explanation, the ability to perceive exertion to accurately understand the difference between dangerous strain and fatigue could decrease chances of overexertion.

The benefits of exercise outweigh the risks, especially in older adults. Exercise not only helps improve cardiovascular function and strength, but it also can help with the symptoms, causes, and pain of diseases (American College of Sports Medicine [ACSM], 1998). Diabetic Older Americans make up 25% of those over the age of 60 years (American Diabetes Association [ADA], 2015). In patients with diabetes, exercise can improve glycemic control, decrease hemoglobin A_1C levels, and improve insulin sensitivity (ACSM, 1998). Exercise can also help increase bone mineral density (BMD), strength, and decrease the risk of falls in older adults (ACSM, 1998). The Center for Disease Control (CDC) showed that 49.7% of adults over the age of 65 reported they had diagnosed arthritis (CDC, 2016). Regular exercise can be beneficial for those with arthritis to manage pain, increase mobility, and improve joint function (ACSM, 1998). Exercise improves quality of life and decreases all-cause mortality in all individuals (ACSM, 1998).

Guidelines. The Department of Health and Human Services (DPHP) guidelines for physical activity in older adults states that aerobic activity is important for the heart to enable it to keep up with daily physiological demands (DPHP, 2008). The DPHP (2008) also added that older adults should have the ability to determine their physical strain during activities in accordance with their fitness level. Ensuring the accuracy of RPE in those who are 65 and older promotes safe physical activity and limits the possibility of overexerting.

ACSM (2014) recommends that older adults achieve 3 days of vigorous exercise or 5 days of moderate aerobic exercise per week, which would be a 5-6 or 7-8 on the CR-10 scale (ACSM, pp. 208-209). ACSM and the American Heart Association reported that these recommendations are in addition to activities of daily living (ADL), including light to moderate activities that last less than 10 minutes (Nelson et al., 2007). In order for older adults to achieve the recommendations of exercise, it may be beneficial to understand which RPE levels equate to certain intensities.

Ehsani, Holloazy, Kohrt and Spina (1998) found a contradiction with the ACSM guidelines for RPE by showing that RPE was typically lower at certain percentages of maximal effort in HR and VO_2 than the recommended equivalents. Eston and Williams (1998) found that correlations to VO_2 percentage of max (%VO2max) and heart rate percentage max (%HRmax) increased with the use of the RPE scale over time. This finding supports what Chen et al. (2002) found, which is that fit individuals tended to be more accurate in perceiving their efforts than those who were sedentary. Familiarization with the RPE scale, or the feeling of effort during exercise, could be the cause for the increase in validity and reliability (Thompson & West, 1998). This leads to the idea that familiarization can improve the accuracy of the scales, or that repeated instruction of the scale allows for improved understanding.

Purpose

Noble and Robertson (1997) stated that perception of physical exertion scales are linearly equivalent to rising intensities, provided that instructions are unambiguous and absolute. Without a clear understanding of the equivelents of effort to the scale numbers, participants may misperceive the exercise intensity at which they are working. In comparison of RPE equivalents to %HRmax, people are more likely to perceive efforts inaccurately (Chen et al., 2002). Accuracy of perception is essential during exercise testing in those starting rehabilitation programs. Several sessions of familiarization with the scale and the exercise may decrease the possibility of over/under exertion during rehabilitation. Borg (1998, pp. 15) said, “Correct instructions for the test leader and the subject are essential for administering the scale and ensuring the correct interpretation of a response.” The purpose of this study was to determine the impact of instruction types and familiarization on the correlation between physiological measures of intensity (HR and VO_2) and RPE.

Hypothesis

The first hypothesis is that by ensuring the participant understands the RPE scale, the treatment group will show an increased correlation of RPE to HR and VO_2 from session one to session two (Borg, 1998, pp. 47-48; Noble & Robertson, 1997). The second hypothesis is that the treatment group will have a significantly higher correlation than the control group at session two. The third hypothesis is that both the control group and the treatment group will show a familiarization effect (Eston & Williams, 1988; Katsanos & Moffat, 2005; Thompson & West, 1998).

Operational Definitions

- Instructions – are the verbal instructions of how to use the rate of perceived exertion scale.
- Fatigue – being in a state of "drowsiness" or extreme tiredness, when an individual's exhaustion causes a decrease in performance (Borg, 1998, pp. 2).
- Perceived Exertion – the feeling of how strenuous a task is (Borg, 1998, pp. 8).
- Rate of Perceived Exertion (RPE) – the subjective intensity in which a person feels fatigue, strain, and/or discomfort during exercise (Noble & Roberston, 1997). The degree of strain experienced during work estimated in accordance with a rating methodology (Borg, 1998, pp. 9).
- Volume of Oxygen Consumption (VO_2) – is cardiac output and the arterial-venous oxygen difference measured by the consumption and exhalation amounts of oxygen and carbon dioxide (ACSM, 2014, pp. 74-75).

- Respiratory Exchange Ratio (RER) – volume of carbon dioxide ratio to the volume of oxygen (ACSM, 2014, pp. 133).
- Submaximal Exercise Test – measuring HR and other means at several exercise intensities in order to extrapolate maximal exertion levels (ACSM, 2014, pp. 75).

Assumptions

- All participants will perform to their best ability.
- Participants of this study represent the general population of older adults.
- Ability to perceive fatigue will vary between participants.
- Ability of the person to perceive the amount of exertion being performed during exercise and equate it to an RPE level (Borg, 1960).

Limitations

- Lack of transportation to the laboratory.
- Inability to commit the time to participate.
- Possibility of injury, drop outs, and the inability to complete testing procedures.

Delimitations

- Population is specifically those who are age 65 years and older.
- Participants of this study are only recruited from Oklahoma County.
- In order to participate, volunteers are required to pass the Exercise And Screening for You (EASY) questionnaire, showing physical activity readiness with six easy questions.
- Only those who are comfortable with walking on the treadmill and are able to walk on the treadmill for at least 5 minutes without assistance of any kind will be able to participate.
- Those who do not have a disease that causes neurological or musculoskeletal problems will be able to participate.

Summary

The RPE scale developed by Gunnar Borg has become a popular method of interpreting physical strain during exercise (Chen et al., 2002; Christle, Halle, Pressler, Scherr, Wolfarth & Wagenfeil, 2013; Coquart, Eston, Garcin, Parfitt & Tourny-Chollet, 2014). Exercise can benefit older adults by increasing their quality of life, health, fall prevention, and help manage disease. The ability to perceive exertion accurately during exercise is important to ensure that overuse injuries do not occur. Also, in rehabilitation, the common use of RPE for exercise prescription is contingent on the safety of the participants. ACSM's (2014) general guidelines for physical activity use RPE as one of the methods to measure intensity. Thus, it is vital to use the RPE scale accurately to successfully meet the intensity guidelines for physical activity and to exercise safely. The instructions have the potential to affect accuracy of using the scale and perceived effort.

Chapter Two: Literature Review

Introduction

Since Borg's rate of perceived exertion (RPE) scale development, it has been well researched among various populations, body compositions, ages, genders, and diseases (Chen et al., 2002; Christle et al., 2013; Coquart et al., 2014). Research has also examined possible correlations of physiological measures to RPE: (a) heart rate (HR), (b) volume of oxygen consumption (VO_2), (c) blood lactate levels, and (d) respiration rate or respiratory exchange ratio (RER). Various modes of exercise including the cycle ergometer, treadmill, and water submersion exercises have been used to test the validity and reliability of Borg's RPE scale,. Validity is the ability of a test, or scale, to correctly measure what it is intended to measure (Nelson, Silverman & Thomas, 2015, p. 203). Reliability is the repeatability of the test or scale of measuring the intended measure (Nelson, Silverman & Thomas, 2015, pp. 208).

RPE is often questioned in research for the accuracy of its use during exercise in various populations. Some researchers try to determine if participants are actually meeting the ACSM (2014) activity intensity guidelines using RPE. Research has compared differences between genders, ages, fitness levels, and obesity statuses with the use of RPE. The articles that were chosen for this review paper evaluated RPE in healthy adults or older adults. Youth and athletic populations were excluded from this study.

Johnson and Phipps (2006) discussed the importance of educating the public on RPE after surveying young women on their knowledge and use of RPE. To the author's knowledge, there has been no published research on the instructions for using RPE. Many articles do not provide the methods with which RPE is explained to participants. The reliability and validity of RPE may be affected by many factors that are researched and others that are not (Borg, 1998, pp.

15-16, pp. 31-38). The purpose of this literature review paper was to examine the topics of RPE validity and its use in adults and older adults. An additional purpose of this paper was to review the RPE explanation or instruction used in research.

Methods

Database Search. For this systematic literature review, the University of Central Oklahoma Max Chambers Library and Google Scholar were used to perform literature searches. Databases included in the searches were Wolters Kluwer Ovid, EBSCOHOST, EBSCOHOST MEDLINE, Wiley Online Library, PubMed, and ProQuest. Articles were searched from January to March in 2016.

When searching for articles these phrases were used: (a) ‘rating of perceived exertion (RPE),’ (b) ‘rate of perceived exertion in older adults RPE,’ (c) ‘RPE rate of perceived exertion older adults,’ (d) ‘Borg, Gunnar RPE rate of perceived exertion older adults,’ (e) ‘Borg, Gunnar RPE rate of perceived exertion,’ (f) ‘Borg perceived effort,’ (g) ‘accuracy of RPE rate of perceived exertion,’ and (h) ‘rate of perceived exertion reliability and validity.’ Among these phrases that were searched, 95 articles were found.

Article Criteria. Inclusion criteria were comprised of studies that questioned RPE, or if the study used RPE in the statistical analysis. Articles chosen discussed RPE with walking, cycling, or running performed indoor, outdoor, or underwater. Studies that did not use these modes, did not question RPE, and involved athletes or children, were considered unrelated. Studies with middle to older aged adults were preferred, although all studies found that in accordance with the criteria were examined. Additionally, diseased populations were not included in this article due to the difficulty to compare to healthy adults. Narrowing articles for randomized control trials, quality, and publish dates were not restricted for this article because of the limited research on the focused populations.

After a complete review of all articles, 58 were found to be unrelated, three used the OMNI scale, eight were duplicates, and four were conference poster abstracts not yet published. Twenty-two were chosen to be included in this review. Of the studies that were chosen to be included in this review, eight used a cycle ergometer, twelve used the treadmill, three used a track either outside or inside, eight performed walking, and three performed running.

Results

Reliability and Validity. Reliability and validity studies examining the use of the Borg RPE scales have been performed since the scale was developed in the 1960s (Borg, 1960, 1962; Chen et al., 2002; Noble & Robertson, 1997). These studies have looked at correlations of HR, VO_2, blood lactate, and respiratory exchange ratio (RER) with RPE in various populations and modes of exercise, including self-regulating exercise.

A meta-analysis of 64 studies by Chen et al. (2002) found the mean correlation of RPE was 0.60 with HR, 0.58 with blood lactate, 0.64 with VO_2max, and 0.68 with VO_2. RPE had a valid moderate relationship to the physiological parameters used to measure exercise intensity. Chen et al. (2002) concluded that RPE's validity was not as high as professionals thought. The results of the mean validity coefficients ranged from r = 0.80 - 0.90 which was higher than what they found (Chen et al., 2002). On the other hand, a large study done with 2,560 Caucasians (1,790 males; 764 females; ages 13 to 83, M = 28 years) looked at RPE in comparison to the various physiological measures of intensity and found that HR (r = 0.74) and blood lactate (r = 0.83) held the highest correlations with RPE (Christle et al., 2013). This shows a higher correlation than Chen et al. (2002) reported. In agreement with Chen et al. (2002), Christle et al.

(2013), and Askew, Benson, Hannon, and Skatrud-Mickleson (2011) found that RPE is a good measurement of exercise intensity. They found that females were significantly more likely to overestimate RPE and regular exercisers were significantly more likely to underestimate RPE (Askew et al., 2011).

Cycle Ergometer. Reliability and validity of the RPE scale with physiological measures during exercise on the cycle ergometer have shown various results. Of the five studies reviewed that utilized the cycle ergometer, two had significantly strong correlations and three had moderate to strong varying by either RPE level or comparison. One of the studies by Angelopoulos et al. (1996) studied RPE by body region and total body during semi-recumbent ergometer underwater. Four predetermined revolutions-per-minute were performed at three wattage power outputs (Angelopoulos et al., 1996). Angelopoulos et al. (1996) found that power and RPE had moderate to strong correlations with leg RPE, holding the highest during all wattages. Eston et al. (2009) found that RPE had a strong significant correlation with VO_2 (r = 0.97), even at lower intensities. This is in agreement with the findings of Eston and Faulkner (2007) who found strong correlations between RPE and $VO_{2,}$ and RPE and HR (r = 0.95 - 0.98). This is analogous to the findings of Eston and Williams (1998), who found that an RPE of 9 had a strong correlation with VO_2 of 0.83, RPE of 13 had a strong correlation of 0.94, and RPE of 17 had a strong correlation of 0.92.

Similar to Eston and William's (1998), Katsanos and Moffat (2005) evaluating the cycle ergometer in healthy men at RPE levels of 11, 13, and 15 finding that RPE validity was moderate to strong. Eston and Williams (1998) also questioned the reliability of RPE over time through three exercise sessions working at RPEs of 9, 13, and 15. To have a measure to compare with the exercise session a maximal exercise test was performed (Eston & Williams, 1998). They found that correlations with RPE and the physiological factors increased from sessions one and two versus sessions two and three (Eston & Williams, 1998). This means that RPE became more accurate between sessions two and three than it was between one and two. Katsanos and Moffatt (2005) noticed that reliability of RPE increased when they analyzed the second and third trials (r = 0.85-0.96) compared to the analysis of all three trials (r = 0.81-0.86).

Biren, Chaloupka, Hoffman, Kang, and Masterangelo (2009) questioned the reliability of RPE with exercise durations of 20 and 40 minutes in 20 healthy young adults (M = 22.4 years). Participants were asked to obtain a certain level of RPE and continue working at that RPE for the remainder of the time (Biren et al., 2009). The researchers found no significant differences in actual VO_2 from estimated VO_2 throughout the sessions outside (Biren et al., 2009). There were significantly lower VO_2 scores than estimated during the first 3-4 minutes at intensities of 50% and 75% VO_2peak (Biren et al., 2009). RPE was a sufficient measure of regulating intensity exercise duration once the desired intensity is met (Biren et al., 2009).

Walking and Running. Accuracy of RPE during running and walking has also been questioned. Out of the four studies reviewed one found a strong correlation, one found a moderate relationship, one found a moderate to strong correlation, and one found higher HR in outdoor running**.** Askew et al. (2011) compared RPE to a recently studied accelerometer for reliability and validity while walking on an indoor 0.29-mile track. The accelerometer data and RPE were converted into MET's with justifications from other studies (Askew et al., 2011). The participants walked three laps at increasing intensities during each additional lap (Askew et al., 2011). RPE was found to be 3.67 times more underestimated in those who regularly exercised compared to non-exercisers who overestimated exertion (Askew et al., 2011). Of those who exercised regularly, 32.7% underestimated their RPE, while 13.6% of those who did not exercise overestimated (Askew et al., 2011).

Additionally, Katsanos and Moffat (2005) also looked at three intensities through self-regulating exercise to different predetermined RPE levels of 11, 13 and, 15. The researchers found that self-regulating exercise on the treadmill at an RPE of 15 had the strongest correlation of $r = 0.91$ (Katsanos & Moffat, 2005). RPE had correlations with HR of $r = 0.80$ at 15 and $r = 0.88$ at 11 when including the three trials that were performed (Katsanos & Moffat, 2005).

Similarly, Ceci and Hassman (1991) studied the effects of self-regulating exercise at predetermined RPE levels of 11, 13, and 15 while running on a treadmill or on a track outdoors with eleven physically active males ages 33-65. Ceci and Hassman (1991) found that RPE correlations with HR and blood lactate were significantly positive and moderate to strong (r = 0.60-0.92); however, an RPE of 11 and blood lactate were not significantly correlated during treadmill running ($r = -0.04$). Also, an RPE of 11 was not correlated with HR during the field running with a low-moderate relationship ($r = 0.41$; Ceci and Hassman, 1991). The relationship between RPE and velocity, at all three levels, was the strongest with a correlation coefficient of $r = 0.80$-0.98 (Ceci and Hassman, 1991). Ceci and Hassman (1991) also found a significantly higher HR, blood lactate, and velocity in the field running group during all three RPEs compared to treadmill running (HR/RPE and velocity/RPE, $p < 0.001$; blood lactate/RPE, $p < 0.05$). Thompson and West (1998) also looked at treadmill running and outdoor running in males and females ages 19-24 at 2.5 mmol blood lactate. The researchers found that treadmill running had significantly ($p < 0.05$) lower values of HR and RPE (Thompson & West, 1998).

Older Adults. Not many studies have considered the reliability and validity of RPE use in older adults as a means of measuring exercise intensity. Three studies and one meta-analysis were examined. All four articles questioned and reported reliability and validity of RPE, two studies found moderate correlations, and one had strong correlations. A meta-analysis that looked at reliability and validity of RPE, included four studies that questioned RPE use with older adults but did not discuss them separately from the adult group (Chen et al., 2002). Chen et al. (2002) found that the mean correlation coefficients for the 15-point scale were 0.69 and 0.70 from 21 articles. Articles that had studied the productions of a prescribed RPE had higher mean correlations than those who estimated RPE during a set speed or resistance (Chen et al., 2002).

Nakagaichi, Nho, Shigematsu, Tanaka, and Ueno (2004) looked at the effectiveness of RPE on the cycle ergometer in older adults. By comparing middle-aged and older Japanese women through a graded maximal exercise test (Nakagaichi et al., 2004). Nakagaichi et al. (2004) found that the older women had lower results in all areas except RPE, in which they matched the middle age women with an RPE of 13 as the mean. Determining that RPE is a used validly in older women, Nagaichi et al. (2004) recommended RPE not be the only measure of intensity. In addition, Chung, Liu, Quach, and Zhao (2015) found that there was a significant moderate correlation of RPE with HR (r = 0.70) and VO_2 (r = 0.51) in healthy older adults. Chung et al. (2015) also found that they could measure exercise intensity with the Cantonese Borg RPE 6-20 scale with significant test-retest reliability.

Additionally, Eston, Norton, Parfitt, and Smith (2015) examined perceptually regulated exercise test (PRET) through RPE in 22 older adults (10 males and 12 females) with a mean age of 64.8 years (SD = 3.7). PRET uses RPEs of 9, 11, 13, and 15 to gather information for extrapolating the predicted VO_2 peak (Eston et al., 2015). They found a significant overestimation of VO_2 at RPE of 19 and 20 compared to measure VO_2 (Eston et al., 2015).

Rating of Perceived Exertion Older Adults. RPE use in older adults has been studied with strength training and cardiorespiratory responses during cycle ergometer, and treadmill walking underwater and on dry ground. A study that was reviewed used the Borg CR-10 scale with 20 healthy older adults ages 60-70 while performing three stages of measures: (1) a graded maximal test, (2) a submaximal RPE of 4 for 2 km., and (3) a resting measure (Cordes et al., 2013). Cordes et al. (2013) discovered that there was significant ($p < 0.01$) time effect for RPE and %HRmax between minutes 5 and 10, and minutes 10 and 25 during submaximal exercise during the 2 –km testing.

A study questioned the ACSM prescription guidelines for older women. The study found that older women's %VO_2 max and %HRmax were similar to the guidelines, but the RPE levels were lower (Ehsani et al., 1998). ACSM guidelines say that a %HRmax of 60-70% should equal an RPE of 12 to 13; although, in this study at 64% and 70% HRmax participants reported RPEs of 9 and 11 (Ehsani et al., 1998). Percentages of predicted maximal HR were significantly ($p <$ .05) higher than actual %HRmax measurements (Ehsani et al., 1998).

Some reviewed studies questioned underwater treadmill walking and dry ground treadmill walking. One study with 23 older adults ($M = 74 \pm 4$ years) self-regulated speeds to acquire a 12-13 RPE for 60 minutes while walking on the treadmill underwater and then over ground (Johnson et al., 2006). The researchers found that RPE and walking speed were significantly lower during underwater walking ($p < .001$). Similar research was done by Fujishima, Hotta, Masumoto, and Shono (2008) opposing Johnson et al. (2006) by finding that RPE breathing and RPE legs were significantly higher while walking underwater in 9 older adults ($M = 61.8$ years) at three walking speeds. The significance in the increases of RPE matched the rate of increase of HR, VO_2, blood lactate levels, and muscle activation compared to overground treadmill walking (Fujishima et al., 2008). Additionally, a study that was done with upper middle-aged adults (M = 58.0 years) that examined physiological measures during three different walking speeds on a dry and underwater treadmill (Caputo, Dolbow, Farley & Kim, 2008). Caputo et al. (2008) found that there was a significant interaction effect between mode and speed with RPE ($p < .0001$). RPE significantly ($p < .05$) increased with speed increases with both treadmill walking on dry land and underwater (Caputo et al., 2008).

Brach, Julius, VanSwearingen, and Wert (2012) looked at RPE with physical activity, physical function, fear of falling, and walking self-efficacy in older adults. Brach et al. (2012) found that of the community-dwelling older adults who reported a higher RPE during walking had significantly weak relationships with physical activity (r = 0.30, p =.04) and low confidence in walking (r = -0.33, p = .02). Those who reported no effort during walking had significantly higher ($p < .05$) confidence in walking (Brach et al., 2012).

Rate of Perceived Exertion Instructions. Of the studies examined, only seven studies mentioned the importance of ensuring the participants understood the RPE scale in order to equate bodily perception of exertion to numbers. Eston and Williams (1998) mentioned that participants were given a copy of the scale to take home after the initial maximal testing prior to the data collection sessions. The participants then came back to the proceeding sessions and were asked to select their grade and speed for certain RPE levels (Eston & Williams, 1998). Askew et al. (2011) provided the script given to participants on instructing the RPE scale. An additional study by Nakagaichi et al. (2004) had the participants study until they were able to match examples to the maximal and minimal RPE levels, and report the definition of RPE. The researchers identified that this was in accordance with suggestions from Borg (1998) and Robertson and Noble (1998). Eston and Faulkner (2007) and Eston et al. (2015) used the same source (Borg, 1998) to develop the Borg 6-20 scale instructions given to their participants. Thompson and West (1998) used the in-depth instructions from the ACSM handbook from 1995 in order to instruct their participants of the Borg 6-20 scale. Thompson and West (1998) even provided a short excerpt of the script that was provided to participants in the study.

Furthermore, the six studies that were examined only mentioned that the participants were instructed, familiarized, or introduced to the Borg scale (Angelopoulos et al., 1996; Beason, Brown, Chitwood & McLermore, 1996; Chung et al., 2015; Cordes et al., 2013; Johnson et al., 2006; Johnson & Phipps, 2006). Another study involving Eston, said that the participants were given standardized instructions and were able to view the scale on a poster for the entirety of their exercise bout (Eston et al., 2009). It was not clear how instructions were being given to participants of these studies. Eight studies reviewed did not mention whether there were instructions presented to participants of the studies or not (Askew et al., 2011; Begg et al., 2014; Brach et al., 2012; Ceci & Hassmen, 1991; Ehsani et al, 1998; Fujishima et al., 2008).

Discussion

The Borg 6-20 scale has been found to be highly correlated with %VO2max and %HRmax (Chen, Fan & Moe, 2002; Eston & Faulkner, 2007; Noble & Robertson, 1997; Eston & Williams, 1998) and blood lactate levels during exercise in the general population (Ceci & Hassman, 1991; Thompson & West, 1998). On the other hand, the articles found anywhere between weak and strong correlations with mostly moderate and strong results. Some of the studies, like the meta-analysis by Chen et al. (2002) and the large study by Christle et al. (2013), found moderate reliability and validity coefficients with RPE. Cycle ergometer studies found slightly higher correlations when comparing RPE to physiological measures, even over multiple sessions (Eston et al., 2009; Eston & Faulkner, 2007; Eston & Williams, 1998; Biren et al., 2009;

Katsanos & Moffat, 2005). The second and third session revealed an increase in reliability and validity using RPE compared to the first two sessions (Kastsonos & Moffat, 2005). Thus, the increase in validity and reliability over three sessions may explain a difference in the findings of the other studies with *r* of 0.41 to *r* of 0.70, which did not have multiple sessions (Ceci & Hassman, 1991; Chen et al., 2002; Chung et al., 2015). Familiarization of the use of RPE during exercise may increase their correlation, reliability, and validity. More research should be done over the reliability and validity of RPE over several sessions for this conclusion to be meaningful.

Running and walking studies typically compared RPE to physiological measures during treadmill and track use, performed indoor or outdoor. A few studies examined dry treadmill with underwater treadmill use in adults and older adults (Fujishima et al., 2008; Johnson et al., 2006; Caputo et al., 2008). More research on the proper use of and familiarization of using RPE needs to be performed to know if RPE has a moderate or strong validity with physiological measures during different modes. Studies that examined reliability and validity during running or walking found that there were also moderate to strong relationships with physiological measures; although, some studies had very weak or negative correlations reported at some levels of RPE (Askew et al., 2011; Ceci & Hassman, 1991; Thompson & West, 1998). Application of instruction method or RPE scale familiarization may have an impact on the validity findings (Borg, 1998, pp. 15-16).

