4-18-2012

RPE and Mode of Exercise

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Recommended Citation
Victoria Helmus, having been admitted to the Carl and Winifred Lee Honors College in the spring of 2009, successfully completed the Lee Honors College Thesis on April 18, 2012.

The title of the thesis is:

RPE and Mode of Exercise

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Abstract

The American College of Sports Medicine currently recommends that all individuals age 18 – 65 perform vigorous aerobic activity for at least 20 minutes 3 days a week, or moderate intensity aerobic activity for at least 30 minutes 5 days a week. Activities that fall under this category include, but are not limited to walking, running, cycling, swimming and elliptical machines. When an individual exercises, they have a sense of what their intensity level is based on how they ‘feel’. Ratings of Perceived Exertion charts serve as a guide for this subjective thought process. There are wide ranges of intensities associated with levels of exercise and the type of exercise the individual has chosen to perform. Therefore, there is a possibility that the mode of exercise may influence the actual exercise intensity (expressed as a % of maximal heart rate or maximal oxygen consumption) even though the individual is exercising at pre-determined perceived exercise intensity levels. Previous research has examined such a likelihood utilizing shorter time frames such as 20 minutes of exercise on a specific mode of exercise. Therefore, the purpose of this study is to investigate how different modes of exercise (cycle ergometry vs. treadmill exercise vs. elliptical exercise) for 40 minutes will affect the actual exercise intensity at a predetermined rating of perceived exertion. This increased duration of activity conforms more closely to the guidelines set forth by the American College of Sports Medicine.

Purpose/Background Information

The American College of Sports Medicine (ACSM) currently recommends that “all healthy adults aged 18 to 65 years perform moderate-intensity aerobic physical activity for a minimum of 30 minutes five days per week, or vigorous activity for a minimum of 20 minutes three days a week” (ACSM, 2010). This amount of exercise has been shown to support the inverse relationship between physical activity and cardiovascular disease, hypertension, stroke, osteoporosis, type 2 diabetes, obesity, colon cancer, breast cancer, anxiety, and depression. Fortunately, most fitness facilities offer a wide variety of equipment for people to engage in aerobic physical activity. For example, the typical modes of exercise that qualify as aerobic activity include treadmill walking and running, cycle ergometry, rowing, stepper use, and elliptical exercise.

To begin, exercise is defined as a type of physical activity consisting of planned, structured, and repetitive bodily movements done to improve or maintain one or more components of physical fitness. In addition, it is important to clearly define the wide ranges of intensities associated with
exercise. This can be quantified through several scientific methods, including percentages of maximal oxygen consumption ($\text{VO}_2\text{max}$) and maximal heart rate ($\text{HR}_{\text{max}}$). As a standard measure of aerobic fitness, $\text{VO}_2\text{max}$ is the greatest amount of oxygen in milliliters per kilogram of body weight that a person can utilize in one minute. ACSM defines moderate intensity exercise as an individual exercising at approximately 40-60% of their $\text{VO}_2\text{max}$ or 64-76% of their $\text{HR}_{\text{max}}$.

Furthermore, there are also qualitative ways in which a person can determine his or her intensity level. For instance, a Rating of Perceived Exertion (RPE) scale (Appendix A) offers a subjective mind-body connection to help guide people to determine how intense an exercise feels. One such scale, the Borg Scale, is a 15 point scale ranging from 6-20, and it is used to rate the feelings caused by a person’s exertion while involved in physical activity. For example, at a rating of 7, the exercise should feel “very, very light”; whereas at a 19, it would feel “very, very hard.” The way a person chooses his or her place on the scale is totally dependent on the feelings caused by his or her actual exertion during exercise. RPE is a subjective way to determine how a person feels, and thus how hard he or she is exercising. ACSM defines a moderate intensity occurring at an RPE of approximately 12 and 13 according to the Borg scale (ACSM, 2010).

