VALIDATION OF OMNI RPE AND PREFERRED METHOD OF REGULATING EXERCISE INTENSITY IN OBESE ADULTS

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Submitted to the Graduate Faculty of

School of Education in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2012

UNIVERSITY OF PITTSBURGH

SCHOOL OF EDUCATION

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The Adult OMNI-Walk/Run RPE Scale (OMNI RPE) has not been validated in overweight and obese adults. In addition, the preferred method that overweight and obese individuals use to self-regulate exercise intensity is unknown. **PURPOSE:** The primary purpose of this investigation was to examine concurrent and construct validity of the OMNI RPE in overweight and obese adults. The secondary purpose of the present study was to examine the preferred method of self-regulating exercise intensity (SRE) in this same cohort. **METHODS:** Sixty (males, n = 22, age = 37.18 ± 9.70 yrs; females, n = 38, age = 34.45 ± 7.92 yrs) sedentary to physically active overweight or obese adults participated in this study. A single observation, cross-sectional research design was employed where subjects performed a progressively incremented submaximal graded treadmill exercise test to 85% of age predicted maximal heart rate (APMHR) followed by a questionnaire-based interview. HR and Oxygen consumption (VO_2) were regressed against OMNI RPE responses from every second minute of exercise to examine concurrent validity. OMNI RPE responses were regressed against Borg RPE to establish construct validity. Subjects completed interview-led questionnaires post-exercise to assess physical activity history and preferred method of SRE. **RESULTS:** A strong relation between OMNI RPE and HR ($r = 0.866$; $p < 0.001$) was observed for the total sample. A moderate-strong relation between OMNI RPE and VO_2 ($r = 0.731$; $p < 0.001$) was also observed. OMNI RPE displayed a very strong relation with Borg RPE ($r = 0.963$; $p < 0.001$). In the past, more subjects (88.2%) reported using a perceptual method to SRE than the 11.8% who reported using a HR method ($p < 0.001$). There was no difference in subject's preference in the future. **CONCLUSION:** Concurrent and construct validity of OMNI RPE were established in overweight and obese adults. Therefore, OMNI RPE may be used in treadmill exercise testing in overweight and obese adults. In addition, more subjects previously used perceptual methods to SRE. However, there was no difference in preference for SRE in the future. The reason behind this finding is uncertain and warrants further investigation.

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PREFACE

I would like to thank the following for their contribution to this investigation:

- Dr. Goss; Thank you for your time and assistance with this project. I am grateful for all your guidance over the past several years that have led to my educational and professional development.

- Dr. Jakicic, Dr. Nagle, Dr. Storti, Dr. Davis, & Dr. Rubinstein; Thank you for all your advice and guidance through this process. Your assistance has been invaluable.

DEDICATION

I would like to dedicate this dissertation to my God, family, and friends. You have each supported me in your own way:

- God; Thank you for everything you have provided me in my life. I am eternally grateful for your grace and love.

- My beautiful bride Lisa; Thank you for always supporting and encouraging me since the day we met. I hope I always make you proud.

- Mom, Dad, Shannon, & Staci; Thank you for all the love and support you've shared with me since the day I was born. You are the best family a man could ask for.

- All my friends; Thank you for your friendship, support, and patience with me over the past several years. I hope we can maintain our friendships as my life continues on another great journey.

1.0 INTRODUCTION

The obesity epidemic is a critical public health concern in the United States. Obesity is considered a risk factor for developing coronary heart disease (CHD) (ACSM, 2010; Hubert et al., 1983), and appears to exacerbate the negative effects of other cardiovascular disease risk factors such as hypertension and dyslipidemia (Stunkard, 1996). In 2010, approximately 64% of American adults were classified as overweight or obese according to the Behavioral Risk Factor Surveillance System (BRFSS) (Centers for Disease Control and Prevention [CDC], 2010a).

Increased prevalence of physical inactivity is another public health concern. In 2009, 49% of American adults did not meet the current American College of Sports Medicine (ACSM) and American Heart Association (AHA) recommendations of at least 30 minutes of moderate physical activity at least five days per week or vigorous activity for at least 20 minutes three or more days per week (CDC, 2009). Furthermore, in 2010 approximately 24% of adults reported that they did not participate in any leisure-time physical activity in the previous month (CDC, 2010b). Achieving higher amounts of physical activity has been shown to have an inverse relationship with the incidence of CHD and other cardiovascular disease risk factors (Berlin & Colditz, 1990; Hagberg, 1990; Lakka, 1994). Therefore, regular exercise provides many health and fitness benefits for individuals who are overweight. However, the preferred method of self-regulating the exercise intensity of overweight individuals is currently unknown.

The prescription of any exercise program should include five components: 1) Frequency, 2) Intensity, 3) Duration, 4) Mode of exercise, and 5) Progression. Of these five components, selection of exercise intensity is the most complex process. The prescription of exercise intensity for aerobic exercise assumes that a predetermined level of total body oxygen consumption (VO_2) is achieved during the stimulus portion of each training session, producing a physiological overload that improves aerobic fitness (Robertson, 2001b). There are several strategies that can be used to establish the appropriate exercise intensity. These include the utilization of physiological markers such as heart rate (HR) and VO_2, and perceptual measures such as rating of perceived exertion (RPE).

Heart rate and VO_2 prescription methods typically employ the use of a specific range of values determined from their respective physiological ranges to establish the exercise intensity. The use of HR-based prescription methods to establish aerobic exercise intensity requires the determination of a range from rest to maximal HR, measured either during a graded exercise test or predicted based upon age. Age predicted maximal HR (APMHR) has a standard deviation of 11 beats per minute which may result in overestimating or underestimating the exercise intensity (Dishman, 1994). Other factors such as ambient air temperature, humidity, psychological stress, caffeine, and medications may also contribute to variability in the exercise HR response. Purchasing expensive HR monitors or performing cumbersome HR palpations, which may reduce the time on stimulus, are further disadvantages of using HR for exercise intensity self-regulation. In addition, the use of VO_2 for regulating exercise intensity outside of clinical settings is impractical, because of the need of expensive aerobic metabolic equipment. However, RPE is not limited by these negative factors, and therefore, may be a more appropriate tool for exercise intensity self-regulation than HR or VO_2.

The perception of physical exertion is defined as the intensity of effort, strain, discomfort, and/or fatigue that is felt during exercise (Robertson & Noble, 1997). This perceptual construct is assessed using RPE scales. The first perceived exertion scale was developed by the Swedish psychologist Gunnar Borg in the early 1960s. Since then, many RPE scales have been produced and validated over the past 50 years including the Borg Fifteen-Category (6 – 20) RPE Scale, Borg Category Ratio-10 scale, and OMNI 11-category (0 – 10) scales (Borg, 1998; Robertson, 2004). The Borg Fifteen-Category perceived exertion scale has a numerical rating from 6 to 20 with nine verbal descriptors (Borg, 1998). Strong concurrent validity of the Borg 6 – 20 RPE Scale has been determined by correlating RPE with corresponding physiological variables observed during aerobic exercise in individuals who vary in fitness level. These physiological mediators include heart rate (HR), VO_2, ventilation, respiration rate, respiratory exchange ratio, and blood lactate responses during progressively incremented cycle and treadmill exercise tests (Chen et al., 2002; Hall et al., 2005; Noble & Robertson, 1996; Robertson, 2004; Utter et al., 2004). Therefore, the Borg 6 – 20 RPE Scale has been considered an acceptable instrument for assessing RPE during a range of aerobic exercise modes (Robertson, 2004).

Among the recently developed OMNI RPE scales is the OMNI-Walk/Run RPE Scale for adults. The term OMNI is a contemporary contraction of the word omnibus referring to a scale with broadly encompassing properties (Robertson et al, 2001). The Adult OMNI-Walk/Run RPE Scale is an 11-category perceived exertion rating scale that has a numerical rating from 0 to 10 with verbal and mode-specific pictorial descriptors (Robertson, 2004). The design of the OMNI scale may result in stronger concurrent validation with physiological markers because of the addition of pictures to the numbers and verbal descriptors. Also, the 0 to 10 format of this scale may better generalize to every day applications, and therefore may be easier to understand and use than the Borg 6 – 20 RPE Scale format. The OMNI-Walk/Run RPE Scale has been shown to be valid when HR and VO_2 responses to exercise were used as the concurrent variables. This metric has also been proven to be valid when compared to the Borg 6 – 20 RPE Scale (construct variable) and reliable in healthy, normal weight subjects (Utter et al., 2004; Robertson, 2004). In addition, the children's version of the OMNI-Walk/Run RPE Scale showed a stronger correlation with HR (r = 0.86) and VO_2 (r = 0.89) than the Borg 6 – 20 RPE Scale (r = 0.66 and r = 0.70, respectively) during treadmill exercise in adolescent girls (Pfeifer et al., 2002).

The ACSM recommends that perceived exertion, measured by either the Borg 6 – 20 RPE Scale or OMNI scale, should be a primary or adjunct measure of the intensity component of the exercise prescription (ACSM, 2010). Until recently, the extent that RPE has been used to self-regulate exercise intensity was not known. Several questionnaires have been developed to examine the frequency, intensity, type, and duration of physical activity or exercise that individuals perform. The two most commonly used questionnaires to quantify physical activity in weight control studies are the Seven-Day Physical Activity Recall (PAR) (Sallis et al., 1985), and the Paffenbarger Physical Activity Questionnaire (PAQ) (Paffenbarger et al., 1986). However, neither of these questionnaires examine how an individual regulates or judges their exercise intensity during aerobic exercise sessions.

In 2006, Johnson and Phipps developed a questionnaire in an attempt to bridge this gap in the literature. They found that 86% of the 100 healthy, non-obese women (22.3 ± 0.44 years of age) interviewed used effort perception to judge exercise intensity (Johnson & Phipps, 2006). However, they only assessed young adult females who were participating in regular exercise programs. Therefore, the results of their investigation are not generalizable to overweight, obese, or sedentary individuals.

1.1 RATIONALE

Ratings of perceived exertion have been widely employed in exercise testing and prescription in normal weight, overweight, and obese individuals of varying fitness levels (Ceci & Hassmen, 1991; Demello et al., 1987; Dishman et al., 1994; Dunbar et al., 1992; Eston et al., 1987; Eston & Williams, 1988; Glass et al., 1992; Jakicic et al., 1995; Kang et al., 1998; Kang et al., 2003; Kang et al., 2009; Robertson et al., 1990; Skinner et al., 1973a; Skinner et al., 1973b). The OMNI RPE scale may be an easier metric to comprehend and use to self-regulate exercise intensity when compared to the Borg RPE scale. Therefore, it may be more appropriate for use in clinical and public health settings. This method of rating perceived exertion has been validated in children, normal weight recreationally active adults, and adults with metabolic syndrome (Irving et al., 2006; Robertson et al., 2000; Robertson et al., 2001; Robertson et al., 2004; Utter et al., 2004). However, the Adult OMNI-Walk/Run RPE Scale has not been validated in overweight and obese adults. In addition, the preferred method that overweight and obese individuals use to self-regulate exercise intensity, or what strategy they would prefer to use is unknown. Therefore, it is important to determine if the Adult OMNI-Walk/Run RPE Scale is a valid assessment tool in overweight and obese subjects, and what method these individuals prefer to use when self-regulating exercise intensity.

1.2 SPECIFIC AIMS

The primary aim of this investigation was to examine concurrent and construct validity of the OMNI-Walk/Run RPE Scale in overweight and obese adults. Concurrent validation was examined by regressing OMNI-Walk/Run RPE with HR and VO_2. Construct validation was examined by correlating responses from the OMNI-Walk/Run RPE Scale with those of the Borg 6 – 20 RPE Scale.

The secondary aim of this investigation was to determine the preferred method of self-regulating exercise intensity, for previous and future exercise sessions, in the same cohort. These findings may provide the basis to develop future physical activity interventions.

1.3 HYPOTHESES

1. It was hypothesized that concurrent validity of the Adult OMNI-Walk/Run RPE Scale with HR and VO_2 would be established in overweight and obese, male and female adults.

2. It was hypothesized that construct validity of the Adult OMNI-Walk/Run RPE Scale with the Borg 6 – 20 RPE Scale would be established in overweight and obese, male and female adults.

3. It was hypothesized that overweight and obese adults who have previously exercised have used perceptual methods to self-regulate exercise intensity.
   - 3.1. It was hypothesized that subjects would prefer to use perceptual methods to self-regulate exercise intensity in future exercise sessions over HR methods.
   - 3.2. It was hypothesized that subjects would prefer to use the Adult OMNI-Walk/Run RPE Scale over the Borg 6 – 20 RPE Scale to self-regulate exercise intensity in future exercise sessions.

2.0 LITERATURE REVIEW

2.1 METHODS OF REGULATING EXERCISE INTENSITY

The American College of Sports Medicine (ACSM) has provided guidelines for exercise prescription in healthy and at-risk populations. The framework of every exercise prescription utilizes the FITT principle. This training principle dictates: the frequency of exercise sessions performed each week, the intensity of the exercise, the duration of the exercise, the type or mode of the exercise, and the progression of increasing the volume or load. The ACSM guidelines of exercise frequency, duration, mode, and progression are simple and easy to understand. However, the prescription of exercise intensity can be a complex process.

The most common approach to prescribing exercise intensity in most populations involves varying the exercise stimulus to achieve a prescribed physiological outcome (Noble & Robertson, 1996). The most common physiological outcome used today is a percentage of total body oxygen consumption reserve (%VO_2R). This is determined by using the following equation $\{[(VO_{2max}) - VO_{2rest}) \text{ x desired \%}] + VO_{2rest}\}$. Exercise intensity prescription during aerobic exercise assumes that this predetermined level of VO_2 is achieved during the stimulus portion of each training session, producing a physiological overload that improves aerobic fitness (Robertson, 2001b). However, direct measurement of VO_2 requires expensive equipment, and is impractical for use outside the laboratory setting. Therefore, exercise intensity is typically prescribed using heart rate (HR), and/or ratings of perceived exertion analogues of VO_2.

Heart rate is commonly used for exercise intensity prescription because it shares a linear relationship with VO_2. The use of HR reserve (HRR) is the recommended approach to establish the predetermined %VO_2R (ACSM, 2010; Dishman, 1994; Swain & Leutholtz, 1996). Heart rate reserve is determined using the same technique employed to calculate VO_2R, substituting resting and maximal HR for the corresponding VO_2 values. However, this method has its limitations in prescribing and self-regulating exercise intensity.

In the public health setting, the maximal HR (HR_{max}) may be estimated based on the person's age rather than measured during a graded exercise test. An estimated HR_{max} has a standard deviation of approximately 11 beats·min^{-1} that can lead to an overestimation or underestimation of exercise HR (Dishman, 1994; Buckworth & Dishman, 2002; Noble & Robertson, 1996; Londeree & Moeschberger, 1982). Various emotional states, environmental conditions, hydration status, stimulants (i.e., caffeine), and certain medications can affect both resting and exercising HR. Changes in resting HR also occur following significant weight loss and/or aerobic training.

An investigation by Levy et al. (1998) examined the effect of six months of intensive aerobic endurance exercise training on resting HR in healthy young (24 – 32 years of age) and older (60 – 82 years of age) males. They reported resting HR values decreased by 5 and 9 beats·min^{-1} ($p = 0.0001$) for the young and older males, respectively. Another study by Jurca et al. (2004) examined the effect of eight weeks of moderate-intensity exercise training on resting HR in sedentary, postmenopausal (50 – 64 years of age) overweight and obese (body mass index, BMI = 25 – 40 kg·m^{-2}) women. The subjects' resting HR decreased from 68.1 ± 8.5 beats·min^{-1}

(pre-training) to 65.0 ± 7.4 beats·min^{-1} (post-training) ($p < 0.001$). In addition, sedentary subjects (34.9 ± 13.2 years of age, BMI = 26.3 ± 5.1 kg·m^{-2}) in the HERITAGE Family Study decreased resting HR (-2.7 – 4.6 beats·min^{-1}) following a 20 week endurance training program (Wilmore et al., 2001). If the HRR method is used to determine the training intensity, this decrease in resting HR results in an overestimation of VO_2. Ratings of perceived exertion are not influenced by this discrepancy (Jakicic et al, 1995). Therefore, perceived exertion rather than HR may be a more effective way of determining the intensity component of the exercise prescription, and subsequently, self-regulating exercise intensity.