The studies that were examined found that RPE had a moderate relationship with physiological measures in older adults (Nakagaichi, 2004); however, there is insufficient research on RPE use in older adults during aerobic exercise. Many studies that were found in the search for this topic on older adults were with strength training or diseased populations.

Additionally, studies with older adults and RPE during walking found significantly higher exertion and muscular activation while walking underwater (Caputo et al., 2008; Fujishima et al., 2008; Johnson et al., 2006). RPE may be reliable due to the correlated increase in RPE and muscle activation; although, the researchers did not analyze reliability directly. Finally, Broch et al. (2012) found that older adults who had more confidence and lower RPE in walking were significantly more active than their counterparts. This shows increased confidence is associated with decreased perceived effort while walking. This could be due to fitness level or physical capacities as well.

One limitation to the reviewed research is that only one of the studies examined RPE accuracy over several exercise sessions, finding that accuracy increased with more sessions (Eston & Williams, 1998). Scales of perception rely on the person's ability to create a measure of fatigue or feeling based on his or her body awareness. Borg (1990) stated that perception may not be exact, but it does communicate sensory disturbances in the body during exertion that can help monitor exercise. In the same way a person perceives pain, distinct exercise levels will be perceived as different efforts of intensity from person to person. Due to the person to person variability that comes with perception, there is a great importance that everyone understands the scale's anchors or equivalents to intensities. Christle et al. (2013) showed 2,560 Caucasian adults (ages 18-83) who reported RPEs ranging from 17 to 20 at their maximal exertion, with 33.8% of the group reporting an RPE of 19 at maximal exertion. Furthermore, Noble and Robertson (1997) stated that perception of physical exertion scales are linearly equivalent to rising intensities as long as the instructions are "unambiguous and absolute." Literature has shown that people are likely to perceive their intensities inaccurately (Chen et al., 2002). Without a clear understanding of the scales exertion equivalents, participants may misperceive their effort to exercise. Borg (1998, pp. 15-16) wrote that one of the common misuses when teaching the use of the scale is when instructions are altered or the instructor does not provide further explanations when necessary.

To conclude, there needs to be more research of RPE validity changes over several exercise sessions. Also, ensuring that the scale is understood by the participants can be important when the goal is accuracy of RPE. RPE is a relatively good scale of measuring exercise intensity in healthy adults during walking, running, and working on the cycle ergometer (Angelopoulos et al., 1996; Askew et al., 2011; Borg, 1960; Chen et al., 2002; Christle et al., 2013; Eston & Williams, 1998; Eston & Faulkner, 2007). If possible, physiological measures should still be taken during exercise to ensure safety and correct intensities are met. Aerobic RPE should be further researched with older adults before conclusions on validity are made. Prior to making conclusions of RPE's validity, effects of instructions should be researched.

Chapter Three: Methodology

The RPE scale developed by Gunnar Borg has become a popular method of interpreting physical strain during exercise (Chen et al., 2002; Christle et al., 2013; Coquart et al., 2014). Older adults commonly have disease and can highly benefit from exercise for health, quality of life, and fall prevention. The ability to perceive exertion accurately during exercise is important to ensure that overuse injuries do not occur. Also, in rehabilitation, the common use of RPE for exercise prescription is contingent on the safety of the participants. ACSM's (2014) general guidelines for physical activity use RPE as one of the methods to measure intensity. Thus, it is vital to be able to perceive exertion and apply it to the scale Borg has created accurately for safety and meeting the physical activity recommendations. The instructions have a possibility of affecting one's ability to understand the use of the RPE scale and the capability to perceive exercise effort. The purpose of this study was to determine the impact of instruction type and familiarization on the correlation between physiological measures of intensity (HR%max and VO_2%max) and RPE.

Participants

Chung et al. (2015) studied Rate of Perceived Exertion (RPE) reliability and validity in older adults, and reported a 0.70 correlation of RPE and HR. At least 25 participants were needed were needed in this study to acquire the statistical power of 0.80. All participants signed the informed consent and completed a pre-participation questionnaire entitled "Exercise And Screening for You" (EASY) in order to identify readiness to participate in physical activity. Instructions and the EASY are seen in Appendix A. Participants of this study were required to: (a) be over the age of 65 years, (b) be able to walk without assistance for a minimum of five minutes, (c) not have a disease that causes neurological or musculoskeletal problems, and (d) be comfortable with walking on the treadmill (Fujishima, Hotta, Masumoto & Shono, 2008; Johnson et al., 2006). This information was shown in a basic profile form (Appendix B). Recruitment of the participants was from UCO's Center for Active Living and Learning and a local retirement community. Recruitment methods were by flyers and scripted announcements. The participants were randomly assigned into two groups: a control group and treatment group. Participants were randomly assigned to groups by drawing from a cup with a one or two listed on the paper. Participants had no knowledge of which group was the control group or treatment group.

Instruments

EASY Form. The EASY was developed and found valid by Bazzarre et al. (2008). The EASY questionnaire is a validated activity readiness questionnaire (Appendix A) that will be utilized. The EASY was used to determine whether or not a participant was ready for exercise or needs a medical release to participant in the study. According to the EASY guidelines (seen in Appendix A), if any of the six questions are answered with 'Yes' a medical release may be required. The guidelines suggest further questions be asked by the researcher if any questions are answered 'Yes.' The situations in which it is okay to exercise without a medical release would be if the condition is not new and the participant's doctor either knows or is treating it. Reported dizziness will require a medical release in addition to a list of contraindicated exercises from the participant's doctor. The last question asks if there is any concern or further reason as to why the participant should not exercise. If a medical release is required by the answers to the EASY the participant was unable to participate.

Borg 15-point Scale. Gunnar Borg developed the RPE scale in the 1960s to create a scale that could accurately portray one's perception of their exertion during exercise (Borg, 1962). The scale measures gestalt, the body's interpretation of aches, pains, strains, and fatigue (Borg, 1962). Borg's 15-point RPE scale is the most commonly used scale for exercise testing and has been validated for use in all age groups (Borg, 1962, 1982, 1998).

Treadmill. Prior to the participants' arrival to the laboratory, the treadmill and the metabolic cart were calibrated. Calibration of the treadmill was in line with the ACSM guidelines (Human Kinetics, 2014).

Parvo Medics True One 2400. The calibration of the *Parvo Medics True One 2400* was in accordance with the company instructions (Appendix C). The metabolic cart *(Parvo Medics True One 2400)* was used to measure volume of oxygen consumption (VO_2), respiratory exchange ratio (RER), and heart rate (HR) measured via Polar Heart Rate Monitor strap. The *Parvo Medics TrueOne 2400* was validated (r = 0.994 and r = 0.991) with VO_2 and volume of carbon dioxide consumption (VCO_2) by Antezak, Crouter, Della Valle, Haas, and Hudak (2006). The metabolic cart was available for research in the Kinesiology laboratory at the University of Central Oklahoma upon reservation. The researcher was trained to use the equipment by the manager of the laboratory in preparation for this study.

Balke-Ware Submaximal Test Protocol. Participants were asked to attend two sessions during which they would walk on the treadmill using the Balke-Ware submaximal test protocol (Eston et al., 2015). The Balke-Ware protocol involves a 2-3 minute warm-up at the speed of the participants choosing. The first stage had a 0% grade at a constant speed of 3.4 mph for one minute. At the start of the second minute, the grade was increased to 2% with the speed remaining the same. This stage and the subsequent stages were 3 minutes long and increase by 1% grade at the beginning of all the following stages. Completion of the test could take up to 26 minutes. The Balke-Ware protocol was developed by Balke and Ware (1959) and was found to be reliable and valid in measuring maximal and submaximal cardiovascular capacity.

During both sessions and both groups, RPE was recorded every minute of exercise. Additionally, HR and VO_2 was measured continuously for termination criteria, safety, and recording intensity. Testing termination criteria for this study was when at least two items of the list below are met:

1. Reached 85% of age-predicted HRmax for one stage
2. HR no longer increases with increased intensity
3. RPE ≥17 is collected

(ACSM, 2014)

If the participants had physical problems that occured or participants wished to no longer participate, protocols were set in place to terminate testing in accordance with the *ACSM's Guidelines for Exercise Testing and Prescription* (2014).

RPE Instructions. During the first session, all participants received a scripted education on the Borg RPE 15-point scale from a book by Borg (1998), copyright by Gunnar Borg (Appendix D). Use of Borg's copyright instructions were provided by the CDC (2015) were also shown in a study by Askew et al. (2011). During the second session, the treatment group received the Modified Borg instructions from the study by Henderson (2016) seen in Appendix E. The modified script was formulated from a book entitled *Borg's Perceived Exertion and Pain Scales* and the article by Nakagaichi et al. (2004) among other sources that may enhance the instructions. The script developed was modified according to the results of a pilot study performed prior to this study (Henderson, 2016). In Henderson's (2016) pilot study, participants were read the two scripts, and then questions were asked to enhance the quality of the script.

Procedures

Research Preparation. Approval from the Institutional Review Board and Thesis Committee was acquired prior to the start of this study. The estimated time of the testing sessions was about 30 to 45 minutes each. Permission from the two sites of recruitment, Center for Active Living and Learning at UCO and Bradford Village, was obtained.

Recruitment. The researcher read an announcement script (Appendix F) at fitness classes at the retirement community and at the Center for Active Living and Learning in order to recruit participants. Flyers were posted and handed out at the time of the announcements (Appendix G). The script and flyers included the requirement criteria for participation.

Pre-participation Screening. Upon volunteering for the research study, the researcher schedule the first exercise session with the participant. At the first session, the informed consent was given to the participant to read and was told to ask questions if they had any. Once the informed consent form was signed, the participant received coded forms to fill out, including the EASY and a basic profile form. The researcher then reviewed the forms and asked any questions necessary. In the case that a participant answered 'Yes' on any of the EASY questions that were not regulated by medication, they were unable to participate. At that time the participant's age-predicted maximal HR was calculated in accordance with 220 – age.

Exercise Test Day One. Each participant drew from a cup to assign them to a group. Both groups were read the Borg script prior to exercise. All participants were able to view a poster of the 6-20 Borg RPE scale (Figure 1) throughout the exercise test. The Balke-Ware protocol took place until the termination criteria were met or the participant requested termination. Following the first session, participants made an appointment to be tested again at least seven days later.

Exercise Test Day Two. The control group received the same RPE script from the first session. The treatment group received the Modified Borg instructions script with a poster of the scale describing the scale. Participants of the treatment group were asked if they were able to provide examples for each point on the scale to prove they understood. The Borg 6 – 20 poster scale was provided for the control group and a more in-depth poster (Figure 3) with descriptions of the RPEs was provided for the treatment group. The Balke-Ware protocol was then run.

Research Design

This study was a randomized group design. The treatment group had the Borg instructions at the first session and the Modified Borg instructions at the second session. There were two independent variables in this study: group and time. The dependent variables in this study were the correlations of RPE with HR and RPE with VO_2. The two groups were the control group and the treatment group.

Statistical Analysis

- The first null hypothesis was that by ensuring the participant understands the RPE scale the treatment group would not show an increased correlation of RPE to HR and VO_2 from sessions 1 to session two (Borg, 1998, pp. 47-48; Noble & Robertson, 1997).
- The second null hypothesis was that the treatment group would not have a significantly higher correlation than the control group at session two.
- The third null hypothesis was that both the control group and the treatment group would not show a familiarization effect (Eston & Williams, 1988; Katsanos & Moffat, 2005, Thompson & West, 1998).

Alpha was set at .05. RPE was correlated to each recorded HR and VO_2 for every participant, being the dependent variable. A Pearson's correlation coefficient test was run to compare the correlations of session one and session two. A dependent *t*- test analyzed the first and third null hypothesis and an independent *t*- test was run to test the second null hypothesis. Effect sizes (*d*) were examined with Cohen's *d* for each group and time point.

Chapter Four: Results

Purpose

The purpose of this study was to determine the impact of instruction types and familiarization of the correlation between physiological measures of intensity (HR and VO_2) and rate of perceived exertion (RPE). This section will include the statistical analysis of the data collected. One participant dropped out of the control group. There was one outlier in the VO_2 measurements that was removed from group two due to data inaccuracy. Thirteen of the 16 (81.25%) participants in this study were unable to achieve the goal speed of 3.4 mph on the treadmill for the Balke-Ware submaximal protocol.

Baseline Statistics

Participants in this study included 4 males and 12 females (75%) for a total of 16. Participants were randomly assigned to two groups. The treatment group made up 56.5% (n = 9) of the participants and the control group was 43.8% (n = 7). The treatment group contained eight females (88.9%) and one male (11.1%). The control group consisted of four females (57.1%) and three males (42.9%). Ages ranged from 65 to 88 years with a mean age of 74.19 years (SD=7.28). The control group's mean age was 73.57 years (SD = 8.86) and the treatment group's mean age in years was 74.67 (SD = 6.32). Overall mean calculated HRmax was 145.81 beats per minute (bpm; SD = 7.28), mean 85%HRmax was 123.88 bpm (SD = 6.35), and mean HRpeak 137.68 (SD = 14.71). For the control group the mean HRmax, 85%HRmax and HRpeak (peak hear rate) were 146.43 bpm (SD = 8.86), 124.43 bpm (SD = 7.74), and 143.71 (SD = 17.31). The treatment group's mean HRmax, 85%max, and HRpeak were 145.33 bpm (SD = 6.32), 123.44 bpm (SD = 5.50), and 133.00 (SD = 11.15). All baseline statistics are shown in Table 1. Thirteen of the 16 (81.25%) participants met or exceeded their age-predicted 85%HRmax.

Heart Rate and RPE

The first null hypothesis was that the treatment group would have an increased correlation of RPE with HR from session one to two. A Pearson's correlation coefficient was run for each participant and a dependent *t*-test was run to compare the treatment group's mean correlations of HR with RPE from session one to two (Table 2). The mean correlation of session two (*M* = .955, *SD* = 0.072) was not significantly higher than session one (*M* = .943, *SD* = 0.037) in the treatment group with a small effect size, *t* (8) = -.393, *p* = .705, *d* = 0.324. The first null hypothesis that the treatment group would have an increased correlation of RPE with HR from session one to two was accepted.

The second null hypothesis of this study was that the treatment group would not have a significantly higher mean correlation than the control group at session two. An independent *t*-test was run to compare the 2 groups for session two (Table 2). There was not a significant difference between mean correlations for the treatment group and control group at session two with a moderate effect size, *t* (14) = .417, *p* = .189, *d* = 0.611. The mean correlations of HR with RPE were not significantly higher in the treatment group (*M* = .955, *SD* = 0.072) than the control group (*M* = .966, *SD* = 0.018). Mean correlations for HR and RPE for each group and session can be seen in Figure 4. The null hypothesis that the treatment group would not have a significantly higher correlation than the control group at session two was accepted.

The third null hypothesis was that the two groups would not show a familiarization effect. Dependent *t*-tests were conducted to compare each group's correlation of HR with RPE from session one to two (Table 2). The mean correlation of HR with RPE in the control group for session one was .920 (*SD* = 0.055) and session two was .966 (*SD* = 0.018). No significant difference in mean correlations were found in the control group from session one to two, *t* (6) = -

2.121, p = .078, d = 0.836; however, a large effect was observed. The mean correlation for the treatment group for session one (M = .943, SD = 0.037) was not significantly different than session two (M = .955, SD = 0.072). Session two mean correlation was not significantly higher than session one in the treatment group, t (8) = -.393, p = .705, d = 0.324, with a small effect size. The null hypothesis that the two groups would not show a familiarization effect was accepted.

VO_2 and RPE

The first null hypothesis was that the treatment group would not have an increased correlation of RPE with VO_2 from session one to session two. A Pearson's correlation coefficient was run for each participant to correlate VO_2 with RPE. A dependent t-test was run to compare the treatment group's mean correlations of VO_2 with RPE from session one to session two (Table 2). The mean correlation for the treatment group session one (M = .824, SD = 0.166) was not significantly different than session two (M = .927, SD = 0.079) with a moderate effect size, t (7) = -1.678, p = .137, d = 0.620. The null hypothesis that the treatment group would have an increased correlation of RPE with VO_2 from session one to session two was accepted.

The second null hypothesis of this study was that the treatment group would not have a significantly higher correlation than the control group at session two. No significant difference in mean correlations of the groups were found for session two, t (13) = 0.108, p = .457, d = 0.093. The mean correlations of VO_2 with RPE in the treatment group (M = .927, SD = 0.079) were not significantly higher than the control group (M = .931, SD = 0.043) at session two. Mean correlations for VO_2 and RPE for each group and session can be seen in Figure 5. The null hypothesis that the treatment group would not have a significantly higher correlation than the control group at session two was accepted.

The third null hypothesis was that both groups would not show a familiarization effect. A dependent *t*-test was run to compare the groups' mean correlations of VO_2 with RPE from session one to session two (Table 2). The mean correlation for VO_2 with RPE in the control group for session one was (*M* = .915, *SD* = .056) and session two was (*M* = .931, *SD* = 0.043). No significant difference was found in the control group from session one to session two mean correlations with a small effect size, *t* (6) = -.497, *p* = .637, *d* = 0.285. The mean correlation for the treatment group for session one (*M* = .824, *SD* = 0.166) was not significantly different from session two (*M* = .927, *SD* = 0.079). Session two was not significantly higher than session one in the treatment group with a moderate effect size, *t* (7) = -1.67, *p* = .137, *d* = 0.620. The third null hypothesis was that both groups would not show a familiarization effect was accepted.

Group Effect Sizes

Effect sizes were run for both groups together with the mean correlations for HR with RPE. The overall effect size for mean correlations of HR with RPE was moderate (*d* = 0.600). Session one effect size was small (*d* = 0.418). Session two effect size was moderate (*d* = 0.611). Effect sizes were calculated with mean correlations of VO_2 with RPE. The overall group effect size for the mean correlation of VO_2 and RPE was moderate (*d* = 0.469). Session one's effect size was large (*d* = 1.625). Session two's effect size was small (*d* = 0.093). All effect sizes can be seen in Table 3.

Additional Results

There was a significant difference in mean correlations between the groups at session one, *t* (13) = 1.365, *p* = .021, *d* =1.625, with a strong effect size. The mean correlations of VO_2 with RPE for sessions one were significantly higher in the control group (*M* = .915, *SD* = 0.056) than the treatment group (*M* = .824, *SD* = 0.166).

Chapter Five: Discussion

Purpose

Gunnar Borg (1998, pp. 15) explained that proper instruction to the participant is necessary for the application and interpretation of the scale. The rate of perceived exertion (RPE) scale can be used to promote self-monitoring of intensity and prevent injury during exercise if used accurately (Little et al., 2013; Raina et al., 2012). Eston and Williams (1998) found that the correlation of RPE with heart rate (HR) and volume of oxygen consumption (VO_2) during exercise increased in strength from session two to session three. The main purpose of this study was to determine the impact of instruction amount and familiarization on the correlation of RPE with HR and VO_2 with older individuals.

Hypotheses

The first hypothesis was that by ensuring the participant understands the RPE scale, the treatment group will show an increased correlation of RPE to HR and VO_2 from sessions 1 to session two (Borg, 1998, pp. 47-48; Noble & Robertson, 1997). The second hypothesis was that the treatment group will have a significantly higher correlation than the control group at session two. The third hypothesis was that both the control group and the treatment group will show a familiarization effect (Eston & Williams, 1988; Katsanos & Moffat, 2005, Thompson & West, 1998).

Significance

The Administration on Aging (AOA, 2016) defines an older adult to be the age of 65 years and older. Of the 44.7 million older adults on record in 2013, 80% have at least one chronic disease and 68% of older adults have more than one (AOA, 2016; National Council on

Aging [NCOA], 2016). Half of the American adults that have cardiovascular disease are over the age of 65 years (American Heart Association & American Stroke Association, 2014).

A reported barrier to quality of care by primary care and specialty physicians was lack of time with the patients (Demelloe & Deshpande, 2011). This may lead to unclear exercise prescription to patients' post-myocardial infarction (Borg, 1998, pp. 29). RPE is used during cardiac rehabilitation to monitor intensity during exercise (Chen et al., 2015). Aamot et al. (2014) found that patients who monitored their exercise intensity with RPE rather than HR had a significantly lower mean peak HR than the group that used HR. Borg and Dahlstrom (1962) also found in a pilot study that reported RPE was higher than HR during exercise. These differences may be sourced from the disease condition or the ability to perceive exertion accurately.

The American College of Sports Medicine (ACSM, 2014) recommends that RPE be used to monitor intensity during exercise with older adults. The RPE scale is a range of numbers with anchor phrases that help give a reference to the number's intensity (Borg & Borg, 2001). It is important that the participant understands how to apply the RPE scale during exercise (Borg, 1998; Noble & Robertson, 1997). When educating a participant or client about the RPE scale, spending time on the difference between dangerous strain and fatigue may be beneficial (Borg, 1998, pp. 3). This is an important factor for any perception of exertion scale. Dangerous strain can be chest pain, joint pain, or injury during exercise (Borg, 1998, pp. 3). If the participant cannot tell the difference between fatigue and dangerous strain, injuries and medical emergencies can occur (Raina et al., 2012). With the ACSM (2014) recommendation to monitor intensity using the RPE scale, it would be beneficial to find ways to increase the accuracy of the scale's application in older adults and special populations.

The RPE scale has been researched by correlating RPE during exercise to HR, VO_2, and blood lactate since the scale's development (Cordes et al., 2013; Thompson & West, 1998). Studies have looked at the RPE scale during exercise on the recumbent bike, walking, and running on dry ground or underwater (Ceci & Hassmen, 1991; Eston et al., 2009; Fujishima et al., 2008). Becque, Hutchins, and Palm (2004) published the only study found that questioned instructions for the RPE scale. One group was read instructions, performed a maximal exercise test for memory-anchoring, and then started the exercise (Becque et al., 2004). The second group performed the memory-anchoring maximal exercise test on a different day than the exercise with instructions read prior to the exercise (Becque et al., 2004). They examined the effects of timing of which the memory anchors were given, finding no significant difference between groups (Becque et al., 2004).

Analysis of Results

Mean Correlations. The overall correlations for both HR and VO_2 with RPE were strong (Table 2). The literature reviewed with older adults as subjects tended to have lower correlations than the mean correlations in this study (HR M = 0.93-0.96; VO_2 M = 0.86-0.92). Chung et al. (2015) found a significant moderate correlation between RPE with HR (r = 0.70) and VO_2 (r = 0.51). A meta-analysis by Chen et al. (2002) had similar mean correlations (r = 0.69 – 0.70) from the 21 articles reviewed with older adults as participants. One of the closest mean correlations with older adults to the present study were with VO_2peak at an RPE of 19 (r = 0.80) and 20 (r = 0.87) in a study by Eston et al. (2015).

With a comparable methodology, Eston and Faulkner (2007) had two graded exercise tests performed by healthy adults, finding strong correlations with HR and VO_2 (r = 0.95 – 0.98). The strong correlations found were similar to the mean correlations from the current study. Eston and Faulkner (2007) did go to maximal exertion and compared percentages of HR and VO_2 to RPE enabling them to assess accuracy, which was not analyzed in the current study.

The majority of the participants in this study exercised on a regular basis, were educated, and had no major physical limitations. Borg (1998) mentioned that education and fitness level may affect the accuracy of RPE, which could explain the strong correlations found in the present study. Through surveys, Johnson and Phipps (2006) found that 86% of exercising women used perception to monitor intensity during exercise. People who exercise may be more familiar with feelings of exertion but do not have the practice of equating their exertion to a scale. This leaves to question the body awareness of those who do not exercise regularly. In two studies, those with high fitness levels had higher correlations between RPE and HR than low fitness; however, regular exercisers were more likely to underestimate RPE than be accurate (Askew et al., 2011; Marisi & Travlos, 1996). From this, participants in the current study were more likely to have higher correlations and may have underestimated their RPE because of their fitness level.

Treatment Group Change. The first hypothesis was that the treatment group would have an increased correlation of RPE with HR and with VO_2 from session one to session two. The treatment group showed no significant increases in mean correlations from session one to session two for both HR (p = .705, d = 0.324) and VO_2 (p = .137, d = 0.620). The small effect size for the difference between session one and session two for HR showed that the mean correlations had little change (Figure 4). The moderate effect found for the mean correlations of VO_2 and RPE suggests that there was a change from session one to session two and significance may have been found with more participants (Figure 5). The varying effect sizes for HR and VO_2 from the treatment group indicate that HR mean correlations with RPE were less variable than VO_2.

A study with younger adults by Eston and Williams (1998) found that correlations at RPE of 9, 13, and 15 increased from session one to session two and more so from session two to 3. A similar study also found that there was an increase in correlations from session two to session 3 (Katsanos & Moffatt, 2005). Although no significance was found, there were increases in the mean correlations from session one to session two. The increases could propose that instructions being given a second time improved understanding of the scale or that an increase in accuracy occurred. This study's design differed from Eston and Williams (1998) in that there were only two sessions with each session an exercise test was conducted. Participants in their study worked at a self-selected pace and resistance to work at the prescribed RPE levels (Eston & Williams, 1998; Katsanos & Moffatt, 2005).

