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Monitoring different types of resistance training using session rating of perceived exertion

Favil Singh
Edith Cowan University

Edith Cowan University

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Monitoring Different Types of Resistance Training Using Session Rating of Perceived Exertion

BY

Favil Singh

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

ABSTRACT

The purpose of the study was to evaluate the effectiveness of using the session rating of perceived exertion (RPE) scale to measure physical effort during different types of resistance training exercises and to examine the validity of this scale in rating the entire resistance training sessions of different workouts and intensities. Fifteen male subjects (26.7 ± 4.3 years) performed three different types of resistance training protocols. All protocols consisted of the same five exercises (bench press, back squat, bench pull, shoulder press, and leg extension) but the intensities, rest periods, and numbers of repetitions were different. The strength protocol consisted of 3 sets of 5 repetitions per exercise at a load of 90% of 1-RM of the subject with a 3-minute rest period between sets. The hypertrophy session was performed with 3 sets of 10 repetitions per exercise at 70% of 1-RM with 1-minute of rest between sets. The power session required subjects to perform at a fast lifting speed for 5 repetitions for 3 sets per exercise at 50% of 1-RM with a 3-minute rest period. The order of the sessions was also randomised. RPE was measured using the CR-10 Borg scale following the completion of each set. Session RPE was collected 30 minutes postexercise. Within-subjects repeated measures ANOVA showed a significant difference among the mean RPE and the session RPE values of both the strength and hypertrophy protocol ($p \leq 0.05$) but mean and session RPE values for the power protocol showed no significant difference. During the familiarisation session, the session RPE was measured at 5-minute time intervals for thirty minutes after the completion of the entire workout. The data of the test collected during the familiarisation session was compared between the different time intervals. It was found that there was a significant difference ($p \leq 0.05$) between the mean RPE values at the fifth minute mark and tenth minute mark when compared to the thirty minute mark. All other session RPE values showed no significant difference. It was concluded that the session RPE method appears to be an effective and valid method in monitoring different types of resistance training and a useful tool of measuring the different intensities of different resistance training session. It was also demonstrated that the session RPE taken after 30 minutes was a better indicated of the overall resistance training workout sessions and its intensities.

DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;

(ii) contain any material previously published or written by another person except where due reference is made in the text; or

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Signature

Date 24/01/06

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Favil.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Resistance training is a well-established mode of exercise conditioning for many different populations to increase levels of physical fitness and the primary method to increase muscular strength, power, and hypertrophy (Simpson, Rozenek, Garhammer, Lacourse & Storer, 1997; Baechle & Earle, 2000; Kraemer & Ratamess, 2004). Strength refers to the ability to generate force (Simpson et al., 1997; Binkley, 2002; Fry, 2004) whereas power is the ability to create force quickly (Newton & Kraemer, 1994; Binkley, 2002) and hypertrophy refers to the increase in muscle size (Binkley, 2002; Fry, 2004). These protocols differ in the organization of the acute program variables such as intensity, number of repetitions, total work, and rest interval (Baechle & Earle, 2000; Zafeiridis, Smilios, Considine & Tokmakidis, 2003; Fry, 2004; Bird, Tarpenning & Marino, 2005). In addition, these variables place a specific physiological stress on the body and elicit distinct acute neuroendocrine and metabolic responses (Baechle & Earle, 2000; Zafeiridis et al., 2003; Goto, Ishii, Kizuka & Takamatsu, 2005). Athletic strength training typically involves the development of a general strength base which is then enhanced with sports specific strength training during later phases of training (Baechle & Earle, 2000). One problem facing strength athletes, coaches, and researchers is how to monitor the intensity of different modes and phases of resistance training. Unlike aerobic exercise, there is no universally accepted method of monitoring resistance training (McGuigan & Foster, 2004).

Strength training incorporates concentric (tension in muscles as it shortens), eccentric (tension in muscle as it lengthens) or isometric (tension in muscle when length is constant) muscle actions to generate improvements (Tan, 1999; Fry, 2004; Kraemer & Ratamess, 2004). This type of training enhances strength by increasing the neuromuscular response which intensifies the force developed leading to strength improvements (Simpson et al., 1997; Binkley, 2002; Fry, 2004; Signorile, Carmel, Lai & Roos, 2005). Strength gains are characterized by lifting heavy weights with low repetitions and moderate to long rest periods of between two and four minutes (Tan, 1999; Gearhart et al., 2002; Goto et al., 2004; Kraemer & Ratamess, 2004; Woods,

Bridge, Nelson, Risse & Pincivero, 2004; Signorile et al., 2005). Hypertrophy training utilises both complex (multi-joint) and isolation (single joint) exercises with concentric and eccentric movement patterns across a range of joint angles (Fry, 2004). Hypertrophy training manipulates intensity by adjusting workload (moderate to high) with high repetitions and back to back sets of exercises for the same muscle group with short rest periods (Baechle & Earle, 2000; Binkley, 2002; Goto et al., 2004; Kraemer & Ratamess, 2004). Power training involves generating explosive speed to produce force (Newton & Kraemer, 1994; Kraemer & Ratamess, 2004). These exercises improve the nervous system and increase coordination of muscle actions (Newton & Kraemer, 1994; Fry, 2004; Kraemer & Ratamess, 2004). Linnamo et al. (2000) demonstrated explosive movements facilitate the neuromuscular system by increasing the amount of the fast twitch motor units compared to heavy resistance exercises. This was further confirmed by Signorile and co workers (2005) who showed that high-speed low-load training targets power improvements and low-speed heavy resistance training increases strength. Power training incorporates concentric and eccentric exercises, plyometrics and weightlifting exercises (eg. Clean and Jerk) through the use of explosive exercises with low repetitions and moderate to long rest periods between sets (Newton & Kraemer, 1994; Baechle & Earle, 2000; Binkley, 2002; Signorile et al., 2005).