2.2 PERCEIVED EXERTION

2.2.1 Rating of Perceived Exertion (RPE)

The perception of physical exertion is defined as the intensity of effort, strain, discomfort, and/or fatigue that is felt during exercise (Robertson & Noble, 1997). Borg, a Swedish psychologist, is considered the father of perceived exertion as he coined the term, and his early work has served as the foundation for all research in the field of perceived exertion. In the early 1960’s, Borg developed and validated the first category scale to measure perceived exertion during a graded exercise test conducted on a cycle ergometer (Borg, 1961, 1962; Borg & Dahlstrom, 1960). In 1970, an updated version of this scale was constructed by Borg to improve the linear relationship between RPE and work load (Borg, 1970, 1973, 1982). This measurement concept has led to the development and validation of additional scales by Borg and other researchers over the past 50 years. However, Borg’s Fifteen-category Perceived Exertion Scale (Borg 6 – 20 RPE) is the most widely used RPE scale for exercise testing and prescription in clinical, research, and health-fitness settings (Borg, 1998). Further research in the perceived exertion domain has expanded from the development and validation of new scaling methodologies to its use in exercise prescription.

2.2.2 Global Model

An individual's perception of exertion during dynamic exercise is derived from the interaction between physiological, psychological, and performance elements. Noble and Robertson (1996) attempted to explain the interrelationship of these components in a theoretical global model of perceived exertion (Figure 1). The model explains the flow of neurosensory information from an exercise stimulus to the resulting perceptual response, and is interpreted sequentially from left to right.

The physiological responses to exercise serve as the primary mediators in establishing the intensity of the perceptual signal. These mediators, either individually or collectively, act to alter the tension-producing properties of the skeletal muscle. During exercise, a greater discharge of feed-forward commands from the motor cortex results in an increase in muscle tension of the peripheral and/or respiratory muscles. These commands are copied, and sent through corollary pathways to be interpreted as perceptual signals of exertion in the sensory cortex. The final mediating step in the model matches the signal arising from the sensory cortex to the contents within the perceptual-cognitive reference filter. This filter refines the perceptual signal, and modifies its intensity according to the matrix of past and present events that regulate the individual's perceptual style (Noble & Robertson, 1996). The resulting perceptual response for the overall body is determined from the differentiated perceptual signals that arise from the localized body segments involved in the exercise.

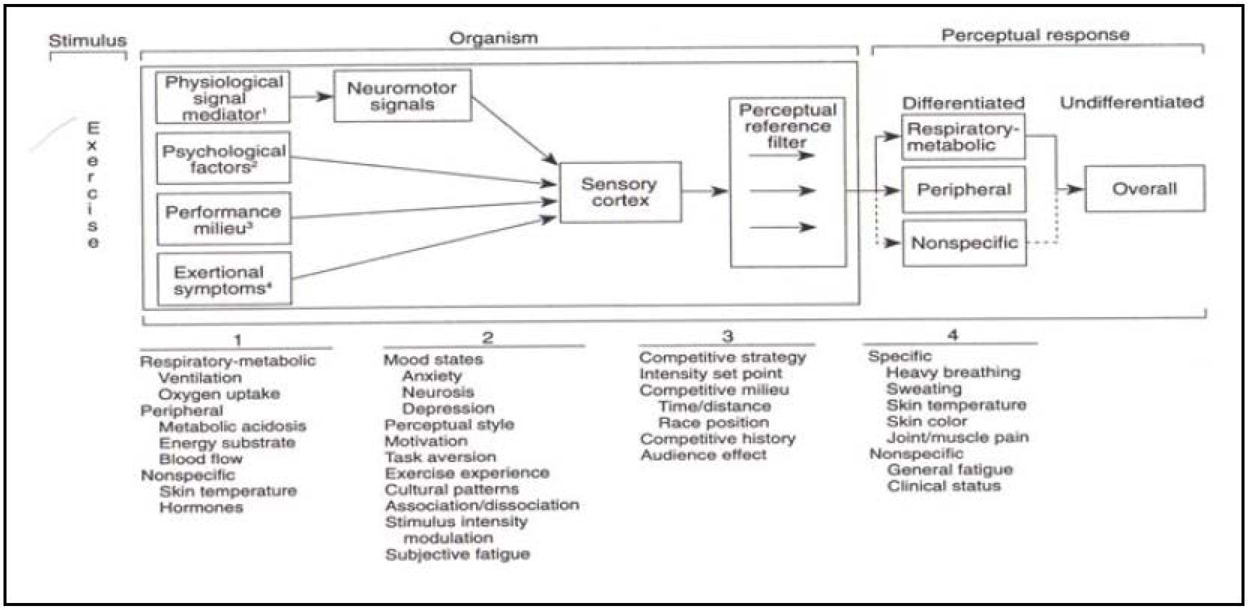

Figure 1. Global exploratory model of perceived exertion
(Noble & Robertson, 1996)

2.2.3 Effort Continua

The theoretical rationale underlying the practical application of RPE relies on the functional interdependence of perceived and physiological responses during exercise (Robertson, 2004). The three main effort continua involved in an individual's subjective response to exercise are physiological, perceptual, and performance (Robertson, 2001a). Figure 2 illustrates the relationship between an exercise stimulus and the three effort continua. As the intensity of exercise increases, corresponding and interdependent increases occur in performance, perceptual (RPE), and physiological (VO_2 and HR) processes (Borg, 1998; Robertson, 2004). Therefore, the relations between the effort continua indicate that perceptual responses provide the same information about exercise performance as physiological responses.

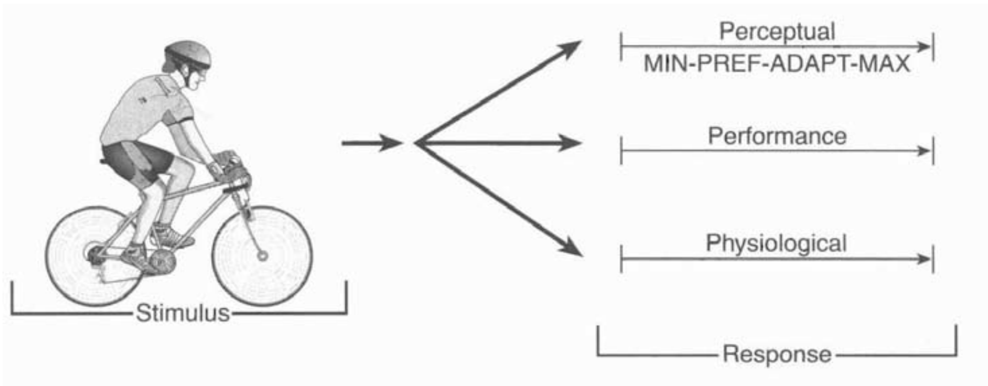

Figure 2. Effort continua model of perceived exertion
(Borg, 1998; Robertson, 2004)

2.2.4 Borg's Range Model

The Borg Range Model is considered the cornerstone of perceived exertion measurement and application as it provides the theoretical basis for the validation of RPE scales. The model describes the changes that occur in perceived exertion as exercise intensity increases from low to high levels (Figure 3) (Borg, 1961, 1998). The model makes two major assumptions: 1) for any given exercise range between rest and maximum, there is a corresponding and equal RPE range; and 2) in all clinically normal individuals, both the RPE range and the intensity of perceptions at low and high exercise levels are equal (Borg, 1998; Robertson & Noble, 1997). Therefore, an increase in exercise intensity from a minimal to maximal level results in a corresponding and equal increase of effort. This allows for the standardized comparison of RPE between individuals who have different fitness levels. An RPE at a specific relative intensity will be similar for both a lower and higher fit individual despite a higher absolute intensity in the higher fit individual. The application of the model translates the perception of exertion into numerical ratings, and establishes the low and high perceptual anchors of an RPE scale at low and high exercise intensities (Robertson, 2004).

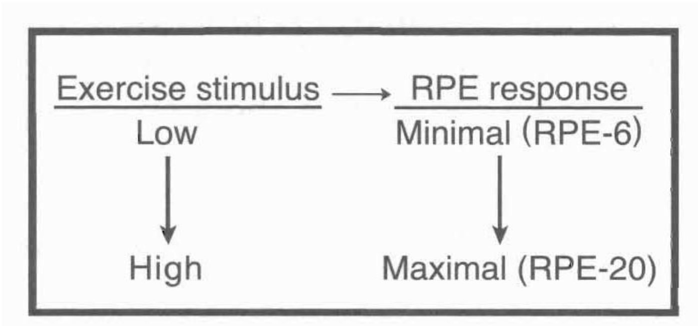

Figure 3. Borg's range model for category scales of perceived exertion (Borg, 1998)

2.2.5 Physiological Mediators

Physiological processes that are subjectively monitored and evaluated in clinical, research, and health-fitness settings are important mediators in the application of perceived exertion. The physiological mediators of perceived exertion can be classified into three groups: 1) respiratory-metabolic, 2) peripheral, and 3) nonspecific (Table 1) (Noble & Robertson, 1996; Robertson, 2004). Pulmonary ventilation (V_E), VO_2, carbon dioxide production (VCO_2), HR, and blood pressure (BP) responses during exercise influence the respiratory-metabolic drive. The composition of localized skeletal muscles in the trunk and exercising limbs, and their contraction efficiency provide the peripheral contribution to the overall exertion signal. The nonspecific mediators of perceived exertion are generalized or systemic physiological responses that occur during exercise that are not directly linked to peripheral or respiratory-metabolic perceptual signals (Noble & Robertson, 1996).

Table 1. Physiological mediators of perceived exertion
(Noble & Robertson, 1996; Robertson, 2004)

Respiratory-Metabolic	Peripheral	Nonspecific
Pulmonary ventilation	Metabolic acidosis (pH, lactic acid)	Hormonal regulation (catecholamines, β-endorphins)
Oxygen uptake	Blood glucose	Temperature regulation (core and skin)
Carbon dioxide production	Blood flow to muscle	Pain
Heart rate	Muscle fiber type	Cortisol and serotonin
Blood pressure	Free fatty acids	Cerebral blood flow and oxygen
	Muscle glycogen	

2.2.6 Effectiveness in Exercise Intensity Self-Regulation

An investigation by Koltyn and Morgan (1992) examined the effectiveness of using RPE, compared to HR, to monitor exercise intensity during aerobic dance classes in 76 female college students (20.0 ± 4.0 years of age). Subjects attended two 50-minute aerobic dance classes per week for 14 weeks. During these classes, one group regulated exercise intensity using the HRR method (70 – 85 % HRR) while another group employed the Borg 6 – 20 RPE Scale at an intensity (13 – 15, "somewhat hard – hard") that typically corresponds to 70 – 80% HRR. Endurance performance was assessed by total distance covered during a 15-minute run at baseline, and following the intervention. Subjects in both groups significantly improved endurance performance ($p < 0.001$). However, the greatest improvement was observed in subjects who perceptually regulated exercise intensity (11%) compared to those who utilized the HRR method (6%). Therefore, RPE may be more effective in exercise intensity self-regulation than HR methods in improving health and fitness.

2.3 EXERCISE IN OVERWEIGHT AND OBESITY

2.3.1 Special Considerations

Overweight and obese individuals are characterized by excess body weight using BMI as the typical criterion to define these conditions (ACSM, 2010). The extra body weight contributes to a higher metabolic cost of walking in these individuals that may lead to an earlier onset of fatigue, and therefore, a lower exercise capacity (Bloom & Marshall, 1967; Browning & Kram, 2005; Foster et al., 1995; Freyschuss & Melcher, 1978; Mattson et al., 1997). In addition, this excess weight may contribute to the development of musculoskeletal pathologies (i.e., knee osteoarthritis), and discourage exercise participation. However, walking is still popular, and the recommended form of exercise to reduce excess body weight in overweight and obese individuals (Hill et al., 2003).

Exercise that incorporates the weight of the body (i.e., walking) produces higher energy expenditures (6.6 ± 2.1 kcal·min^{-1}) than non-weight bearing activities (i.e., cycling, 5.3 ± 2.1 kcal·min^{-1}) in obese adults (37 – 71 years of age) (Kim et al., 2008). An investigation by Browning et al. (2006) compared the energy cost of walking, and effects of adipose tissue distribution between obese and normal-weight adult (18 – 33 years of age) men and women. They reported the net metabolic rates of walking were approximately 10% greater in obese individuals than their normal-weight counterparts. In addition, obese women had net metabolic rates that were approximately 10% greater than those reported for obese men. The greater total percent body fat of obese individuals contributed more to the difference in walking metabolic cost than the distribution of adiposity ($r^2 = 0.42$, $p < 0.001$). Therefore, the extra weight in these individuals contributes most to the greater energy expenditure during walking.

The additional body mass in overweight individuals also leads to a greater amount of stress placed on the knees during walking. This repetitive strain may lead to the development of osteoarthritis in the knees. An investigation by Browning and Kram (2007) compared the biomechanics of walking at different speeds (30 – 105 $m \cdot min^{-1}$, 1.12 – 3.92 mph) between obese and normal-weight adults. Ground reaction forces (GRF) increased linearly with speed with greater GRF observed in the obese. Obese subjects also recorded greater step widths (distance between the mediolateral centers of pressure for both feet during walking) at all speeds compared to their normal-weight peers. However, another investigation reported that obese individuals prefer to walk at approximately 90 $m \cdot min^{-1}$ (3.4 mph), and that this intensity (70% HR_{max}) is sufficient for the improvement of cardiovascular fitness (Hills et al., 2006). Therefore, in overweight and obese individuals, exercise testing should avoid faster speeds that can cause discomfort and pain, and exercise prescription should involve walking at a moderate speed that will elicit health and fitness benefits.

2.3.2 Use of RPE

The Borg 6 – 20 RPE or Category-Ratio RPE scales may be used in exercise testing (ACSM, 2010; Borg 1982, 1990). However, only the Borg 6 – 20 RPE Scale is recommended for use in exercise prescription (Borg, 1982). In 1973, Skinner et al. examined the validity and reliability of this scale in obese and lean college-aged males. The subjects completed two exercise trials on a cycle ergometer while rating their perceived exertion. The first trial consisted of a progressively increasing workload (150 $kgm \cdot min^{-1}$ per stage) to maximal effort while the second test involved a random assignment of each workload (i.e., 150, 750, 300, 600 $kgm \cdot min^{-1}$, etc.). Subjects reported no significant differences in RPE between the two trials or weight classification. Therefore, validity and reliability of the RPE scale across individuals with various body weights was established.

Several weight loss studies have employed RPE to determine exercise intensity in overweight and obese individuals (Jakicic et al., 1995, 1999, 2003, 2008). An investigation by Jakicic et al. (1995) examined the relationship between HR, VO_2, and ratings of perceived exertion in 122 obese female adults following significant weight loss. Cardiorespiratory adaptations following 12 weeks of exercise training and weight loss led to a decrease in resting HR by 16.69 ± 11.5 beats·min^{-1} ($p < 0.001$) in obese women. This decrease resulted in %HRR overestimating VO_2 by approximately 10%. However, the relationship between perceived exertion and %VO_2 remained stable following the weight loss. Other investigations have shown the same stability of this relationship following aerobic training interventions in non-obese, trained and un-trained cohorts (Boutcher et al., 1989; Demello et al., 1987; Hill et al., 1987). Therefore, perceived exertion may be more appropriate than HR in self-regulating exercise intensity, and has been recommended for use in obese individuals (McInnis, 2000).