Group Comparison. The second hypothesis was that the treatment group would have a significantly higher correlation than the control group at session two. The mean correlation for HR with RPE found in this study was not significantly (p = .189, d = 0.611) different between the two groups from at session two (Table 2). The mean correlation of HR with RPE indicates a difference between the two groups at session two, shown by the moderate effect size. There was no significant (p = .457, d = 0.093) difference of the mean correlation of VO_2 with RPE between the groups at session two. The small effect for the comparison of the mean correlations of VO_2 and RPE found at session two between groups suggests that the groups were similar.

The contrasting effect sizes for HR and VO_2 mean correlations with RPE could be from the accuracy of the equipment used. The HR strap and the *Parvo Medics True One 2400* metabolic cart each have a percentage of error in measurements causing a potential for variability. HR may also have been affected by medication in some participants, which could have increased the inter-individual variability. Additionally, effect sizes for each group from session one to session two for the mean correlations of HR and VO_2 with RPE were also opposite from each other (Table3). The control group was made up of more males and had less total participants than the treatment group. Askew et al. (2011) found that females were more likely to be accurate with RPE, while males were more likely to underestimated. This also may explain the variability's found between the two groups for HR and VO_2 in this study.

The control groups mean correlations being higher at session two suggest that the change of instruction in the treatment group may have effect results. Participants in the control group had the opportunity to familiarize with the same instruction and scale at both sessions while the treatment group did not. A conclusion on the impact of the instruction types cannot be made until further research on the two types has been conducted.

To the author's knowledge, no other studies have analyzed the differences of mean correlations between sessions or trials. Chung et al. (2015) observed no differences between the two maximal trials on the cycle ergometer, but they did not analyze the differences between the two trials. Similarly, Eston and Faulkner (2007) looked at the accuracy of RPE during two graded exercise sessions, but did not compare the two sessions only analyzed the consistency of the results. Other studies that have researched RPE accuracy over time have done a graded maximal exercise test, then three prescribed sessions at three different prescribed RPE levels (Eston & Williams, 1998; Katsanos & Moffatt, 2005). The studies found increases in correlations over the three sessions at each of the prescribed RPE levels like this study (Eston & Williams, 1998; Katsanos & Moffatt, 2005).

Familiarization. The third hypothesis was that the two groups would show a familiarization effect. The control group approached a significant difference (p = .078, d = 0.836) from session one to two for the mean correlation of HR with RPE. The strong effect size suggests that there may have been a familiarization effect for the control group, if the control group contained more participants. No significant difference with a small effect size (*p* = .705, *d* = 0.324) was found from session one to session two in the control group for the mean correlation of VO_2 with RPE. The treatment group did not have a significant change in the mean correlations of VO_2 (*p* = .137, *d* = 0.620) and HR (*p* = .705, *d* = .324) with RPE. The moderate effect found for the difference from session one to session two for VO_2 mean correlation with RPE suggests that there could have been a familiarization effect. This may have been from the change to the modified instructions at session two compared to session one since there was no familiarization effect for the control group. A stronger effect or significance may have been found if more participants volunteered for this study.

A familiarization effect may have occurred, but there was not enough of an increase for significance. Correlations in this study tended to be strong for each participant, leaving less room for a significant increase at session two. Even though no significance was found, mean correlations did increase in both groups from session one to session two. This shows that repeat instruction and practice with the scale could increase accuracy of RPE. Henderson (2016) was told in interviews that participants thought they would be more accurate using RPE with practice. This and other studies suggest that there can be a familiarization effect with using RPE while exercising (Eston & Williams, 1998; Katsanos & Moffat, 2005).

It is possible that participants in this study were not comfortable or familiar with walking on the treadmill and wearing the VO_2 mask until the second session. One study concluded that familiarization for walking on the treadmill can take roughly 20 minutes (Kruger, Lindernberger, Lovden, Schellenbach & Verrel, 2010). Some participants expressed concern that it was either their first time walking on a treadmill or have not walked on a treadmill in years. There were visible comfort and biomechanical improvements during the time on the treadmill. Some participants were observed to have improvement in comfort and gait at session two.

Low confidence in walking and higher physical activity levels were significantly related to higher RPE levels while walking in a study by Brach et al. (2012). Gait changes during fast walking and treadmill walking may have had an impact on the participants' comfort and ability to walk on the treadmill at the protocol's fast pace. Begg et al. (2014) found that during fast walking foot clearance decreased, increasing the tripping risk for younger and older adults. This may have contributed to the discomfort that the participants expressed during the speed increase at the beginning of the Balke-Ware submaximal protocol. The comfort level and biomechanical difference of walking on the treadmill may have affected the accuracy of results in the current study.

Additional Findings

There was no significant (p = .70, d = 0.418) difference between the two groups mean correlations of HR and RPE at session one with a small effect size. The treatment group did have a higher mean correlation with HR and RPE at session one compared to the control group, but was not enough of a difference to find significance (Table 2). Correlations in this study tended to be strong for each participant, which may have led to the findings being more similar at both sessions. If more participants were in this study there may have been able to show a stronger effect.

The treatment group's mean correlation was significantly (p = .021, d = 1.625) lower at session one for the mean correlation of VO_2 with RPE; however, there was no difference between groups at session two with a small effect size (Table 2). There was a significant difference, with a high effect size (Table 3), between the groups at session one of the mean correlations of VO_2 with RPE. The significance causes some speculation because the instructions were the same for both groups at session one. The very large effect size shows that there was a practical significance in the difference between groups at session one. The mean correlation of the treatment group at session two decreased the difference between the two groups at session one (Table 2). This could suggest that the modified instructions affected the use of the RPE scale in the treatment group. The increase from session one to two for the treatment group was greater than the increase for the control group from session one to session two; although, this finding was not found significant with a small effect size.

Strengths

The research question presented here was unique in nature. Instructions of RPE have not yet been researched in this way. Instructions of RPE are important to research because it is a practical monitoring method for general and special populations. ACSM recommends that RPE should be used with older adults, those with arthritis, and other special populations to monitor exercise intensity (ACSM, 2014). Rehabilitation clinics use RPE as a way to monitor patients during exercise to have additional information for patient progression (Chen et al., 2015). Some studies have shown that RPE and HR have not been correlated in rehabilitative patients, because some medications can affect the heart's ability to increase rhythm during activity (Aamott et al., 2014; Borg & Dahlstrom, 1962). Research that has reported mean correlations with RPE have ranged from weak to strong (Ceci & Hassman, 1991; Chen et al., 2002; Chung et al., 2015; Eston & Faulkner, 2007; Eston et al., 2015; Katsanos & Moffatt, 2005). This suggests that there could have been insufficient understanding of the scale's use with some populations.

A pilot study was performed prior to the start of this study to review and to analyze the understanding of the instructions for RPE (Henderson, 2016). The pilot study was an interview style where the participants were read the Borg copyrighted instructions and Modified Borg instructions (Henderson, 2016). Similar to this study, the participants came twice and were randomly read the two scripts with an interview afterwards (Henderson, 2016). Participants in the study requested a poster version of the modified instructions and provided suggestions for revising the script (Henderson, 2016). The modifications were made and the poster was developed for the treatment group of this study.

Not many studies have researched RPE accuracy with older adults. This study will add to the literature of RPE use with older adults while walking on the treadmill; however, age may not be an important factor for researching the accuracy of RPE. A group of middle-age and older-age women using the RPE scale during exercise were compared with no difference found (Nakagaichi et al., 2004). Older-age women in the study had lower overall exercise performance, but they were working at similar perceived exertion levels as the middle-age women (Nakagaichi et al., 2004). Askew et al. (2011) also found that there were no significant differences in accuracy by age group. Instructions may be an important factor for using RPE among various age groups.

Limitations

The main limitation of this study was the chosen exercise testing protocol. The Balke-Ware protocol's walking speed of 3.4 mph was considerably fast for more than half of the participants in this study. Participants that were unable to walk at the set pace performed a self-determined brisk walking pace (1.5 – 2.7 mph), which was used for that participant for the remainder of the study. Participants were still taken through the normal steps of the Balke-Ware protocol and were able to reach the termination criteria. Walking at the self-perceived brisk pace may have affected the results of this study. Eston et al. (2015) had participants perform the Balke-Ware maximal protocol. The participants' mean age in their study was 64.8 years (*SD* = 3.7), which was 10 years younger than the mean age of this study (*M* = 74.19 years, *SD* = 7.28).

All participants in this study were considered active, limiting the ability to apply these findings to the general population of older adults. Although a requirement for participation in this study was to be comfortable with walking on the treadmill, there were participants with visible discomfort or anxiety during the first session of exercise testing. This may have affected the correlation of session one to session two for those individuals. Improvements in gait and comfort were seen either by the end of the exercise test of session one or during session two. Gait changes, including foot clearance, can be altered during walking on the treadmill and while walking at a brisk pace (Begg et al., 2014; Kruger et al., 2010).

Participants tended to meet or exceed their age predicted 85%HR derived from the equation 220-age (Table 1). Engels, Moffatt, and Zhu (1998) found that in adults the absolute error rate for the 220-age equation was 9.2 beats per minute. The authors also stated that there was increased error with increased age (Engels, Moffatt & Zhu, 1998). Possibly a more accurate equation could have been utilized instead of 220-age. Häkkinen et al. (2008) concluded that age was not a good predictor for heart max and other factors should be included in the equation. Validation of a more accurate HRmax prediction equation is needed, especially for older adults.

Performing a maximal exercise test may have allowed the author to compare the results to the ACSM (2014) published %HR and %VO_2 equivalents of RPE. The maximal protocol would enable analysis of RPE accuracy during exercise. Although, Ehsani et al. (1998) showed that older women reported RPEs higher than the published equivalents to %HRmax and %VO_2max. The published equivalents would provide a comparison.

In the current study the researcher who read the instructions to the participants was well-versed in the use of the RPE scale and was able to provide clarification to the participants when asked. This may have affected the results in that the researcher was able to explain better regardless of the instructions provided. Specifically defining each level of the Borg 15-point scale could have created a restriction on the participant or enabled them to anchor an exertion to a number. Borg and Borg (2001) stated that participants should not have restrictions while using the perception scales.

Future Research Directions

To the author's knowledge, no study of this kind has been conducted. More research on the instruction effects on the accuracy of RPE should be done in older adults and in adults with different diseases. Although the current study did not show significantly higher correlations with the Modified instructions, accuracy could be affected by lack of instruction. In the field, many professionals may not take the time to read the copyrighted instructions of the scale to their patients or clients. Research on the differing amounts of instructions and its effects on the correlations to HR and VO_2 are needed. For example, a study comparing the correlations of HR and VO_2 with and without Borg's instructions may show the importance this study aimed to show.

Further research should be done with the Modified instructions to determine if the more in-depth instructions are more beneficial for learning how to use RPE. During this study the control group had higher correlations at session two, suggesting that the change of instruction in the treatment group affected the results. A study on the impact of the Modified instructions over two or more sessions compared to the Borg instructions could better show the influence of the two instructions types.

A future study may try to reach a greater range of education and activity levels than the participants in this study. For better understanding of the instructions' effect on accuracy, the variety of people could enhance the ability to apply it in the field. Also, researching changes in results over three to four sessions could show stronger trends and differences over time. A familiarization session prior to exercise testing sessions could increase the validity of the changes in correlations of HR and VO_2 with RPE. Kruger et al. (2010) found that gait changes do occur walking on the treadmill compared to ground walking. Older individuals had required a longer time to normalize gait than younger adults (Kruger et al., 2010). This may impact the research by choosing field testing protocols for comfort and falling risk of the participants.

Testing to maximal exertion would be another step that would allow a closer analysis of the accuracy of RPE. Eston and Faulkner (2007) did two maximal graded exercise test finding similar correlations to this study, but they were able to analyze the percentages of HR and VO_2 to RPEs to test accuracy. Ehsani et al. (1998) tested the accuracy of the ACSM (2014) published equivalents to RPE in older women, finding that RPEs reported were significantly lower than the recommended RPE at their percentage of maximal exertion. HR and VO_2 equivalents should be further researched in those of all ages and diseases for a more accurate equivalent.

Practical Implications

This study was the first to question the effect of the instructions on the correlations of HR and VO_2 with RPE. RPE should be understood well enough that it can be used for exercise prescription (Borg & Borg, 2001). Doctors and fitness professionals should be able to prescribe an RPE or RPE range to their patients providing the scale and the instructions. Borg & Borg (2001) disclosed that when emotion and preference are involved with the perception scales, a well-phrased definition is necessary. Motivation and enjoyment could affect the accuracy of RPE without clear instruction.

Some studies that have researched the accuracy of the RPE scale mentioned that the participants were instructed with standardized instructions (Biren et al., 2009; Cordes et al., 2013; Eston & Faulkner, 2007; Eston et al., 2009; Eston et al., 2015; Johnson & Phipps, 2006; Katsanos & Moffatt, 2005). Sources for these standardized instructions were from the ACSM, CDC, and several different publications by Gunnar Borg (Angelopoulos et al., 1996; Biren et al., 2009; Eston & Faulkner, 2007; Eston et al., 2015; Katsanos & Moffatt, 2005; Thompson & West, 1998; Johnson & Phipps, 2006). Each participant in this study was read instructions before each exercise session, which may explain the strong correlations found in both groups. Once more research has been obtained on the effects of instructions on the accuracy of RPE updated instructions should be published and provided by accredited exercise programs. The instructions should be widely accessible and consistently used for research and field purposes.

Overuse injuries are possible in the older adult population (Little et al., 2013; Raina et al., 2012). Generations coming into old age will start to become more physically active, increasing the need for using RPE to monitor exercise. Using RPE during older adult fitness classes may help to decrease the chance of overexertion injuries (Raina et al., 2012). Little et al. (2013) and Raina et al. (2012) both found that overexertion injuries were the most common (12 out of 18) injury for older adults attending a community dwelling fitness center and older adult fitness classes.

Borg and Borg (2001) mentioned that the scale itself can be displayed differently as long as the anchors and their meaning line up with the design. The poster used in the treatment group was colored by the anchor phrases intensity levels. The modified instructions provided and read to the treatment group were developed to provide education on the feel of exertion and fatigue separate from dangerous strain. The colors on the scale may increase the awareness of the intensity zones the RPE is anchored to.

Some researchers have expressed their aversion to the RPE scale, because of its common use by those who are ill-informed of the scale's utilization (Borg & Borg, 2001). Educating researchers and professionals about the RPE scales and the anchored meaning may decrease the misuse of the scale. If professionals are well informed they may be able to better clarify the scales meanings when participants or clients ask questions about the scale.

Conclusion

Instructions should be read to anyone who is intended to use RPE to help monitor intensity during exercise. The overall strong correlations in this study were possibly due to the fact that both groups were read instructions for RPE. Correlations of HR and VO_2 with RPE are beneficial to analyze, but cannot assess the accuracy of RPE. With increasing intensity RPE, HR, and VO_2 will increase, but that does not make the RPE accurate at that level of HR or VO_2. Familiarization to exercise, RPE, and the equipment used might lead to an increase in accuracy; however, this study did not show a familiarization effect. RPE is important for the prevention of overuse injuries and monitoring exercise intensity when HR is affected by medication or disease. Older adults and younger adults may not differ in accuracy of RPE, but performance level may vary from person to person. The ability to explain the use of the RPE scale with instructions may be an important factor for field application. The modified instructions in this study did not show any significant differences indicating that it was a better method. More research needs to be done on the impact the instructions have on the participant's ability to accurately perceive their exertion before a conclusion can be made.

References

American College of Sports Medicine. (1998). Exercise and physical activity for older adults. *Medical Science of Sports Exercise, 30,* 992–1008. doi: 10.1097/00005768-199806000-00033

American College of Sports Medicine. (2014). *ACSM's Guidelines for Exercise Testing and Prescription.* (ed. 9). Pescatello, L.S., Arena, R., Riebe, D. & Thompson, P.D. Baltimore, Maryland: Lippincott Williams and Wilkins.

Aamot, I.L., Forbord, S.H., Karlsen, T. & Stoylen, A. (2014). Does rating of perceived exertion result in target exercise intensity during interval training in cardiac rehabilitation? A study of the Borg scale versus a heart rate monitor. *Journal of Science and Medicine in Sport, 17*(5), 541-545. doi:10.1016/j.jsams.2013.07.019

American Diabetes Association [ADA]. (2015). Older Adults. Retrieved from: http://www.diabetes.org/in-my-community/awareness-programs/older-adults/?referrer=https://www.google.com/

American Heart Association [AHA], American Stroke Association [ASA]. (2013). Heart disease and stroke statistics. Retrieved from: https://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319574.pdf

Angelopoulos, T., Dasilva, S., Gordon, P., Goss, F., Kang, J., Metz, K. … & Visich, P. (1996). Validity of the Borg rate of perceived exertion scale for use in the semi-recumbent ergometry during immersion in water. *Perceptual and Motor Skills, 83*(1), 3-13. doi: 10.2466/pms.1996.83.1.3

Antezak, A., Crouter, S.E., Della Valle, D.M., Haas, J.D. & Hudak, J.R. (2006). Accuracy and reliability of the PravoMedics TrueOne 2400 and MedGraphics VO2000 metabolic systems. *European Journal of Applied Physiology, 98*(2), 139-151. doi: 10.1007/s00421-006-0255-0

Askew, E.W., Benson, J., Hannon, J.C. & Skatrud-Mickleson, M. (2011). A comparison of subjective and objective measures of physical exertion. *Journal of Sports Sciences, 29*(15), 1635-1644. doi: 10.1080/02640414.2011.609898

Balke, B. & Ware, R.W. (1959). An experimental study of physical fitness of Air Force personnel. *United States Armed Forces Medical Journal, 10*(6), 675-688. Retrieved from: https://babel.hathitrust.org/cgi/pt?id=mdp.39015074002737;view=1up;seq=721

Bazzarre, T.L., Bolin, J.N., Chodzko-Zajko, W., Hora, K., Lyle, R.M., Page., P. … & Sipe, C. (2008). A proposal for a new screening paradigm and tool called exercise assessment and screening easy for you. *Journal of Aging and Physical Activity, 16*, 215-233. Retrieved from: http://journals.humankinetics.com/loi/japa

Beason, K.R., Brown, S.P., Chitwood, L.F. & McLermore, D.R. (1996). Perceptual responses to deep water running and treadmill exercise. *Perceptual and Motor Skills, 83*(1), 131-139. doi: 10.2466/pms.1996.83.1.131

Becque, M.D., Hutchins, M.D. & Palm, C.M. (2004). Comparison of memory and combined exercise and memory-anchoring procedures on ratings of perceived exertion during short duration, near-peak-intensity cycle ergometer exercise. *Perceptual and Motor Skills, 99,* 775-784. doi: 10.2466/pms.99.3.775-784

Begg, R.K., James, L., Hanatsu, N. & Sparrow, W.A. (2014). Effect of walking-induced fatigue on gait function and tripping risk in older adults. *Journal of NeuroEngineering and Rehabilitation, 11*(155), 1-7. doi:10.1186/1743-0003-11-155

Biren, G.B., Chaloupka, E.C., Hoffman, J.R., Kang, J. & Masterangelo, M.A. (2009). Regulating intensity using perceived exertion: Effect of exercise duration. *European Journal of Applied Physiology, 105,* 445-451. doi: 10.1007/s00421-008-0922-4

Borg, G. & Dahlstorm, H. (1960). The perception of muscular work. *Publication of the Umera Research Library, 5,* 1-27.

Borg, G. & Dahlstorm, H. (1962). A pilot study of physical working capacity and perceived exertion. *Acta Societatis Medicorum Upsaliensis, 67,* 21-27.

Borg, G.A.V. (1962). Physical performance and perceived exertion. *Lund: Gleerup, 11*, 5-64. Retrieved from: http://w3.psychology.su.se/staff/eb/Borg_G_1962_thesis.pdf

Borg G. (1970). Perceived exertion as an indicator of somatic stress. *Scandinavian Journal of Rehabilitative Medicine*, *2*, 92-98.

Borg, G. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sport and Exercise, 14*(5), 377-381. Retrieved from: http://journals.lww.com/acsm-msse/pages/default.aspx

Borg, G. (1990). Psychophysical scaling with applications in physical work and the perception of exertion. *Scandinavian Journal of Work: Environment & Health, 16*(1), 55-58. doi: 10.5271/sjweh.1815

Borg, G. (1998). *Borg's perceived exertion and pain scales*. Champaign, Illinois: Human Kinetics.

Borg, G. & Borg, E. (2001). A new generation of scaling methods: Level-anchored scaling. *Psychologica, 28,* 15-45. Retrieved from: http://w3.psychology.su.se/staff/eb/

Brach, J.S., Julius, L.M., VanSwearingen, J.M. & Wert, D.M. (2012). Perceived effort of walking: Relationship with gait, physical function and activity, fear of falling, and confidence in walking in older adults with mobility limitations. *American Physical Therapy Association*, *92*(10), 1268-1277. doi: 10.2522/ptj.20110326

Caputo, J.L., Dolbow, D.R., Farley, R.S. & Kim, J.K. (2008). Oxygen consumption, heart rate, rating of perceived exertion, and systolic blood pressure with water treadmill walking. *Journal of Aging and Physical Activity, 16,* 14-23. Retrieved from: http://journals.humankinetics.com/loi/japa

Ceci, R. & Hassmen, P. (1991). Self-monitored exercise at three different RPE intensities in treadmill versus field running. *Medicine and Science in Sports and Exercise, 23*(6), 732-738. doi: 10.1249/00005768-199106000-00013

Center of Disease Control and Prevention [CDC]. (2015). Measuring physical activity intensity. Division of Nutrition, Physical Activity, and Obesity. Retrieved from http://www.cdc.gov/physicalactivity/basics/measuring/exertion.htm

Center of Disease Control and Prevention [CDC]. (2016). Arthritis Related Statistics. Retrieved from: http://www.cdc.gov/arthritis/data_statistics/arthritis-related-stats.htm

Chen, M.J., Fan, X. & Moe, S.T. (2002). Criterion-related validity of the Borg ratings of perceived exertion scale in healthy individuals: A meta-analysis. *Journal of Sports Sciences, 20,* 873-899. doi: 10.1080/026404102320761787

Chen, Y.W., Huang, Y.H., Ting, C.T. & Tsai, S.W. (2015). Influence of β-blockers on heart rate recovery and rating of perceived exertion when determining training intensity for cardiac rehabilitation. *Journal of Chinese Medical Association, 78,* 520-525. Retrieved from: http: 10.1016/j.jcma.2015.05.009

Christle, J.W., Halle, M., Pressler, A., Scherr, J. Wolfarth, B. & Wagenfeil, S. (2013). Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. *European Journal of Applied Physiology, 113*, 147-155. doi: 10.1007/s00421-012-2421-x

Chung, P.K., Liu, J.D., Quach, B. & Zhao, Y. (2015). A brief note on the reliability of the rating of perceived exertion scale in monitoring exercise intensity among Chinese older adults in Hong Kong. *Perceptual and Motor Skills: Motor Skills and Ergonomics, 121*(3), 805-809. doi: 10.2466/29.PMS.121c24x8

Coquart, J.B., Eston, R. G., Garcin, M., Parfitt, G. & Tourny-Chollet, C. (2014). Prediction of maximal or peak oxygen uptake from ratings of perceived exertion. *Sports Medicine, 44*, 563-578. doi: 10.1007/s40279-013-0139-5

Cordes, M., Donath, L., Faude, O., Hannssen, H., Schmidt-Truksass, A. & Zahner, L. (2013). Recommendations for aerobic endurance training based on subjective ratings of perceived exertion in healthy seniors. *Journal of Aging and Physical Activity, 21*(1), 100-111. doi: 10.1123/japa.21.1.100

Curtis, L.H., Hammill, B.G., Schulman, K.A. & Whellan, D.J. (2010). Relationship between cardiac rehabilitation and long-term risks of mortality and myocardial infarction among elderly Medicare beneficiaries. *National Institute of Health, 121*(1), 63-70. doi: 10.1161/CIRCULATIONAHA.109.876383

Demelloe, J. & Deshpande, S.P. (2011). A comparative analysis of factors that hinder primary care physicians' and specialist physicians' ability to provide high-quality care. *Health Care Management (Frederick), 30*(2), 172-178. doi: 10.1097/HCM.0b013e318216fa81.