There is a linear relationship between exercise $\text{VO}_2\text{max}$ and $\text{HR}_{\text{max}}$ and the perceived level of exertion levels, and this is directly related to a person’s physiological response to exercise. For instance, as the intensity of exercise increases, so do HR, oxygen consumption ($\text{VO}_2$) and rating on the RPE scale. Over the years, research has utilized this relationship to compare the cardiovascular and perceived exertion responses to various modes of exercise. For example, Kravits et al. (1997), compared $\text{VO}_2$ and energy expenditure for 20 minutes of exercise using treadmill running, cross-country skiing, cycling, and an aerobic riding exercise at a “self-selected” submaximal intensity of exercise. This study found that the treadmill elicited the greatest $\text{VO}_2$ and energy expenditure during self-selected exercise despite an RPE similar to cross-country skiing and cycle ergometry. On the other hand, researchers will sometimes instruct their participants to exercise at a constant rating of perceived exertion. To illustrate this, Thomas et al. (1995) had each of their participants perform a 20 minute bout of exercise at a constant RPE of 14 (between “Somewhat Hard” and “Hard”) followed by a second bout of exercise at 60% of mode-specific peak oxygen consumption ($\text{VO}_2\text{max}$) for various modes of exercise. Their results indicated that a variety of exercise modes can be used to develop fitness, but jogging may induce a slightly more favorable $\text{VO}_2$-to-RPE relationship.

Moreover, most studies of this fashion are out to answer a similar question – which mode of exercise is generally most effective for expending energy? Our research aims to expand upon this question in a novel manner by examining how mode of exercise influences the actual exercise intensity (expressed as a percentage of $\text{HR}_{\text{max}}$ or $\text{VO}_2\text{max}$) while the individual is exercising at a pre-determined “perceived” exercise intensity. In addition, we are also examining if a subject perceives the difficulty of various modes of exercise differently, whether he or she will make more adjustments to that particular exercise device while still maintaining a constant level of “perceived” intensity.

For the present study, we will not only instruct our participants to exercise at a set RPE of what they believe to be 13 (moderate intensity), but we will also have them exercise for a total of 40 minutes; a more extensive amount of time than previous studies as well as more in sync with
ACSM's recommendations for duration of exercise. However, one of the most distinctive qualities to our research is that we will allow our participants to freely change their resistance settings on the machines in order for them to maintain the ACSM's recommended intensity of an RPE of 13. Since we will be using exercise equipment commonly found in most fitness facilities: treadmill, cycle ergometer, and elliptical, our experimental design closely matches up to how a person would exercise in his or her daily routine.

Our study not only fits into the context of previous research, but expands upon current knowledge as well since only a few studies match closely to our methods. For instance, Moyna et al. study compared the rate of energy expenditure among six popular exercise machines at a light (RPE 11), somewhat hard (RPE 13), and hard (RPE 15) between genders, and found that there are large differences in energy expenditure between exercise machines at these various RPE settings (2001). Our study will also use quantitative methods (HR max, VO2 max and lactate concentrations) to determine intensity while paralleling qualitative methods (RPE), in an attempt to see which mode of exercise elicits the greatest VO2 and energy expenditure during exercise at a constant RPE. Our research seeks to find which mode of exercise may be the modality of choice for individuals seeking to improve cardiorespiratory endurance and expend a greater number of calories. Furthermore, using the RPE scale to determine exercise intensity is important for people on certain medications, such as β-blockers, because these medications may affect the HR response to exercise. Since RPE is based on perceptions of how a person feels according to his or her physiological responses, information found from research such as ours can help determine if one particular mode of exercise is perceived as being “easier,” even though that person may actually be exercising at an intensity beneficial for his or her physical health.

Subject Recruitment

Fifteen individuals between the ages of 18 and 35 years will serve as participants in this study. Both males and females will be eligible to participate. The justification for the upper age range of 35 years is due to the fact that ACSM classifies being 45 years or older for a male and 55 years or older for a female as being a risk factor for cardiovascular disease. By reducing the upper age range to 35 years we are decreasing the potential risks of participating in the study.