2.4 OMNI SCALE OF PERCEIVED EXERTION

The ACSM recommends the use of either the Borg 6 – 20 RPE Scale, or an OMNI scale to measure the perception of exertion (ACSM, 2010). The OMNI Picture System of Perceived Exertion is one of the latest contributions to the perceived exertion domain. The term OMNI is a contemporary abbreviation for the word omnibus, which refers to a perceptual scale that is applicable over a wide range of individuals and physical activity settings (Robertson, 2004). An OMNI scale includes pictures of an individual exercising at different intensity levels combined with verbal cues arranged along a numerical scale ranging from 0 – 10 (Figure 4). Each OMNI scale has specific pictures for the type of exercise being performed by the individual. Separate OMNI scales have been developed and validated for resistance (Robertson et al., 2003, 2005a), cycle (Robertson et al., 2000, 2004; Utter et al., 2006), stepping (Krause et al., 2012; Robertson et al., 2005b), kayaking/rowing (Nakamura et al., 2009), elliptical (Mays et al., 2010), and walking/running exercise (Groslambert et al., 2005; Irving et al., 2006; Roemmich et al., 2006; Utter et al., 2004; Utter et al., 2002) in healthy children and young adults.

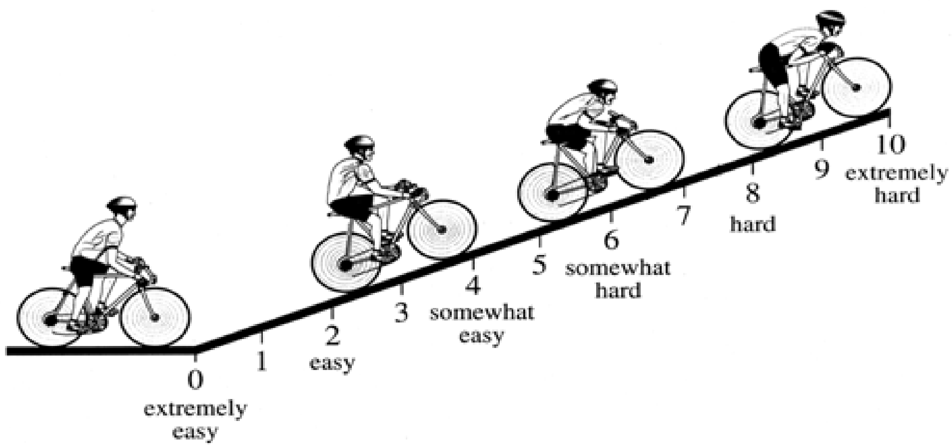

Figure 4. OMNI Scale of Perceived Exertion: Adult Cycle Format
(Robertson, 2004)

The first version of the OMNI scale was designed for use in children and adolescents in response to the growing interest in measuring perceived exertion in that population (Robertson, 2000; Robertson, 2004). Researchers studying children and exercise originally used RPE scales designed for adults. However, children younger than 11 years of age have difficulty interpreting the verbal cues that are not part of their present vocabulary, and have trouble assigning numbers to these words or phrases (Williams et al., 1991). Therefore, the terminology used to describe perceived exertion was adapted for children, and pictures were added to show the progression of intensity performance. The conceptual basis of the children scales was used in the construction of adult versions of the OMNI scale. This sequence of lifelong progression of scales from adolescence to adult allows an individual to continue to self-regulate exercise intensity into adulthood using an OMNI perceived exertion scale.

There are several advantages of using the OMNI scale over other perceived exertion scales. The numerical range of the scale is narrow, ranging from 0 to 10. This range is similar to the category rating system used by individuals to evaluate most facets of their daily living making the scale easier to understand. The scale also utilizes a single set of verbal cues that are the same for all interchangeable picture cues. Previous perceived exertion scales only included verbal descriptors along a numerical range. The set of interchangeable pictures allows the scale to be used for exercise intensity assessment and prescription in individuals who vary in age, health status, fitness level, and exercise preference. In addition, the last picture cue on the upper right portion of the scale helps the individual recall a memory of, and improve their sense of maximal exertion. This allows for the individual to establish the high perceptual anchor prior to performing the exercise, and during a submaximal exercise test. Therefore, the OMNI scale has distinct advantages over other RPE scales.

2.4.1 Validation of the OMNI-Walk/Run RPE Scale

Concurrent and construct paradigms are used to establish measurement validity of RPE scales across populations. A concurrent validation paradigm employs a two variable scheme: a) criterion (i.e., stimulus) variable, and b) concurrent (i.e., response) variable (Robertson, 2004). The most common criterion variables used for RPE concurrent validation during aerobic exercise have been HR, VO_2, and power output (Robertson, 2004). During the development and validation of the various OMNI RPE scales, it was expected that perceptual responses would increase “concurrently” and linearly with increases in those criterion variables (Robertson, 2004). Therefore, a strong positive correlation between the criterion and concurrent variables over the full perceptual-physiological range of Borg's Range Model (Figure 3) provides evidence of concurrent validity. Several investigations have examined the concurrent validity of OMNI RPE using this approach (Barkley & Roemmich, 2008; Krause et al., 2012; Mays et al., 2012; Robertson et al., 2005b; Robertson et al., 2000; Robertson et al., 2004; Roemmich et al., 2006; Utter et al., 2004; Utter et al., 2002).

A construct validation of perceived exertion paradigm regresses responses from a new perceived exertion scale against the responses of an already validated RPE scale (i.e., the criterion metric). Previous validation studies involving OMNI scales have used the Borg 6 – 20 RPE Scale as the criterion scale across different exercise modalities to examine construct validity of the OMNI scale (Pfeiffer et al., 2002; Irving et al., 2006; Utter et al., 2004; Utter et al., 2002). The Children's OMNI-Walk/Run RPE Scale has also been used as the criterion metric to test newer developed RPE scales in children (Roemmich et al., 2006). Construct validity is established when the responses from the new scale are positively correlated with responses from the criterion scale. Therefore, it is assumed that the two scales measure the same perceptual "construct".

The Children's OMNI-Walk/Run RPE Scale has shown strong positive correlations in concurrent paradigms. A study by Utter et al. (2002) examined the scale's concurrent validity in 63 healthy male and female children between 6 and 13 years of age. Subjects completed a graded exercise test on a treadmill until they reached maximum exertion. Their perceptual (OMNI RPE) and physiological (VO_2 and HR) measures were obtained every minute throughout the test. They reported the strongest correlations occurred between OMNI-Walk/Run RPE and $\%VO_{2max}$ ($r = 0.41 – 0.60$, $p < 0.001$) throughout all stages of the exercise test. The relationship between OMNI RPE and HR ($r = 0.26 – 0.52$, $p < 0.01$) was also strong. Therefore, the Children's OMNI-Walk/Run RPE Scale was established as a valid assessment tool over a wide range of exercise intensities in children 6 – 13 years of age (Utter et al., 2002).

An investigation by Pfeiffer et al. (2002) examined the validity and reliability of both Borg 6 – 20 RPE and the OMNI-Walk/Run RPE scales in 57 adolescent (15.3 ± 1.5 years) females. Subjects underwent two separate treadmill exercise test protocols one week apart. They rated their exertion with either the Borg 6 – 20 RPE or OMNI-Walk/Run RPE Scale while they: a) walked on a 0% grade, b) walked on a 5% grade, or c) jogged on a 0% grade. The reliability estimate of the OMNI-Walk/Run RPE Scale ($r = 0.95$) was stronger compared to the Borg 6 – 20 RPE Scale ($r = 0.78$). Concurrent validity assessments of RPE with $\%HR_{max}$ and $\%VO_{2max}$ were also stronger for the OMNI scale ($r = 0.86$ and $r = 0.89$, respectively) compared to the Borg scale ($r = 0.66$ and $r = 0.70$, respectively). Therefore, the OMNI-Walk/Run RPE Scale was shown to be a more reliable and valid assessment tool of perceived exertion in adolescent females. However, it is unknown if these results will generalize to males and adults.

The first examination into the validity of the Adult OMNI-Walk/Run RPE Scale was conducted in 2004. Utter et al. (2004) investigated both concurrent and construct validity of the scale in 67 healthy men and women ranging in age from 18 to 36 years of age. Subjects performed a single graded exercise test on a treadmill to determine VO_{2max}. They were asked to provide estimates of the undifferentiated feelings of effort associated with the entire body using both the Borg 6 – 20 RPE Scale and Adult OMNI-Walk/Run RPE Scale, in counterbalanced order, during the exercise test. Validity coefficients between OMNI and the criterion measures $\%VO_{2max}$ and HR, were significant for men ($r = 0.86$ and $r = 0.75$, respectively; $p < 0.05$) and women ($r = 0.85$ and $r = 0.84$, respectively; $p < 0.05$). The results also showed a high level of construct validity between the two RPE scales in both men and women ($r = 0.96$ and $r = 0.96$, respectively; $p < 0.01$). Therefore, concurrent and construct validity of the OMNI-Walk/Run RPE Scale was established in healthy young adult men and women.

An investigation by Irving et al. (2006) compared the validity of using the OMNI-Walk/Run RPE Scale and the Borg 6 – 20 RPE scale as markers of the blood lactate response to exercise in 36 adults with metabolic syndrome. Subjects were sedentary-to-lightly active obese men ($n = 10$) and women ($n = 26$), ranging in age from 41 to 49 years. Body mass index (BMI) was 36.4 ± 2.4 and 35.5 ± 1.3, for the men and women, respectively. A single graded exercise test to volitional fatigue was performed. Subjects used the OMNI and Borg scales to estimate RPE, in counterbalanced order, during the final minute of each exercise stage. The correlations between RPE and blood lactate responses were $r = 0.82$ ($p < 0.01$) and $r = 0.82$ ($p < 0.01$) for the Borg and OMNI RPE scales, respectively. These results established concurrent validity for OMNI RPE when compared against exercise blood lactate responses. Construct validity was also established when OMNI RPE was compared with Borg 6 – 20 RPE ($r = 0.96$, $p < 0.01$). Therefore, the adult version of the OMNI-Walk/Run RPE Scale is a valid assessment tool for examining blood lactate responses during exercise in adults with the metabolic syndrome.

2.5 PREFERRED METHOD OF SELF-REGULATING EXERCISE INTENSITY

In the United States, obesity prevalence is increasing, and nearly half the population is not meeting physical activity recommendations (CDC, 2009, 2010a, 2010b). Researchers have attempted to explain these trends, in part, through the utilization of questionnaires and surveys. Several questionnaires have been developed over the years resulting in the accumulation of qualitative data on the exercise patterns of adults and children. The most commonly used questionnaires to quantify physical activity in weight control studies are the Seven-Day Physical Activity Recall (PAR) (Sallis et al., 1985) and the Paffenbarger Physical Activity Questionnaire (PAQ) (Paffenbarger et al., 1986). These questionnaires focus on the frequency, intensity, type, and duration of exercise the individuals perform. Neither of these surveys inquired as to the method the individuals use to self-regulate their exercise intensity, or which method they would prefer to use.

In 2006, Johnson and Phipps asked 100 exercising women what procedure they used for judging exercise intensity during aerobic exercise. Subjects were young adult (22.3 ± 0.44 years of age) women who had exercised regularly for at least three months prior to their participation. Each subject was interviewed to determine what method they use to judge or select aerobic exercise intensity, and their general knowledge on exercise prescription methods. Of the 100 women interviewed, 7% stated that they use HR exclusively as their method of regulating exercise intensity, and only 55% had any knowledge of HR_{max}. The majority (86%) of the women interviewed stated that they use some sort of effort perception to select exercise intensity, although only 16% had any previous knowledge of RPE. Only 7% of the interviewed women used a combination of HR and RPE to judge exercise intensity. Johnson & Phipps (2006) theorized that individuals may begin exercising using HR and then switch to a perceptual method as they become more familiar with exercise. Therefore, Ekkekakis et al. (2006) have proposed a paradigmatic shift in exercise prescription that moves away from models based on physiological variables to models based on how an individual perceives the exercise intensity.

2.6 CONCLUSIONS

There is a considerable amount of evidence in the scientific literature that supports the use of various perceived exertion scales to estimate aerobic exercise intensity. The Adult OMNI-Walk/Run RPE Scale is easy to understand and administer. Therefore, it may be the preferred perceptual metric to estimate exercise intensity. However, concurrent and construct validity of the Adult OMNI-Walk/Run RPE Scale has not been established in overweight and obese adults. Recent findings suggest that the majority of a sample of young adult, physically active women prefer to regulate their aerobic exercise intensity using some form of perceived exertion. The preference of self-regulating exercise intensity in overweight and obese individuals is unknown. This gap in the perceived exertion and public health literature has led to the conceptual basis for the present investigation.

3.0 METHODS

3.1 SUBJECTS

Sixty three men and women between 25 and 55 years of age, either being screened for participation or currently participating in a weight loss intervention study, were recruited for the present investigation. Previous validation studies of OMNI-Walk/Run RPE have been conducted on physically active young adults with normal body weights (Utter et al., 2004), or obese adults with metabolic syndrome (Irving et al., 2006). Therefore, subjects in this investigation were healthy, overweight or obese adults according to body mass index (BMI) stratification ($25\ kg \cdot m^{-2}$ – $39.9\ kg \cdot m^{-2}$). Individuals classified at low or moderate risk, based upon ACSM risk stratification guidelines, were recruited. Individuals classified at high risk were excluded from participation. In addition, individuals meeting the following criteria were excluded:

1. Unable to walk for exercise. Subjects were required to complete a progressively incremented submaximal treadmill test. Physical limitations that hinder an individual’s ability to walk on the treadmill may negatively affect their performance and perceptions of effort.
2. Medical history of, or currently diagnosed with and/or being treated for coronary heart disease, diabetes mellitus, angina, hypertension, cancer, previous heart attack, or stroke.

Medical clearance and supervision is required when administering treadmill tests in subjects with these conditions, and was beyond the scope of this investigation.

3. Currently taking medications that affect heart rate (HR) (i.e., beta blockers). The treadmill protocol used in this investigation required subjects to exercise until they reached 85% of their age-predicted maximal HR. These medications make it unlikely that subjects will achieve 85% of age-predicted maximal HR.
4. Currently being treated for any psychological problems or taking any psychotropic medications. The primary aim of this investigation involved the measurement of psychological (perceived exertion) responses to exercise. Some psychological and sociological factors can systematically influence an individual's ability to assess their effort (Morgan, 1981; Noble & Robertson, 1996; Robertson, 2004). Therefore, individuals with diagnosed psychological disorders were excluded from this study.
5. Currently pregnant, pregnant within the previous six months, planning to become pregnant within the next 12 – 24 months, currently lactating, or breast feeding within the previous three months. Pregnant women may have potential limitations to performing the standardized graded treadmill protocol proposed in this investigation. Vigorous exercise is not recommended for women who are pregnant. Therefore, their participation in this study would have required alterations to the exercise protocol.
6. Subjects being recruited for the weight loss intervention studies must not: 1) be taking medications for the purpose of weight loss; 2) lost over 5% of, or 15 pounds of their body weight within the previous three months; 3) undergone bariatric surgery; and 4) currently being treated for an eating disorder. Therefore, these criteria were also applied to prospective subjects in the present investigation.

3.2 EXPERIMENTAL DESIGN

The present investigation employed a cross-sectional research design to examine the validity of the Adult OMNI-Walk/Run RPE Scale, and preferred method of self-regulating exercise intensity in overweight and obese adults. Subjects recruited for weight loss intervention studies reported to the University of Pittsburgh Physical Activity and Weight Management Research Center for all assessments required for this investigation.

3.3 RECRUITMENT PROCEDURES

Subjects for the weight loss intervention studies were recruited through several media outlets throughout the greater Pittsburgh area. These included radio and television advertisements, local flyer postings, and notices placed on Craigslist. In addition, individuals registered in the Obesity and Nutrition Research Center (ONRC) database were mailed letter notifications about the studies. All advertisements and letters provided the telephone number for the University of Pittsburgh Physical Activity and Weight Management Research Center. Interested individuals were instructed to contact the Center and were interviewed over the phone by either trained staff or graduate students to determine initial eligibility. This screening included a brief description of the individual's respective study of interest, and eligibility was determined by responses to questions relevant to inclusion and exclusion criteria.

Potential subjects who appeared to be eligible, based on the phone screening, were invited to attend an orientation session where the Principal Investigators and Director of the Physical Activity and Weight Management Research Center provided complete details of the respective study. Individuals were encouraged to ask questions during this session so they had full knowledge of the study protocols and expectations. Interested subjects provided written informed consent to participate in the weight loss intervention study, completed a Physical Activity Readiness Questionnaire (PAR-Q) (APPENDIX B) (Thomas et al., 1992), and medical history (APPENDIX C). In addition, subjects were required to provide written approval from their personal physician to participate in the investigation.