Ehsani, A.A., Holloazy, J.O., Kohrt, W.M. & Spina, R.J. (1998). Prescribing exercise intensity for older women. *Journal of the American Geriatric Society, 46*(2), 129-133. doi: 10.1111/j.1532-5415.1998.tb02528.x

Engels, H.J., Moffattm R.J. & Zhu, W. (1998). An empirical evaluation of the prediction of maximal heart rate. *Research Quarterly for Exercise and Sport*, *69*(1), 94 – 98. Retrieved from: http://www.shapeamerica.org/publications/journals/rqes/

Eston, R.G. & Williams, J.G. (1988). Reliability of ratings of perceived effort regulation of exercise intensity. *British Journal of Sports Medicine, 22*(4), 153-155. Retrieved from http://bjsm.bmj.com/

Eston, R. & Faulkner, J. (2007). Overall and peripheral ratings of perceived exertion during a graded exercise test to volitional exhaustion in individuals of high and low fitness. *European Journal of Applied Physiology*, *101,* 613-620. doi: 10.1007/s00421-007-0536-2

Eston, R. G., Faulkner, J.A., Lambrick, D.M. & Rowlands, A.V. (2009). Prediction of maximal oxygen uptake from submaximal ratings of perceived exertion and heart rate during a continuous exercise test: The efficacy of RPE 13. *European Journal of Applied Physiology, 107,* 1-9. doi:10.1007/s00421-009-1093-7

Eston, R.G., Norton, B., Parfitt, G. & Smith, A.E. (2015). A perceptually-regulated exercise test predicts peak oxygen uptake in older active adults. *Journal of Aging and Physical Activity 23*, 205-211. doi: http://dx.doi.org/10.1123/japa.2013-0213

Fujishima, K., Hotta, N., Masumoto, K. & Shono, T. (2008). Muscle activation, cardiorespiratory response, and rating of perceived exertion in older subjects while walking in water and on dry land. *Journal of Electromyography and Kinesiology, 18,* 581-590. doi: 10.1016/j.jelekin.*2006*.12.009

Häkkinen, A. , Häkkinen, K. Karavirta, L., Kinnunen, H., Laaksonen, D., Laukkanen, R., … & Tulppo, M. (2008) Estimation of maximal heart rate using the relationship between heart rate variability and exercise intensity in 40–67 years old men. *European Journal of Applied Physiology, 103*(1), 25-32. doi: 10.1007/s00421-007-0667-5

Henderson, M.O. (2015). *Evaluating Instructions for use of the Rate of Perceived Exertion Scale: A Pilot Study.* Unpublished. Department of Kinesiology and Health Studies. University of Central Oklahoma, Edmond, Oklahoma, United States.

Human Kinetics (Producer). (2014). *Advanced Fitness Assessment and Exercise Prescription: Calibrating Treadmills [Video]*. Available from http://courses.humankinetics.com/shell.cfm?pageid=31172

Johnson, L.K., Katula, J.A., Koury, K.L., Marsh, A.P., Pacchia, C.F. & Rajeski, W.J. (2006). Effect of treadmill and overground walking on function and attitudes in older adults. *Medical Science of Sports Exercise, 38*(6), 1157-1164. doi: 10.1249/01.mss.0000222844.81638.35

Johnson, J.H. & Phipps, L.K. (2006). Preferred method of selecting exercise intensity in adult women. *Journal of Strength and Conditioning Research, 20*(2), 446-449. Retrieved from: http://journals.lww.com/nsca-jscr/Pages/default.aspx

Katsonos, C.S. & Moffat, R.J. (2005). Reliability of heart rate responses at given ratings of perceived exertion in cycling and walking. *Research Quarterly for Exercise and Sport, 76*(4), 433-439. Retrieved from http://www.shapeamerica.org/publications/journals/rqes/

Kruger, A., Lindernberger, U., Lovden, M., Schellenbach, M. & Verrel, J. (2010). Adult age differences in familiarization to treadmill walking within virtual environments. *Gait and Posture, 31*(3), 295-299. doi: 10.1016/j.gaitpost.2009.11.008

Little, R., Raina, P., Stathokostas, L., Theuo, O. & Vandervoort, T. (2013). Physical activity-related injuries in older adults: A scoping review. *Journal of Sports Medicine, 43*, 955-963. doi: 10.1007/s40279-013-0076-3

Marisi, D.Q. & Travlos, A.K. (1996). Perceived exertion during physical exercise among individuals with high and low fitness. *Perceptual and Motor Skills, 82*(2), 419-424. doi: 10.2466/pms.1996.82.2.419

Nakagaichi, M., Nho, H., Shigematsu, R., Tanaka, K. & Ueno, L.M. (2004). Rate of perceived exertion as a tool to monitor cycling exercise intensity in older adults. *Journal of Aging and Physical Activity, 12* (1), 3-9. Retrieved from: http://journals.humankinetics.com/loi/japa

National Council on Aging [NCOA]. (2016). Chronic disease management. Retrieved from: https://www.ncoa.org/healthy-aging/chronic-disease/

Nelson, J.R., Silverman, S.J. & Thomas, J.R. (2015). *Research Methods in Physical Activity.* Champaign, IL: Human Kinetics.

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., ... & Castaneda-Sceppa, C. (2007). Physical activity and public health in older adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Circulation, 116*(9), 1094-1105. doi: 10.1161/CIRCULATIONAHA.107.185650

Noble, B.J. & Robertson, R.J. (1997). Perception of physical exertion: Methods, mediators, and applications. *Exercise and Sports Sciences Reviews, 25*(1), 407-452. Retrieved from: http://journals.lww.com/acsm-essr/Pages/default.aspx

Office of Disease Prevention and Health Promotion [DPHP], health.gov. (2008). Physical activity guidelines for Americans. Retrieved from: http://health.gov/paguidelines/guidelines/chapter5.aspx

Raina, P., Stathokostas, L., Theuo, O. & Vandervoort, T. (2012). Psychometric properties of a questionnaire to assess exercise-related musculoskeletal injuries in older adults attending a community-based fitness facility. *British Medical Journal Open*, *2*, 1-8. doi: 10.1136/bmjopen-2012-001777

Thompson, D.L. & West, K.A. (1998). Ratings of perceived exertion to determine intensity during outdoor running. *Canadian Journal of Applied Physiology*, *23*(1), 56-65. doi: 10.1139/h98-003

United States Department of Health and Human Services, Administration on Aging. (2016). Administration on Aging [AOA]: Aging Statistics. Retrieved from: http://www.aoa.acl.gov/aging_statistics/index.aspx

World Health Organization [WHO]. (2015). Ageing and health. Retrieved from: http://www.who.int/mediacentre/factsheets/fs404/en/

TABLES

Table 1

Participant Characteristics

	Male (%)	Female (%)	Age	HRmax	%85HRmax	HRpeak
Control	3(42.9)	4 (57.1)	73.57	146.43	124.43	143.71
Treatment	1 (11.1)	8 (88.9)	74.67	145.33	123.44	133.00
Total	4 (23.5)	12 (70.6)	74.19	145.81	120.49	137.68

Note. HRmax is the mean age-predicted heart rate max. %85HRmax is the mean of 85% of the age-predicted heart rate max. HRpeak is the mean peak heart rate measured for both session one and session two.

Table 2

Comparison of Mean Correlations for Session one and 2

	Mean (*SD*)	Mean Difference	*p*	*t*	*df*
Control					
HR 1	0.920 (0.055)				
HR 2	0.966 (0.018)	-0.046	.078	-2.121	6
VO_2 1	0.915 (0.056)				
VO_2 2	0.931 (0.043)	-0.015	.637	-0.497	6
Treatment					
HR 1	0.943 (0.037)				
HR 2	0.955 (0.072)	-0.011	.705	-0.393	8
VO_2 1	0.824 (0.166)				
VO_2 2	0.927 (0.079)	-0.102	.137	-1.678	7
Total					
HR 1	0.933 (0.045)				
HR 2	0.960 (0.054)	-0.026	.172	-1.434	15
VO_2 1	0.867 (0.132)				
VO_2 2	0.929 (0.063)	-0.061	.111	-1.701	14

Note. HR 1 = heart rate correlation with RPE at session one; HR 2 = heart rate correlation with RPE at session two; VO_2 1 = volume of oxygen correlation with RPE at session one; VO_2 2 = volume of oxygen correlation with RPE at session two.

Table 3

Effect Sizes of the Differences between Groups and Sessions

	d	Mean Difference	% Change	Group Difference at Session one		Group Difference at Session two	
				HR	VO_2	HR	VO_2
Control							
HR1 – HR2	0.836	-0.046	-5.00%	-	-	-	-
$VO_2$1 – $VO_2$2	0.285	-0.016	-1.75%				
Treatment							
HR1 – HR2	0.324	-0.012	-1.27%	-	-	-	-
$VO_2$1 – $VO_2$2	0.620	-0.103	-12.50%				
Total							
HR1 – HR2	0.600	-0.027	-2.89%	-	-	-	-
$VO_2$1 – $VO_2$2	0.469	-0.062	-7.15%				
d	-	-	-	0.418	1.625	0.611	0.093
Mean Difference	-	-	-	-0.023	0.091	0.011	0.004
% Change	-	-	-	-2.50%	9.95%	1.14%	0.43%

Note. HR 1 = heart rate correlation with RPE at session one; HR 2 = heart rate correlation with RPE at session two; VO_2 1 = volume of oxygen correlation with RPE at session one; VO_2 2 = volume of oxygen correlation with RPE at session two

FIGURES

Borg's RPE scale	
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 1. Borg’s RPE Scale 6 – 20 (Borg, 1990)

Borg CR- 10 Scale	
0	Nothing at all
0.5	Extremely Weak (Just noticeable)
1	
2	Weak (Light)
3	Moderate
4	
5	Strong (Heavy)
6	
7	Very Strong
8	
9	
10	Extremely Strong (Almost Max)

Figure 2. Borg CR-10 Scale (Borg, 1990)

6	"No exertion at all" or at rest
7	"Extremely Light" very little effort to perform the activity
8	feels like you are working to do the activity, still able to perform for long periods
9	"Very Light" feels like you are showing an effort to perform the activity but it is small and can be performed for long periods
10	effort to perform the activity is known and your breathing rate/heart rate is starting to increase slightly, you are still able to perform this for long periods
11	feel a slow increase in breathing and heart rate, can continue activity for a long period
12	Elevated heart rate and breathing rate but still able to perform, increased effort to perform
13	"somewhat hard" increased breathing rate and heart rate. You are starting to feel fatigued, but you can still continue.
14	Breathing rate and heart rate increase even further. Fatigue is increasing but you can still continue.
15	"Hard" the activity is heavy and fatiguing, can continue but feel tired continuing for a shorter time
16	starting to become hard to perform the activity, ability to perform may not be much longer
17	very heavy, fatigue is high, breathing rate & heart rate are high, you can continue for shorter amount of time.
18	approaching maximal exertion with breathing rate highly elevated and the body is close to not being able to keep up with the activity.
19	your maximal exertion. You are extremely fatigued and cannot perform the exercise for much longer, the most fatigue during exercise that has ever been experienced
20	is the most strenuous exertion imaginable

Figure 3. The Modified Borg Poster

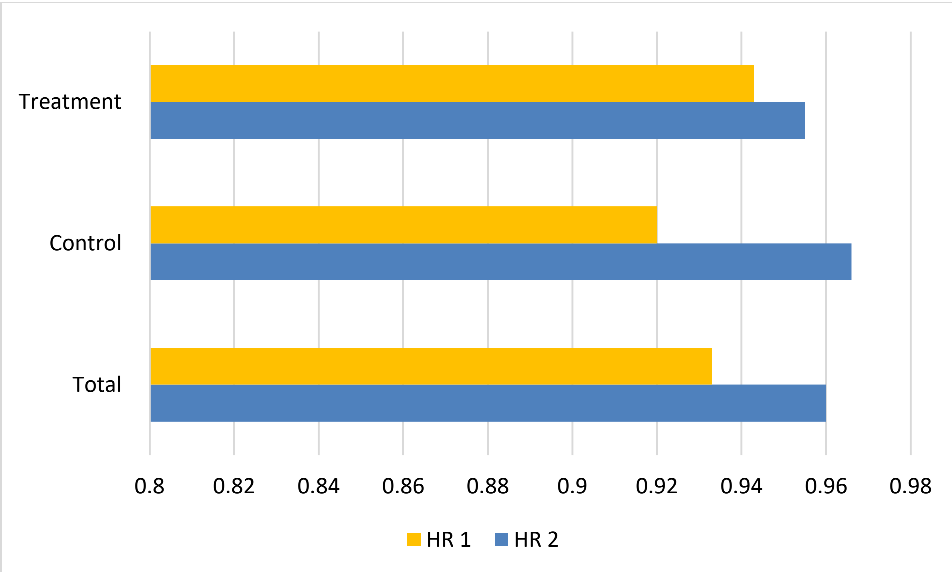


Figure 4. Mean Correlation Changes for Heart Rate with RPE. HR 1 = heart rate at session one; HR 2 = heart rate at session two

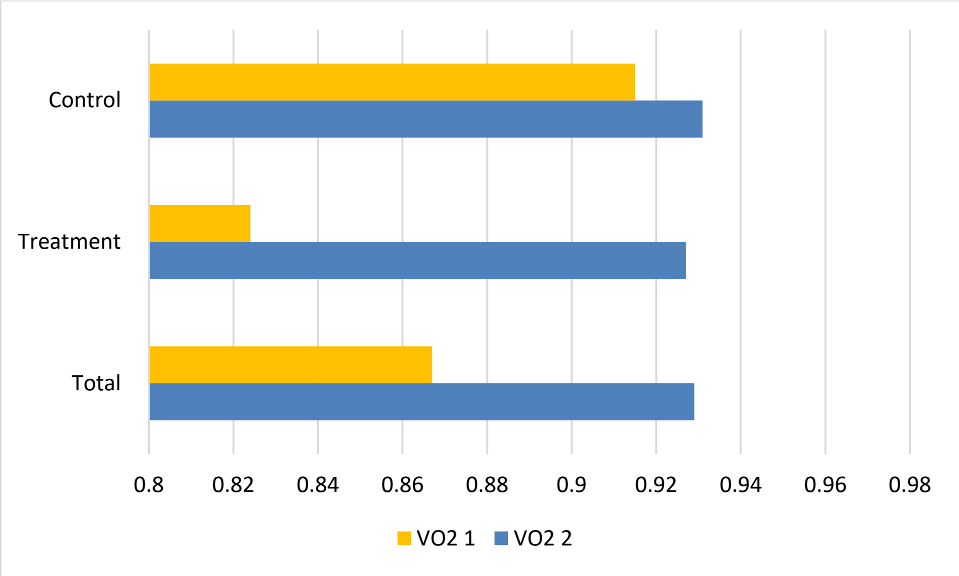


Figure 5. Mean Correlation Changes for VO_2 and RPE. VO2 1 = volume of oxygen consumption at session one; VO2 2 = volume of oxygen consumption at session two

APPENDICES

APPENDIX A

EXERCISE AND SCREENING FOR YOU (EASY)

www.easyforyou.info

easy
Exercise And
Screening for You

Nearly all older adults can safely meet the national recommendations of engaging in moderate intensity physical activity (such as brisk walking or gardening) for at least 30 minutes a day, most days of the week. The EASY tool helps you know when to see a health care provider to discuss your exercise plan and how to choose activities for optimal benefit if you have any health problems.

Getting Started

It is always a good idea to start at a level that is easy for you and to build up slowly. See the attached safety tips.

While it is generally not necessary to see a health care provider before beginning every-day physical activities that are of light or moderate intensity, we encourage you to talk with your health care provider about your health and exercise as part of your regular visits.

The EASY tool at www.easyforyou.info helps identify ways you can be active safely.

For more information
on using the EASY tool please contact:
Phone: 979-458-3507
Email: ahpp@srph.tamhsc.edu

www.easyforyou.info **Revised 4/3/2008**

Email: ahpp@srph.tamhsc.edu

www.easyforyou.info

Answering the Six Easy Questions:

EASY QUESTIONS (Circle Response):

1) Do you have pains, tightness or pressure in your chest during physical activity (walking, climbing stairs, household chores, similar activities)?	Yes	No
2) Do you currently experience dizziness or lightheadedness?	Yes	No
3) Have you ever been told you have high blood pressure?	Yes	No
4) Do you have pain, stiffness or swelling that limits or prevents you from doing what you want or need to do?	Yes	No
5) Do you fall, feel unsteady, or use assistive device device while standing or walking?	Yes	No
6) Is there a health reason not mentioned why you would be concerned about starting an exercise program?	Yes	No

Revised 4/3/2008

Please see the answer sheets for recommended actions and for how to get additional information

EASY RECOMMENDATIONS BASED ON RESPONSES

If you answer No to all of the questions on the EASY, follow these four steps to begin or continue your exercise program:

1. **Choose enjoyable activities that fit into your everyday routine.**

2. **Set a goal of being active 30 minutes daily most days of the week (it is best to work toward this goal slowly).**

3. **Review the safety tips in this packet.**

4. **Request a free copy of the NIA Exercise Guide by calling 1-800-222-2225 or go to www.easyforyou.info for additional exercise options.**

If you answered Yes to any of the EASY questions, use the recommendations sheet for exercising safely with your condition. It is always a good idea to review the safety hints and be aware of what the experts say are the most appropriate exercises for any specific condition. For each question, we provide a link for further information. Talk with your healthcare provider about your exercise program during your regular visits.

www.easyforyou.info **Revised 4/3/2008**

Answering Yes to any of the EASY Questions:

Question	YES
1. Do you have pain, tightness or pressure in your chest during physical activity (walking, climbing stairs, household chores, similar activities)?	If you answered yes to this question and this is a NEW problem, see your health care provider first before starting any exercises. Ask your health care provider "Are there any exercises that I can not do"? Work with your doctor to identify activities that are appropriate for you. If it is not new, or has already been evaluated, begin or continue your exercise program. American Heart Association 1-800-242-8721 http://www.americanheart.org
2. Do you currently experience dizziness or lightheadedness?	If you answered yes, it is recommended that you talk with your health care provider before initiating a new activity program. Ask if there are any exercises you cannot do. Work with your provider to identify exercises good for you. NIH SeniorHealth 1-800-222-2225 http://seniorhealth.gov/exercise/toc.html

Question	Helpful Tips
3. Have you ever been told you have high blood pressure?	If your blood pressure has not been checked in the last 6 months, get it checked by a healthcare provider. If you answered yes, you may continue to exercise to improve your overall heart health and prevent disease. American Heart Association 1-800-242-8721 http://www.americanheart.org
4. Do you have pain, stiffness or swelling that limits or prevents you from doing what you want or need to do?	If you answered yes, continue to enjoy your exercise to prevent worsening of your arthritis and help manage your pain. If you have osteoporosis always avoid stretches that flex your spine or cause you to bend at the waist, and avoid making jerky, rapid movements. Call the Arthritis Foundation 1-800-283-7800 for the local office number and for specific exercises for people who have arthritis. Arthritis Foundation 1-800-283-7800 http://www.arthritis.org

5. Do you fall, feel unsteady, or use an assistive device while standing or walking?	**If you answered yes, it is recommended that you talk with your health care provider before initiating a new activity program.** **Ask if there are any exercises you cannot do. Work with your provider to identify exercises good for you.** **NIH SeniorHealth 1-800-222-2225** **http://seniorhealth.gov/exercise/toc.html**
6. Is there a health reason not mentioned why you would be concerned about starting an exercise program?	**If you answered yes, SHARE this information with your health care provider** **Most reasons can be addressed and you can begin an exercise program that will improve your overall health and well-being.**

SAFETY TIPS

Follow these EASY safety tips for when to start and stop exercise. Use the recommendations below for exercising safely with your condition.

Exercise Safety Tips to Always Consider Prior to Starting Exercise

- **Always wear comfortable, loose-fitting clothing and appropriate shoes for your activity.**
- **Warm up: Perform a low to moderate intensity warm-up for 5-10 minutes.**
- **Drink water before, during and after your exercise session.**
- **When exercising outdoors, evaluate your surroundings for safety: traffic, pavement, weather, and strangers.**
- **Wear clothes made of fabrics that absorb sweat and remove it from your skin.**
- **Never wear rubber or plastic suits. These could hold the sweat on your skin and make your body overheat.**
- **Wear sunscreen when you exercise outdoors.**

Exercise Safety Tips for When to STOP Exercising

Stop exercising right away if you:

- **Have pain or pressure in your chest, neck, shoulder, or arm.**
- **Feel dizzy or sick.**
- **Break out in a cold sweat.**
- **Have muscle cramps.**
- **Feel acute (not just achy) pain in your joints, feet, ankles, or legs.**
- **Slow down if you have trouble breathing. You should be able to talk while exercising without gasping for breath.**

Exercise Safety Tips to Recognize Days/Times When Exercise Should NOT be Initiated:

- **Avoid hard exercise for 2 hours after a big meal. (A leisurely walk around the block would be fine).**
- **Do not exercise when you have a fever and/or viral infection accompanied by muscle aches.**

- **Do not exercise if your systolic blood pressure is greater than 200 and your diastolic is greater than 100.**
- **Do not exercise if your resting heart rate is greater than 120.**
- **Do not exercise if you have a joint that you are using to exercise (such as a knee or an ankle) that is red and warm and painful.**
- **If you have osteoporosis, always avoid stretches that flex your spine or cause you to bend at the waist, and avoid making jerky, rapid movements.**
- **Stop exercising if you experience severe pain or swelling in a joint. Discomfort that persists should always be evaluated.**
- **Do not exercise if you have a new symptom that has not been evaluated by your health care provider such as pain in your chest, abdomen or a joint, swelling in an arm, leg or joint, difficulty catching your breath at rest, or a fluttering feeling in your chest.**

Additional Safety Information is provided at the National Institute of Health Web page

www.nlm.nih.gov/medlineplus/safety.html

How To Learn More About the EASY Recommendations:

Additional information and readings about the EASY recommendations are readily available on the Internet. You do not have to be an expert on computers to be able to access this information. All public libraries and most senior centers have public access computers.

SIMPLE INSTRUCTIONS ON HOW TO ACCESS MORE INFORMATION:
Tip: If you are not sure about any of these steps ask your librarian at the public library.

1. **Open any internet web browser program.**
2. **Type www.easyforyou.info in the address line at the top of the page**
3. **Click on the "links and resources" box at the top of the page**
4. **If you would like to take the information home with you ask how to the print the web pages you are most interested in.**

www.easyforyou.info

Supporting links and websites:

The following links are included on the easyforyou.info website. For easy access to this information follow the instructions listed immediately above.

Links for General Exercise Options:

American Heart Association: www.americanheart.org/ presenter.jhtml?identifier=1200013

International Council on Active Aging: www.icaa.cc/ PressInfo/onehouradayrelease.htm

International Society for Aging and Physical Activity: www.isapa.org/ISAPA_Newsletter

National Blueprint: Increasing Physical Activity Among Adults Age 50 and Older: www.agingblueprint.org/tips.cfm

NIH SeniorHealth: www.nihseniorhealth.gov/exercise/toc.html

Novartis Health and Age: www.healthandage.org

President's council on Physical Fitness and Sports: www.fitness.gov

The Canadian Centre for Activity and Aging's Home Support Exercise Program. Geriatrics and Aging:
www.geriatricsandaging.ca/ PDF/PDFJuly2003/ 0607homesupport.pdf

Links for Exercises for Dizziness or Lightheadedness:

AARP- Better Ballance Prevents Falls: www.aarp.org/health/staying_healthy/prevention/better_balance_prevents_falls.html
American Physical Therapy Association- Head To Toe Program (Level 1): http://headtotoe.apta.org/kbase/frame/ug117/ug1176/frame.htm
American Physical Therapy Association- Head To Toe Program (Level 2): http://headtotoe.apta.org/kbase/frame/ug128/ug1287/frame.htm

American Physical Therapy Association- What You Need To Know About Falls:
http://physicaltherapy.about.com/gi/dynamic/offsite.htm?zi=1/XJ&sdn=physicaltherapy&cdn=health&tm=26&gps=146_677_685_561&f=11&tt=13&bt=1&bts=1&zu=
http%3A//www.apta.org/AM/Template.cfm%3FSection%3DConsumer_Awareness%26CONTENTID%3D24756%26TEMPLATE%3D/CM/HTMLDisplay.cfm

Mayo Clinic- Senior Health on Balance Exercises: www.mayoclinic.com/health/balance-exercises/SM00049/RETURNTOOBJID=5275756E-2AEC-4537-B8886B71D55BD479&RETURNTOLINK=1&slide=1

Links for Cardiovascular Specific Exercise Programs/Information:

American College Sports Medicine- Exercise and the Older Adult: www.acsm.org/pdf/EOA.pdf

Cardiovascular Institute and Center for Cardiovascular Health Cardiovascular: www.mssm.edu/cvi/exercise.shtml

Centers for Disease Control- Strength Training for Older Adults: Why Strength Training? www.cdc.gov/nccdphp/dnpa/ physical/growing_ stronger/why.htm

Human Kinetics: Benefits of Aerobic Endurance Training for Older Adults: www.humankinetics.com/products/ showproduct.cfm?isbn=0736045139

The Physician and Sports Medicine: www.physsportsmed.com/issues/ 1999/10_15_99/kligman.htm

Women's Heart Foundation: www.womensheartfoundation.org/ content/Exercise/intro_to_exercise.asp

Links for Exercises for Joint problems:

American College of Rheumatology: www.rheumatology.org/ public/factsheets/ exercise_new.asp

American Physical Therapy Association-Exercising with Osteoarthritis:

http://headtotoe.apta.org/kbase/as/tr4782/actionset.htm Arthritis

Foundation- The 12-week Walking Plan:

www.arthritis.org/media/12%20week%20walking%20plan%20pdf.pdf

Arthritis Organization: www.arthritis.org/conditions/exercise

Centers for Disease Control: www.cdc.gov/ nccdphp/dnpa/physical/ growing_stronger/ exercises/warmup.htm

Human Kinetics: www.humankinetics.com/products/ showproduct.cfm?isbn=0736045139

National Arthritis Foundation: www.arthritis.org.sg/ 101/treat/exercise.html

National Guideline Clearing House- Exercise Program for Osteoarthritis: www.guideline.gov/ summary/summary.aspx?