Ratings of perceived exertion (RPE) has been investigated as a marker of exercise intensity and has shown to correlate well with intensity of effort (Noble & Robertson, 1996; Corder, Potteiger, Nau, Figoni & Hershberger, 2000; Glass & Chvala, 2001; Anderson, Triplett-McBride, Foster, Doberstein & Brice, 2003; Day, McGuigan, Brice & Foster, 2004; McGuigan & Foster, 2004; Simao, Farinatti, Polito, Maior & Fleck, 2005). RPE is defined by the amount of intensity of discomfort or fatigue felt through a workout (Noble & Robertson, 1996; Hollander et al., 2003; Gearhart, Becque, Palm & Hutchins, 2005). The RPE scale has also been used as a tool for correlating the exercise intensity demands with overtraining of athletes (Foster, 1998; Anderson et al., 2003). The Borg 10-point category-ratio (CR-10) RPE scale was developed to evaluate nonlinear physiological responses and has become a standard method of measuring perceived exertion (Noble & Robertson, 1996; Lagally, McCaw, Young, Medema & Thomas, 2004). The CR-10 RPE scale was studied by Noble, Borg, Jacobs, Ceci and Kaiser (1983) comparing its relationship to blood, muscle lactates, and heart rate. They concluded that the scale was consistent and capable of measuring the exercise intensity in the same way as heart rate and lactate analysis. Studies have also demonstrated that

there was no difference between genders when comparing RPE during both aerobic (Robertson et al., 2000) and resistance training situations (Glass & Stanton, 2004). Several other studies have indicated the high reliability of the Borg CR-10 RPE scale in measuring the perceived exertion of an individual during resistance training (Noble & Robertson, 1996; Gearhart et al., 2001; Day et al., 2004; Lagally et al., 2004).

Session RPE is a modified version of the standard RPE scale developed by Foster et al. (1995) that is used to rate intensity of the entire workout. This RPE scale has been accepted as a reliable and valid method in quantifying aerobic exercise intensities (Foster et al., 2001) and has been used to rate the perception of effort of an individual during a resistance exercise session (Day et al., 2004; McGuigan, Egan & Foster, 2004; Sweet et al., 2004; McGuigan & Foster, 2004). Research has demonstrated the effectiveness of session RPE in monitoring the different resistance training exercise intensities (Day et al., 2004; Sweet et al., 2004; McGuigan & Foster, 2004). Studies have found a higher average rating of perceived exertion for the high intensity exercises performed with a lower number of repetitions and a lower average rating for a lower intensity exercises performed with high number of repetition (Day et al., 2004; McGuigan et al., 2004). These studies have found the RPE averaged across the workout to be comparable to the session RPE (Day et al., 2004; McGuigan et al., 2004).

1.2 SIGNIFICANCE OF THE STUDY

Studies have evaluated the effectiveness of session RPE in measuring physical effort during resistance training (Day et al., 2004; McGuigan et al., 2004; Sweet et al., 2004). Day et al. (2004) demonstrated that the session RPE method was reliable when quantifying resistance training exercises. However, it should be noted that in this study only one set per exercise was evaluated during the exercise session. McGuigan et al. (2004) investigated the validity and the reliability of monitoring multiple set resistance training exercises using session RPE. The findings from this investigation indicated that the session RPE was reliable. However, research completed thus far using RPE has not sufficiently addressed the effectiveness of its use during multiple sets of different types of resistance training.

It is known that the monitoring exercise training load and intensity during resistance training is vital for a successful periodized exercise plan to obtain optimal results (Baechle & Earle, 2000; Day et al., 2004). Before the development of a successful periodized plan with different exercise protocols can be achieved, an accurate measurement of the intensity of testing protocols is required. Different types of resistance training exercises induce different responses from the muscles and neurological system (Kraemer et al., 1993), therefore it is critical that these differences be acknowledged and measured appropriately. Thus this study examined the session RPE method for different types of resistance training programmes. This would benefit athletes and coaches by providing a reliable method in assessing and monitoring different types of resistance training workouts in their periodized plan. The session RPE method provided after each session would allow coaches to assess the intensity levels for each athlete. Furthermore, coaches can always follow up on the previous data to look for signs of fatigue or even overtraining. There is clearly a need for a valid and reliable method of monitoring the different types of resistance training exercises.

1.3 PURPOSE OF THE STUDY

The purpose of the study was to evaluate the effectiveness of using the session RPE scale to measure physical effort during different types of resistance training exercises and to examine the validity of this scale in rating the entire resistance training sessions of different workouts and intensities.

1.4 HYPOTHESES/ RESEARCH QUESTIONS

It was hypothesised that:

1. There would be no significant difference between the average rating of perceived exertion and the session RPE.
2. The session RPE values for the strength workout would be higher than the session RPE values of both the hypertrophy and power workouts.
3. The session RPE values for the power workout would be the lowest compared to the strength and hypertrophy workouts.

1.5 DEFINITIONS OF TERMS

ANOVA	Analysis of variance
RPE	Ratings of perceived exertion
1RM	One Repetition Maximum

CHAPTER TWO
REVIEW OF LITERATURE

2.1 INTRODUCTION

This section will review the current literature associated with monitoring resistance training using the session RPE scale. The session RPE is slightly different to traditional methods of RPE. Session RPE is used to measure the perceived exertion of a participant or intensity of an entire exercise session whereas RPE is the same measurement that is used after each set of an exercise. The development of the CR-10 RPE scale will be introduced followed by the discussion of the reliability and the validity of the RPE scale, reliability and validity of RPE measuring different variables, and using the RPE in different intensities of exercises. The last section of the literature review will focus on monitoring resistance training using session RPE.