Subjects from the larger weight loss intervention studies reported to the Physical Activity and Weight Management Research Center for assessments (i.e. Baseline, 6 months, or 12 months) associated with those studies. Subjects from the current investigation were recruited during these assessment visits. Upon arrival at the Center, individuals were given a brief description of the present investigation and were asked if they would be willing to participate. Interested subjects provided written informed consent (APPENDIX A) to participate in this investigation. The University of Pittsburgh Institutional Review Board (IRB) approved all the recruitment methods and materials.

3.4 ASSESSMENT PROCEDURES

All assessment procedures for this investigation were performed at the University of Pittsburgh Physical Activity and Weight Management Research Center. They were conducted between 7:30 and 10:30 am, Monday through Friday, and lasted approximately 45 to 60 minutes. The assessments included measurements of height, weight, body mass index, a submaximal treadmill test, and answering two questionnaires. Subjects were instructed to refrain from eating or drinking for at least 12 hours prior, consuming alcohol for 24 hours prior, and smoking 12 hours prior to assessment. They were instructed to wear lightweight, comfortable clothing and tennis shoes/sneakers for the assessment.

3.4.1 Height, Body Weight, and Body Mass Index

Height, while barefoot, was measured to the nearest 0.01 cm using a wall-mounted stadiometer (perspective Enterprises, Portage, MI). Weight of the subject, while wearing only a light weight hospital gown, was measured to the nearest 0.1 kg on a Tanita WB-110A electronic scale (Tanita Corporation, Arlington Heights, IL). Body mass index (BMI, $kg \cdot m^{-2}$) was determined from standard BMI calculation of dividing the weight (kg) by the squared height ($meters^2$).

3.4.2 Estimation Trial

The submaximal graded treadmill exercise test was conducted by an American College of Sports Medicine (ACSM) certified Clinical Exercise Specialist. Subjects were given a brief overview of the testing protocol, and instruction on how to use the rating of perceived exertion (RPE) scales prior to performing the exercise. They also underwent 12-lead electrocardiogram (EKG) preparation procedures which included: 1) rubbing each electrode site with a cotton ball soaked in rubbing alcohol to clean the area; 2) lightly rubbing each site with an abrasive pad to remove dead skin; and 3) placing the EKG electrode on each site. The EKG recorded HR responses during the exercise. The subject's oxygen consumption (VO_2) during the test was assessed using a CareFusion Vmax Encore metabolic cart (CareFusion, Yorba Linda, CA). This system was calibrated prior to each test using standard gases and calibration procedures. Subjects were fitted with a nose clip and mouth piece to ensure that all expired gas passed through the metabolic cart.

3.4.2.1 Graded Treadmill Exercise Test

The subjects performed a progressively incremented submaximal graded treadmill exercise test until a HR equal to 85% of their age predicted maximal HR (APMHR) was attained. This target HR was calculated as (220 – subject's age in years) multiplied by 0.85. For overweight and obese individuals, the ACSM (2010) recommends that the exercise test should begin at a low workload, and increase intensity in small increments due to the potential of a limited exercise capacity in these individuals. The speed of the treadmill remained constant at 80.4 $m \cdot min^{-1}$ (3.0 mph) throughout the test. The grade of the treadmill began at 0%, and increased by 1% every minute until the subject reached 85% of their APMHR. However, the test was terminated at any point if the subject reported or showed any signs or symptoms indicative of exertional intolerance described by the ACSM (ACSM, 2010).

The EKG was recorded at rest (sitting), and during the last 10 seconds of every minute of exercise. Oxygen consumption was measured in 20-second increments throughout the test. Heart rate was also assessed immediately after termination of the test. Following test termination the mouthpiece and noseclip were removed, and the subject underwent a seven minute recovery period including a three minute active cool-down (2.0 mph, 0% grade) and four minute seated phase. During recovery, HR was assessed every minute. Recovery time was extended, if needed, until HR returned to baseline levels.

3.4.2.2 RPE Measurements

Each subject was read the definition of RPE, and standard instructions (APPENDIX D) on how to use the Borg 6 – 20 RPE (Borg, 1998) (Figure 5), and Adult OMNI-Walk/Run RPE (Utter et al., 2004; Robertson, 2004) (Figure 6) scales prior to performing the submaximal graded treadmill exercise test. During the exercise test, subjects were asked to rate their feelings of exertion corresponding to their entire body (RPE-Overall, RPE-O). Treadmill exercise may produce stronger sensations arising from the entire body rather than the stronger sensations in specific regions (i.e., legs) observed during cycle exercise. Therefore, the global undifferentiated measure may be more useful in treadmill exercise than the differentiated RPE associated with the legs (Robertson, 2004).

Each subject estimated RPE-O using the Borg 6 – 20 RPE and OMNI-Walk/Run RPE scales during the last 15 seconds of every second minute of exercise. The two RPE scales were presented in a counterbalanced order. Ratings of perceived exertion using both scales was also obtained at the time of test termination. The OMNI-Walk/Run responses were correlated with the concurrent (HR and VO_2) and construct (Borg 6 – 20 RPE) variables.

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Figure 5. Borg Fifteen-Category (6 - 20) RPE Scale
(Borg, 1998)

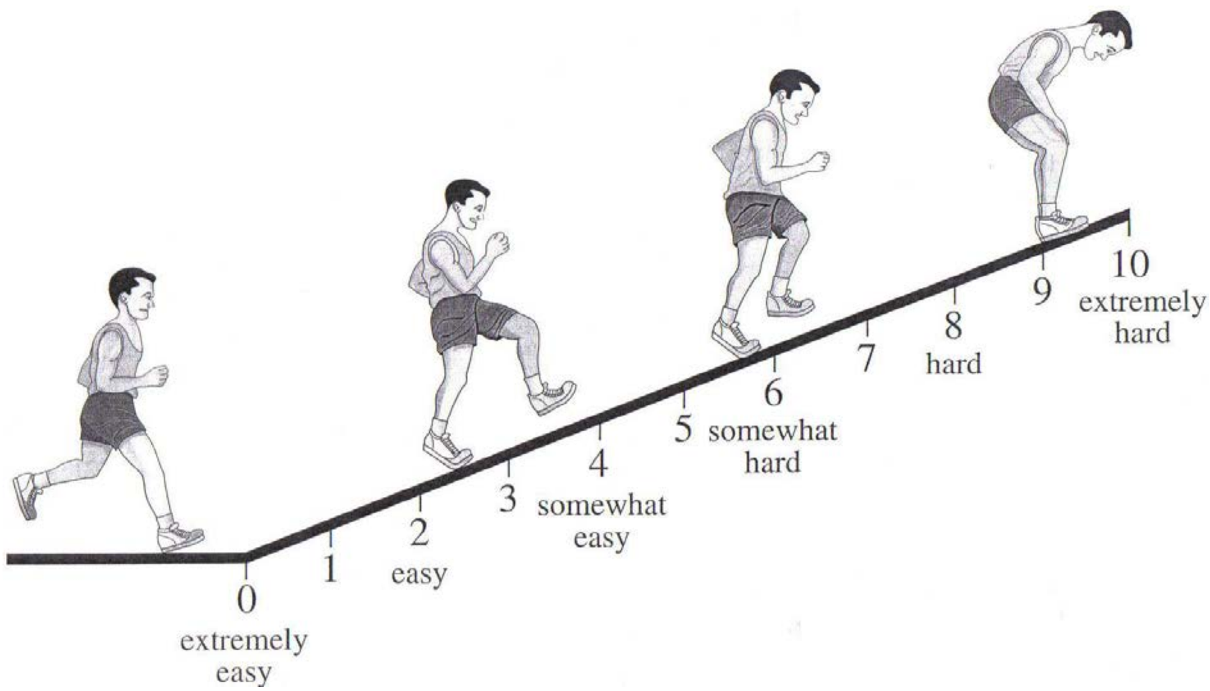

Figure 6. Adult OMNI-Walk/Run RPE Scale
(Utter et al., 2004; Robertson, 2004)

3.4.3 Post-Exercise Test Interview

Upon completion of the submaximal graded treadmill exercise test and recovery period, subjects were interviewed in a separate room of the Physical Activity Weight Management Research Center by a staff member or graduate student. During this interview, the subject's physical activity and preferred method of self-regulating exercise intensity was assessed by completing two questionnaires.

3.4.3.1 Physical Activity

The subjects completed the Physical Activity History Questionnaire (APPENDIX E) to subjectively assess their physical activity. This questionnaire assessed the total amount of moderate- and vigorous-intensity sports, fitness, or recreational (leisure) physical activity minutes per week the subject performs. These questions were taken from the validated Global Physical Activity Questionnaire (GPAQ) version 2 (Armstrong & Bull, 2006). The total number of minutes per week for each subject was used in the statistical analyses to determine physical activity level. An individual who performs less than ninety minutes of moderate intensity physical activity per week is considered sedentary according to ACSM Guidelines and Risk Stratification (ACSM, 2010; Pate et al., 1995). Therefore, in the present investigation subjects who participated in less than 90 minutes of physical activity per week were classified as sedentary, and those who participated in 90 minutes or more of physical activity per week were classified as physically active.

3.4.3.2 Method of Self-Regulating Exercise Intensity

During the post-exercise test interview, subjects also completed the Preferred Method of Self-Regulating Exercise Intensity Questionnaire (APPENDIX F) that was designed specifically for this investigation. This questionnaire, which consists of four items, was designed based on the survey questions employed by Johnson and Phipps (2006). Subjects were asked to select one method [either (A) HR, or (B) Perceptual] in questions two and three. Once they had selected one of these two methods, they selected a subset category [(1), (2), or (3)] within the selected method. This questionnaire allowed for the analysis of how overweight and obese individuals have self-regulated their exercise intensity in the past, and how they would prefer to self-regulate their exercise intensity in future exercise sessions.

3.5 STATISTICAL ANALYSES

All statistical analyses were performed using version 19.0 of the IBM Statistical Package for the Social Sciences (SPSS) software (IBM co., Armonk, NY). The statistical significance was set *a priori* at $a = 0.05$. Descriptive statistics (mean ± *SD*) were used to summarize characteristics of male and female subjects, respectively. Independent samples *t*-tests were used to evaluate gender differences in age, height, weight, BMI, 85% APMHR, and VO_2 at 85% APMHR. All analyses for subject demographics and the primary specific aim were conducted for the combined sample, and for males and females, separately. The analyses for the secondary aim were examined using the total combined sample. Exploratory analyses were conducted to examine the effect of age, sex, race, weight loss intervention study assessment (baseline, 6 months, or 12 months), previous knowledge of RPE, BMI classification, and Physical Activity Status on the preferred method of self-regulating exercise intensity.

A concurrent validation paradigm employs a two variable scheme: a) criterion (i.e., stimulus) variable, and b) concurrent (i.e., response) variable (Robertson, 2004). A significant and positive correlation between the criterion (physiological responses) and concurrent variables (perceptual responses) over the perceptual-physiological range provide evidence of concurrent validity. The HR and VO_2 at 50%, 70% and 85% of the APMHR served as the criterion variables for this analysis. These relative intensities allow for the comparison of RPE among individuals who differ in fitness level (Dishman, 1994), and are similar to intensities previously used in RPE investigations (Dunbar et al., 1992; Kang et al., 1998, 2003; Robertson, 2004). For each subject, regression analyses were run to predict RPE for the Borg and OMNI scales from HR and VO_2, respectively. RPE using both scales were determined at each of the three intensities (50%, 70%, and 85% APMHR) using individual regression equations. The corresponding OMNI RPE responses served as the concurrent variable.

A construct validation paradigm of an RPE scale employs the same two variable scheme as concurrent validation. However, a previously validated RPE scale serves as the criterion variable (Borg 6 – 20 RPE), and the scale being validated (OMNI-Walk/Run) serves as the concurrent variable. Therefore, OMNI-Walk/Run RPE responses were plotted against Borg 6 – 20 RPE at the three relative intensities.

The following statistical analyses were conducted to examine the primary and secondary aims/hypotheses of this investigation:

1. To examine concurrent validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults, the relationship between the criterion and concurrent variables was examined using linear regression analyses. Data for all three intensity levels for each subject were included, resulting in a total of 177 data points [number of participants (n = 59) X 3 (intensity levels)] for each analysis. The Adult OMNI-Walk/Run RPE Scale was regressed against HR, and VO_2 for the combined sample, and for males and females separately. Concurrent validity of the Borg 6 – 20 RPE Scale was assessed using the same procedures.

2. To examine construct validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults, the relationship between the criterion and concurrent variables was examined using linear regression analyses including data for all three intensity levels for both OMNI and Borg RPE. The Adult OMNI-Walk/Run RPE Scale was regressed against Borg 6 – 20

RPE responses at the designated intensity levels for the combined sample, and for males and females separately. Data from all three intensity levels was included in this analysis as well.

- One of the assumptions of regression analysis is independence of observations. It was recognized that this assumption was violated in the present analysis. However, consequences of assumption evaluation are considered to be more serious for inference than for description. The focus of the current investigation was on description rather than on estimation of population parameters. In addition, the method used in the present study in consistent with the methods used in previous OMNI RPE validation studies (Robertson et al., 2005b; Robertson et al., 2000; Robertson et al., 2004; Utter et al., 2004).

3. To assess the preferred method of self-regulating exercise intensity, frequencies of subject responses [(A) HR, and (B) Perceptual methods] for questions two (method used in past exercise sessions) and three (methods preferred for future exercise sessions) from the Preferred Method of Self-regulating Exercise Intensity Questionnaire were calculated. Analysis for the second specific aim was carried out in two stages. In the first stage all HR based methods for self-regulation of exercise intensity were collapsed into one category, and all perceptual methods were collapsed into another category. In the second stage differences in these frequency distributions were compared.

3.0. & 3.1 & 3.2. Differences in these frequencies for the combined sample were assessed using nonparametric binomial tests with the null hypothesis that method preference (i.e, HR vs. Perceptual, or OMNI vs. Borg RPE) distribution would be equal (50%) among participants. For Hypothesis 3.0, this analysis was performed on subjects who reported previous or current participation in a regular exercise program. For Hypothesis 3.1, this analysis was conducted on all participants to examine their preference for future exercise intensity self-regulation. For Hypothesis, 3.2, the binomial test was only conducted in subjects who preferred to use RPE (Borg or OMNI) to self-regulate exercise intensity in the future.

- In addition, exploratory analyses were conducted to examine significance of change in preference from past to future. A two (general method used in the past) by two (general method preferred for future use) contingency table was analyzed using the McNemar test for correlated proportions (Powers & Gose, 1986) to determine if there was a significant change in the general method participants prefer. Only participants who indicated previous or current participation in exercise were included in this analysis.

3.6 POWER ANALYSES

The primary aims of this investigation were to examine concurrent, and construct validity of the OMNI-Walk/Run RPE Scale in overweight and obese adults. The secondary aim was to determine the preferred method of self-regulating exercise intensity in this cohort. A power analysis (G*Power 3.1.2) was performed to determine the proposed and achieved power of the two specific aims.

3.6.1 Proposed Power

1. To examine the first specific aim: a minimum of 50 subjects were required to establish concurrent and construct validity based on a large effect size of 0.35 with a power of 0.80, and α, set *a priori*, at 0.05. These values are consistent with the previous validation of the adult OMNI-Cycle RPE Scale (Robertson et al., 2000, 2004, 2005b).

2. To examine the second specific aim: a minimum of 23 subjects were required to examine the preferred method of self-regulating exercise intensity in past/current and future exercise sessions, and between the two RPE scales (OMNI-Walk/Run and Borg 6 – 20). This sample size was based on a large effect size of 0.25 with a power of 0.80, and α, set *a priori*, at 0.05.

3.6.2 Achieved Power

1. Regression analyses were used to examine the first specific aim: 59 subjects used to establish concurrent and construct validity achieved a power of 0.99 with a large effect size of 0.37 ($p < 0.001$).