In addition to the age requirement, individuals must meet the following inclusionary criteria in order to be eligible to participate:

- Non-smoking
- Healthy, free of disease and free of medication use which may affect the cardiovascular or metabolic responses during exercise;
- Free of any orthopedic injuries or conditions that would make exercise difficult;
- Classified as “Low-Risk” (asymptomatic for cardiovascular, respiratory or metabolic diseases and possessing ≤ one risk factor for atherosclerotic cardiovascular disease; see Appendix B) based on ACSM Risk Stratification guidelines;
- Recreationally active (exercise at least three times per week) and not a trained athlete (competing in sports or athletic competitions);
- Not obese (body mass index < 30 kg/m²);
- Not being pregnant (self-reported).
The exclusionary criteria include any individual who does not meet all of the inclusionary criteria.

The procedures by which the inclusionary criteria will be assessed are described in the “Informed Consent Process” and the “Research Procedure” sections.

Participants will be solicited through announcements made in courses offered in the Department of Health, Physical Education, and Recreation, and by posting flyers (Appendix C) in the Student Recreation Center at Western Michigan University. These announcements and flyers will provide overviews of the purpose of the research study, the inclusionary criteria, the major research procedures, the time commitment, and the contact information (telephone and e-mail) of the student investigators.

If a potential participant is interested in learning more about the study, he or she will contact one of the student investigators via telephone or e-mail. The student investigator will then provide an overview of the study and respond to any questions the potential participant may have. If the potential participant is still interested in participating, an appointment will be made to review the informed consent document and potentially obtain consent (see “Informed Consent Process” section).

**Informed Consent Process**

When a prospective participant first contacts the student investigator and expresses interest in learning more about the study, the student investigator will briefly go over the purpose of the study and a summary of the major research protocols, and the inclusion/exclusion criteria. If the potential participant is still interesting in participating and meets the general inclusionary criteria that can be self-determined by the potential participant (i.e. age, orthopedic injuries, activity status), an appointment will be made to review the informed consent document and potentially obtain informed consent. During this meeting, the student investigator will explain all the research protocols, the risks and benefits of participating in the study, and provide a copy of the informed consent for the potential participant to read. Any questions the prospective participant may have will be answered by the student investigator. Following this, the prospective participant will be invited to sign the informed consent document (Appendix D). A copy of the informed consent form signed by the participant and the student investigator will be given to each participant to take with them. Following the signing of the consent document, the participant will complete two health history questionnaires (Appendix E) in order to assess the inclusionary/exclusionary criteria of stated in the “Participant Recruitment” section of this proposal. No data will be collected prior to obtaining informed consent.

If the results of the health history questionnaires indicate that participant does not meet the inclusionary criteria, the investigators will explain the reasons why the participant is ineligible to continue and provide the participant with a copy of the health history questionnaires.
Research Procedures

Methods of Data Collection

Design

Each participant will visit the Human Performance Research Laboratory four times. The first visit will consist of the informed consent process, anthropometric measurements (height, weight, percent body fat), and a maximal graded exercise test (GXT) on a treadmill to determine aerobic fitness. The second, third, and fourth visits will consist of 40 minutes of exercise at a given RPE level. The procedures for the second, third, and fourth visits will be identical except for the mode of exercise (either cycle ergometry, treadmill walking/running, or elliptical exercise). The order of these trials will be counter-balanced and at least 48 hours will separate all of the visits.

Visit One – Informed Consent, Anthropometric Measurement, Maximal GXT

Upon arrival for the first visit, the informed consent process will be performed as previously described. If informed consent is obtained, each participant’s height and weight will be measured via a stadiometer and a digital scale, respectively. If the eligibility to participate is confirmed, each participant’s percent body fat will be measured. This procedure requires that the thickness of the skin and the subcutaneous fat layer be measured at seven sites on the body (triceps, abdomen, thigh, calf, suprailiac, chest, subscapular) using skinfold calipers.