National Institute of Arthritis and Musculoskeletal and Skin Disorders: www.niams.nih.gov/ hi/topics/arthritis/ arthexfs.htm

Links for Exercises with assistive devices:

American Heart Association: Description of Exercise Recommendations for Stroke Patients: http://circ.ahajournals.org/ cgi/content/full/ 109/16/2031

The Center for Neurological Study: www.cnsonline.org/ www/archive/ parkins/park-03.html

Cleveland Clinic: www.webmd.com/ content/article/46/ 1833_50756

Victorian Government- Regular Exercise Program for Parkinson's Disease Patients: www.betterhealth.vic.gov.au/ bhcv2/bhcarticles.nsf/ pages/Parkinson's_disease _and_exercise?OpenDocument

APPENDIX B

BASIC PROFILE FORM

Code:_______________ Group: ___________________

Age: ____________ Calculate HR max: ________________

Are you comfortable walking on the treadmill? Yes No

Are you comfortable walking on the treadmill with an incline? Yes No

Have you every used a treadmill while walking at an incline? Yes No

Are you able to walk 5 minutes without assistance? Yes No

Have you ever been told you have a neurological or musculoskeletal problems?

Yes No

Do you take any prescribed medications? If so, list them here.

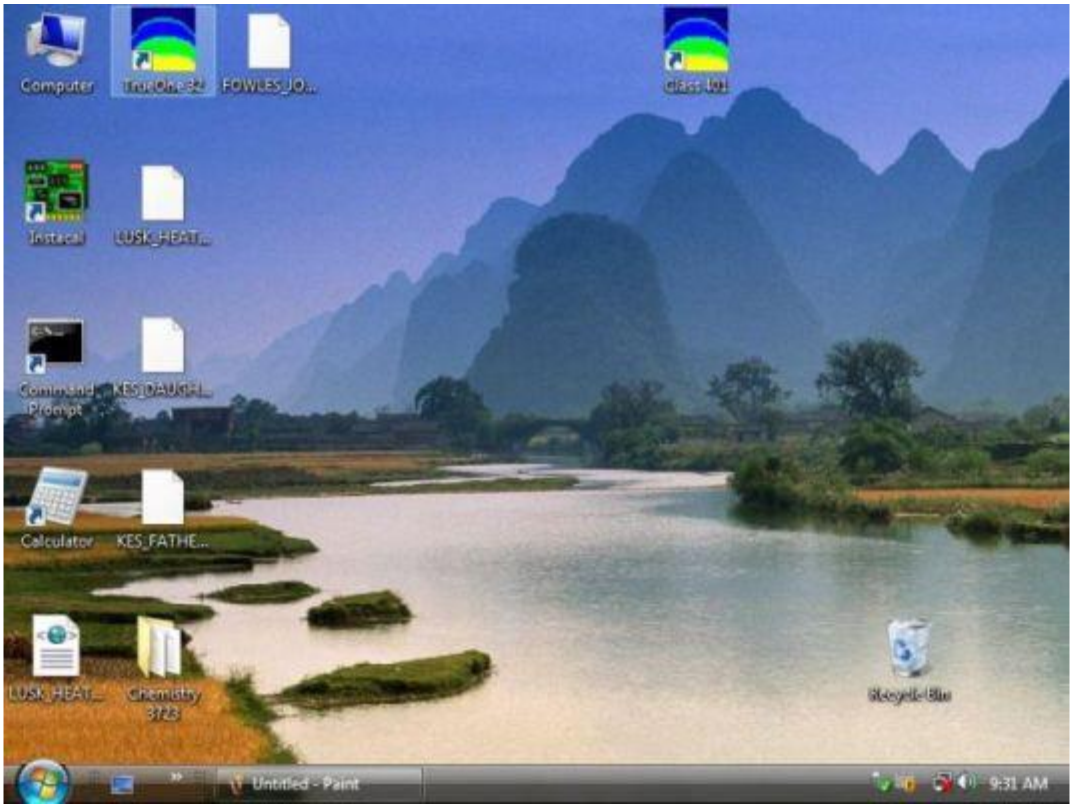
APPENDIX C

METABOLIC CART DIRECTIONS

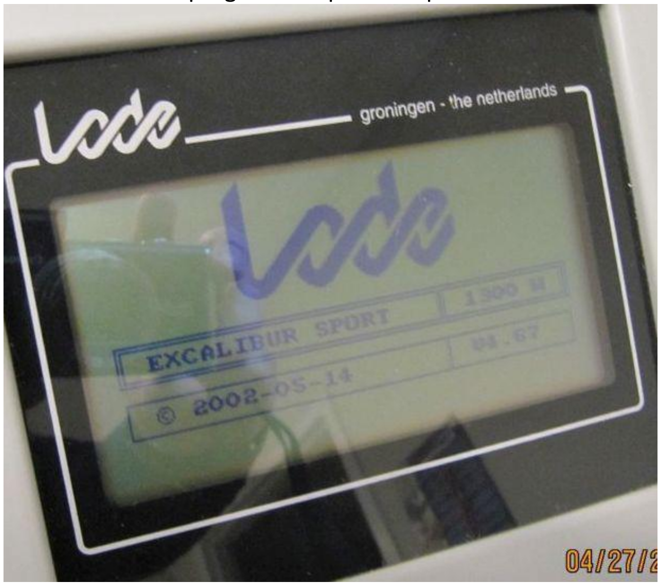
Directions for Setup, Calibration and Testing of the Parvo TrueOne Metabolic Cart

Setup:

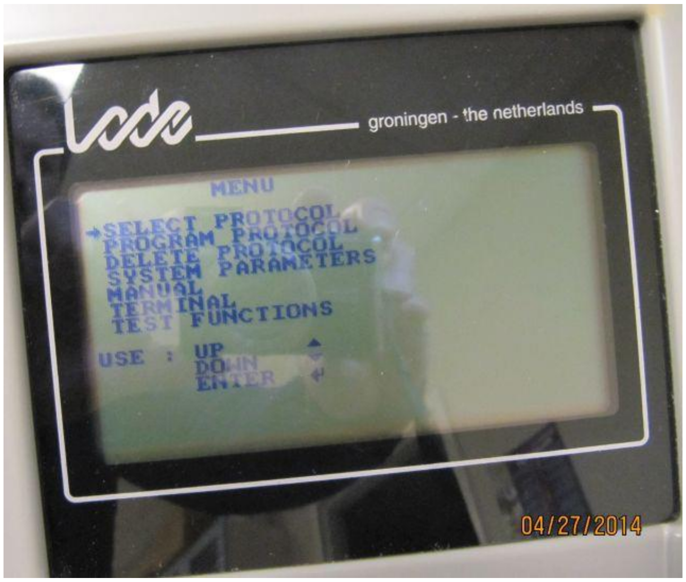
- Turn on main power switch (green switch) on the back of the unit
- Turn on Pump/Heater switch on the front of the unit (circle with dot in the middle is the On position). This turns on the oven for the pneumotach. You must wait at least 20 minutes for this to come up to temperature before any testing is done
- Turn on computer. The TrueOne software should open. Click the Desktop icon if it does not open on boot up



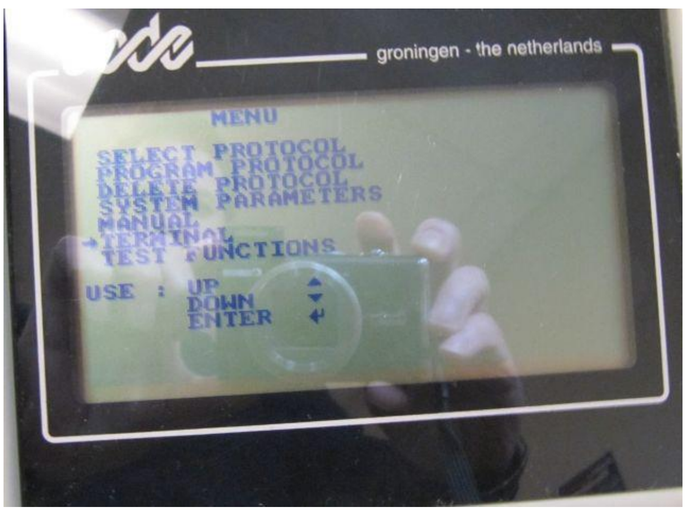
- Turn on the device used for testing. The treadmill power switch is on the front. Treadmill is connected to COMM 1 on PC
- The Lode WLP programmer drives the Lode Excalibur ergometer. The Lode WLP programmer is connected to COMM 2 on PC. The power switch for the Lode WLP programmer is on the back
- You will see this when the programmer powers up



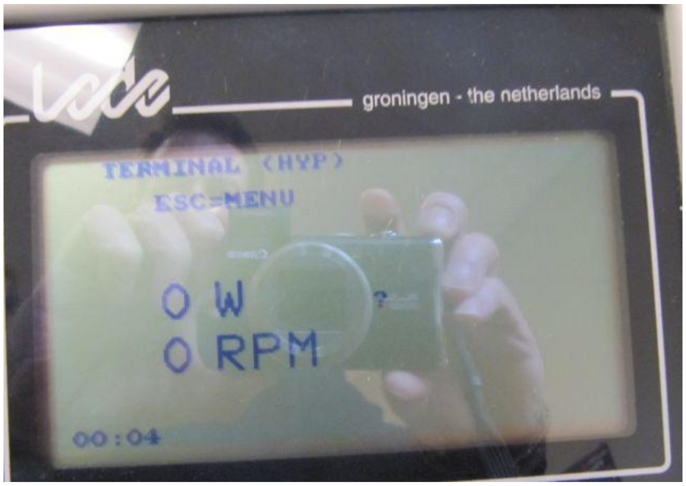
- Push Enter. You will see this Menu appear



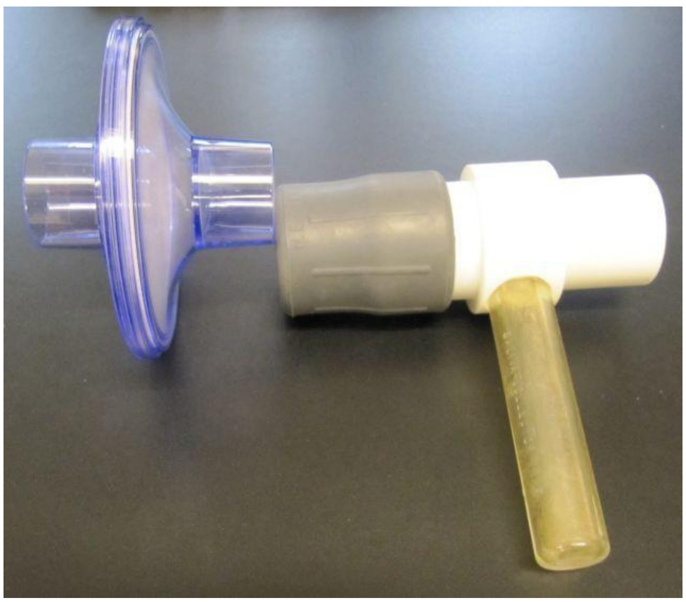
- Push the Down arrow and press Enter to choose Terminal



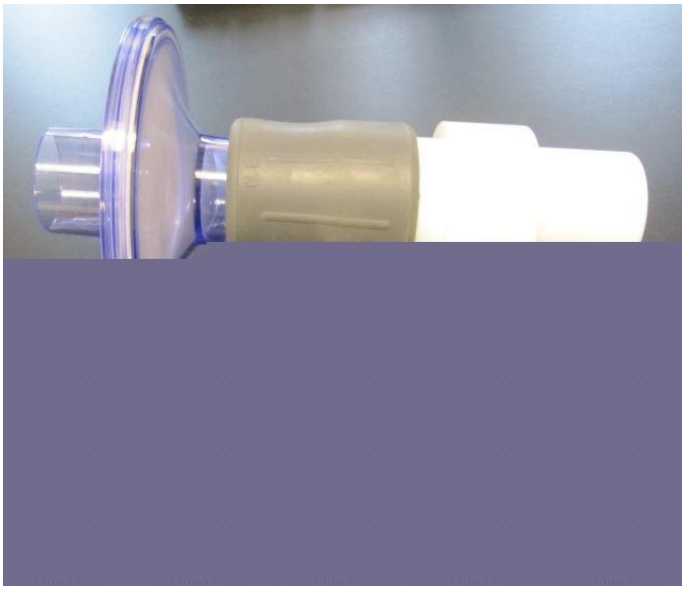
- This will appear on the screen. The Excalibur ergometer is now ready to be used for testing



- Get the grey connector, the T-connector, a purple filter and the calibration mouthpiece (this has a metal bracket attached) from the cabinet assembled and ready to calibrate the cart. The grey connector is ribbed on the inside

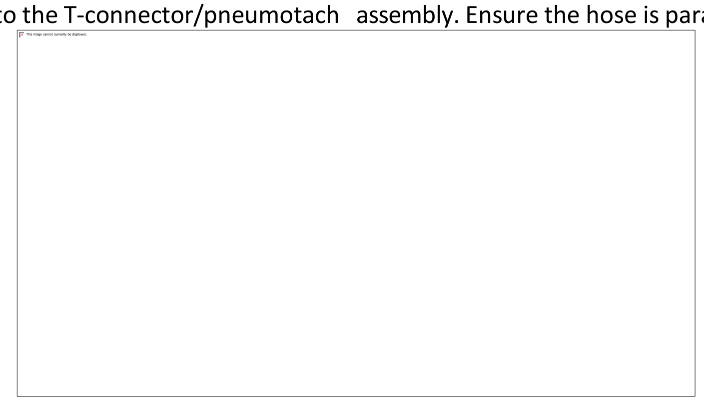


- The grey connector for the T-connector, the T-connector and the grey connector to interface the 3-Litre syringe and the calibration mouthpiece are to be kept in the Ziploc bag when not in use (cabinet)
- Connect the purple filter to the T-connector using the grey connector. Gently push the grey connector on to the T-connector. Then gently push the purple filter into the grey connector. Ensure the tapered side of the purple filter is the side being attached

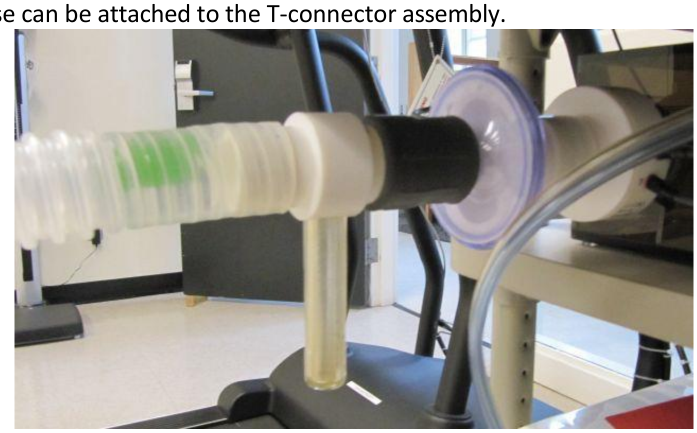


- Attach this assembly to the pneumotach. Again all that is needed is slight pressure to make the following attachment. Ensure that the mixing chamber (tinted rectangular box) does not fall to the floor. Grab the white connector (not the round oven) of the pneumotach and gently push the assembly (purple filter end) together to make the connection

- The hose can be attached to the reticulated arm using Velcro straps. The black device (with the orange dot) is the heart rate monitor receiver (the chest strap on the subject is the transmitter). Take the far end (from the cart) and attach to the T-connector/pneumotach assembly. Ensure the hose is parallel to the floor.

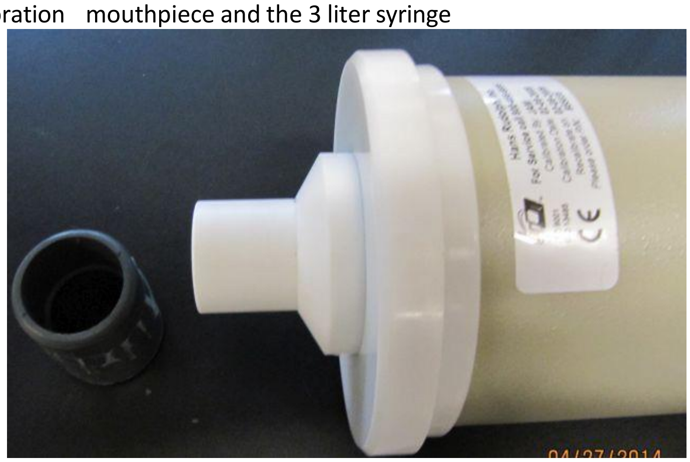


- The hose can be attached to the T-connector assembly.



- The result will be something like this. The weak point is the hose mating with the T-connector. Ensure a good connection. If this separates during testing, continue testing and re-attach as quickly as possible

- If you feel the pneumotach, it should be getting very warm to the touch. Ensure at least 20 minutes has elapsed to allow proper temperature to be achieved
- All of the mouthpieces/full masks have arrows indicating input and output airflow. The calibration mouthpiece has a metal bracket attached to the backside of it. You do not have to disassemble this mouthpiece for disinfecting like we do with testing mouthpieces/full masks used on subjects
- The smaller grey connector, that is smooth on the inside with a ridge halfway down the middle, is used to interface the calibration mouthpiece and the 3 liter syringe

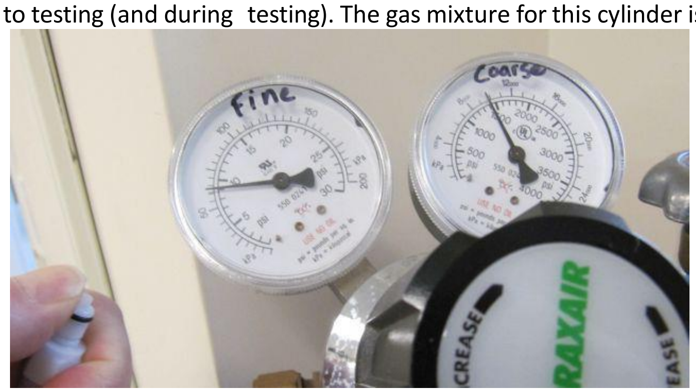


- Attach the grey connector to the syringe

- Attach the other end of the hose to the calibration mouthpiece. Ensure you are on the output valve when making this connection

- The three similar mouthpieces have arrows on the top (beside the black cap) indicating input/output. The full face masks have the same indicators. The output is the clear end, the input is the white end
- We want to keep a tight seal. Using the cart, we can lay the 3 liter syringe flat on the cart while interfacing it with the calibration mouthpiece that is attached to the hose. We will keep the setup like this for the calibration process

- Turn on the calibration gas cylinder. Turn the metal knob on top of the cylinder counterclockwise 1 and 1/2 turns. Do not adjust the Praxair black plastic knob. This is for the Fine indicator and has been preset.
- The Fine and Coarse indicators will deflect to values seen below. The Coarse will deflect to the total O_2 and CO_2 in the cylinder, the Fine will deflect to a range between 10 – 15 psi. The cal gas hose can be left connected to the unit right up to testing (and during testing). The gas mixture for this cylinder is 16% O_2 and 4.05% CO_2



- As you can see, the Fine indicator is showing 10-12 psi. This is too high to input to the Cal Gas port on the metabolic cart. We need to bleed off the excess until the needle drops to the preset level of 3 psi. (I have preset this level already).
- Find the end of the calibration gas hose and gently push on the plastic connector/opening at the end. You should get air escaping and the Fine indicator needle should fall to 3 psi.
- Ensure this excess has been bled off before attaching the cylinder hose to the Cal Gas port on the metabolic cart. The internal circuitry will be damaged if the cylinder hose attached to the Cal Gas port of the metabolic cart exceeds 3 psi

- The Cal Gas calibration is key to accurate testing results. You can run the gas calibration as many times as needed during calibration. It is recommended to run the cal gas calibration one last time just before (gets on the treadmill or ergometer) testing the subject. We need to ensure the CO2 levels the Parvo cart is reading for room air have not floated above 3-4%. If this happens, the RER value in the test window with be inflated when the test starts
- Here is what you need to see on the Fine dial after bleeding off the excess. The coarse indicator will not change

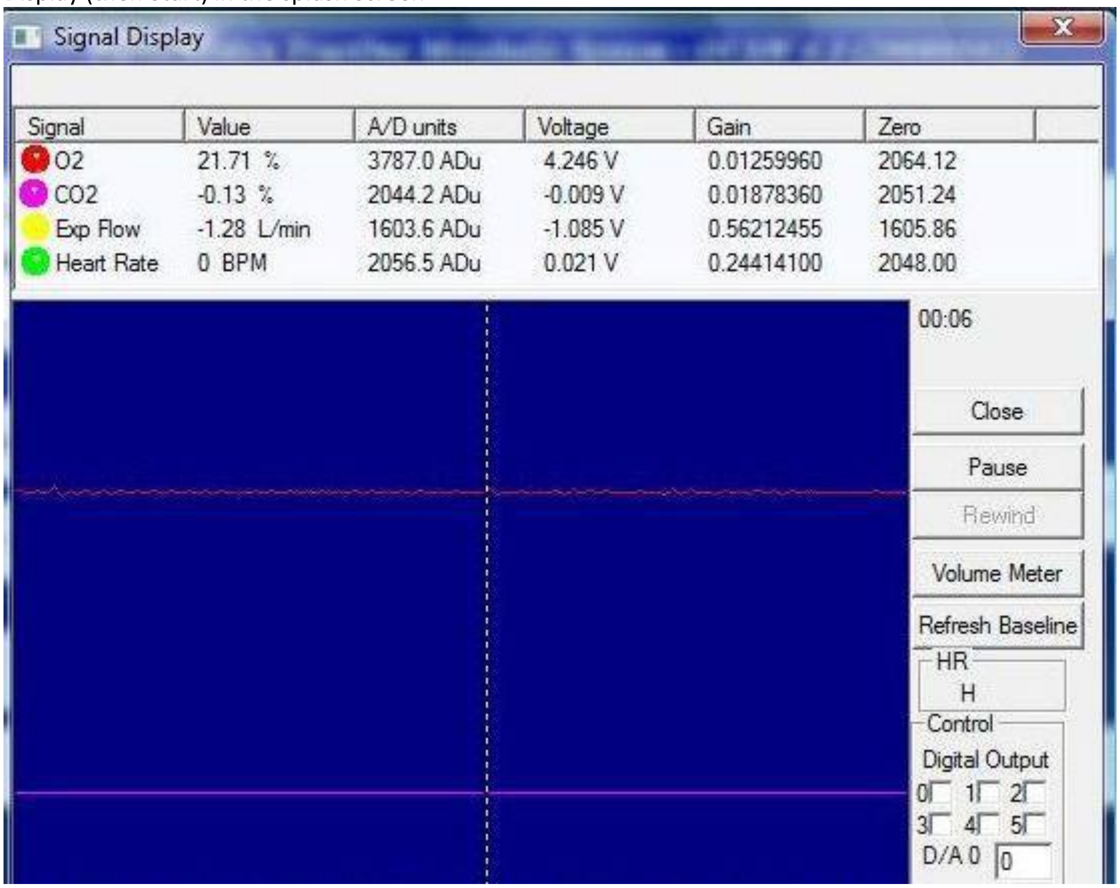
- Now you can attach the calibration gas hose/white connector from the cylinder to the Cal Gas Port on the metabolic cart. This is located on the back of the unit. It is to the left of the Room Air port and just above the O2 Range switch. You must hold the front of the unit, so it does not fall to the floor, while bringing the calibration gas hose/white connector to the Cal Gas port. Stay parallel to the floor and push the connector straight in the port connector. To remove, push down lightly on the metal clasp and pull the calibration gas hose/white connector away

- This is what you want to see. This connection can be left intact up to and including testing. Remove when you are finished. Turn off the calibration gas cylinder by turning clockwise hand tight. Then bleed of the excess left in the regulator and the calibration gas hose/white connector by gently pushing on the plastic connector/opening at the end. Bleed off until both indicators read zero

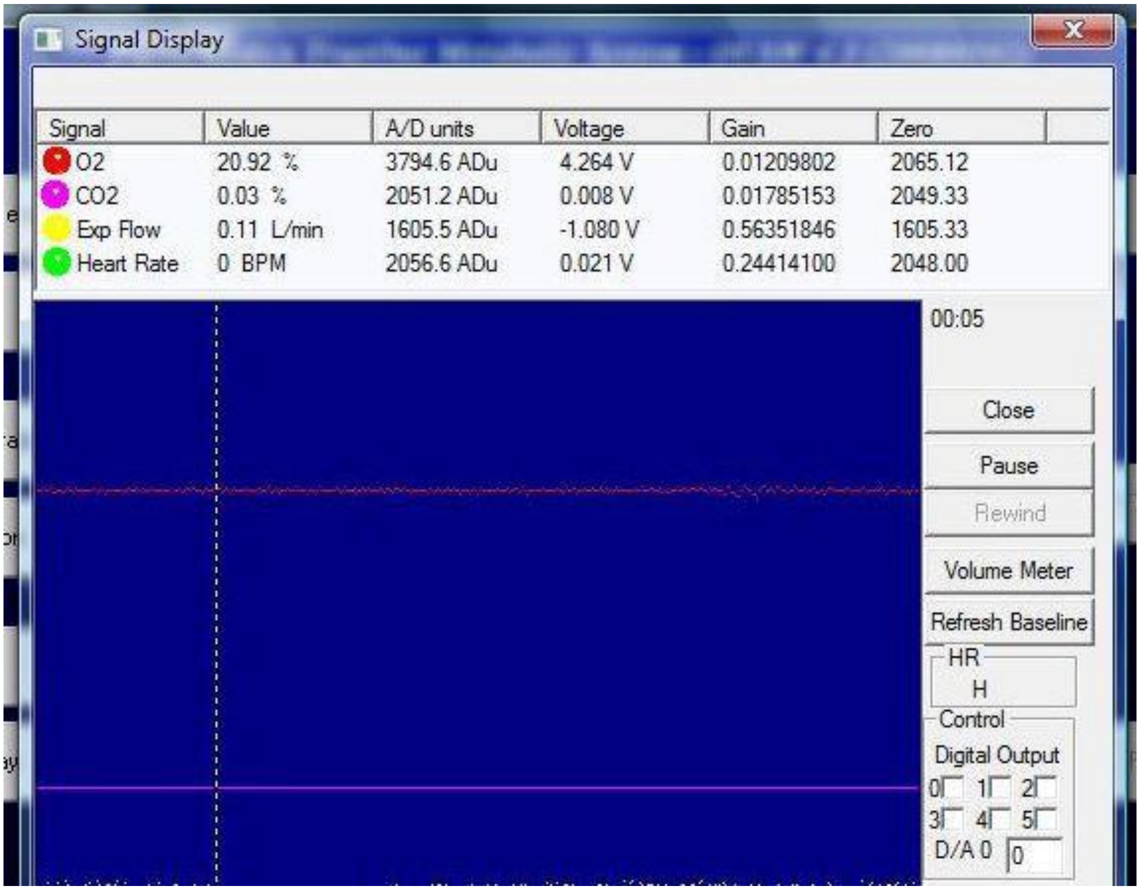
- The system is now ready for the three step calibration. Once the system has been setup, the calibration process is very quick and easy. The system should be calibrated again in between multiple subjects or if it has been sitting turned on but not used for a long period of time. The only calibration step theoretically needed after initial calibration is to apply the calibration gas again. However, the enemy of the pneumotach is moisture. Excess moisture will electrically distort what the pneumotach is sensing; this will be reflected in erroneous reading of the 3 liter syringe as 9, 12, 15 liters etc... The screen inside the round oven needs to be as dry as possible, so you may have to use the syringe to input room air across the sensor and into the mixing chamber if you are testing multiple subjects. The pneumotach is very sensitive to subtle changes in CO2. This is the reason why we need to let the pneumotach heat up to operating temperature. Doing a test with a cold pneumotach will have distorted CO2 results – the RER and VO2 kg readings will be way off.