2. Nonparametric binomial tests were used to examine the second specific aim: 51 subjects used to examine the past/present preferred method of self-regulation of exercise intensity achieved a power of 0.99 with an effect size of 0.38 ($p < 0.001$). 60 subjects used to examine the future preferred method achieved a power of 0.28 with an effect size of 0.06 ($p = 0.366$). 8 subjects who chose RPE as the preferred method of future exercise intensity self-regulation achieved a power of 0.04 with an effect size of 0.00 ($p = 1.000$).

4.0 RESULTS

The primary purpose of this investigation was to examine concurrent and construct validity of the OMNI-Walk/Run RPE Scale in overweight and obese adults who vary from sedentary to physically active. Subjects performed a submaximal treadmill exercise test. Oxygen consumption, HR, Borg 6 – 20 RPE, and OMNI-Walk/Run RPE were recorded every other minute of exercise, and at termination of the exercise test (85% APMHR). In order to establish concurrent validity of the OMNI scale, correlation analyses were performed between OMNI RPE, HR (beats • min^{-1}), and VO_2 (ml • kg^{-1} • min^{-1}) at 50%, 70%, and 85% APMHR. In order to establish construct validity of the OMNI scale, correlation analyses were performed between OMNI RPE and Borg 6 – 20 RPE at 50%, 70%, and 85% APMHR. Separate correlation analyses were conducted for the total sample, and for male and female subjects to examine gender specific concurrent and construct validity. Although both correlation and regression analyses were conducted, only results of the correlation analyses are reported here since the results are equivalent when there is only one predictor. However, intercepts, slopes, and standard error of the estimate (SEE) from the regression analyses examining both concurrent and construct validity are presented in Appendix G.

The secondary purpose of this investigation was to determine the preferred method of self-regulating exercise intensity, for previous and future exercise sessions, in the same cohort of overweight and obese adults. The past/present method of self-regulating exercise intensity, and preferred method of self-regulating in the future were collected through an interview-based questionnaire. In order to examine the preferred method of self-regulation of exercise intensity, questionnaire answer frequencies were calculated, and nonparametric binomial tests were conducted using the total sample of adults.

4.1 SUBJECTS

Sixty-three adult (25 – 55 years) males (n = 22) and females (n = 41) were recruited for this investigation. Two female subjects were considered normal weight (based on BMI), and one female subject did not complete the submaximal exercise test due to an irregular resting heart rhythm. Therefore, these three female subjects were excluded from all data analyses. In addition, one female subject attained termination criteria within the first few minutes of the exercise test and was therefore excluded from the regression data analyses. However, this subject was included in analyses examining the preferred method of exercise intensity self-regulation. The total sample (N = 60) was comprised of White/Caucasian (n = 42), Black/African American (n = 14), and Asian/Other (n = 4) adult males and females. In addition, the total sample included 21 (males, n = 11; females, n = 10) sedentary and 39 (males, n = 11; females, n = 28) physically active participants. Subject characteristics for the total sample are presented in Table 2.

Table 2. Subject Characteristics

	Males (n = 22)	Females (n = 38)
Age (yrs)	37.18 ± 9.70	34.45 ± 7.92
Height (cm)	180.23 ± 7.79	166.00 ± 6.49 *****
Weight (kg)	102.85 ± 16.44	83.06 ± 11.31 *****
BMI ($kg \cdot m^{-2}$)	31.50 ± 3.56	30.11 ± 3.43
$HR_{85\%\ APMHR}$ (beats • min^{-1})	155.41 ± 8.27	157.79 ± 6.76
$VO_{2\ 85\%\ APMHR}$ (ml • kg^{-1} • min^{-1})	31.46 ± 8.64	24.33 ± 5.17 *****

Data are means ± *SD*
***** Significantly different from males, $p < 0.001$

4.2 CONCURRENT VALIDITY

A primary research objective of this investigation was to examine concurrent validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults. The relation between OMNI RPE and the physiological variables (HR and VO_2) were examined separately throughout a range of three exercise intensities (50%, 70%, and 85% APMHR) to establish concurrent validity. The correlations were examined within-subjects for the total sample, and separately for both male and female subjects. The regression analyses demonstrated a strong relation between OMNI RPE and HR for the total sample ($r = 0.866$, $p < 0.001$), males ($r = 0.879$, $p < 0.001$), and females ($r = 0.859$, $p < 0.001$). In addition, a moderate-strong relation was also observed between OMNI RPE and VO_2 for the total sample ($r = 0.731$, $p < 0.001$), males ($r = 0.733$, $p < 0.001$), and females ($r = 0.795$, $p < 0.001$). Results of regression analyses examining concurrent validity are presented in Table 3.

Table 3. Relation between physiological variables and OMNI and Borg RPE

Sample	Criterion	OMNI (r)*	Borg (r)*
Total (n = 59)	HR (beats • min^{-1})	0.866	0.841
	VO_2 (ml • kg^{-1} • min^{-1})	0.731	0.739
Males (n = 22)	HR (beats • min^{-1})	0.879	0.862
	VO_2 (ml • kg^{-1} • min^{-1})	0.733	0.760
Females (n = 37)	HR (beats • min^{-1})	0.859	0.829
	VO_2 (ml • kg^{-1} • min^{-1})	0.795	0.774

***** $p < 0.001$

4.3 CONSTRUCT VALIDITY

Another primary research objective of this investigation was to examine construct validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults. The Borg 6 – 20 RPE Scale was used as the criterion variable. The relation between OMNI RPE and Borg RPE was examined throughout the range of three exercise intensities (50%, 70%, and 85% APMHR) to establish construct validity. The correlations were examined within-subjects for the total sample, and separately for both male and female subjects. The regression analyses demonstrated a very strong relation between OMNI and Borg RPE for the total sample ($r = 0.963$, $p < 0.001$), males ($r = 0.962$, $p < 0.001$), and females ($r = 0.965$, $p < 0.001$). Results of regression analyses examining construct validity are presented in Table 4.

Table 4. Relation between Borg and OMNI RPE

Sample	Criterion	r *
Total (n = 59)	Borg RPE	0.963
Males (n = 22)	Borg RPE	0.962
Females (n = 37)	Borg RPE	0.965

***** $p < 0.001$

4.4 PAST/PRESENT METHOD OF SELF-REGULATING EXERCISE INTENSITY

A secondary research objective of the present investigation was to determine which method (i.e., HR or perceptual) overweight and obese adults who have previously exercised have used to self-regulate exercise intensity. Subjects reporting current or previous exercise participation were asked to identify which method, HR or perceptual, they typically used to self-regulate exercise intensity. A total of 51 subjects of the total sample (N = 60) reported that they previously participated (n = 9) or currently participate (n = 42) in regular exercise. Significantly more ($p < 0.001$) subjects (88.2%, n = 45) reported using a perceptual method to self-regulate exercise intensity, and only 11.8% (n = 6) reported using a HR method. Of those 51 total subjects, 62.7% (n = 32) reported having previous knowledge of RPE. Figures 7 and 8 depict frequency data for the total sample and for males and females, respectively.

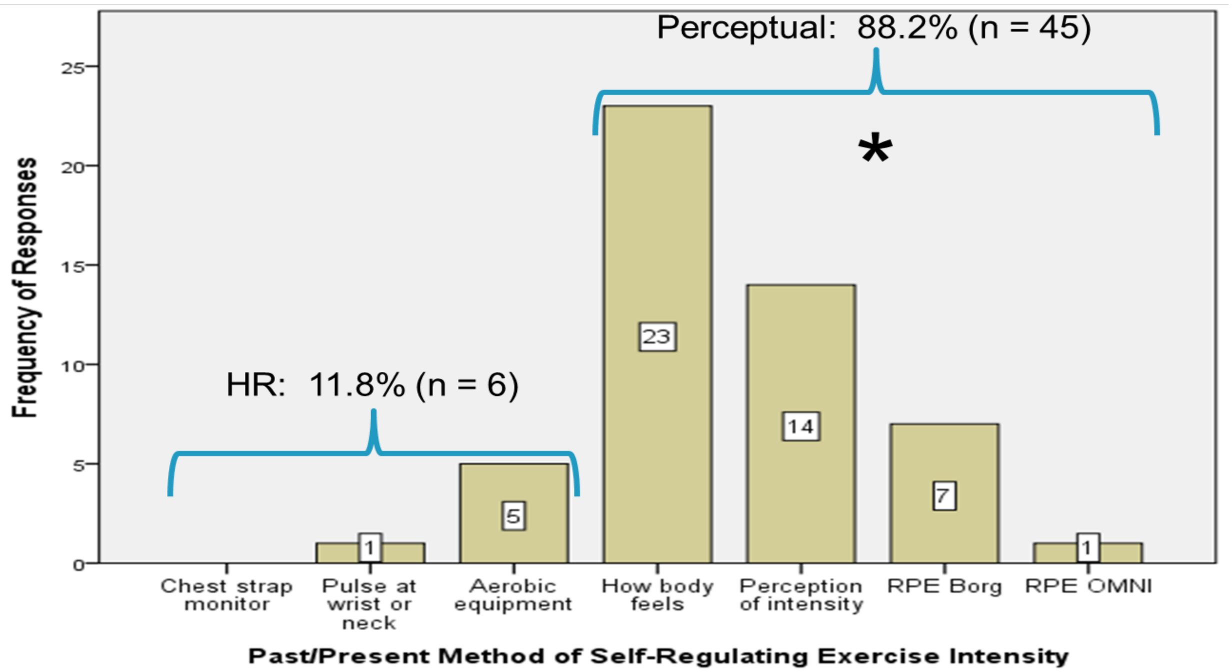

Figure 7. Total sample past/present method of self-regulating exercise intensity (*****) signifies significantly greater than HR methods, p < 0.001

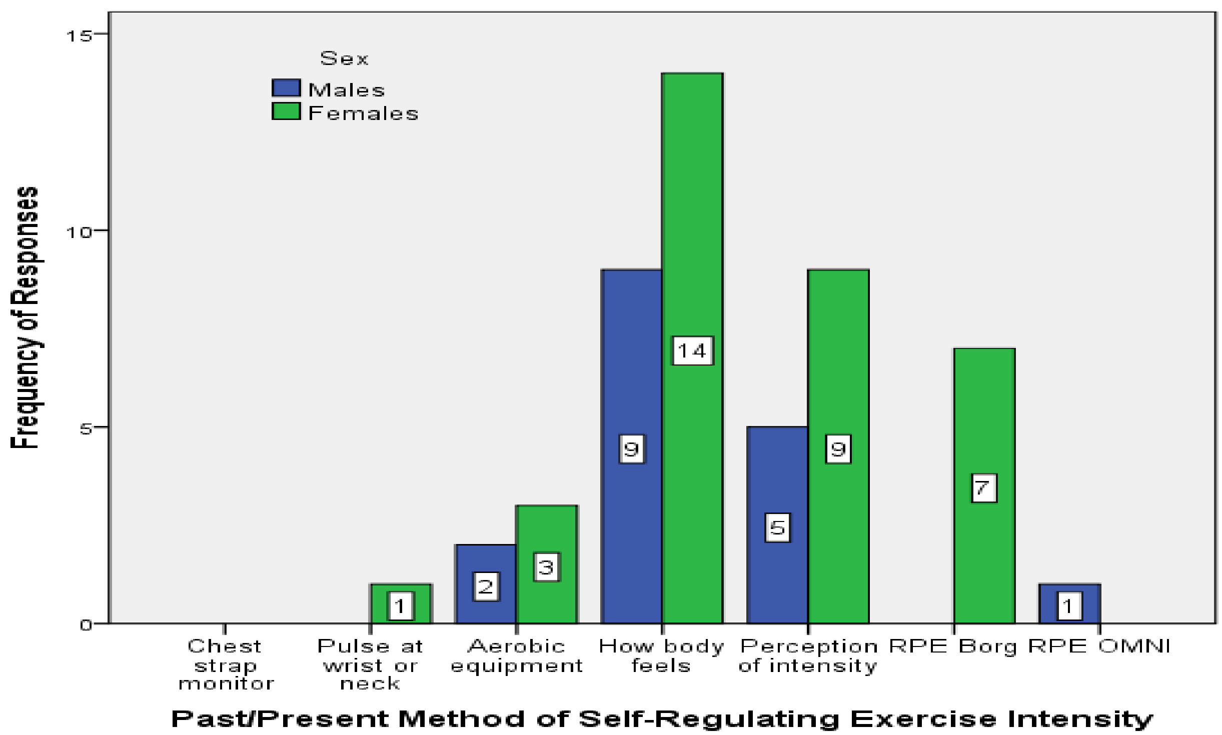

Figure 8. Gender specific past/present method of self-regulating exercise intensity

4.5 FUTURE METHOD OF SELF-REGULATING EXERCISE INTENSITY

Another secondary research objective of the present investigation was to determine which method overweight and obese adults would prefer to use to self-regulate exercise intensity in future exercise sessions. Of the 60 total subjects, 56.7% (n = 34) preferred a perceptual method to self-regulate exercise intensity in the future, and 43.3% (n = 26) preferred the use of a HR method. These results were not significantly different ($p > 0.05$). Of those 60 total subjects, 56.7% (n = 34) reported having previous knowledge of RPE. Nineteen (55.9%) of those who had previous knowledge of RPE preferred to use a perceptual method to self-regulate exercise intensity in the future. A total of eight subjects preferred to use perceived exertion (Borg, n = 4; OMNI, n = 4) to self-regulate their exercise intensity in the future.

Figures 9 and 10 depict frequency data for the total sample and for males and females, respectively. There were no significant differences ($p > 0.05$) in change of preference of self-regulating exercise intensity within the perceptual methods from past/present to future. However, 16 subjects indicated that although they had used a perceptual method in the past/present they preferred to use a HR method in the future (Table 5, $p < 0.001$). The direction and magnitude of the arrows in Table 5 show this change. In the current investigation, the change from a perceptual to HR method of self-regulating exercise intensity was significant in individuals who were: a) in the 1st quartile of age (25 – 28 years, $p < 0.05$) (APPENDIX H.1); b) White/Caucasian ($p < 0.001$) (APPENDIX H.2); c) completing six month assessments associated with their respective weight loss intervention study ($p < 0.05$) (APPENDIX H.3); d) classified as overweight according to BMI ($p < 0.01$) (APPENDIX H.4), e) currently physically active ($p < 0.01$) (APPENDIX H.5), and f) participate in vigorous activity ($p < 0.01$) (APPENDIX H.6). These changes were significant ($p < 0.05$) in both males and females. Of all African American subjects (n = 14), 71.4% (n = 10) preferred to use perceptual methods in the future, and this was not significantly different from their past method of choice.