Each participant will then complete a maximal GXT on the treadmill in order to measure maximal oxygen consumption (VO2max). Each participant will be fitted with a nose clip and a mouthpiece for the collection of expired respiratory gases using the metabolic measurement cart. The metabolic measurement cart measures ventilation and the oxygen and carbon dioxide concentrations of the expired respiratory gases to determine VO2 and carbon dioxide production (VCO2). The mouthpieces and nose piece will be disinfected with Cidex solution after each trial. Each participant will then be fitted with a Polar heart rate monitor which is a strap that goes around the chest. Lastly, each participant will be instructed on using the RPE chart (Appendix E). This procedure requires that the participant point to a number on a chart representing the level of fatigue that he/she feels. Once instrumentation of the participant is complete, the exercise test will begin.

The maximal GXT protocol will consist of a 2-minute warm-up of walking at 3.0 mph followed by two minutes of running at a comfortable speed (typically between 5.0 and 6.5 mph). After this two minute period, exercise intensity will be increased by increasing the grade of the treadmill by 2.5% every minute. Each participant will continue through as many stage of the protocol as possible until the point of volitional fatigue. Volitional fatigue is the point during exercise when the participant feels like he or she can exercise no longer. Although there is no specific criterion for this concept, it is analogous to the exercise being of a sufficient intensity that the participant feels like he or she has reached his or her maximal potential. In other words, the exercise is just too hard to continue. This feeling might occur due to leg fatigue, overall fatigue, hyperventilation, or other factors relating to maximal exercise. On average, the maximal GXT typically consists of between 8 and 15 minutes of actual exercise, although this
can vary based on the fitness level of the participant. The following will be stated to each participant immediately before the start of each trial.

"One of the purposes of this test is to determine your maximal exercise intensity and your overall fitness level. Because of that, we need you to give us your best effort. The exercise test continues until you feel that you can no longer continue. You may feel that you can't continue because you can't "keep-up" with the speed of the treadmill or that you have an overall feeling of fatigue that makes it feel that it is impossible to exercise any harder."

During the exercise test protocol, expired respiratory gases will be measured continuously using the metabolic measurement cart, heart rate will be measured continuously using the Polar heart rate monitor, and RPE will be assessed during the last 10 seconds of each exercise stage.

Once the exercise test protocol is terminated, a small blood finger-prick blood sample will be obtained to measure maximal blood lactate concentration (See Blood Collection and Analysis Section). Each participant will then continue to walk at a very low intensity for approximately five minutes as an active cool-down.

Visits Two, Three, and Four – 40 Minutes of Exercise at a Given RPE Level

The procedures for the second, third, and fourth visits will be identical except for the mode of exercise (either cycle ergometry, treadmill walking/running, or elliptical exercise). The order of these trials will be counter-balanced.

Upon arrival to the laboratory, each participant’s body weight will be measured and the participant will be instrumented with the mouthpiece, nose clip, and heart rate monitor as previously described. A small finger-prick blood sample will then be obtained in order to measure resting blood lactate concentration.

The participant will then begin the 40 minutes of exercise using one of the modes of exercise. The participant will be asked to maintain a perceived exercise intensity of “13, Somewhat Hard” on the 6-20 RPE scale. This intensity of exercise was chosen due to the fact that ACSM recommends an RPE between “12, fairly light/somewhat hard” to “16, Hard” for physiological adaptation from exercise to occur. Participants will be instructed that they are allowed to continuously adjust the settings on the exercise device in order to maintain this perceived level of exercise intensity. Expired respiratory gases and heart rate will be measured continuously and a small finger-prick blood sample will be obtained every 10 minutes for the measurement of blood lactate concentration. In addition, any adjustments that the participant makes to the settings on the exercise device will be noted.