2.2 THE DEVELOPMENT OF THE CR-10 RPE SCALE

The RPE scale or commonly referred to as the Borg scale was developed to study the perception of exertion during an exercise or workout in different physical exercises settings (Noble et al., 1983; Noble & Robertson, 1996; Gearhart et al., 2002; Swank et al., 2005). Perceived exertion as explained by Noble and Robertson (1996) is the act of identifying and interpreting sensations from the body during a physical activity. The Borg scale was developed from a ratio scaling method which was considered the gold standard in measuring development of perceptual reaction as a function of physical stimulation (Noble & Robertson, 1996). However, Borg recognised certain deficiency in the scale and devised a theoretical framework for assessing interindividual differences (Noble & Robertson, 1996).

This led to a development of a category scale with 21 grades (0-20) to provide data that corresponds linearly to heart rate and power output. Following experiments with this scale, results indicated that some perceptual data did not match up linearly with heart rate and therefore a new 15-graded scale (6-20) was developed (Skinner, Hustsler, Bergsteinova, Buskirk, 1973; Noble & Robertson, 1996). Borg tested the reliability and validity of this new scale and found that it can be considered a reliable

measurement and a valid assessment of perceived exertion (Noble et al., 1983). But studies done with lactate accumulation and pulmonary ventilation found this scale not appropriate (Noble & Robertson, 1996). A scale that identified fatigue associated with non-linear physiological responses was needed (Noble et al., 1983). Therefore, Borg developed the CR-10 scale to improve on the inadequacies (Noble et al., 1983; Noble & Robertson, 1996). This scale not only measured non-linear physiological variables but was simple to use. The scale was tested and found to be reliable and valid (Noble et al., 1983; Noble & Robertson, 1996).

2.3 THE RELIABILITY AND THE VALIDITY OF RPE

Several studies have confirmed the use of the RPE scale as a reliable and valid method of evaluating exercise intensity (Noble et al., 1983; Borg, Hassmen & Lagerstrom 1987; Engbretson et al., 2004). Noble et al. (1983) examined the validity and the reliability of the category-ratio (CR-10) RPE and physiological variables during cycling exercise. The CR-10 scale measures 0 as nothing at all to 10 as very, very strong (maximal). Ten male subjects were tested on a cycle ergometer until fatigue. The test started without any load and progressively increased by 50 Watts every four minutes. Heart rate and three RPE scores (leg effort, cardio respiratory effort, and leg pain) were measured after three minutes and thirty seconds of each stage. Blood lactate was obtained at the end of each stage. All ratings demonstrated an increase with exercise intensity, lactate analysis, and heart rate. This suggests that the CR-10 is consistent and capable of measuring the exercise intensity in the same way as heart rate and lactate analysis.

Later work by Borg et al. (1987) investigated the reliability and the validity of the CR-10 and the standard 6-20 RPE scale in quantifying intensity across various modes of exercises. Eight subjects performed two incremental workload tests on a cycle and arm ergometer, power output was increased every four minutes (cycling: 40, 70, 100, 150, 200 W and arm crank: 20, 35, 50, 70, 100 W). Heart rate and blood samples were recorded thirty seconds before an increase in workload. RPE ratings were collected at the same time using both scales. All measurements increased linearly during both exercises. Blood lactate levels, heart rate, and RPE readings were higher with arm ergometer exercise compared to cycle ergometer exercise. A linear relationship between both exercises was found when using the CR-10 RPE scale. It was concluded that both

sets of RPE scales could quantify intensity across different modes of steady-state exercises.

RPE has also been investigated using resistance training models. For example, Engbretson et al. (2004) studied the reliability and validity of the RPE scale when applied in the context of resistance type exercise using non-fatiguing contractions. Researchers evaluated the internal consistency and interindividual variability of RPE responses to different percentages of a one repetition maximum lift (1-RM) for four different exercises. Forty-three subjects were tested for their 1-RM, performing knee extensions, knee flexions, elbow flexions and shoulder abduction. Subjects were tested on lifts requiring 20, 40, 60 and 80% of their 1-RM and were required to provide RPE values using a Borg 15 point scale. The internal consistency of application of the Borg scale was calculated by examining the relationships between RPE and %1-RM for each individual between each exercise and all four exercises combined. By examining both the slopes of lines that describe the correlation between RPE and %1-RM and the averaged RPE response over all four %1-RM's for each of the four exercises, interindividual variability was obtained. The result indicated that the interindividual variability was similar when the same scale was used to assess aerobic exercise intensity. Thus from the results obtained, the authors concluded that the Borg scale can be consistent and valid when applied to predicting %1-RM.

The findings on the reliability and the validity of the both the RPE scales show that the scale corresponds to the different physiological variables. The first review papers indicated that the CR-10 scale was consistent and capable of measuring the exercise intensity in the same way as heart rate and lactate analysis (Noble et al., 1983). The second review paper found both sets of scales could validly quantify intensity across different modes of steady-state exercises (Borg et al., 1987) and the article by Engbretson et al. (2004) showed it to reliably and validly predict %1-RM. This leads to the next section where the RPE scale was tested in measuring different variables.

2.4 RELIABILITY AND VALIDITY OF RPE AND SESSION RPE MEASURING OTHER VARIABLES

Many studies have found the RPE scale to be reliable and valid when monitoring weight training (Pierce, Rozenek and Stone, 1993; Simao, et al., 2005), different types

of training (Foster et al., 1995; Foster, 1998), various aerobic activities (Foster, Daines, Hector, Snyder and Welsh, 1996), rest intervals (Woods et al., 2004), and gender (Robertson et al., 2000).