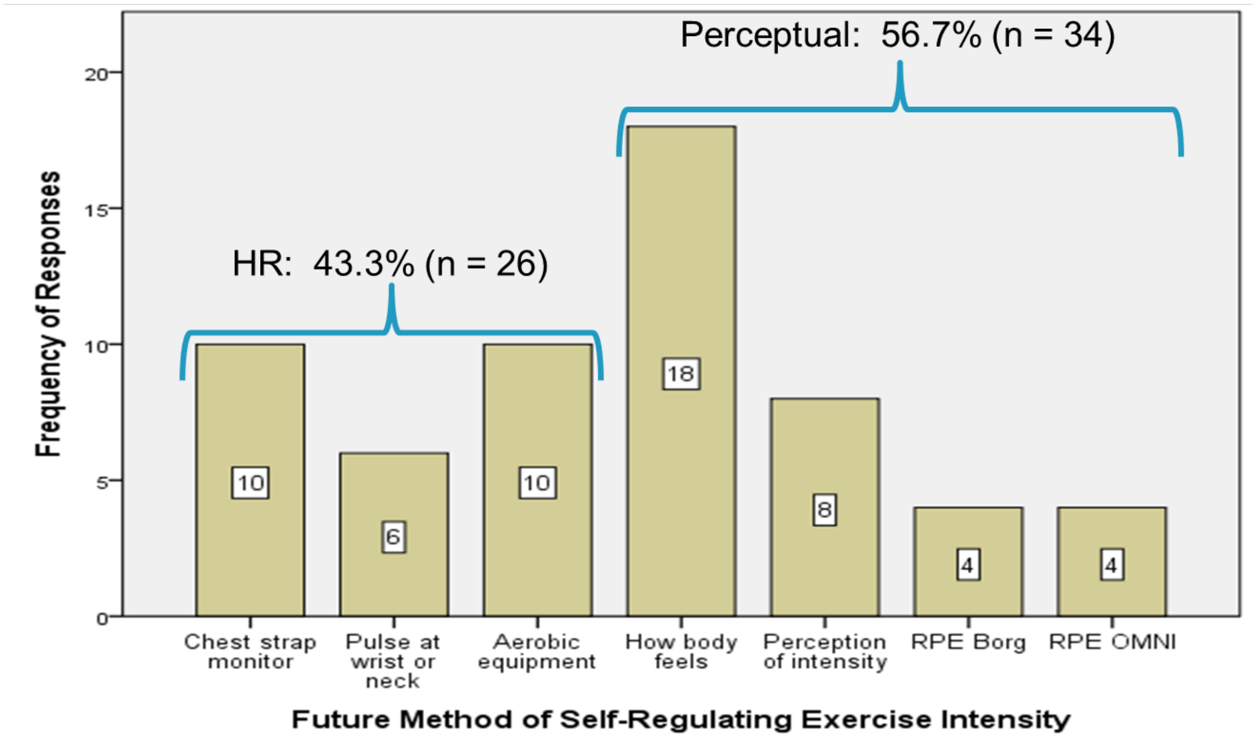

Figure 9. Total sample future method of self-regulating exercise intensity

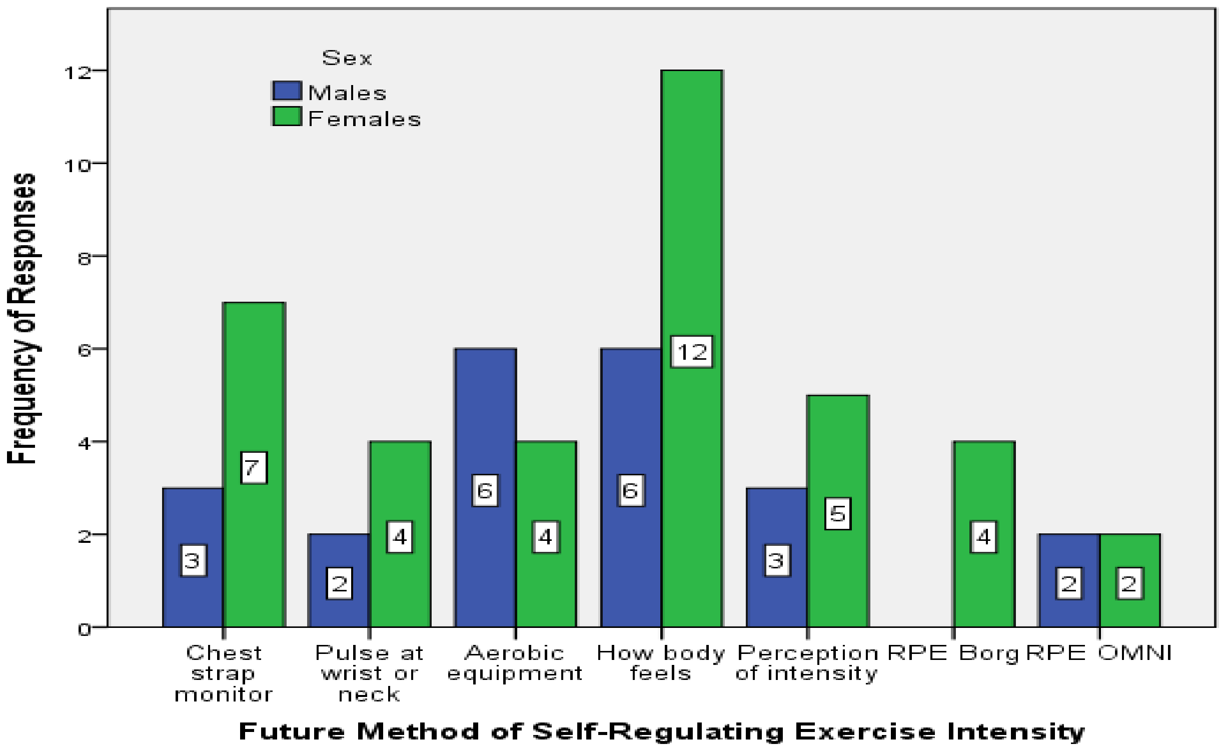

Figure 10. Gender specific future method of self-regulating exercise intensity

Table 5. Preference change from past to future of exercise intensity self-regulation method

			Future Method of Exercise Intensity Self-Regulation		Total
			HR	Perceptual	
Past Method of Exercise Intensity Self-Regulation	HR	Count	5	→ 1	6
		% within Future Method	23.8%	3.3%	11.8%
	Perceptual	Count	16 *	← 29	45
		% within Future Method	76.2%	96.7%	88.2%
Total		Count	21	30	51
		% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, p < 0.001

5.0 DISCUSSION

The primary purpose of this investigation was to examine concurrent and construct validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults. The relations between OMNI RPE and VO_2 and HR were examined to establish concurrent validity. The relation between OMNI RPE and Borg 6 – 20 RPE was examined to establish construct validity. No previous investigations have examined the validity of the Adult OMNI-Walk/Run RPE Scale in healthy overweight or obese adults.

The secondary purpose of this investigation was to examine the preferred method of self-regulating exercise intensity in overweight and obese adults. The self-regulatory method primarily utilized in past exercise sessions was determined and compared to the method subjects would prefer to use in the future. A previous investigation examined the method of self-regulating exercise intensity used by young adult women who currently exercise. However, this investigation did not examine if subjects would prefer a different method in future exercise sessions, or if these preferences were similar in overweight, obese, sedentary males and females.

5.1 CONCURRENT AND CONSTRUCT VALIDITY

A RPE scale should be validated prior to its use in clinical and health-fitness settings. A concurrent validation paradigm employs a two variable scheme where the criterion (i.e., stimulus) variable is regressed against the concurrent (i.e., response) variable. A significant and positive correlation between the criterion (HR and VO_2) and concurrent (OMNI RPE) variables over the perceptual-physiological range provide evidence of concurrent validity. Previous investigations have used concurrent validation paradigms to develop and validate the various OMNI RPE Scales (Krause et al., 2012; Irving et al., 2006; Mays et al., 2010; Robertson et al., 2005a; Robertson et al., 2005b; Robertson et al., 2000; Robertson et al., 2004, Robertson et al., 2003; Roemmich et al., 2006; Utter et al., 2004; Utter et al., 2002). Therefore, it was hypothesized that OMNI RPE would increase as HR and VO_2 increased, and thus establish concurrent validity. In the present investigation, RPE increased concurrently with physiological markers of exercise intensity (HR and VO_2). The OMNI responses showed a positive, strong relationship with HR (males, $r = 0.879$; females, $r = 0.859$; $p < 0.001$) and moderate-strong relationship with VO_2 (males, $r = 0.733$; females, $r = 0.795$; $p < 0.001$).

The results of the current investigation provide evidence that in overweight and obese adults the Adult OMNI-Walk/Run RPE Scale is a valid measurement tool for assessing exercise intensity that ranges from low to high levels. These findings conform to the basic concepts of Effort Continua and Borg's Range Model (Borg, 1998; Robertson, 2001a; Robertson, 2004; Robertson & Noble, 1997). The general concepts of Effort Continua and Borg's Range Model state as the intensity of exercise increases from low to high levels, corresponding and interdependent increases occur in performance, perceptual (RPE), and physiological (HR and VO_2) processes (Borg, 1998; Robertson, 2004). Therefore, in the current investigation the relationships between RPE and HR and VO_2 indicate that perceptual responses from the Adult OMNI-Walk/Run RPE Scale provide the same information as physiological responses in identifying the intensity of the exercise.

In addition to concurrent validation, construct validation is also needed in order for an RPE scale to be considered a valid metric. Construct validation paradigms employ the same two variable scheme as concurrent validation. However, a previously validated RPE scale serves as the criterion variable, and the scale being validated serves as the concurrent variable. A strong positive relation between these variables establishes construct validity. In the current investigation, the Adult OMNI-Walk/Run RPE Scale was the concurrent variable while the Borg 6 – 20 RPE Scale served as the criterion variable. Previous investigations have established construct validation of the various OMNI RPE scales in various populations (Irving et al., 2006; Mays et al., 2010; Robertson et al., 2005b; Robertson et al., 2004; Roemmich et al., 2006; Utter et al., 2004). The present investigation established that responses from the Adult OMNI-Walk/Run RPE Scale were very strongly related to responses from the Borg 6 - 20 RPE Scale (males, $r = 0.962$; females, $r = 0.965$; $p < 0.001$). Therefore, the OMNI scale measured the same properties of perceived exertion as the Borg scale, as was hypothesized.

This investigation also established sex specific validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese male and female adults who vary from sedentary to physically active. The relationships between OMNI RPE, HR, VO_2, and Borg RPE are similar to those reported in previous investigations that examined sex stratified analyses across different exercise modalities (Irving et al., 2006; Mays et al., 2010; Pfeiffer et al., 2002; Robertson et al., 2005a; Robertson et al., 2005b; Robertson et al., 2000; Robertson et al., 2004; Robertson et al., 2003; Utter et al., 2004; Utter et al., 2002). Therefore, the Adult OMNI-Walk/Run RPE Scale may be used to assess exercise intensity in healthy overweight and obese male and female adults who vary in physical activity level.

5.2 PREFERRED METHOD OF SELF-REGULATING EXERCISE INTENSITY

The preferred method that overweight and obese individuals use to self-regulate exercise intensity, or what strategy they would prefer to use in the future was unknown. Previous research has examined the preferred self-regulation method in young adult women who were currently participating in regular exercise programs. They found the majority of these women (86%) used some sort of effort perception to select their exercise intensity, and only 7% used HR (Johnson & Phipps, 2006). Therefore, it was hypothesized that overweight and obese adults who have previously exercised have used perceptual methods to self-regulate their exercise intensity. In the present investigation, the majority of subjects (88.2%, n = 45) who have previously (n = 9) or currently (n = 42) exercised stated they have used a perceptual method, and only 11.8% (n = 6) reported the use of HR to self-regulate their exercise intensity. These results are consistent with those reported by Johnson & Phipps (2006). However, the current investigation had a greater percentage of individuals who had previous knowledge of RPE (62.7%) compared to 16% from the Johnson & Phipps (2006) study. This discrepancy may be due to the fact that subjects from the present investigation were participants in weight loss intervention studies that include the Borg 6 - 20 RPE Scale in testing and prescription applications.

The preferred method of self-regulating exercise intensity in the future was also assessed in the current investigation. To our knowledge, this preference has not been previously examined. It was hypothesized that overweight and obese subjects would prefer to use perceptual methods over HR methods to self-regulate their exercise intensity in future exercise sessions. There was no significant difference in the number of subjects preferring to use a perceptual method (56.7%) over a HR method (43.3%) in the future. More subjects indicated they would change from using a perceptual method to a HR method in the future than reported a preference to switch from a HR to perceptual based self-regulation strategy. This change was significant in younger, overweight (not obese), White/Caucasian adults who were physically active and performing their 6 month assessment for their respective weight loss intervention study. Those who were Black/African American (n = 13) or Other (Asian or mix, n = 4) primarily reported no change, preferring to continue to use perceptual methods in the future. This non-significance may be due to the minimal power achieved with the smaller subset sample sizes.

The significant shift from using perceptual methods to preferring HR methods in the future is inconsistent with the previous theory that individuals may begin exercising using HR and then switch to a perceptual method as they become more familiar with exercise (Johnson & Phipps, 2006). The current findings would suggest, in healthy overweight and obese adults, the opposite may be true. The shift towards HR methods of self-regulating exercise intensity may be due to several physical characteristics and traits. According to Sallis et al. (1985) younger, physically active adults are more likely to engage in more vigorous, fitness-related activities than older, obese, or sedentary adults. In the present investigation, individuals who indicated they would switch to HR methods of self-regulating exercise intensity were younger, primarily classified as overweight (according to BMI), and physically active. These individuals may be more tolerant of vigorous exercise intensities than their older, obese, or sedentary counterparts, and may have an increased knowledge on proper ways to exercise for improving health and fitness (completing 6 months of a weight loss intervention study compared to baseline). Therefore, in order to improve their fitness they may perceive an objective method (HR) to self-regulate their intensity as being more accurate than a subjective method (perceptual).

Lastly, it was hypothesized that subjects would prefer to use the Adult OMNI-Walk/Run RPE Scale over the Borg 6 – 20 RPE Scale to self-regulate exercise intensity in future exercise sessions. In the present investigation, there was no difference in the number of subjects who preferred to use Borg RPE (n = 4) or OMNI RPE (n = 4) in the future. These were also the least chosen methods among subjects for future self-regulation of exercise intensity despite 56.7% of the subjects having previous knowledge of RPE. It was uncertain if subjects, although having previously heard of RPE, fully understood the concept and advantages of self-regulating exercise intensity using the perceptual metric. In addition, many subjects had used the Borg 6 – 20 RPE Scale, and due to this familiarity/comfort level may have chosen to continue using this scale. Therefore, familiarization of the different regulation techniques (HR and Perceptual) may be required to get an accurate preference of self-regulation method.

The method primarily chosen by subjects in the past (45%, n = 23) and future (30%, n = 18) was "How your body feels". Previous investigations have examined this perceptual method using the Feeling Scale during exercise testing and prescription in various populations (Ekkekakis et al., 2004; Hardy & Rejeski, 1989; Parfitt et al., 2006; Parfitt et al., 2000; Rose & Parfitt, 2008; Welch et al., 2007). The Feeling Scale is an 11-point bipolar scale that ranges from very good (+5) to very bad (-5). Individuals generally self-regulate exercise at an intensity that produces more positive feelings (Rose & Parfitt, 2008), and this intensity is considered safe and effective for improving health (Ekkekakis et al., 2004) and fitness (Hills et al., 2006; Londeree, 1997). This is consistent with the belief that people generally do what makes them feel good, and avoid what makes them feel bad (Ekkekkais & Lind, 2006; Emmons & Diener, 1986). In addition, the extra body mass in the overweight and obese creates biomechanical inefficiencies such as greater ground reaction forces and wider step widths (Browning & Kram, 2007). Performing exercise at higher intensities may increase the risk of developing musculoskeletal injuries and cause pain, especially in the obese (Hootman et al., 2002; Hootman et al., 2001; Jeffery et al., 2003). Therefore, obese individuals may prefer to regulate exercise intensity based upon how their body feels in order to avoid discomfort and injury.

5.3 CLINICAL APPLICATIONS

There are several clinical applications associated with the present investigation. Primarily, the Adult OMNI-Walk/Run RPE Scale has been validated for use in overweight and obese adults during graded treadmill testing. Future studies should examine the use of this perceptual scaling metric in prescriptive and self-regulation paradigms. In addition, overweight and obese adults who have previously or currently participated in a regular exercise program prefer to use a perceptual measure to self-regulate exercise intensity. However, when introduced to several different HR or perceptual methods, there was no difference in choice. The most commonly selected method of choice to self-regulate exercise intensity was the perceptual method of "how your body feels." Therefore, exercise prescriptions in research, clinical, and public health settings should focus on developing and evaluating exercise programs that allow the participants to use perceptual methods to self-regulate the exercise intensity.

5.4 STRENGTHS AND LIMITATIONS

5.4.1 Strengths

The results of the current investigation had a few distinct strengths. The present investigation used a large sample of overweight and obese adults to examine the validity of the Adult OMNI-Walk/Run RPE Scale. The validity of the Adult OMNI-Walk/Run RPE Scale is generalizable to individuals who are overweight and obese. In addition, the validity of the scale is applicable to overweight and obese adults who vary in Physical Activity Status (Sedentary or Physically Active), race/ethnicity (White/Caucasian and Black/African American), and previous knowledge of RPE (Appendix I). Chen et al. (2002) claimed that studies involving larger heterogeneous samples would result in greater and more stable validity coefficients, and improve the generalizability of the results. Therefore, these results improve the external validity of the use of OMNI RPE. This investigation was also the first to examine the preferred method of self-regulating exercise intensity in overweight and obese adults. These results are also generalizable to a mixed sample of adults.