Calibrate System:

- When the metabolic is initially turned on, the pneumotach sensor is reading low levels of CO2 and more or less accurate O2 levels of the room air. The pneumotach is not up to temperature. You can see this by clicking Signal Display (then Start) in the splash screen

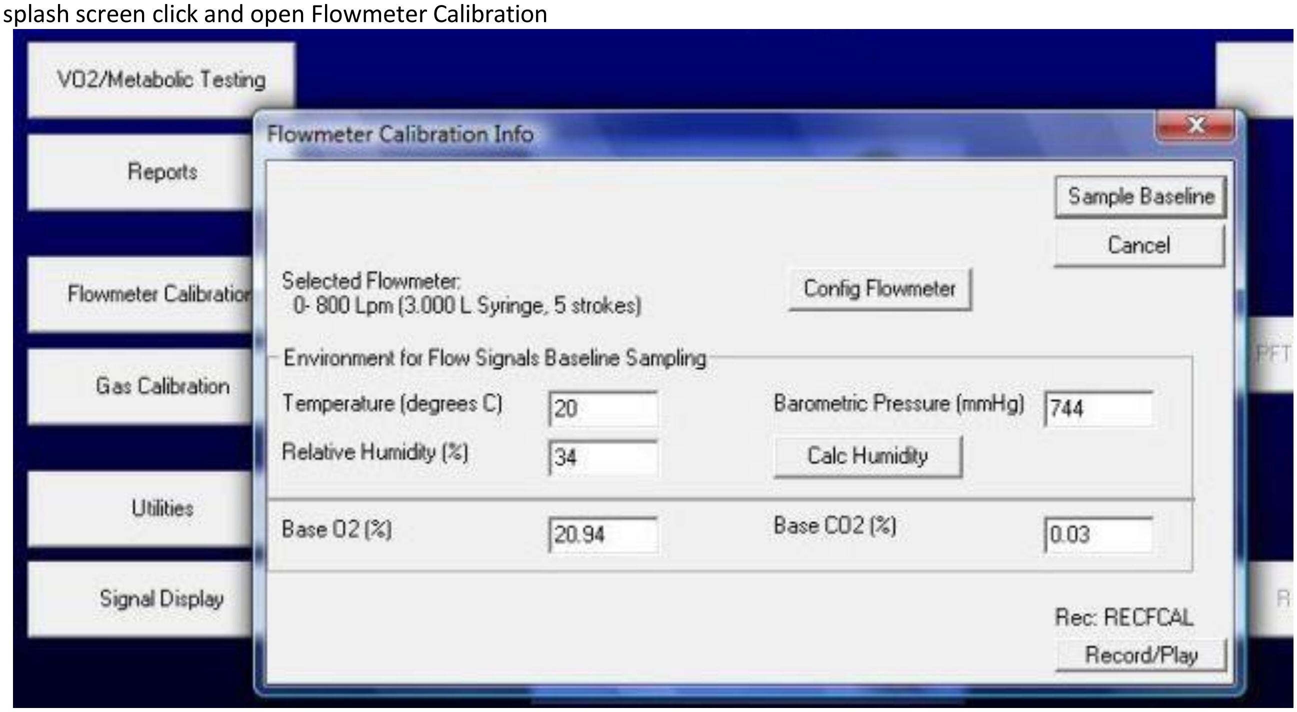


You want to have the values for O2 and CO2 seen below after a 20 minute warm up and calibration



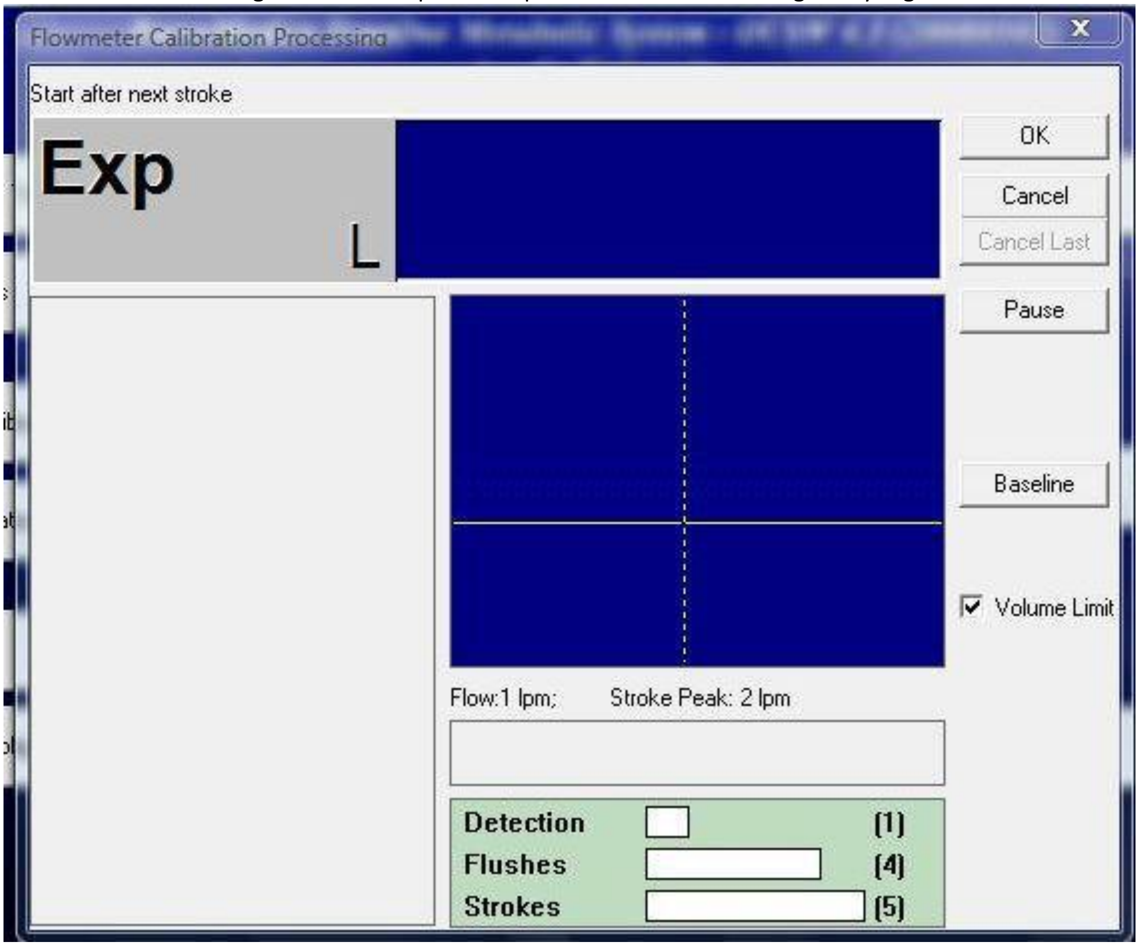
Flowmeter Calibration

- In main splash screen click and open Flowmeter Calibration

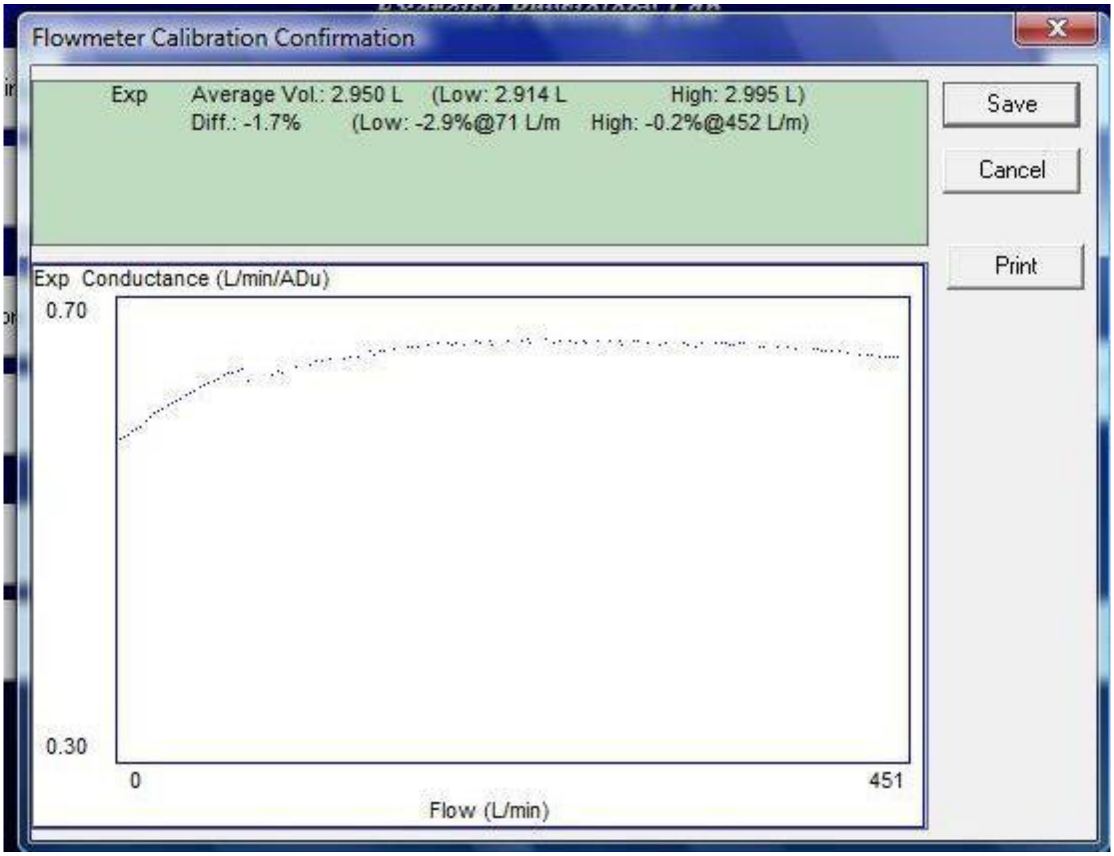


- Enter room temperature, barometric pressure and relative humidity
- Click and open Sample Baseline (upper right corner of Flowmeter Calibration Info window)

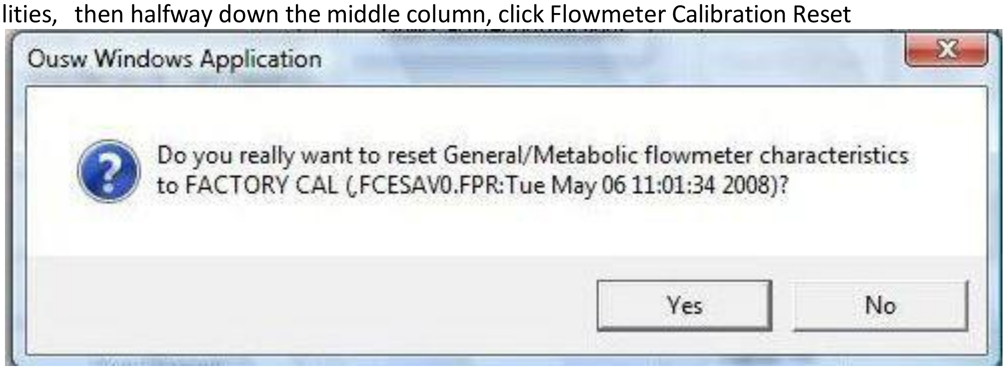
- Flowmeter Calibration Processing window will open. All input strokes are done using the syringe



- **Detection stroke** - one input stroke indicates air is flowing into the system (mouthpiece and all assemblies are properly configured).
  *Notice the Flow indicator will show the real time input velocity, Stroke Peak with show the peak in real time and in the blank blue field beside the Cancel button, the volume of the syringe will be displayed at the end of any stroke. This value should be around 3 liters. If it reads high – 9, 12, 15 liters etc.. the pneumotach has a moisture issue (if testing multiple subjects over a short period of time) and must be allowed to dry. You can use the syringe setup to do the Flowmeter calibration, but don't open the software. You are just physically driving air across the pneumotach, through the mixing chamber and into the system
- **Flush Stroke** – four input strokes to push fresh air into the system
- The pneumotach can sense 800 lpm. Of the five calibration strokes input next, two must be less than 80 lpm. The number will fluctuate beside the Flow numerical indicator (to the left of Stroke Peak
- **For Exercise Stroke** velocity is very very slow, very slow, slow, fast, faster.
- Stroke 1 → approximately 50 -80 lpm (very, very slow)
- Stroke 2 → approximately 100+ lpm (very slow)
- Stroke 3 → approximately 200+ lpm (slow)
- Stroke 4 → approximately 300+ lpm (fast)
- Stroke 5 → approximately 400+ lpm (faster)
- For Resting Stroke velocity can stay at 50 -80 lpm
- The result is something like this curve

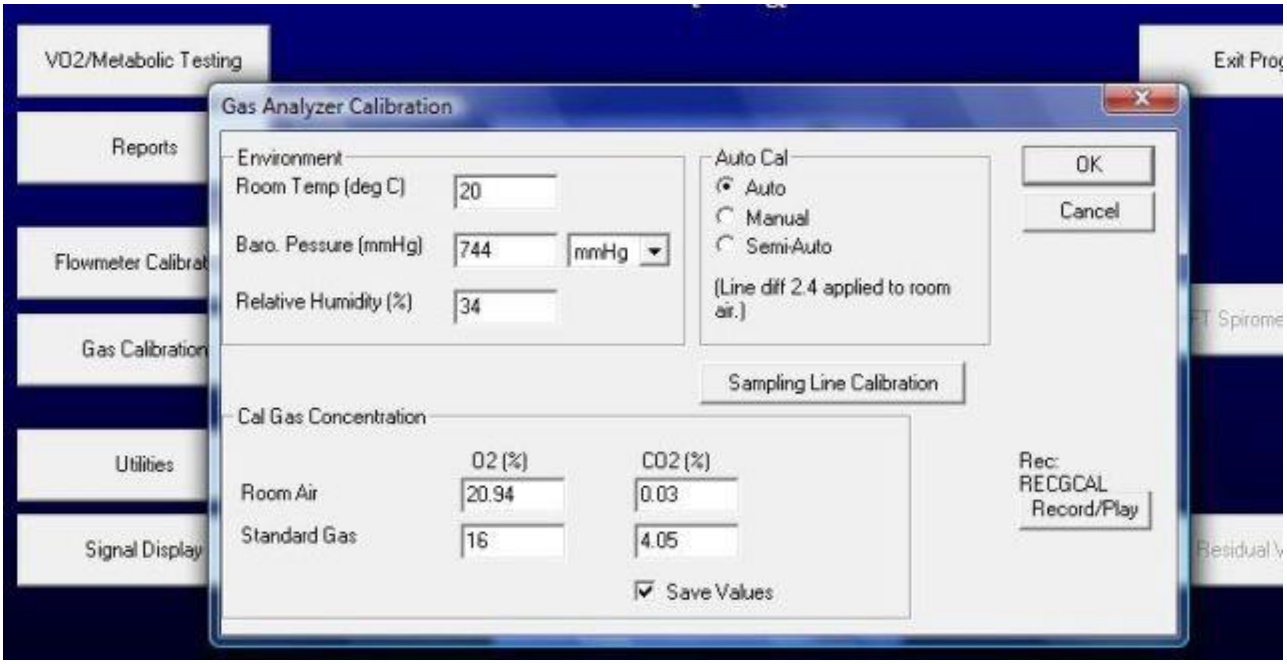


- If you feel the need, the Flowmeter calibration can be reset to the factory levels. In the main splash screen, click and open Utilities, then halfway down the middle column, click Flowmeter Calibration Reset

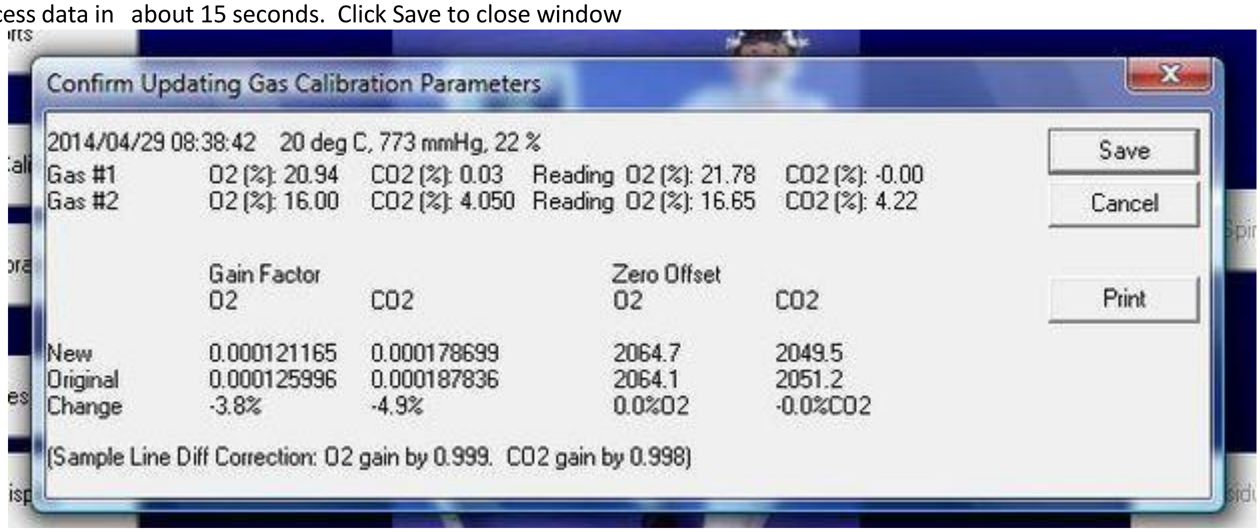


2). <u>Gas Calibration</u>

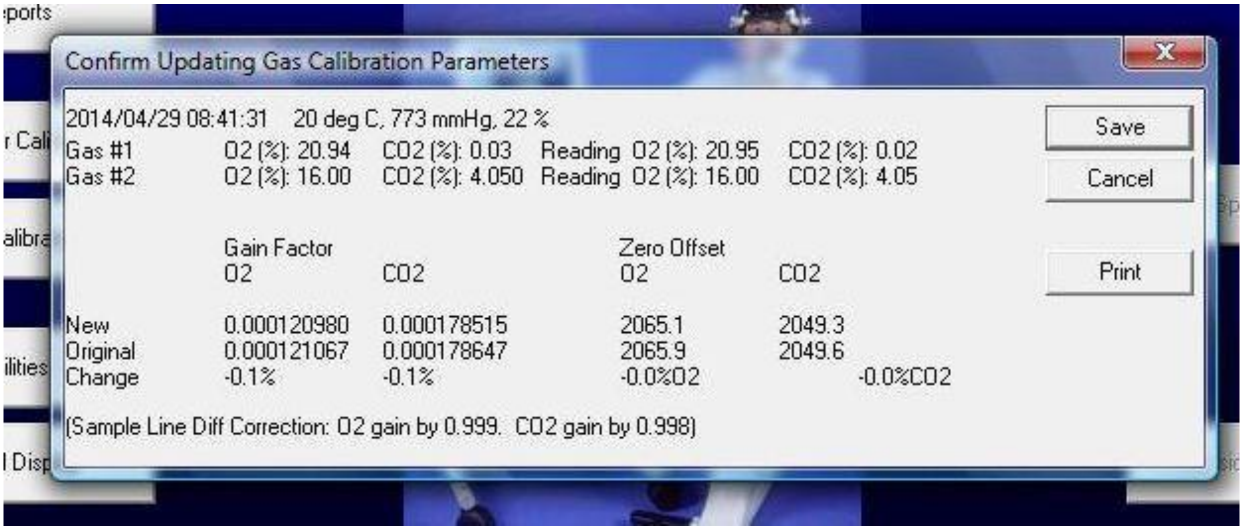
- In the splash screen click and open Gas Calibration.
- Gas Analyzer window will open



- Enter room temperature, barometric pressure and relative humidity. Click OK
- Ousw Windows Application window opens. The Cal gas tube should already be connected so click OK. The program will process data in about 15 seconds. Click Save to close window



- The pop-up will prompt you to turn off the calibration gas. It is recommended to do the Cal Gas calibration until you get the exact numbers on the cylinder. Also, you may do this step just before your subject is ready for testing

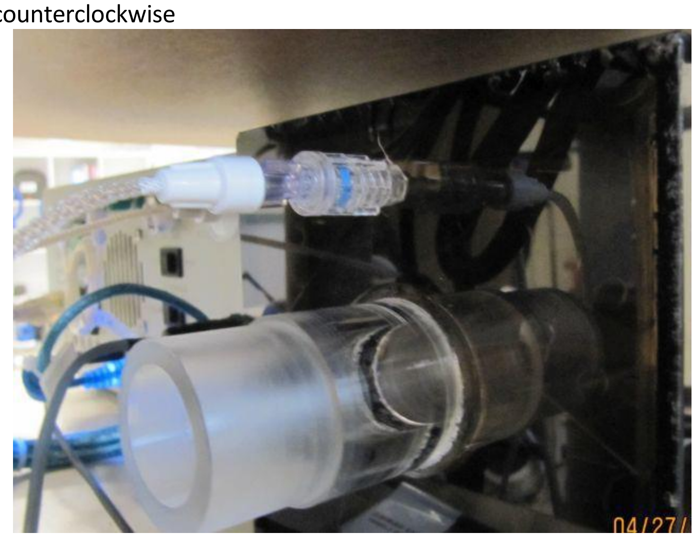


Click OK then Save

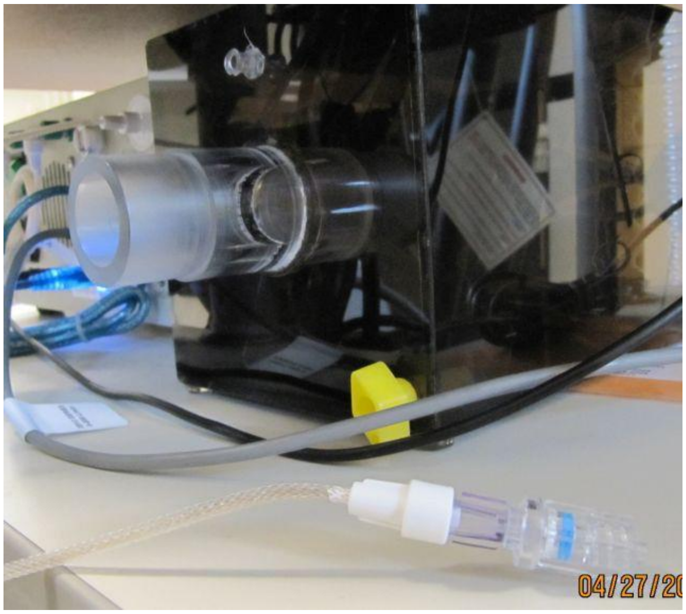
- When done, turn off the calibration gas cylinder by turning clockwise hand tight. Then bleed of the excess left in the regulator and the calibration gas hose/white connector by gently pushing on the plastic connector/opening at the end. Bleed off until both indicators read zero