Pierce et al. (1993) examined the effects of a high volume weight training on lactate, heart rate, and perceived exertion. The purpose was to look at the response of the above variables after an eight-week weight-training program emphasizing large muscle-mass exercises in untrained subjects. Twenty-three males were divided into either a control or experimental group. All subjects were tested before the experimental group commenced an eight-week training program. Testing consisted of seven sets of ten repetition full squats at different intensities of each subject's 1-RM. Following the eight-week weight-training program, all subjects were retested using the original testing protocol along with each subject's new 1-RM. Results indicated that there was a significant decrement in blood lactate and heart rate levels for the experimental group compared to the control group. RPE values showed an increase proportional to the exercise intensity, with lower values for the experimental group after the eight-week weight-training program. The authors concluded that an eight-week high volume weight-training program could reduce the physiological stress associated with resistance training. Moreover, the RPE method seems to be a valid for quantitating the intensities of resistance training as it gave similar results when compared to heart rate.

A study by Foster et al. (1995) evaluated the effects of sport specific training compared to cross-training programs on running performance. The purpose was to investigate whether adding a non-sport specific muscular dissimilar activity into an exercise program would benefit sport specific running performance. Thirty well-trained individuals participated in this study, conducted over a sixteen-week period. The first eight-weeks of exercise, involving all participants, included thirty-minute baseline running for five days a week at moderate intensity. All participants were tested on two 3.2-km time trials after the eight weeks of baseline running. Subjects were then randomly assigned into one of three groups for a further eight-week of enhanced training (control, sport–specific, and cross-training groups). The control group continued training as before, the sport specific group performed the same training plus 10% more running, and the cross training group did the same training plus 3 sessions of swimming each week. Each subject was tested after completing the second eight-week training block using two 3.2-km time trials. Session RPE was used to quantify the

intensity of exercise instead of heart rate. A pilot study completed earlier showed that session RPE correlated well to %HRR (Heart Rate Reserve). The relationship of session RPE and heart rate at varying blood lactate levels was also correlated. Training load was quantified using the multiplication of the session RPE and duration. The results found that there was a 5.4-second improvement between the first and second test time trials for the control group. The sport specific group had the highest improvement at 26.4s followed by the cross-trained group at 13.2s. Training load was highest for the cross-training group. It was concluded that non-sport specific exercises do not improve sports performance to the same level as enhanced sport specific exercises. Session RPE was found to validly and reliably quantify intensity of exercise across various types of trainings.

Foster et al. (1996) monitored fifty-six athletes from various aerobic disciplines (running, cycling, and speed skating) during twelve weeks of training to evaluate the relationship between training load and athletic performance. The first six weeks included moderate baseline training and the second six weeks a self-selected higher load of training. Subjects were required to provide a session RPE value thirty minutes after each day of training. The product of session RPE and duration of exercise were calculated to derive the training load. Performance measurements taken following six and twelve weeks using unpaced time trials showed improvement. Mean session RPE for the second six weeks increased thus demonstrating an increase in training load, however the duration of exercise for training for the twelve weeks remained constant throughout the twelve weeks. Average time to complete the time trials decreased thus indicating and providing evidence that varying the training load does influence athletic performance. As the athlete increased their load during the second six weeks, their performance times on time trials also improved. The increase in load was also due to the increase in the session RPE values as the duration did not alter much between the training sessions. It was also found that the session RPE was valid and reliable for quantifying exercise intensity between varied training load periods.

Foster (1998) examined various levels of training and incidence of illness or injury associated to overtraining using twenty-five athletes for a period of six months to three-years. Athletes were instructed to record their training intensity using session RPE (recorded thirty minutes post exercise) and the duration of the session. The daily training loads (multiplication of the session RPE and session duration) were summated

to create a weekly training load. Daily mean training load and the standard deviation summated over a week provided a monotony value. The product of monotony and weekly training load was calculated as training strain. Incidence of illness or injury caused by overtraining were noted and correlated with changes in strain, monotony, and load values. A pilot study was also performed to validate the session RPE in quantifying exercise intensity. The results of the study indicated a 77, 84, and 89% of illness or injury were accounted by the spike in monotony, load, and strain respectively, thus indicating an increase in training load and session RPE. Results showed that overtraining symptoms do occur from an increase in training load and strain. Therefore, varying the intensity of exercise within a weekly training programme decreases the monotony of exercise and in turn decreases the chances of overtraining. Session RPE method was also found to be reliable and valid in quantifying intensity to monitor training sessions.

Research by Robertson et al. (2000) monitored the effect of gender on RPE for overall body exercise. Nine male and ten female subjects were compared using perceptual estimation paradigm for a treadmill (weight bearing), simulated ski (partial weight bearing), and cycling (non-weight bearing) exercises. These trials consisted of a continuous, incremental maximal/peak exercise tests. The protocol for all exercises had an increment every two minutes and subjects were encouraged to exercise until exhaustion. RPE values were obtained using a Borg CR-10 scale. RPE was compared between genders at absolute oxygen uptake (L/min), heart rate (beats/min), relative oxygen uptake ($\%VO_{2\ max/peak}$), and heart rate ($\%\ HR_{\ max/peak}$) reference criteria. Maximum/peak oxygen uptake and heart rate were also compared at the 70, 80, and 90% mark. No differences were found in RPE values between male and female groups when compared at mode specific relative oxygen uptake criteria and at both absolute and relative heart rate. However, females had a higher RPE reading at sub-maximal absolute oxygen uptake. These responses may be explained by a higher relative aerobic metabolic rate strain experienced by females. It was concluded that RPE validly quantified intensities of exercise and did not differ between gender at intensities between 70 and 90% of mode specific maximal/peak values.

Woods et al. (2004) studied the effect of rest interval length on RPE. Thirty men and women were randomly assigned to either one of three groups (1-, 2-, or 3-min rest interval length) after evaluation of each participant's 1-RM for inertial knee extension

exercise. Subjects in each group performed three sets of ten consecutive repetitions of knee extension exercise at a load equivalent to 70% of theoretical 10-RM (based on each subject's 1-RM). A 1, 2, or 3 minute rest interval was allowed between each set depending on which group was allocated the specific rest interval variables. RPE was recorded using the Borg CR-10 scale after each repetition of each set. Results from the study found a linear increment in RPE measurements as exercise progressed from each repetition of set one until set three despite rest interval lengths, indicating RPE validly measured exercise intensity. RPE values were higher following the first repetition in set three as compared to sets two and one in all groups, leading to the conclusion that an interval of three minutes rest between sets may not be sufficient for mediating muscle recovery.