5.4.2 Limitations

The present investigation also included some limitations. The graded exercise test was a submaximal protocol with a termination at 85% of APMHR. Therefore, the full perceptual-physiological range (rest to maximal) may not have been achieved in some individuals. In addition, the small sample sizes achieved in the secondary aim resulted in minimal achieved power. The design of the present investigation was not specifically set up to address Hypothesis

3.2. All subjects should have been asked to identify which RPE scale they would prefer to use if only given a choice between the two scales. This would have provided a sufficient sample size to examine this hypothesis. In addition, it would have been ideal to have subjects who were complete RPE novices be presented with both RPE scales, and then asked about their preference. Furthermore, the first question from the Preferred Method of Self-Regulating Exercise Intensity Questionnaire asked whether subjects had previously, currently, or never participated in a regular (≥ 3 months) exercise program. A definition of a regular exercise program was not included. Therefore, subjects may have perceived a regular exercise program differently. Future investigations should clearly define a "regular exercise program" including the number of exercise sessions and minutes exercised per week.

5.5 FUTURE RESEARCH

The validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults was not previously examined. Therefore, this was the primary aim of the current investigation. In addition, the preferred method of self-regulating exercise intensity in these adults was also examined. Based on the present results, the following topics should be examined to further expand the knowledge base in perceived exertion and the preferred method of self-regulating exercise intensity:

1. Previous investigations have determined RPE to a be reliable tool for assessing exercise intensity in various populations (Ceci & Hassmen, 1991; Eston & Williams, 1988; Pfeiffer et al., 2002; Skinner et al., 1973b). Reliability of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults should be examined in the future.

2. Previous investigations have identified the response normalized OMNI RPE at the ventilatory breakpoint (Goss et al., 2011; Robertson et al., 2001). Exercise intensities corresponding to the ventilatory breakpoint are considered safe and effective in improving health (Ekkekakis et al., 2004) and fitness (Hills et al., 2006; Londeree, 1997). Future investigations should examine if there is a normalized response at this intensity in overweight and obese individuals.

3. The efficacy of using RPE to monitor exercise intensity in a 14-week aerobic dance class to improve endurance capacity has been previously investigated (Koltyn & Morgan, 1992). Future research should examine the efficacy of using OMNI RPE compared to HR to self-regulate exercise intensity in long-term weight loss and physical activity interventions across various populations.

4. Johnson & Phipps (2006) were the first to report on how normal weight, physically active, young adult women self-regulated their exercise intensity. The present investigation was the first to examine this question in overweight and obese adults who vary in age and physical activity status. Future investigations should explore this concept in children/adolescent, athletic, elderly, and clinical populations.

5. The method (i.e., HR or perceptual) subjects in the present investigation preferred to self-regulate exercise intensity varied across age, BMI, and physical activity status. The reasons for choosing the different methods are unclear. Therefore, future investigations should examine why people choose one method over the other.

6. The Preference for and Tolerance of Exercise Intensity Questionnaire (PRETIE-Q) may help identify those individuals who prefer to exercise at, and have a higher tolerance for, more vigorous intensities (Ekkekakis et al., 2005). These individuals typically participate in more fitness-related activities, and may prefer to use more objective measures to self-regulate their exercise intensity than perceptual methods. Therefore, future investigations should examine the relationship between PRETIE-Q scores and preferred method of self-regulating exercise intensity.

7. The current investigation also showed that more people intended to switch from using a perceptual method to a HR method in the future. The reasons for this change in preference, and when it occurs are unknown. Therefore, future investigations should identify the cause of this change in preference, and when this shift occurs in the training period.

5.6 CONCLUSIONS

In conclusion, several RPE scales have been developed to assess exercise intensity during exercise testing and prescription. The primary purpose of the present investigation was to establish the validity of the Adult OMNI-Walk/Run RPE Scale in overweight and obese adults. Estimates from the OMNI RPE scale exhibited a positive linear relationship with HR, VO_2, and the Borg RPE scale. These responses were in agreement with the theoretical bases of perceived exertion, and were similar to those previously reported for the Adult OMNI-Walk/Run RPE Scale (Irving et al., 2006; Utter et al., 2004). Therefore, concurrent and construct validity was established for the OMNI RPE scale.

Furthermore, the preferred method employed by overweight and obese individuals to self-regulate exercise intensity was previously unknown. Therefore, the secondary purpose of the current investigation was to examine this gap in the literature. The majority of overweight and obese individuals in the present study preferred to self-regulate exercise intensity using a perceptual method during previous exercise. These results were consistent with previous findings in physically active, young adult females (Johnson & Phipps, 2006). The method primarily chosen by subjects was "How your body feels." Further research is needed to examine why certain individuals prefer different methods to self-regulate exercise intensity.

In addition, a significant number of subjects indicated they will switch from a perceptual to HR method when asked what self-regulation strategy they would prefer to utilize in the future. This change from perceptual to HR methods was opposite that reported by Johnson and Phipps (2006) who speculated that individuals may begin exercising utilizing HR and as they became more experienced exercisers switch to a perceptual method. The change noted presently occurred predominantly in those who were younger, classified as overweight, completing six months assessments associated with a weight loss intervention, and physically active. The reasons behind this change, and when the shift occurs are uncertain and warrant further exploration.

APPENDIX A

INFORMED CONSENT DOCUMENT

University of Pittsburgh

School of Education
Physical Activity and Weight Management Research Center

Suite 600 Birmingham Towers
2100 Wharton Street
Pittsburgh, PA 15203
412-488-4184
Fax: 412-488-4174

CONSENT TO ACT AS A SUBJECT IN A RESEARCH STUDY

TITLE: VALIDATION OF OMNI RPE AND PREFERRED METHOD OF REGULATING EXERCISE INTENSITY IN OBESE ADULTS

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Why is this research being done?

Rating of perceived exertion (RPE) can be used to control exercise intensity, with exercise intensity defined as the amount of effort of the exercise that you may be doing. Perceived exertion is defined as your feelings of effort, strain, discomfort, and/or fatigue that are felt during exercise. The RPE can also be linked to related physiological variables during exercise such as your heart rate and the amount of oxygen your body uses while exercising. The purpose of this study is to examine if the RPE provides an accurate measure of exercise intensity in healthy overweight and obese adults. Information from this study will also allow the investigation to understand if overweight and obese adults currently use or will use the RPE when exercising.

Who is being asked to take part in this research study?

Adult men and women who are participating in either the IDEA Study or the Heart Health Study in the Physical Activity and Weight Management Research Center at the University of Pittsburgh are eligible to participate in this study. You are being invited to take part in this research study because you are currently participating in one of these studies.

What procedures will be performed for this research?

If you decide to take part in this research study, you agree to allow the investigators to use some of the data from that which is being collected for either the IDEA Study or Heart Health Study. The data that you allow the investigators to use will include the following:

1. Information about your age, gender, and race/ethnicity.
2. The measurement of weight.
3. The measurement of height.
4. The body mass index that is calculated based on the measurement of height and weight.
5. The heart rate information collected during the exercise test that is conducted.
6. The oxygen consumption information that is collected during the exercise test that is being conducted.
7. The RPE information that is being collected during the exercise test that is being conducted.

In addition, the following new procedures will be performed:

1. Additional RPE information will be collected while you are walking on the treadmill during your exercise test. This will involve you rating your level of exertion on a scale of 0 to 10. You will be asked to provide this information every minute while you are walking on the treadmill, and then the exercise test ends
2. You will complete a questionnaire that will provide information about your current level of physical activity. This questionnaire will take approximately 5 minutes to complete.
3. You will complete a questionnaire that will provide information about how you prefer to monitor the intensity of your exercise. This questionnaire will take approximately 5 minutes to complete.

All procedures will take place in the Physical Activity and Weight Management Research Center. All testing will be administered by trained staff members from the Physical Activity and Weight Management Research Center.

What are the possible risks, side effects, and discomforts of this research study?

During the post-exercise interview, you may become anxious while answering the questions about your exercise history and preferences. If this occurs to you, please inform the individual conducting the interview and the interview will be stopped. There is also a risk of a potential breach of confidentiality of your questionnaire data. However, steps will be taken to avoid such a breach. Data will be identified with a Participant ID number with the name and other identifiable information removed. The questionnaires obtained during the post-exercise interview will be locked in a room within the Physical Activity and Weight Management Research Center.

What are possible benefits from taking part in this study?

You will likely receive no direct benefit from taking part in this research study.

If I agree to take part in this research study, will I be told of any new risks that may be found during the course of the study?

You will be promptly notified if, during the conduct of this research study, any new information develops which may cause you to change your mind about continuing to participate.

Will my insurance provider or I be charged for the costs of any procedures performed as part of this research study?

Neither you, nor your insurance provider, will be charged for the costs of any procedures performed for the purpose of this research study.

Will I be paid if I take part in this research study?

You will not be paid to take part in this research study.

Who will know about my participation in this research study?

Any information about you obtained from this research will be kept as confidential (private) as possible. All records related to your involvement in this research study will be stored in a locked file cabinet. Your identity on these records will be indicated by a case number rather than by your name, and the information linking these case numbers with your identity will be kept separate from the research records. You will not be identified by name in any publication of the research results unless you sign a separate consent form giving your permission (release).

Who will have access to identifiable information related to my participation in this research study?

In addition to the investigators listed on the first page of this authorization (consent) form and their research staff, the following individuals will or may have access to identifiable information related to your participation in this research study:

- Authorized representatives of the University of Pittsburgh Research Conduct and Compliance Office may review your identifiable research information for the purpose of monitoring the appropriate conduct of this research study.

- In unusual cases, the investigators may be required to release identifiable information related to your participation in this research study in response to an order from a court of law. If the investigators learn that you or someone with whom you are involved is in serious danger or potential harm, they will need to inform, as required by Pennsylvania law, the appropriate agencies.

- Authorized people sponsoring this research study, because they need to make sure that the information collected is correct, accurate, and complete, and to determine the results of this research study.

For how long will the investigators be permitted to use and disclose identifiable information related to my participation in this research study?

The investigators may continue to use and disclose, for the purposes described above, identifiable information related to your participation in this research study for a minimum of seven years after final reporting or publication of a project.

Is my participation in this research study voluntary?

Your participation in this study is completely voluntary. You may refuse to take part in it, or you may stop participating at any time, even after signing this form. Your decision will not affect your relationship with, or the care you receive from UPMC or the University of Pittsburgh.

May I withdraw, at a future date, my consent for participation in this research study?

You may withdraw, at any time, your consent for participation in this research study. To do so, you must contact the investigators who are listed on the first page of this consent form. If you withdraw from this study, we will continue to use the information we have already collected.

If I agree to take part in this research study, can I be removed from the study without my consent?

It is possible that you may be removed from the research study by the researchers to protect your safety or if you are unable or unwilling to complete the research protocol.

VOLUNTARY CONSENT

All of the above has been explained to me and all of my questions have been answered. I understand that any future questions I have about this research study during the course of this study, and that such future questions will be answered by the investigators listed on the first page of this consent document at the telephone numbers given. Any questions I have about my rights as a research subject will be answered by the Human Subject Protection Advocate of the IRB Office, University of Pittsburgh (1-866-212-2668). By signing this form, I agree to participate in this research study.

____

Participant's Name (Print)

______________________ ______________________

Participant's Signature Date

CERTIFICATION OF INFORMED CONSENT

I certify that I have explained the nature and purpose of this research study to the above-named individual, and I have discussed the potential benefits, and possible risks associated with participation. Any questions the individual has about this study have been answered, and we will always be available to address future questions as they arise. I further certify that no research component of this protocol was begun until after this consent form was signed.

______________________ ______________________

Printed Name of Person Obtaining Consent Role in Research Study

______________________ ______________________

Signature of Person Obtaining Consent Date

APPENDIX B

PHYSICAL ACTIVITY READINESS QUESTIONNAIRE (PAR-Q)

Subject ID: _______________________________ Date: _____________

Please read the questions carefully and answer each one honestly: check YES or NO

1. Has your doctor ever said you have a heart condition and that you should only do physical activity recommended by a doctor?

☐ Yes ☐ No

2. Do you feel pain in you chest when you do physical activity?

☐ Yes ☐ No

3. In the past month, have you had chest pain when you were not doing physical activity?

☐ Yes ☐ No

4. Do you lose your balance because of dizziness or do you ever lose consciousness?

☐ Yes ☐ No

5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?

☐ Yes ☐ No

6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

☐ **Yes** ☐ **No**

7. Do you know of any other reason why you should not do physical activity?

☐ **Yes** ☐ **No**

Reference: American Medical Association: Guides to the Evaluation of Permanent Impairment. AMA, Chicago, 1990.

APPENDIX C

GENERAL HEALTH AND HEALTH BEHAVIOR HISTORY

Subject ID:________________________________DATE:____/____/____

1. Do you have or have you ever had any of the following medical conditions?

		Approximate Date of Diagnosis	Describe the Problem
a. Heart Attack	☐yes ☐no	___________	_____________
b. Angina (chest pain on exertion)	☐yes ☐no	___________	_____________
c. Irregular Heart Problems	☐yes ☐no	___________	_____________
d. Other Heart Problems	☐yes ☐no	___________	_____________
e. Stroke	☐yes ☐no	___________	_____________
f. Fainting Spells	☐yes ☐no	___________	_____________
g. High Blood Pressure	☐yes ☐no	___________	_____________
h. High Cholesterol	☐yes ☐no	___________	_____________
i. Thyroid Problems	☐yes ☐no	___________	_____________
j. Cancer	☐yes ☐no	___________	_____________
k. Kidney Problems	☐yes ☐no	___________	_____________
l. Liver Problems	☐yes ☐no	___________	_____________
m. Gout	☐yes ☐no	___________	_____________
n. Diabetes	☐yes ☐no	___________	_____________
o. Emotional/Psychiatric Problems	☐yes ☐no	___________	_____________
p. Drug/Alcohol Problems	☐yes ☐no	___________	_____________

2. Do you have any medical problems that would prevent you from participating in a regular walking program? ☐yes ☐no
If yes, please describe the problem:____
____

3. Have you participated in a regular exercise program over the past 6 months which consists of at least 20 minutes of activity, 3 days per week? ☐yes ☐no
Please describe:____
____

4. Do you have to sleep with extra pillows or have to sit up in the middle of the night because of shortness of breath? ☐yes ☐no

5. Please list all medications that you are currently taking on a regular basis (make sure to indicate if you are taking medication for high blood pressure or cholesterol):

MEDICATION	REASON FOR TAKING
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

6. Over the last 6 months, on how many weekdays (Monday through Friday) do you usually drink wine, beer, or liquor on average?