Sampling Line Calibration

- In main splash screen click and open Utilities
- In Utilities window, middle column below 3-Month Maintenance, click on Sampling Line Calibration
- Ousw Windows Application window opens
- Disconnect sampling line from the back of the mixing chamber. The connector is clear with a blue marking. All that is needed is about a
  ½ turn counterclockwise



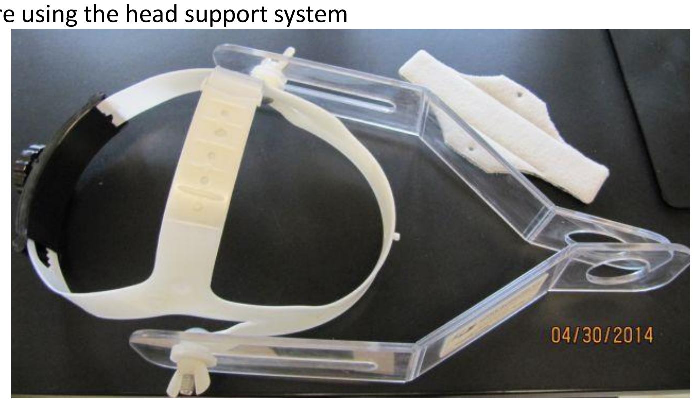
- Click OK
- Ousw Application window opens
- Click OK
- Reconnect sampling line to the mixing chamber



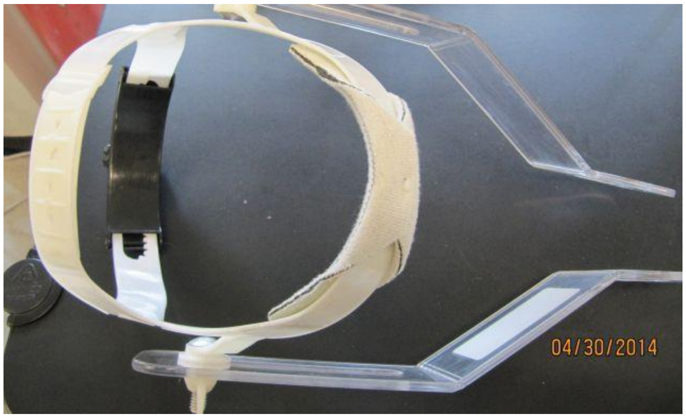
- All that is needed to reconnect is about a ½ turn clockwise – finger tight
- Click OK
- Close the Utilities window
- The system is now ready for testing

Testing Subjects:

- The subject must put on a heart rate monitor. The transmitter is worn by the subject. The receiver is on the reticulated arm. Ensure electrode gel is used on the transmitter strap for ideal electrical conductivity
- If you are using the head support system



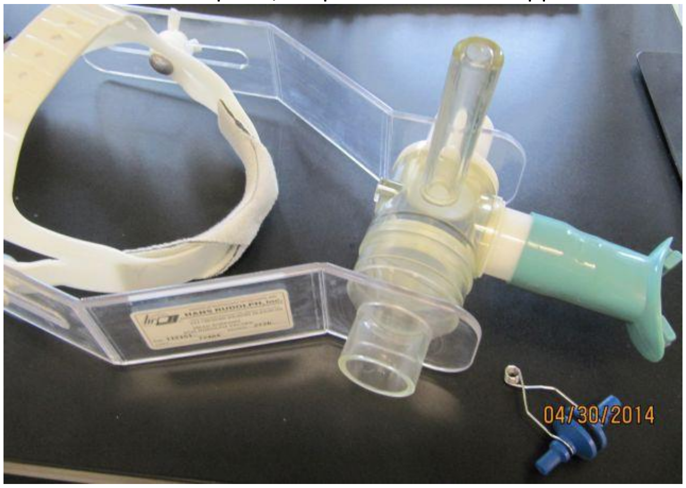
- Attach sweat guard to the front of the system



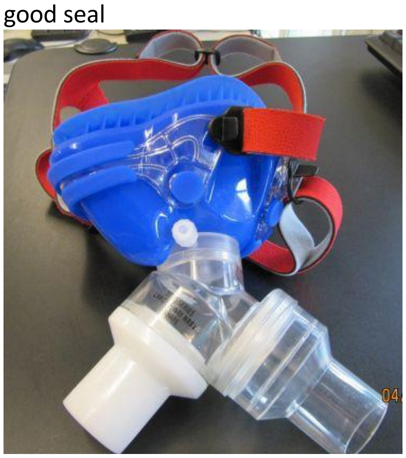
- While subject is seated, fit the head support so the front portion is just above the eyebrows. Ensure a snug fit. Tighten the entire band around the head using the knob on the back. You will be using a mouthpiece and nose clip with this setup. Attach a rubber adaptor to the mouthpiece. The one shown works for most subjects. There are larger adaptors if needed. You want to avoid the subject breathing out of the corner of their mouth (when at maximal exertion). This will skew your test results. We want a tight seal regardless of what device is used - head support or full mask

- When using the head support, the subject must wear a nose clip. This cuts off any airflow through the nose. We want all the breathing down the hose to the pneumotach
- You must wear gloves during the test. Put on a pair of gloves. Fit the appropriate adaptor to the mouthpiece. One method is to jam your thumb down the adaptor and then fit it over the round fitting on the mouthpiece
- The result must look like the image below

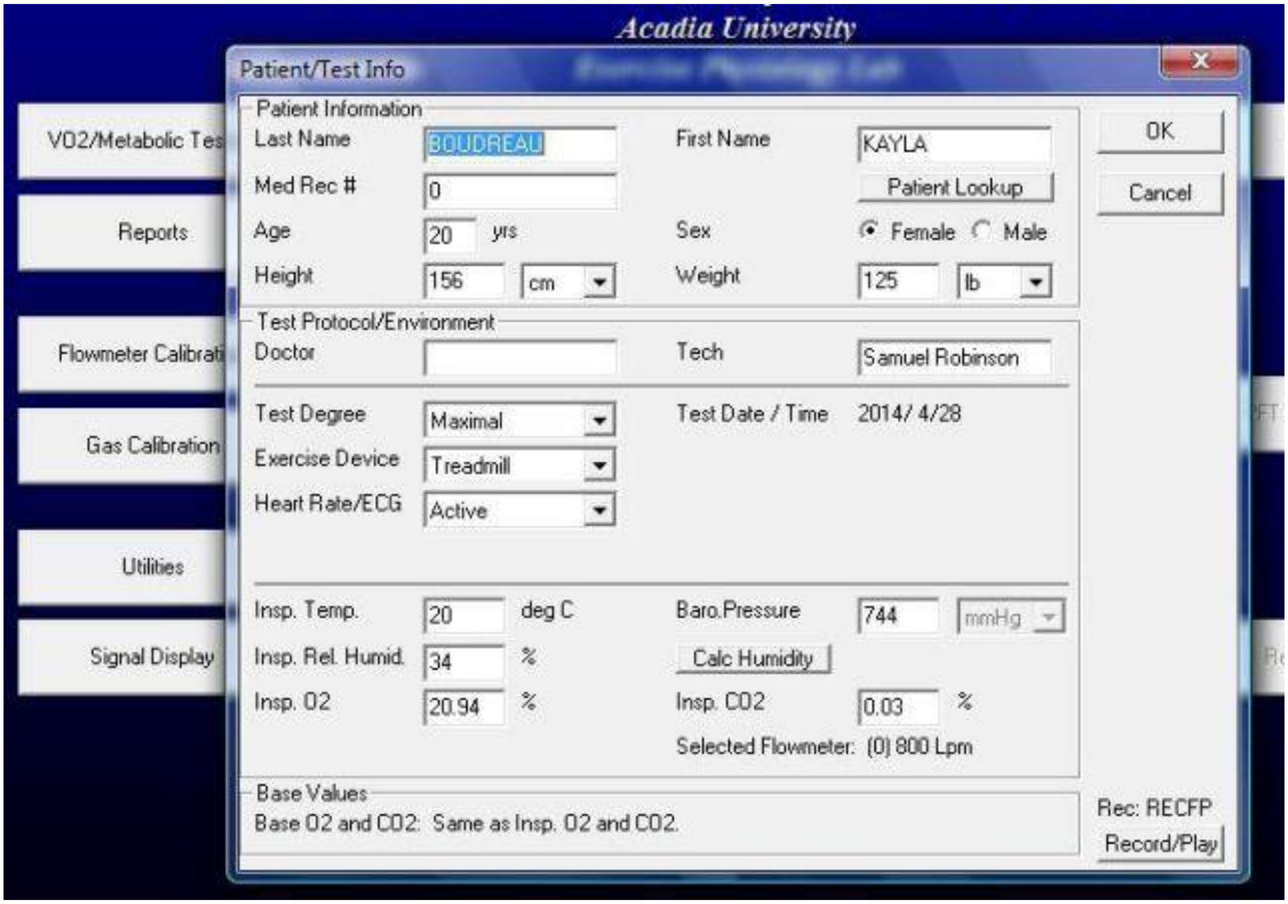
- Attach the assembled mouthpiece/adaptor to the head support while on the subject's head



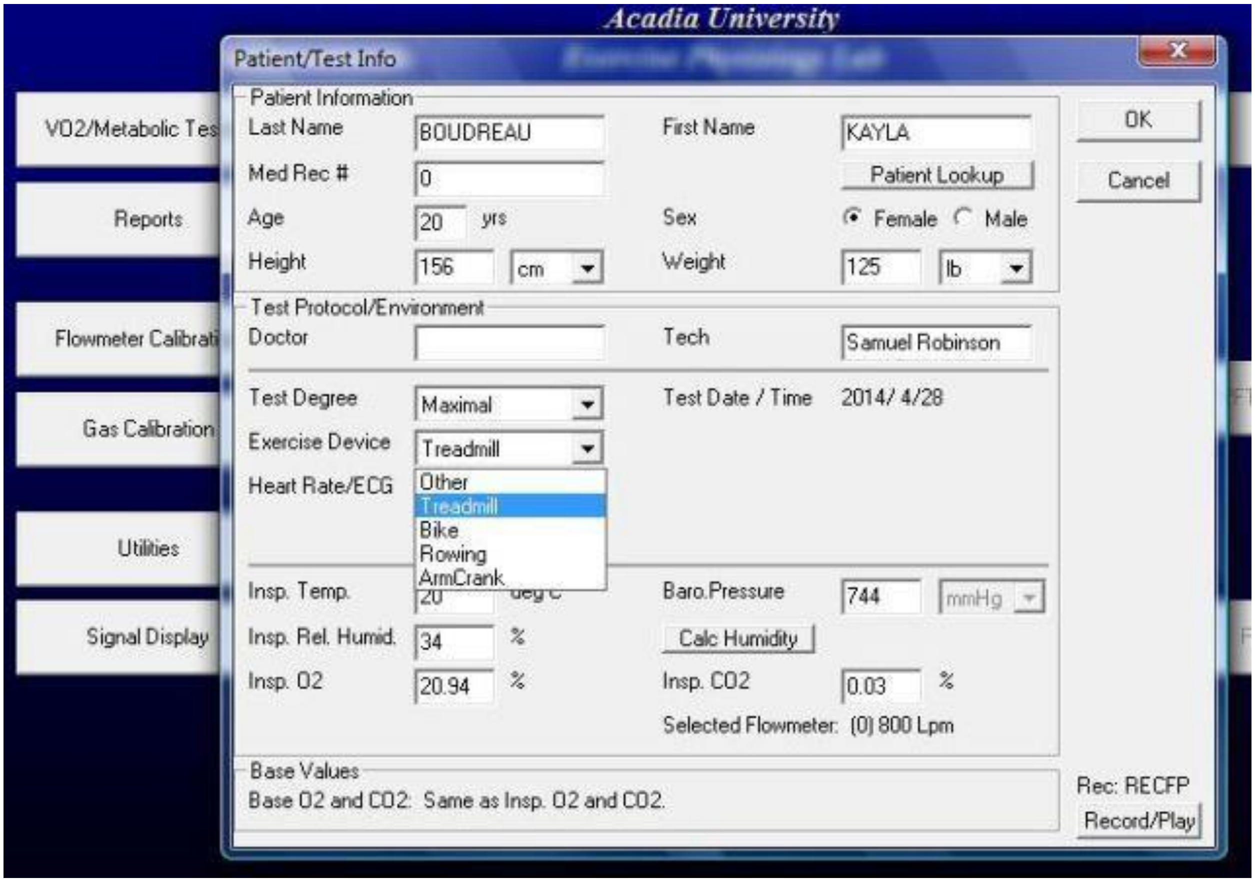
- Give the subject a the nose clip to put on
- They are ready for the treadmill or ergometer. Attach the hose to the output end of the mouthpiece. Do not let the subject insert the adaptor yet. When it is time to start the test, the subject can just spin the adaptor toward their face, place the adaptor in their mouth and begin mouth breathing into the valves. We must wait until the appropriate test window opens for the subject to do this. They are not to breathe into the hose at this time
- The full face mask does not require a nose clip to be used. Facial hair may interfere with a tight seal. Do not hook up the hose to the full face mask until the test starts. The straps wrap around the head and then the black connectors lock into the clear brackets of the mask. The straps are adjustable by sliding the strap through the black connector the using Velcro to keep in place. The mask covers the mouth and nose – so the straps need to be tight to ensure a good seal



- In the splash screen click and open VO2/Metabolic Testing



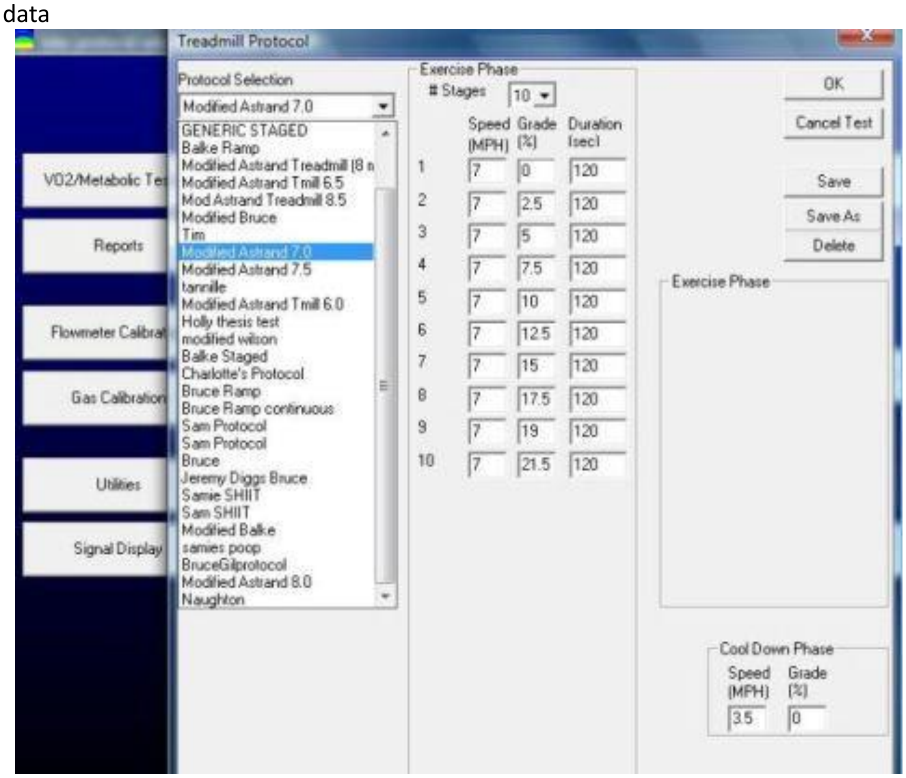
- Update temperature, humidity and barometric pressure if it has changed. Enter subject data. Choose which device you are using



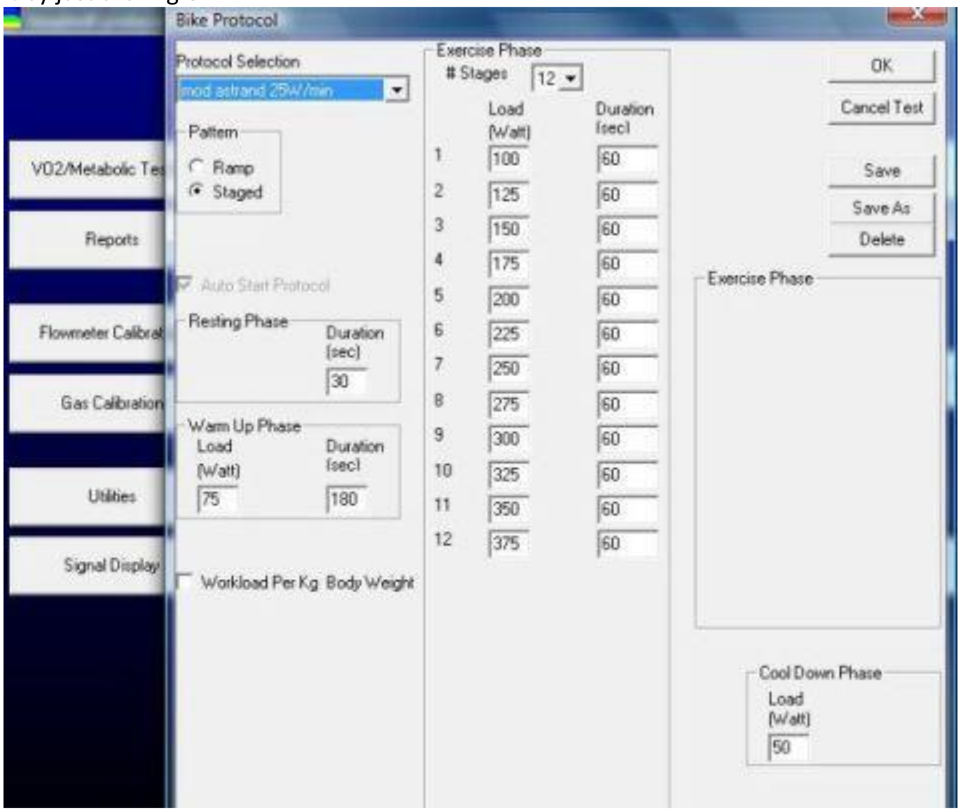
- Click OK

- If we use the treadmill we need to choose a protocol. You can create a new one and name it whatever you want. Modify an existing one and save it. Use what is there already from the pull down menu. Or modify a protocol and not save it by just clicking OK

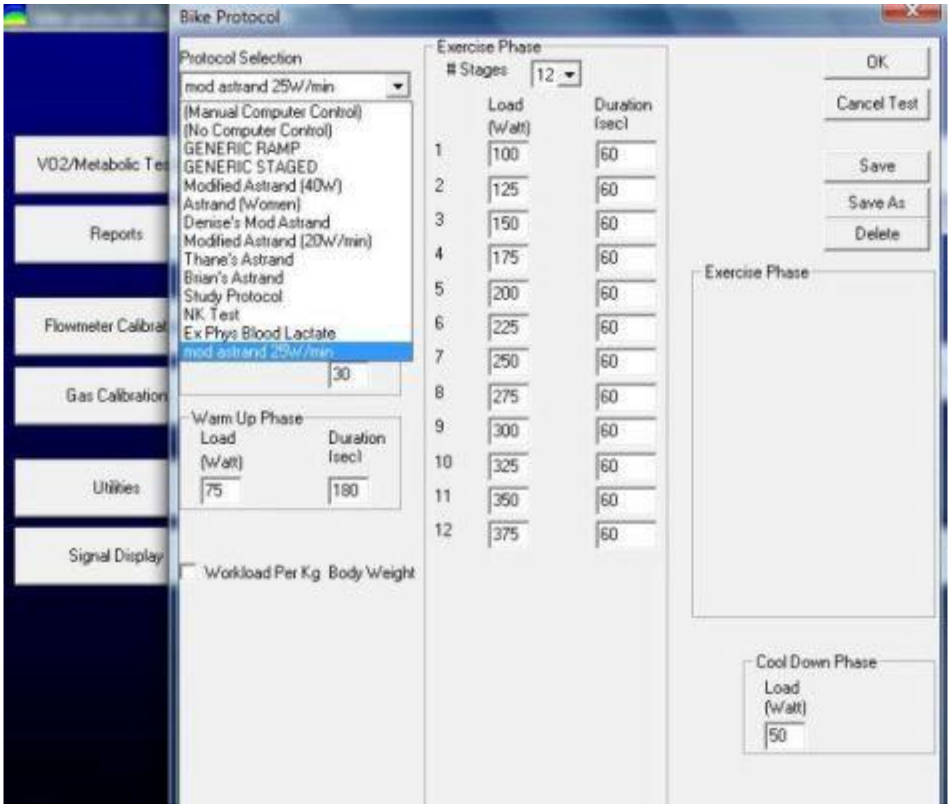
- Treadmill protocols can have a resting, warm up, exercise and cool down phase. If you do not want resting or warm up phases, make the duration = 0
- The protocol window is showing us treadmill protocols. We chose the treadmill as the test device when we entered subject data



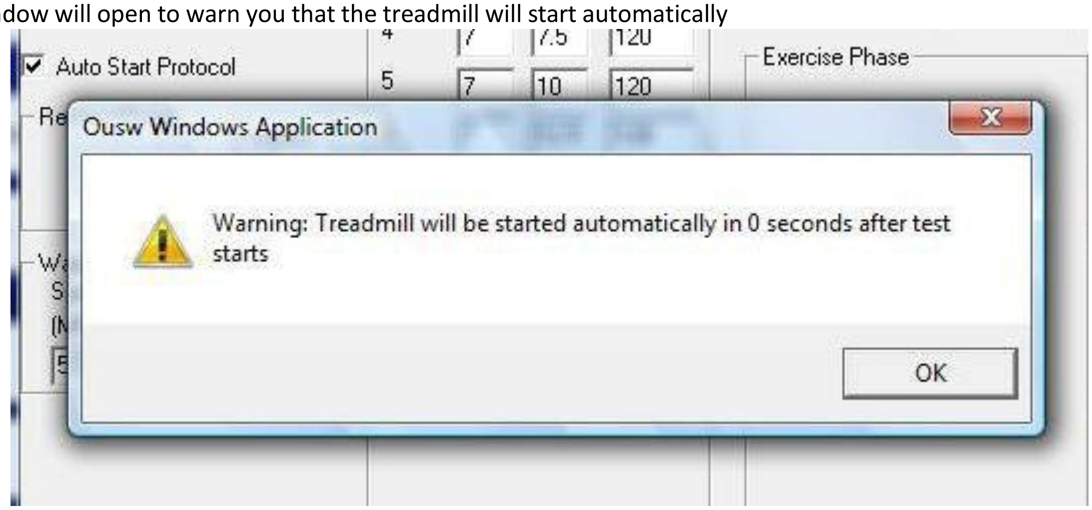
- Click OK
- If we use the ergometer we need to choose a protocol. You can create a new one and name it whatever you want. Modify an existing one and save it. Use what is there already from the pull down menu. Or modify a protocol and not save it by just clicking OK



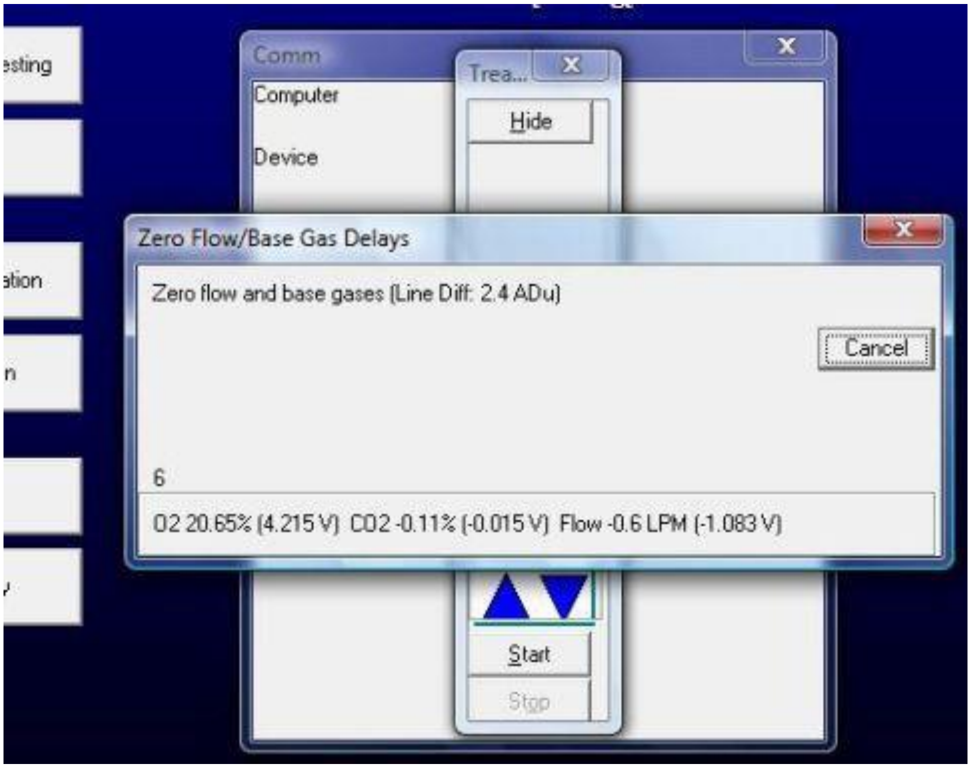
- Ergometer protocols can have a resting, warm up, exercise and cool down phase. If you do not want resting or warm up phases, make the duration = 0
- The protocol window is showing us ergometer protocols. We chose the ergometer as the test device when we entered subject data