Upon completion of the 40 minutes of exercise, the intensity of exercise will be greatly reduced and the participant will complete a five-minute active cool-down.
**Blood Collection and Analysis**

As previously mentioned, blood lactate concentration will be measured during each of the experimental trials. Blood samples will be obtained via finger-stick methods. Prior to each blood sample, the participant’s finger will be cleaned with an alcohol pad and allowed to dry. Gauze will be applied to the finger to keep it dry and free of impurities. The student investigator will then “prick” the participant’s finger with a sterile, disposable finger stick lancet. This disposable, single-use lancet is automated so that the depth of penetration will be standardized. The fingertip will be punctured on the side of the finger to minimize discomfort. With gentle pressure on the finger, the student investigator will collect a very small blood sample (~30 uL, which translates into a few drops) from the finger using a capillary tube. A piece of gauze will then be placed over the small puncture site. If the person continues to bleed, gauze and a tight fitting band-aid will be placed over the puncture site. After the blood collection, the lancet and gauze will be disposed of in a biohazard bag or sharps container. A different site on different fingers will be used as the collection site for the multiple samples collected during the trials. Over the entire trials, less than 2 mL of blood (less than one-fifth of one tablespoon) will be obtained. Blood sampling and products questionnaire is attached (Appendix F). After a blood sample is obtained, the blood will be analyzed for lactic acid concentration using an automated analyzer (Analox GM7, Lunenburg, MA). The capillary tube with the remaining blood will be disposed of in a biohazard, sharps container immediately following centrifuge testing.

The risks associated with blood sampling will be minimized by using universal precautions. The area of blood sampling (finger) will be cleaned prior to blood sampling using an alcohol swab. All supplies utilized for the blood collection will be new, sterile and only used once. All investigators will wear a clean pair of latex gloves throughout the testing. All blood sampling supplies will be properly disposed of in biohazard bags and a sharps container after use. If complications arise during the blood collection, the participant will be referred to Sindecuse health center for further evaluation.

**Instrumentation**

This section will provide details of the measurements of the physiological variables.

**Height/Body Weight:** Will be measured via a stadiometer and digital scale.

**Percent Body Fat:** Will be measured using skinfold calipers.

**Oxygen Consumption/Caloric Expenditure:** Will be measured using a metabolic measurement system (TrueOne 2400, ParvoMedics, Sandy, UT). The metabolic measurement cart measures ventilation and the oxygen and carbon dioxide concentrations of the expired respiratory gases to determine oxygen consumption ($V_{O_2}$) and carbon dioxide production ($V_{CO_2}$) and requires that the participant breathe through a mouthpiece while wearing nose-clips. These variables will be used to calculate caloric expenditure and exercise intensity.
Blood Lactate Concentration: Will be measured from a small finger-prick blood sample and analyzed in duplicate using a blood lactate analyzer (GM7, Analox Instruments, Lunenburg, MA).

Heart Rate: Will be measured using a heart rate monitor that is placed around the participants' chest, just under the sternum. Heart rate will be monitored via a heart rate watch that the participants will be wearing.

Rating of Perceived Exertion (RPE): Will be measured using the Borg 6-20 scale. This scale is used to determine how hard the exercise feels to the participant.

Location of Data Collection

The study will be conducted in the Human Performance Research Laboratory within the Student Recreation Center at Western Michigan University. All data will be saved to a file for retrieval as needed, and only the principal and student investigators will have access to the information. Under HIPPA regulations, all material will be stored in a locked cabinet when not in use in the Principal Investigators office.

Duration of the Study

As previously stated, each participant will visit the laboratory four times. Each visit should take approximately 1.5 hours. Therefore, the total time commitment for the study is approximately six hours. We anticipate that each participant will complete all of the research procedures within a four week time span.

The requested length of approval for the entire study is one year.

Methodology

Design

This study will utilize a repeated measures design in that each participant will complete a maximal GXT and 40 minute exercise sessions using all of the modes of exercise.

Analysis

The primary purpose of this study is to determine the influence of mode of exercise on the actual intensity the participant is exercising at (expressed as a percentage of maximal HR or VO2max) when exercising at a pre-determined, constant “perceived” exercise intensity. In other words, does the mode of exercise influence how difficult a participant perceives exercise to be.