(0)	☐ Never	(4)	☐ 2 days/week
(1)	☐ Less than once/month	(5)	☐ 3 days/week
(2)	☐ 1-2 times/month	(6)	☐ 4 days/week
(3)	☐ 1 day/week	(7)	☐ 5 days/week

7. On those weekdays that you drink wine, beer, or liquor how many drinks do you have?

____

8. Over the last 6 months, on how many weekend days (Saturday and Sunday) do you usually drink wine, beer, or liquor?

(0)	☐ Never	(4)	☐ 1 weekend day/week
(1)	☐ Less than once/month	(5)	☐ 2 weekend days/week
(2)	☐ 1-2 times/month		

9. On those weekend days that you drink wine, beer, or liquor how many drinks do you have?

____

10. In the past year, have you regularly smoked cigarettes, pipes, cigars, or used chewing tobacco?

			Please describe daily habit
Cigarettes	☐yes	☐no	______________________________
Pipe	☐yes	☐no	______________________________
Cigars	☐yes	☐no	______________________________
Chewing Tobacco	☐yes	☐no	______________________________

11. Do you plan to spend frequent time out of town on business or vacation during the next 6 months? ☐yes ☐no Please describe:________________________

____

12. Is it possible that you will relocate in the next 24 months? ☐yes ☐no

If “yes”, please describe:____

WOMEN ONLY ANSWER THE FOLLOWING QUESTIONS

13. Are you currently pregnant? ☐yes ☐no

14. Were you pregnant within the past 6 months? ☐yes ☐no

15. Do you plan to become pregnant in the next 24 months? ☐yes ☐no

16. Have you gone through menopause or the change of life? ☐yes ☐no

17. Have you had a hysterectomy? ☐yes ☐no

18. When was your last menstrual period? DATE:____/____/____

19. Do you take :

Birth Control Pills? ☐yes ☐no
Estrogens (ie. Premarin)? ☐yes ☐no
Progesterone (ie. Provera)? ☐yes ☐no

APPENDIX D

BORG 6 – 20 RPE & OMNI-WALK/RUN RPE SCALE INSTRUCTIONS

You are about to undergo a treadmill exercise test. These two scales contain numbers from 6 to 20 and 0 to 10, and will be used to assess your perceptions of exertion while exercising. Perceived exertion is defined as the subjective intensity of effort, strain, discomfort, and/or fatigue that is felt during exercise. We use these scales so you may translate into numbers your feelings of exertion while exercising.

Borg RPE Instructions

The numbers on this scale represent a range of feelings from NO EXERTION AT ALL to MAXIMAL EXERTION. In order to help you select a number which corresponds to your subjective feelings within this range consider the following. When the level of exertion feels EXTREMELY LIGHT, respond with a number 7. For example, you should respond with 7 when you are walking slowly on a flat surface. When the level of exertion feels EXTREMELY HARD, respond with a number 19. For example, a response of 19 is appropriate when your feelings of exertion are the same as when you walk/run as fast as you can up a steep hill. If your exercise feelings are less intense than EXTREMELY LIGHT, respond with a number 6, and if your feelings are more intense than EXTREMELY HARD, respond with a number 20. If you feel somewhere between Extremely Light and Extremely Hard then give a number between 7 and 19.

OMNI RPE Instructions

The numbers on this scale represent a range of feelings from EXTREMELY EASY to EXTREMELY HARD. Look at the person at the bottom of the hill who is just starting to walk. If you feel like this person when you are walking, the exertion will be EXTREMELY EASY. In this case, your rating should be the number zero. Now look at the person who is barely able to walk at the top of the hill. If you feel like this person when walking, the exertion will be EXTREMELY HARD. In this case, your rating should be the number 10. If you feel somewhere between Extremely Easy (0) and Extremely Hard (10) then give a number between 0 and 10. Use both the pictures and words to help you select a number.

We will ask you to point to a number that tells how your whole body feels. Do not underestimate or overestimate the exertion; simply rate your feeling caused by the exercise at the moment. There are no right or wrong numbers. Use *any* of the numbers to tell how you feel when walking.

Using both scales:
Ask the following questions after reading both sets of instructions, and prior to performing the exercise test:

Please rate your feelings of exertion right now:

Please rate your feelings of exertion while walking at a moderate intensity:

Please rate your feelings of exertion when you exercised as hard as you can remember:

Do you have any questions?

APPENDIX E

PHYSICAL ACTIVITY HISTORY QUESTIONNAIRE

1. Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate (like jogging, a fitness class, etc.) for at least 10 minutes continuously?

    1) Yes
    2) No If 'No', skip to question #4

2. In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?

    _____ Number of days

3. How much time do you spend doing vigorous-intensity sports, fitness or recreational (leisure) activities on a typical day?

    _____:_____ (hours:minutes)

4. Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking (cycling, swimming, volleyball) for at least 10 minutes continuously?

    1) Yes
    2) No If 'No', do not answer questions 5 and 6

5. In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?

    _____ Number of days

6. How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?

    _____:_____ (hours:minutes)

APPENDIX F

PREFERRED METHOD OF SELF-REGULATING EXERCISE INTENSITY QUESTIONAIRE

Circle the Letter or Number before the response that best answers the question.

1) Do you currently participate (for the previous 3 months)**, or have you ever participated in regular** (≥ 3 months) **aerobic physical activity or exercise?** (If No, skip to question 3)

(1) Currently participate
(2) Previously participated
(3) No

2) If you do or have previously exercised, how do/did you judge how hard you are/were working during your aerobic physical activity or exercise?

(A) Heart Rate (HR) Method
- (1) Chest strap HR monitoring system
- (2) Checking HR at the wrist or neck
- (3) HR monitor on aerobic exercising equipment (i.e., treadmill, bike, etc.)

(B) Perceptual Method
- (1) How your body feels (i.e., good, bad, tired, exhausted, etc.) or (focus is on yourself)
- (2) How hard you perceive the intensity (i.e., easy/light, moderate, hard, etc.) or (focus is on the difficulty of the task)
- (3) Using a rating system such as Rating of Perceived Exertion
  - (3a) Borg 6-20 scale
  - (3b) OMNI 0-10 scale
  - (3c) Other: _____________

3) Which method would you prefer to judge how hard you are working during aerobic physical activity or exercise in the future?

(A) Heart Rate (HR) Method
- (1) Chest strap HR monitoring system
- (2) Checking HR at the wrist or neck
- (3) HR monitor on aerobic exercising equipment (i.e., treadmill, bike, etc.)

(B) Perceptual Method
- (1) How your body feels (i.e., good, bad, tired, exhausted, etc.) or
  (focus is on yourself)
- (2) How hard you perceive the intensity (i.e., easy/light, moderate, hard, etc.) or
  (focus is on the difficulty of the task)
- (3) Using a rating system such as Rating of Perceived Exertion
  - (3a) Borg 6-20 scale
  - (3b) OMNI 0-10 scale
  - (3c) Other: ______________

4) Prior to today, have you ever heard of Rating of Perceived Exertion?

- (1) Yes
- (2) No

APPENDIX G

REGRESSION RESULTS

G.1 CONCURRENT VALIDITY REGRESSION

Sample / Criterion	Intercept		Slope		r^2		SEE	
	OMNI	Borg	OMNI	Borg	OMNI	Borg	OMNI	Borg
Total *								
HR	82.534	34.561	9.615	7.755	0.751	0.707	16.598	18.008
VO_2	9.456	-2.870	2.295	1.929	0.534	0.546	6.424	6.341
Male *								
HR	80.832	31.113	9.932	7.945	0.773	0.743	15.878	16.910
VO_2	9.252	-6.853	2.913	2.466	0.538	0.578	7.972	7.612
Female *								
HR	83.532	36.583	9.436	7.645	0.738	0.687	17.126	18.725
VO_2	9.433	-0.567	1.975	1.615	0.631	0.599	4.597	4.795

***** $p < 0.001$ for all criterion variables; SEE, standard error of the estimate; OMNI, Adult OMNI-Walk/Run RPE; Borg, Borg 6 – 20 RPE

G.2 CONSTRUCT VALIDITY REGRESSION

Sample	Criterion	OMNI Predictor				r^2
		Intercept	SEE	Slope	SEE	
Total *	Borg	6.515	0.123	1.159	0.024	0.928
Males *	Borg	6.542	0.206	1.179	0.042	0.925
Females *	Borg	6.493	0.153	1.149	0.030	0.931

***** $p < 0.001$ for all samples; SEE, standard error of the estimate; OMNI, Adult OMNI-Walk/Run RPE; Borg, Borg 6 – 20 RPE

APPENDIX H

PREFERENCE CHANGE FROM PAST TO FUTURE OF EXERCISE INTENSITY SELF-REGULATION METHOD

H.1 AGE-QUARTILES

				Future Method of Exercise Intensity Self-Regulation		
				HR	Perceptual	Total
25-28 years	Past Method of Exercise Intensity Self-Regulation	HR	Count	2	0	2
			% within Future Method	25.0%	.0%	12.5%
		Perceptual	Count	6 *	8	14
			% within Future Method	75.0%	100.0%	87.5%
	Total		Count	8	8	16
			% within Future Method	100.0%	100.0%	100.0%
29-33 years	Past Method of Exercise Intensity Self-Regulation	Perceptual	Count	4	11	15
			% within Future Method	100.0%	100.0%	100.0%
	Total		Count	4	11	15
			% within Future Method	100.0%	100.0%	100.0%
34-40 years	Past Method of Exercise Intensity Self-Regulation	HR	Count	1	1	2
			% within Future Method	20.0%	16.7%	18.2%
		Perceptual	Count	4	5	9
			% within Future Method	80.0%	83.3%	81.8%
	Total		Count	5	6	11
			% within Future Method	100.0%	100.0%	100.0%

41-55 years	Past Method of Exercise Intensity Self-Regulation	HR	Count	2	0	2
			% within Future Method	50.0%	.0%	22.2%
		Perceptual	Count	2	5	7
			% within Future Method	50.0%	100.0%	77.8%
	Total		Count	4	5	9
			% within Future Method	100.0%	100.0%	100.0%
Total	Past Method of Exercise Intensity Self-Regulation	HR	Count	5	1	6
			% within Future Method	23.8%	3.3%	11.8%
		Perceptual	Count	16	29	45
			% within Future Method	76.2%	96.7%	88.2%
	Total		Count	21	30	51
			% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, $p < 0.05$

H.2 RACE

				Future Method of Exercise Intensity Self-Regulation		Total
				HR	Perceptual	
White / Caucasian	Past Method of Exercise Intensity Self-Regulation	HR	Count	4	0	4
			% within Future Method	25.0%	.0%	11.8%
		Perceptual	Count	12 *	18	30
			% within Future Method	75.0%	100.0%	88.2%
	Total		Count	16	18	34
			% within Future Method	100.0%	100.0%	100.0%
Black / African American	Past Method of Exercise Intensity Self-Regulation	HR	Count	1	0	1
			% within Future Method	25.0%	.0%	7.7%
		Perceptual	Count	3	9	12

			% within Future Method	75.0%	100.0%	92.3%
	Total		Count	4	9	13
			% within Future Method	100.0%	100.0%	100.0%
Other	Past Method of Exercise Intensity Self-Regulation	HR	Count	0	1	1
			% within Future Method	.0%	33.3%	25.0%
		Perceptual	Count	1	2	3
			% within Future Method	100.0%	66.7%	75.0%
	Total		Count	1	3	4
			% within Future Method	100.0%	100.0%	100.0%
Total	Past Method of Exercise Intensity Self-Regulation	HR	Count	5	1	6
			% within Future Method	23.8%	3.3%	11.8%
		Perceptual	Count	16	29	45
			% within Future Method	76.2%	96.7%	88.2%
	Total		Count	21	30	51
			% within Future Method	100.0%	100.0%	100.0%

***** Change from past perceptual method to future HR method, $p < 0.001$

H.3 ASSESSMENT

				Future Method of Exercise Intensity Self-Regulation		Total
				HR	Perceptual	
Baseline	Past Method of Exercise Intensity Self-	HR	Count	3	0	3
			% within Future Method	42.9%	.0%	17.6%
		Perceptual	Count	4	10	14

				HR	Perceptual	Total
	Regulation		% within Future Method	57.1%	100.0%	82.4%
	Total		Count	7	10	17
			% within Future Method	100.0%	100.0%	100.0%
6 months	Past Method of Exercise Intensity Self-Regulation	HR	Count	1	1	2
			% within Future Method	9.1%	5.3%	6.7%
		Perceptual	Count	10 *	18	28
			% within Future Method	90.9%	94.7%	93.3%
	Total		Count	11	19	30
			% within Future Method	100.0%	100.0%	100.0%
12 months	Past Method of Exercise Intensity Self-Regulation	HR	Count	1	0	1
			% within Future Method	33.3%	.0%	25.0%
		Perceptual	Count	2	1	3
			% within Future Method	66.7%	100.0%	75.0%
	Total		Count	3	1	4
			% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, $p < 0.05$

H.4 BMI CLASSIFICATION

				Future Method of Exercise Intensity Self-Regulation		Total
				HR	Perceptual	
Overweight	Past Method of Exercise Intensity Self-Regulation	HR	Count	3	0	3
			% within Future Method	23.1%	.0%	11.5%
		Perceptual	Count	10 *	13	23
			% within Future Method	76.9%	100.0%	88.5%
	Total		Count	13	13	26
			% within Future Method	100.0%	100.0%	100.0%
Obese	Past Method of Exercise Intensity	HR	Count	2	1	3
			% within Future Method	25.0%	5.9%	12.0%
		Perceptua	Count	6	16	22

	Self-Regulation	l	% within Future Method	75.0%	94.1%	88.0%
	Total		Count	8	17	25
			% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, $p < 0.01$

H.5 PHYSICAL ACTIVITY STATUS

				Future Method of Exercise Intensity Self-Regulation		Total
				HR	Perceptual	
Sedentary	Past Method of Exercise Intensity Self-Regulation	HR	Count	2	0	2
			% within Future Method	33.3%	.0%	15.4%
		Perceptual	Count	4	7	11
			% within Future Method	66.7%	100.0%	84.6%
	Total		Count	6	7	13
			% within Future Method	100.0%	100.0%	100.0%
Physically Active	Past Method of Exercise Intensity Self-Regulation	HR	Count	3	1	4
			% within Future Method	20.0%	4.3%	10.5%
		Perceptual	Count	12 *	22	34
			% within Future Method	80.0%	95.7%	89.5%
	Total		Count	15	23	38
			% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, $p < 0.01$

H.6 VIGOROUS ACTIVITY

				Future Method of Exercise Intensity Self-Regulation		Total
				HR	Perceptual	
Yes	Past Method of Exercise Intensity Self-Regulation	HR	Count	2	0	2
			% within Future Method	15.4%	.0%	6.7%
		Perceptual	Count	11*	17	28
			% within Future Method	84.6%	100.0%	93.3%
	Total		Count	13	17	30
			% within Future Method	100.0%	100.0%	100.0%
No	Past Method of Exercise Intensity Self-Regulation	HR	Count	3	1	4
			% within Future Method	37.5%	7.7%	19.0%
		Perceptual	Count	5	12	17
			% within Future Method	62.5%	92.3%	81.0%
	Total		Count	8	13	21
			% within Future Method	100.0%	100.0%	100.0%
Total	Past Method of Exercise Intensity Self-Regulation	HR	Count	5	1	6
			% within Future Method	23.8%	3.3%	11.8%
		Perceptual	Count	16	29	45
			% within Future Method	76.2%	96.7%	88.2%
	Total		Count	21	30	51
			% within Future Method	100.0%	100.0%	100.0%

* Change from past perceptual method to future HR method, $p < 0.01$

APPENDIX I

PREVIOUS KNOWLEDGE OF RPE REGRESSION RESULTS

I.1 CONCURRENT VALIDITY

Sample / Criterion	Intercept		Slope		r *		r^2		SEE	
	OMNI	Borg	OMNI	Borg	OMNI	Borg	OMNI	Borg	OMNI	Borg
Yes										
HR	81.347	24.505	10.311	8.698	0.872	0.857	0.760	0.735	16.517	17.362
VO_2	10.073	-5.115	2.431	2.207	0.704	0.744	0.495	0.554	6.996	6.573
No										
HR	83.305	43.223	8.888	6.885	0.868	0.830	0.753	0.689	16.352	18.333
VO_2	8.582	-0.942	2.138	1.646	0.792	0.753	0.627	0.567	5.291	5.704

***** $p < 0.001$ for all criterion variables; SEE, standard error of the estimate; OMNI, Adult OMNI-Walk/Run RPE; Borg, Borg 6 – 20 RPE; Yes, previously heard of RPE; No, did not previously hear of RPE

I.2 CONSTRUCT VALIDITY

Sample	Criterion	OMNI Predictor				r *	r^2
		Intercept	SEE	Slope	SEE		
Yes	Borg	6.856	0.184	1.108	0.037	0.950	0.903
No	Borg	6.153	0.150	1.208	0.029	0.978	0.957

***** $p < 0.001$; SEE, standard error of the estimate; OMNI, Adult OMNI-Walk/Run RPE; Borg, Borg 6 – 20 RPE; Yes, previously heard of RPE; No, did not previously hear of RPE

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