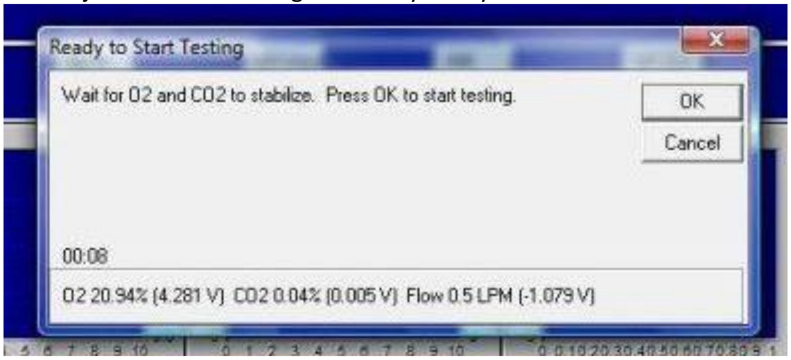
- Click OK
- Now the testing windows will appear. If using the head support, you can attach the hose from the reticulated arm/T - connector to the output connector on the mouthpiece. The nose clip can be worn. Do not let the subject breath into the mouthpiece yet. If using the full face mask, do not attach the hose from the reticulated arm/T - connector to the mask yet
- This window will open to warn you that the treadmill will start automatically



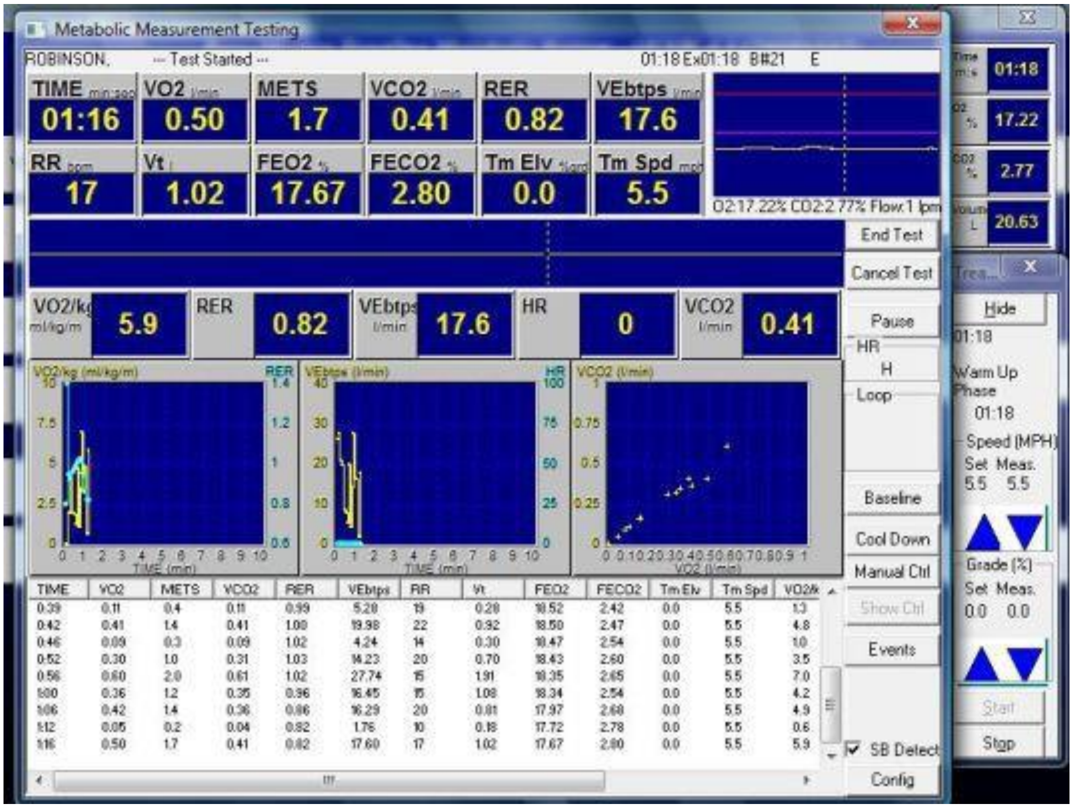
- Click OK. This warning does not appear when using the ergometer
- A series of software windows will open and close



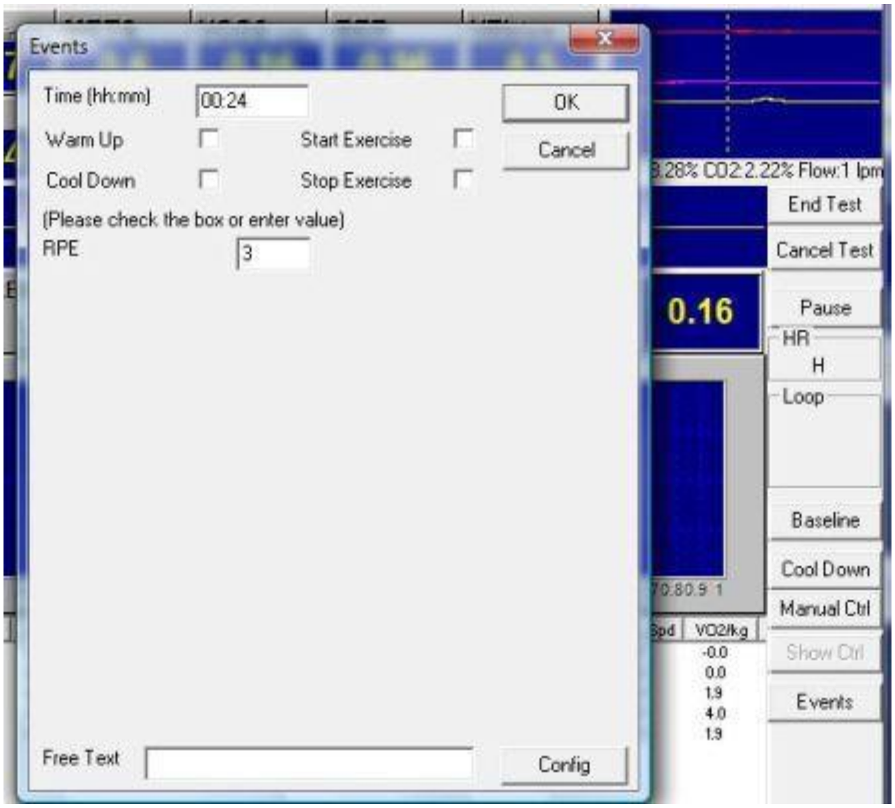
- Then this window will open. You will see the blank test results window open as well. The fields will be blank because the subject is not breathing into the system yet



- Wait until the CO_2 levels exceeds 0.03%, then click OK
- If using the headgear, the subject can spin the mouthpiece toward their face. The adaptor can be placed in the mouth while the nose clip is on. If using the full face mask, the hose from the reticulated arm/T can now be attached to the input connector on the full face mask
- There will be a delay of approximately 15 – 20 seconds before the Metabolic Measurement Testing window updates with data. The white space below will be filled with data every 5 seconds (this resolution level can be changed)



- The Events button to the right can be used to enter RPE values, blood pressure, etc...a pop-up window will appear. Simply enter the RPE value to the empty data field in the pop-up. This new event will be added to the data lines in the white space below



- Well documented reports are available after testing. To the right of the Cancel button is a set of timers. This will show overall test time, rest phase time left, warm-up phase time, and exercise phase time left as you go through the stages of the protocol you are using. When the subject cannot continue due to maximal exertion, hit the Cool Down button. This will cause the treadmill/ergometer to go to this new workload level. The treadmill may take a few seconds to reduce incline/speed. If the workload is not adequate, you can use the up/down arrows (to the right) to increase/decrease speed, incline etc...

Clean Up:

- While wearing gloves, remove headgear or the full face mask from the subject. Remember to keep the subject attached to the cart for about 20 seconds after the test has finished. This allows software delay to fill in the remaining data
- Take all used parts over to the black lined sink
- Detach the mouthpiece from the headgear.
- Rinse the sweat guard under water. The heart rate strap and transmitter can be rinsed as well. Let these parts air dry
- Disassemble the mouthpiece if used in the sink

- Disassemble the full face mask if used in the sink

- Rinse off all parts with cold water

- The cold sterilisation system is an immersion bath in Glutaraldehyde
- After rinsing the parts thoroughly in the sink, you need to immerse everything in a Glutaraldehyde bath for at least two hours

- The container will hold two disassembled mouthpieces or one full face mask
- Close the cover and place this under the fume hood

  - Disinfect for at least two hours. While wearing gloves, bring the container to the sink. Remove all parts and rinse in the sink. Fill the water bath container and immerse all parts in this container. Glutaraldehyde will dry the mouth if not rinsed properly. So these parts can be left in the water bath for an extended period. 24 hours is ideal. Over a weekend is fine
- Remove all parts from the water bath and let air dry on paper towel on the counter by the sink. The sweat guard, heart rate monitor strap and transmitter can be left to air dry here as we

APPENDIX D

RATE OF PERCEIVED EXERTION BORG INSTRUCTIONS

Instructions for Borg Rating of Perceived Exertion (RPE) Scale

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion.

Look at the rating scale below while you are engaging in an activity; it ranges from 6 to 20, where 6 means "no exertion at all" and 20 means "maximal exertion." Choose the number from below that best describes your level of exertion. This will give you a good idea of the intensity level of your activity, and you can use this information to speed up or slow down your movements to reach your desired range.

Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes

13 on the scale is "somewhat hard" exercise, but it still feels OK to continue.

17 "very hard" is very strenuous. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

19 on the scale is an extremely strenuous exercise level. For most people this is the most strenuous exercise they have ever experienced.

Borg RPE scale

APPENDIX E

RATE OF PERCEIVED EXERTION MODIFIED BORG INSTRUCTIONS

This is the rate of perceived exertion scale developed by Gunnar Borg. The scale helps you know and communicate your perceived effort during physical activity or exercise. Listen to your body and try not to think about what someone else might say or what you think you should say. The numbers of the scale and their meanings are:

6 “No exertion at all” or at rest

7 “Extremely Light” very little effort to perform the activity, can be done for prolonged periods

8 feels like you are working to do the activity, still able to perform for long periods

9 “Very Light” feels like you are showing an effort to perform the activity but it is small and can be performed for long periods

10 effort to perform the activity is known and your breathing rate/heart rate is starting to increase slightly, you are still able to perform this for long periods

11 feel a slow increase in breathing and heart rate, can continue activity for a long period

12 is when you can be begin to sweat with elevated heart rate and breathing rate but still able to perform for a moderate amount of time

13 “somewhat hard” increased breathing rate and heart rate. You are starting to feel fatigued, but you can still continue.

14 the activity is fatiguing but not very difficult. Breathing rate and heart rate increase even further. Fatigue is increasing but you can still continue.

15 “Hard” the activity is heavy and fatiguing, you start to become tired at a quicker time frame, can continue but feel tired

16 starting to become hard to perform the activity, ability to perform may not be much longer

17 a very heavy intensity, fatigue is high, breathing rate and heart rate are high, you can continue for what feels like a shorter amount of time.

18 approaching maximal exertion with breathing rate highly elevated and the body is getting close to not being able to keep up with the activity.

19 should be your maximal exertion to where you are extremely fatigued and cannot perform the exercise for much longer, the most fatigue during exercise that has ever been experienced by most people

20 is the most strenuous exertion imaginable

Note that this scale is not a pain scale and if at any time you feel muscle, chest or stomach pain notify me immediately and do not include it with your rating of exertion.

APPENDIX F

RECRUITMENT SCRIPT

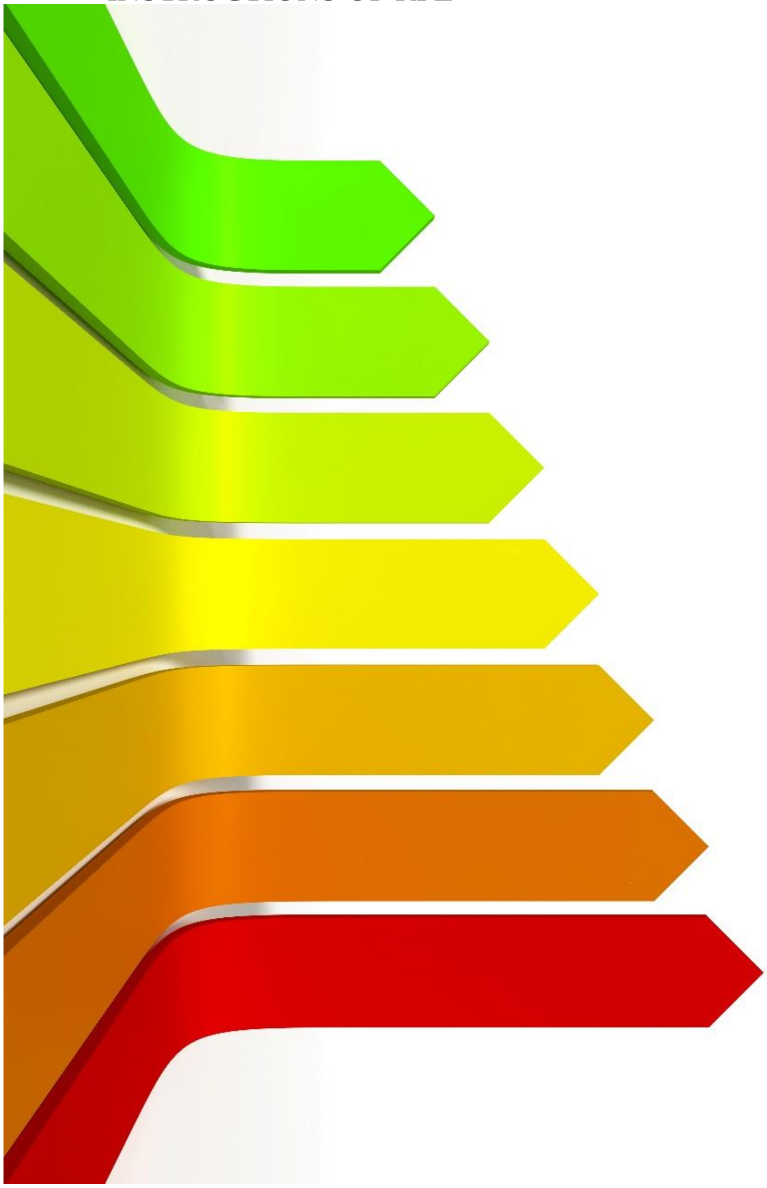
I am here to recruit volunteers for my thesis research. This project has been approved by the University of Central Oklahoma Institutional Review Board, #16192. This project will consist of two separate sessions of the Balke-Ware treadmill protocol to 85% of your predicted maximal exercise capacity. The prediction of your maximal capacity will be calculated through a standardized equation that uses your age. The Balke-Ware treadmill protocol is a walking protocol.

Before every exercise session, you will be read a script of instructions and will be asked to give reports according to the instructions during the test. You can participate in this study if you are over the age of 65 years before the start of the research, can walk for 5 minutes without assistance, are comfortable walking on the treadmill, and have never been told you have a neurological or musculoskeletal problem. Participation in this study is strictly voluntary and you have the ability to drop out at any time during the study without consequence. If you would like to volunteer for this study you can let me know now or I have a flyer with my contact information for you to go home and think about participating if you would like.

APPENDIX G

RECRUITMENT FLYER

INSTRUCTIONS OF RPE



Rate of Perceived Exertion (RPE):

Thesis Project

Olivia Henderson

Kinesiology & Health Studies Department

University of Central Oklahoma

Approved by UCO IRB # 16192

Volunteer for a Research Study

We are conducting research on the rate of perceived exertion (RPE). Your participation will include being read scripted instructions and performing a exercise test up to 85% of your age predicted heart rate max.

Requirements:

- 65 years and older
- Comfortable walking on a treadmill
- Can walk unassisted for 5 minutes or more
- No diagnosed nuerological issues
- No diagnosed musculoskeletal issues

To sign up or have questions contact Olivia by phone or email.

405-615-8222

Mcurtis3@uco.edu

APPENDIX H

THESIS SUMMARY

Thesis Summary

Problem

In 2013, the United States held 44.7 million (14.1% of the population) older Americans, equal to one out of every seven Americans (AOA, 2016). The National Council on Aging (NCOA, 2016) stated that 80% of older adults have at least one chronic disease, and 68% have at least two (NCOA, 2016). In a study researching the barriers to high-quality care, from the physicians' viewpoint, 36% primary care and 27% of specialty physicians reported a lack of adequate time with patients (Demelloe & Deshpande, 2011). Older adults, especially those with chronic disease, may not know what moderate intensity exercise should feel like or how to monitor the intensity their doctors prescribe. Simply being told "exercise at moderate intensity," is not clear enough for someone to know exactly what to feel when instructed to work at certain intensities (Borg, 1998, pp. 29).

In 2010, a study of 5% of those with Medicare showed that 30,161 older adults attended at least one session of cardiac rehabilitation over a five-year span (Curtis, Hammill, Schulman & Whellan, 2010). RPE is utilized in cardiac rehabilitation as a way to measure intensity in those that are taking beta-blockers or other medications that affect HR (Chen, Huang, Ting, & Tsai, 2015). Additionally, a study found that when self-regulating intensity in cardiac patients, the RPE exercise session had a significantly lower mean peak HR than the self-regulation by HR exercise session (Aamot, Forbord, Karlsen & Stoylen, 2014). The differences between HR and RPE could be from the diseased condition or the ability to accurately identify exertion with a number. Educating researchers and professionals about the RPE scales and the anchored meaning may decrease the misuse of the scale increasing the safety of exercise.

Summary of the Literature

To the author's knowledge there has been no published research questioning the effects of RPE instructions on accuracy of HR and VO_2. Validity and reliability studies have found significant moderate to strong correlations with HR, VO_2, and blood lactate (Ceci & Hassmen, 1991; Christle et al., 2013; Coquart et al., 2014; Chung et al., 2015; Eston & Faulkner, 2007, Eston et al., 2009; Eston et al., 2015; Katsanos & Moffatt, 2005). A meta-analysis by Chen et al. (2002) found mean correlations of 0.68 and 0.70 in 21 articles with older adults. Similarly, mean correlations of another study were HR $r = 0.70$ and VO_2 $r = 0.51$ (Chung et al., 2015). A study that had the participants regulate exercise intensity to meet a specific RPE level found correlations of 0.80-0.87 with VO_2 (Eston et al., 2015). All of these studies questioned the overall reliability and validity of using the RPE during exercise testing, but did not question the effects of instruction.

Some studies that have researched the accuracy of the RPE scale mentioned that the participants were instructed with standardized instructions (Biren et al., 2009; Cordes et al., 2013; Eston & Faulkner, 2007; Eston et al., 2009; Eston et al., 2015; Johnson & Phipps, 2006; Katsanos & Moffatt, 2005). Sources for these standardized instructions were from the ACSM, CDC, and several different publications by Gunnar Borg (Angelopoulos et al., 1996; Biren et al., 2009; Eston & Faulkner, 2007; Eston et al., 2015; Katsanos & Moffatt, 2005; Thompson & West, 1998; Johnson & Phipps, 2006).

Purpose

The purpose of this study was to determine the impact of instruction types and familiarization on the correlation between physiological measures of intensity (HR and VO_2) and RPE with older adults.

Methodology

All participants in this study were at least 65 years old, were able to walk independently for a minimum of five minutes, and had no neurological or musculoskeletal problems. The study design consisted of two Balke-Ware submaximal exercise tests at least seven days apart. The groups were read the Borg copyright script before the exercise test at session one. The treatment group was read the Modified Borg script at session two, while the control group was read the Borg script. During the exercise tests participants wore a blood pressure cuff, HR monitor, and a VO_2 mask.

Results

Participants in this study included 4 males and 12 females (N = 16), 23.5% male and 70.6% female. Participants were randomly assigned to two groups. The treatment group made up 53.9% (n = 9) of the participants and the control group was 41.2% (n = 7). Ages ranged from 65 to 88 years with a mean age of 74.19 years (SD=7.28).

There were significant differences between groups at session one for the mean correlation of RPE with VO_2 t (13) = 1.365, p = .021, d = 1.625, but not at session two. There were no significant differences from session one to session two for the control group t (6) = -.497, p = .637, d = 0.285 or the treatment group t (7) = -1.67, p = .137, d = 0.620 for mean correlations with RPE and VO_2. No significant differences were found between groups at session one t (14) = – 1.038, p = .70, d = 0.418 or two t (14) = .417, p = .189, d = 0.611 for the mean correlation of

HR and RPE. No significant differences were found for either the control group t (6) = -2.121, p = .078, d = 0.836 or the treatment group t (8) = -.393, p = .705, d = 0.324 between session one and two.

Thesis Decision

Instructions may impact the correlation between physiological measures of intensity (HR and VO_2) and RPE. The group variance at session one may show that the increase from session one to session two for the treatment group could have been from the instructions given. Provided more volunteers to participate in this study there could have been more significant findings.

Significance of Results

The treatment group showed no significant increases from session one to session two with both HR and VO_2. The control group approached a significant difference (p = .078) from session one to two for HR with RPE. The increases could propose that instructions being given a second time increased understanding of the scale or that a familiarization effect occurred. The significant difference between the two groups at session one could have been just group variance. The increase of the mean correlation of VO_2 and RPE in the treatment group at session two decreased the difference between the two groups (Table 2), suggesting that the modified instructions were more helpful for understanding the RPE scale. Although, the treatment groups increases were not significant there could have been significance with a larger sample size. Past research has not analyzed multiple graded exercise tests in this way. Eston and Faulkner (2007) looked at the accuracy of RPE during two graded exercise sessions, but did not compare the two sessions for familiarization, only consistency of results.

Some researchers have expressed their aversion to the RPE scale, because of its common use by those who are ill-informed of the scale’s utilization (Borg & Borg, 2001). Educating researchers and professionals about the RPE scales and the anchored meaning may decrease the misuse of the scale.

Future Research

More research with older adults over three to four sessions should be done. These studies should perform a maximal test at the first session without RPE used, so that there is a maximal measure to test accuracy and allows time to familiarize with the equipment. Comfort with the equipment used and the instructions developed may have affected the results of the present study. Borg and Borg (2001) stated that participants should not have restrictions while using the perception scales. This study could show that by specifically defining each level of RPE a restriction can be created. A study comparing the accuracy of RPE with and without instructions could better show the effect of the copyrighted instructions. Once more research has been obtained on the effects of instructions on the accuracy of RPE, updated instructions should be published and provided by accredited exercise programs.

APPENDIX I

IRB APPROVAL LETTER

December 15, 2016 IRB Application #: 16192

Proposal Title: *Impact Of Instructions On Accuracy In Exercising Rate Of Perceived Exertion (RPE) In Older Adults*

Type of Review: Full Board

Investigator(s): Ms. Olivia Henderson & Dr. Melissa Powers
Department of Kinesiology & Health Studies
College of Education & Professional Studies
Campus Box 189
University of Central Oklahoma
Edmond, OK 73034

Dear Ms. Henderson and Dr. Powers:

Re: Application for IRB Review of Research Involving Human Subjects

We have received your revised materials for your application. The UCO IRB has determined that the above named application is APPROVED BY FULL BOARD REVIEW.

Date of Approval: 12/15/2016
Date of Approval Expiration: 12/14/2017

If applicable, informed consent (and HIPAA authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. A stamped, approved copy of the informed consent form will be sent to you via campus mail. The IRB-approved consent form and process must be used. While this project is approved for the period noted above, any modification to the procedures and/or consent form must be approved prior to incorporation into the study. A written request is needed to initiate the amendment process. You will be contacted in writing prior to the approval expiration to determine if a continuing review is needed, which must be obtained before the anniversary date. Notification of the completion of the project must be sent to the IRB office in writing and all records must be retained and available for audit for at least 3 years after the research has ended.

It is the responsibility of the investigators to promptly report to the IRB any serious or unexpected adverse events or unanticipated problems that may be a risk to the subjects.

On behalf of the UCO IRB, I wish you the best of luck with your research project. If our office can be of any further assistance, please do not hesitate to contact us.

Sincerely,

Robert D. Mather, Ph.D.
Chair, Institutional Review Board
University of Central Oklahoma
100 N. University Dr.
Edmond, OK 73034
405-974-5497
irb@uco.edu