To examine this question, a two-way ANOVA with repeated measures will be used. The two factors will be mode of exercise and time with both of these being repeated measures factors. If a significant main effect or interaction is observed, the Tukey post-hoc test will be used to
examine specific pair-wise comparisons. An alpha level less than or equal to 0.05 will be established *a priori* as the threshold for statistical significance.

**Dissemination**

This project will serve as the student investigators research project for completion of the Master of Science in Exercise and Sports Medicine (Exercise Physiology Concentration). The results of the study may also be submitted to peer-reviewed journal for publication or for presentation at local, state, or national conferences.

**Risks and Cost to and Protections for Subjects**

Assessing Percent Body Fat via Skinfold Thickness: Participants may experience some slight discomfort due to the pulling of the skin and the application of the skinfold calipers. However, this discomfort, if experienced, is minor and transient.

Performing Maximal Exercise Testing: Completing maximal exercise testing may cause excessive fatigue and some discomfort to the participants. The investigator will suggest stretching exercises and hydration that will aid in muscle recovery. Secondly, there is always a risk for musculoskeletal injuries (muscle strains, pulls, cramping) during exercise. Therefore, it will be requested that the participants stretch prior to exercise to reduce the risk of injury. The student investigators will be monitoring the participant closely during the entire testing. The risks associated with intense, maximal exercise will be minimized by the inclusion of participants who only meet the level of ACSM Risk Stratification of Low Risk. The risk of a major cardiac event during exercise testing in this participant population (Low Risk) is less than 0.1 incidences per 10,000 tests (ACSM Guidelines). In addition, heart rate will be monitored continuously throughout the exercise testing in order to ensure that each participant is having a normal response to the exercise testing. Lastly, the investigators are trained in CPR techniques and emergency procedures. A spotter will be standing next to the treadmill throughout the entire test if the participant becomes dizzy or disoriented.

Performing Submaximal Exercise Testing: Completing submaximal testing will elicit the same general risks as maximal exercise testing. Therefore, the participants may undergo some fatigue and muscle discomfort and also be at risk for musculoskeletal injuries. They will be monitored at all times by the investigators and be requested to perform stretching techniques which will minimize the risk of injury.

Measurement of Heart Rate and RPE: There are no known risks associated with the measurements of these variables.

Blood Sampling: Risks associated with blood sampling can include infection, soreness, and possible hematoma. The risks associated with blood sampling will be minimized by using universal precautions. The area of blood sampling (finger) will be cleaned prior to blood sampling using an alcohol swab. All supplies utilized for the blood collection will be new, sterile and only used once. All investigators will wear lab coats and a clear pair of latex gloves throughout the testing. All blood sampling supplies will be properly disposed of in biohazard
bags and a sharps container after use. If complications arise during the blood collection, the participant will be referred to Sindecuse Health Center for further evaluation. The principal investigator has extensive experience performing blood lactate sampling, and the student investigator has been sufficiently trained to perform these procedures correctly.

Benefits of Research

There may be no direct benefit to the participant as a result of participating in the study. Participants will learn about their aerobic capacity/fitness and their percent body fat. The results of this study may benefit the scientific community by examining the influence of mode of exercise on actual exercise intensity at a given level of “perceived” intensity. The results may have future implications on designing appropriate exercise prescriptions for individuals.

Confidentiality of Data

All participants will have their confidentiality protected. At the start of the study each participant will be assigned a case number for data recordings purposes. The investigators will have a list of participant names, contact information and case numbers that will be used for contact with the participants during the study. The data and results from this study will be stored and locked in a file cabinet in the principal investigator’s office at Western Michigan University with only the investigators having access to the data. Electronic data files will be removed from the computers associated with the testing equipment and stored on the principal investigator’s office computer which is password protected. The student investigators may have electronic data files on their computers but any identifying information will be removed from these files. Data will be kept on file for a minimum of three years at which time it may be destroyed. No names, pictures, videos, or other identifying information of the participants will be used in any subsequent publication of the research data.

References