Simao et al. (2005) investigated the influence of exercise order on the number of repetitions performed and perceived exertion during resistance exercises. This study examined the performance effect of 5 different type of upper-body exercise completed in two different orders. Fourteen men and four women were recruited based on having at least 6-months previous resistance training knowledge. Each subject then had to complete two training session within 48 hours. The first training session called sequence A consisted of exercises from large muscle group to small muscle group and sequence B consisted of the same exercise in the opposite exercise sequence (small muscle to large muscles). During both sessions, 3 sets were performed to concentric failure for each exercise with two-minute recovery between set and exercises. RPE was recorded immediately after completion of each sequence with emphasis on local fatigue. It was found that performing exercises at the end of both sequence produced lower repetition in the 3 sets of exercises and the third set of the last exercise of both sequence produced the lowest number of repetition. Comparison of the RPE between sequences revealed no significant difference suggesting that the exercise order is not an influence on the RPE.

From these studies, the traditional use of RPE and session RPE method were able to measure the different intensities of exercises and it was also demonstrated that RPE is sensitive to different variables such as rest interval, volume, and order of exercise. Moreover, RPE measures between males and females were found to be similar. Session RPE has also been shown to be a potential indicator of overtraining (Foster, 1998).

2.5 RPE WITH DIFFERENT INTENSITIES OF RESISTANCE TRAINING

The majority of research using RPE has been conducted using aerobic exercise, however recently studies have been completed using resistance-training models. Kraemer et al. (1993) evaluated changes in plasma β-endorphin (β-EP) concentrations in response to various heavy resistance exercise protocols while using RPE to indirectly quantify exercise intensity. Eight male subjects were required to perform six heavy resistance exercise protocols. All subjects performed all exercise protocols in a random order. Two exercise series were used and each consisted of three workouts (primary workout, a rest control, and load control). The primary workout strength series consisted of a heavy resistance of 5-RM and three minutes of rest intervals. The hypertrophy series used a lighter primary workout of 10-RM with a one minute rest interval but a higher volume of total work. The rest control workout for both series had the duration of rest intervals manipulated to one and three minutes for strength and hypertrophy respectively, with no changes in the load. During load control workouts for both workouts load changed and duration for rest interval stayed similar to the primary workout. Physiological variables were recorded pre-exercise, mid-exercise, immediately post-exercise, and at different time points (5 mins-48hours) after the exercise session. RPE was recorded using the Borg CR-10 scale along with heart rate immediately after each exercise set. The RPE and heart rate values all increased with the intensity of the exercise protocol, no other significant changes were observed. Plasma β-EP responded differently to various heavy resistance exercise protocol and RPE recorded during exercise validly and reliably quantified the intensities of the different protocols.

Suminski et al. (1997) examined perception of effort during resistance exercise using RPE for the whole body. The purpose was to observe the effect of lifting different percentages of 1-RM on RPE. Eight men completed two trials using a counter balanced design. They were tested on a single bout of resistance exercises at 70% 1-RM and the same exercises at 50% of 1-RM. Blood lactate concentrations, heart rate, and systolic BP were collected before each trial, immediately before each exercise and at thirty and sixty minute post for each trial. RPE was obtained immediately after each exercise using the Borg CR-10 scale. Analysis of the variables indicated a significant elevation in response to both bouts of exercises. The increase in exercise intensity from 50% to 70% of 1RM was associated with an increase in blood lactate and RPE. It was found that

perception of effort increases together with the increment in %1-RM lifted. It was suggested that the CR-10 RPE scale maybe a practical way to monitor resistance exercise intensity.

Glass and Chvala (2001) investigated the preferred exertion of intensity across three common modes of exercise training. Eighteen subjects participated, performing exercises on a treadmill, cycle ergometer, and a stair-stepper. The purpose of this study was to determine the influence of these exercises modes on self-selected exercise intensities. Subjects were instructed to choose a preferred level of exertion for the three submaximal tests. Each preferred intensity trial was twenty minutes in length and subjects were given the opportunity to change the intensity every five minutes. Heart rate, oxygen uptake, and RPE were recorded. All variables collected indicated a linear increase as exercise intensity increased. No significant differences were found in RPE among all 3 modes of exercises. Similar results in RPE were reported for the treadmill, cycle ergometer, and a stair-stepper respectively (12.5 ± 2.9, 12.6 ± 2.9, and 12.8 ± 2.9). It was demonstrated that when subjects were allowed to choose the exercise intensity, they chose work rates that fell within the American College of Sports Medicine guidelines for aerobic cardiorespiratory fitness, and that these intensities did not differ across the three modes of exercise.

Research by Foster et al. (2001) examined the reliability and validity of the session RPE to quantify various forms of training ranging from non-steady-state to prolonged exercise. The study was split into two parts where subjects performed steady state and interval cycle exercise or practiced basketball. Exercise bouts were quantified using both the session RPE method and an objective heart rate method. Part one of the study required twelve well-trained, recreational cyclists to perform eight cycle ergometer tests after completing a preliminary VO_{2max} test on a cycle ergometer. The VO_{2max} test involved a steady state progressive workload increasing every three minutes until exhaustion. Heart rate and blood lactates were collected and anaerobic threshold was calculated. Three out of the eight cycle ergometer tests were steady state exercises sessions performed at power outputs relative to 90% of the individual's anaerobic threshold for a duration of thirty, sixty, and ninety minutes. Five-cycle ergometer tests consisted of interval training sessions for thirty minutes with mean power outputs equivalent to the steady state exercise sessions. Heart rate was observed throughout each exercise bout with blood lactate measurements taken every ten minutes. Session

RPE measurements were obtained thirty minutes post exercise. All measurements were taken for all the cycle ergometer tests. An exercise score was calculated using session RPE multiplied by duration. These values were compared to the five heart rate zones equivalent to the percentage of each individual's heart rate maximum. Part two of the study involved fourteen basketball players. Subjects were required to perform an incremental treadmill exercise using the Astrand protocol to measure predicted VO_{2max} before monitoring of the basketball practice session. Heart rate was monitored throughout the practices and session RPE was used to measure intensity for the entire exercise bout as in part one. Time spent in the five heart rate zones was also measured. Results during the cycle exercise showed consistency between scores derived from both methods, although the absolute score was significantly higher with session RPE. Basketball practice session results were similar to the cycle exercises. Using regression analysis, cycle exercise and basketball practice sessions showed significant correlation between heart rate zone and session RPE. Heart rate, RPE, and blood lactate measures correlated validly and reliably with other studies. The authors concluded that that session RPE was a valid method at monitoring very high intensity exercise bouts rather than the heart rate zone method.

Gearhart et al. (2002) investigated the comparison of RPE to the active muscles during resistance exercises. The 15-category Borg scale was used during high-intensity and low-intensity weight lifting. Ten male and ten female subjects completed two trials of seven different exercises. During the high intensity protocol, subjects completed five repetitions using 90% of 1-RM, whereas during low intensity protocol subjects completed fifteen repetitions using 30% of 1-RM. RPE was measured after every repetition in each set for each exercise during the high intensity protocol. RPE values for the low intensity protocol were collected after every third repetition. Results indicated that the measured RPE for active muscle were greater for the high intensity protocol than for the low intensity protocol for all exercises. RPE validly quantified that performing a few repetitions using heavier weights was more difficult than lifting lighter weight with more repetitions.

From these studies, the validity of the RPE method for delineating different intensities of exercises has been demonstrated. It has been shown that heavy resistance training exercise induces a higher perceived exertion compared to lower resistance exercise (Gearhart et al., 2002; McGuigan et al., 2004). Moreover, Suminski et al.

(1997) suggested that using the RPE scale could be an easier way to monitoring resistance training compared to heart rate. Most studies have used the traditional RPE method for measurements of intensity for each exercise.

2.6 SESSION RPE MONITORING RESISTANCE TRAINING

Several studies have been conducted using session RPE during resistance training. Research by Day et al. (2004) studied the reliability of session RPE scale assessing exercise intensity during high, moderate, and low intensity resistance training. Nineteen subjects comprising of nine men and ten women performed each exercise protocol twice. Each protocol consisted of five exercises and subjects were required to perform one set at three different intensities. The high intensity protocol consisted of four to five repetitions at 90% of a subject's 1-RM, moderate intensity exercise consisted of ten repetitions at 70% of 1-RM and low intensity fifteen repetitions at 50% of 1-RM. Session RPE was taken thirty minutes post exercise and actual RPE was measured following each complete set. A significant difference was shown for session RPE measurements between protocols and a higher intensity workout produced a higher session RPE compared to a moderate or lower intensity exercise. Average RPE and session RPE were found to be a similar, demonstrating the ability of session RPE to quantify resistance training intensity.

Sweet and co workers (2004) investigated the ability of the session RPE method to quantify aerobic and resistance training. Twenty active subjects (10 males and 10 females) with some experience in both aerobic and resistance training performed three 30 min sessions of aerobic exercise and three 30 min resistance exercise sessions. Aerobic exercise was performed on a cycle ergometer at intensities of 56%, 71%, and 83% Vo_2 peak. Thirty minutes following completion of the aerobic exercise subjects were required to rate the global intensity using the session RPE method. Resistance exercises involved them performing two sets of six different exercises at 50% (15 repetitions), 70% (10 repetitions), and 90% (4 repetitions) of their 1-RM. Three different RPE measurements were recorded. After each set, each individual was required to rate their perceived exertion on intensity of that exercise using a RPE scale. Using the same scale, session RPE and RPE of only the lifting components of the session were collected thirty minutes post this workout protocol. Results indicate a relationship between relative intensity and session RPE. All three measurements of RPE

increased with the percentage of 1-RM lifted, despite the decrease in the number of repetitions and the entire workload. It was demonstrated that session RPE is a valid method for quantitating the intensities of resistance training.

McGuigan et al. (2004) studied the reliability of the session rating of perceived exertion scale in monitoring resistance exercise intensity, in addition to measuring the salivary cortisol responses. Subjects comprising of eight men and nine women performed two trials of acute resistance training. High intensity resistance exercise protocol involved six sets of ten repetitions squats at 75% of 1-RM and another six set of ten repetitions of bench presses at the same intensity with two minutes rest between sets. The low intensity protocol consisted of the same exercises however, exercises consisted of three sets ten repetitions at a load of 30%of 1-RM. Rest period were the same as the high intensity protocol. These sessions were repeated to test the reliability of the measurements and the order of exercise bouts was randomised with at least seventy-two hours between sessions. RPE measures were obtained using the Borg's CR-10 scale following each set and session RPE for the entire exercise was obtained thirty minutes after completing of the session. Results indicated a significant difference between session RPE value between intensities (high intensity 7.1 vs. low intensity 1.9) ($p<0.05$). The measurement of the intraclass correlation coefficient for the session RPE was 0.95. Authors concluded the session RPE method was a valid and reliable method to monitor and quantify resistance exercise of low and high intensity.

To date, few studies have been conducted using session RPE and resistance training. Those conducted have concluded that this measure was a valid and reliable method when used to monitor different intensities of resistance training exercises. However there remains paucity in the literature examining how session RPE relates to monitoring the different types of resistance training.

2.7 SUMMARY

It has been shown that RPE is a simple method for measuring intensities of different mode of exercises. RPE has been shown to be reliable and valid when measuring the intensity of an exercise. Many studies have demonstrated that RPE measures the different intensities of exercises in an accurate and consistent manner when compared to heart rate. It was further reported that RPE did validly quantify

resistance training. The session RPE which gives the global rating of the entire training session, has been used to quantify resistance training. It has been shown that session RPE gives a relatively accurate measurement of resistance training and recent findings did show that session RPE corresponds to the intensities of resistance training. Most of these findings have focused on session RPE concerning intensity of exercise and only looked at consistent resistance exercise protocols. Resistance training protocols can be designed with multiple sets with a large range of different exercise activities involved. There were strength, hypertrophy, and power exercises and workouts in a periodized plan and it was not known that session RPE would be able to monitor these intensities. Therefore, the present study examined the validity of using the session RPE, through the comparison of three different resistance training sessions. Furthermore, this study evaluated the effectiveness of using session RPE when monitoring different types of resistance exercise.

CHAPTER THREE
METHODOLOGY

3.1 SUBJECTS

Following approval from Edith Cowan University Human Research Ethics Committee, fifteen subjects were recruited to complete this study. Male subjects between the ages of 18-35 years were selected for the study. They were required to sign an informed consent form before the commencement of the experiment. Subjects were selected based on their resistance-training history. They had to have at least one year of resistance training experience, and also be familiar with the squat and bench press exercises, and have some experience with explosive power training. Subjects were required to answer two questions relating to injuries and medical problems, as it was important that the participants did not have any pre-existing injuries that would hinder their involvement in the study. All subjects were required to refrain from resistance training during the course of the study.

3.2 EQUIPMENT AND INSTRUMENTATION

All familiarisation and testing session were completed in the research Strength Laboratory at the Edith Cowan University. All exercises were performed with free-weights apart from the leg extension which was done using machine-weights. The flat barbell bench press, squat, lying bench row, and the shoulder press involved the use of a standard straight bar with Olympic plates. All exercising equipment was manufactured by Cybex. A CR-10 Borg RPE scale was used to measure both the RPE after each set and the session RPE (Figure 3.1).

Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	*
7	Very Hard
8	*
9	*
10	Maximal

Figure 3.1. Rating of perceived exertion (RPE) scale.

3.3 EXPERIMENTAL APPROACH TO PROBLEM

A randomized, crossover experimental design was used with each subject performing three different whole body workouts for approximately 60-minutes. A strength, power, and hypertrophy workout took place on three separate days with sessions performed at least 48-72 hours apart. Subjects were required to go through a familiarisation session. This session included an informed consent procedure, instructions on how to use the CR-10 RPE scale, demonstration of all the five different resistance training exercises and the measurement of the each individual's 1-RM max (repetition maximum). Session RPE was also recorded at five minute time intervals for thirty minutes following the 1RM testing. Each 1-RM was determined using previously described methods (Newton and Kraemer, 1994; Simpson et al., 1997). The 1RM was defined as the maximal amount of weight that the individual could lift one time without support. It was also explained that the session RPE would be measured 30 minutes following the exercise session during the measurements of the three different resistance training protocols.

3.4 EXERCISE PROTOCOL

This experiment involved approximately 4-5 days of participation by each subject. The first session involved the familiarisation session during which each

subject's one repetition maximum (1-RM) was determined on five different resistance exercises. The subject was instructed to warm up with a light resistance that allowed 5-10 repetitions. This load would be at least 50% of each subject's perceived maximum weight. After at least a three minute rest period, the subject was required to do another warm up at an estimated load that would allow a completion of 3-5 repetitions. This was done by adding 4-9 kilograms (kg) of weight for upper-body and 14-18 kg for lower body exercises. These loads were added throughout the testing for increment until otherwise instructed. Another rest period of 2 minute was provided. The new estimated near-maximum load, which allowed the subject to perform and complete 2-3 repetitions, was added. Once this set was completed, the subject was allowed to rest for a longer time of 2-4 minutes. Even though it was shown by Matuszak, Fry, Weiss, Ireland and McKnight (2003) that one minute would be sufficient to facilitate recovery in back squat and bench press, to keep the experiment consistent for all exercises the rest time following this set was set at 2-4 minutes. During these resting times, the load was increased. The subject would then attempt a 1-RM. If successful, rest was provided and load was increased for the subject to attempt a lift again. The subject was allowed a rest period while the load was increased by adding 2-4 kg for the upper body and 7-9 kg for the lower body. These processes continued increasing until a 1-RM was successfully completed. This procedure would continue until the subject was no longer able to complete the lift. The 1-RM was taken when the subject successfully lifted the maximum weight through a complete range of motion.

According to Baechle and Earle (2000), the subject's 1-RM would be measured within five testing sets. Once the 1-RM was determined, another 2-minute rest period was followed by asking the subjects to lift their maximum weight that they last successfully completed. This lift was defined as the subject's 1-RM. (Gearhart et al., 2001). This procedure for determining the 1-RM was the same for all the five different exercises. Session RPE was also recorded during the familiarisation session. Instead of recording it at the thirty minute mark, recording was started at the fifth minute mark after the completion of 1-RM workout. RPE was recorded at five minutes intervals till the thirty minute mark. This data was recorded to investigate the difference in collection times.

The results from the 1-RM for five different resistance exercises were then used to calculate the required exercise intensity bouts for the three different workouts. The

five different resistance exercises performed during all three sessions included the squat, flat barbell bench press, standing shoulder press, lying bench pull and leg extension. Each subject was required to perform the same five resistance exercises for all the three workouts. The order of the sessions was randomised. For the strength session, characterized by heavy resistance, each subject performed 5 repetitions for 3 sets per exercise at a load of 90% of their 1-RM. A 3-minute rest period between each set was used to facilitate recovery. They followed the same procedure for reps, sets, and time for recovery.

The hypertrophy session included the same resistance training exercises done at a lighter resistance. Subjects performed 10 repetitions for 3 sets per exercise at 70% of their 1-RM with a shorter rest period of 1 minute between sets. The strength and hypertrophy workouts were typical weight-training protocols used for strength development and the increase of muscular size respectively (Kraemer & Ratamess, 2004; Goto et al., 2004). The power session required each resistance exercise to be performed at a fast lifting speed for 5 repetitions for 3 sets per exercise at 50% of their 1-RM. The rest period for this workout was similar to the strength workout. During all training protocols, a six minutes rest interval was allocated between exercises. Table 3.1 below summarizes all exercises protocols. The power workout comprised of exercises done at a rapid pace to maximise muscular power (Newton & Kraemer, 1994; Kraemer & Ratamess, 2004). This workout was different from the standard strength workout because both strength and velocity would be emphasized during lifts (Kraemer & Ratamess, 2004). Before commencing the workloads, subjects performed a warm up set on each resistance exercise consisting 6 reps at <30% of the subject's 1-RM.

Table 3.1

Exercise Protocol

Exercise Protocol	Load (% of 1-RM)	Number of sets	Number of Repetitions	Rest Interval (sets)
Strength	90	3	5	3
Hypertrophy	70	3	10	1
Power	50	3	5	3

Stretching exercises for the selected muscles group were also performed prior to the workout. Body positioning including grip width used by subject were relative to their height and was standardized for each exercise for all protocol. All exercises were done with free-weights apart from the leg extension. The flat barbell bench press, squat, lying bench row, and the shoulder press involved the use of a standard straight bar with Olympic plates added for resistance. The grip was such that the thumbs were level with the exterior of the shoulders when the bar was at resting position.

3.5 RPE MEASURES

For assessing RPE during the exercise sessions, standard instructions, and anchoring procedures were explained during the familiarisation session (Noble et al., 1983; Borg et al., 1987; Day et al., 2004). Subjects were asked to rate their perceived exertion following the completion of each working set based on the CR-10 RPE scale. A series of anchoring tests was used as explain by Gearhart et al. (2001) to establish high and low perceptual anchors. Thirty minutes following each workout session, the subjects had to rate their perceived exertion based on the CR-10 RPE scale. After 30 minutes of resistance training exercise, each subject was shown the scale and had to answer the following question, "How was your workout?" (Foster et al., 2001). The subjects would verbally indicate a number. Numbers from 0 to 10 on the scale were used to rate the intensity of the entire workout session (Noble & Robertson, 1996; Woods et al., 2004). A rating of 0 was associated with the least effort and the highest rating of 10 refers to maximal effort (Noble & Robertson, 1996). This use of rating the perceived exertion of the whole session was different from the more standard approach that asks a subject to rate how difficult they perceived a particular exercise or set. Session RPE was taken 30 minutes after the end of a workout in order to avoid particularly difficult or easy elements near the end of the resistance exercise session from distorting the entire rating of the session (Foster, 1998). The aim of the session RPE was to provide a rating for perceived exertion for the overall resistance training workout sessions and to simplify the myriad of exercise intensity cues.

3.6 STATISTICAL ANALYSIS

A two-way within subjects repeated measures analysis of variance (ANOVA) was used to test for differences in RPE among the different workouts. Each subject's

five RPE values for each exercise during the respective protocol were averaged and compared to their session RPE rating. These values were tested for significant differences as part of the within-subjects repeated measures ANOVA. This test was completed to identify if significant differences exist between the session RPE rating and the accumulated RPE ratings obtained during each resistance training session. Averages of each exercise were also compared to the session RPE to identify any significant differences. The average RPE at different time intervals were compared to the session RPE at the thirty minute mark to examine any significant difference. Statistical significance was set at $p \leq 0.05$.

3.7 LIMITATIONS

A major limitation of this study was the measurement of the 1-RM of all the different resistance training exercises during the familiarisation session. The measurements of 1-RM for all exercise during one session would cause fatigue and measurements for the last two exercises may not achieve actual 1-RM results. To regulate this limitation the best possible solution was to vary the measurements between different set of muscles and also to prolong the rest periods between the different exercises. Another limitation was the rating of perceived exertion was dependent on the subjects' pain threshold and other psychological factors at the time of testing.

3.8 DELIMITATIONS

The major delimitation relates to the selection of subjects for the study. As stated above, subjects were aged between 18-35 years were selected for this study. Subjects were selected based on their resistance-training history with regards to their length of resistance-training participation. They had to have at least one year of resistance training experience, and also had to be familiar with the squat and bench press exercises. All subjects were required to refrain from resistance training during the course of the study.

CHAPTER FOUR

RESULTS

4.1 DIFFERENT TYPES OF EXERCISE PROTOCOLS

Descriptive characteristics of subjects are presented in Table 4.1. The average number of training years was 4.7. The average RPE and session RPE for all the three different types of resistance training are shown in Figure 4.1. The average RPE values for strength, hypertrophy, and power workouts were 7.9 ± 0.9 (mean ± SD), 7.5 ± 1.0, and 3.8 ± 0.9 respectively. The session RPE values for the three workouts were 5.9 ± 1.8, 6.4 ± 1.6, and 3.2 ± 1.4 respectively. A two-way within subject repeated measures ANOVA showed a significant difference among the average RPE and the session RPE values of both the strength and hypertrophy protocol ($p \leq 0.05$). There was a significant difference ($p \leq 0.05$) for both average and session RPE values between the strength and hypertrophy protocol when compared to the power protocol. No difference was found between the strength and hypertrophy protocol for both RPE values as shown in Figure 4.1.

Table 4.1

Subject Physical Characteristics (average± SD)

Subjects (n=15)	Age (years)	Height (cm)	Weight (kg)	Number of training years (1-15 years)
Males	26.7 ± 4.3	177.7 ± 8.6	82.1 ± 12.9	4.7 ± 3.9

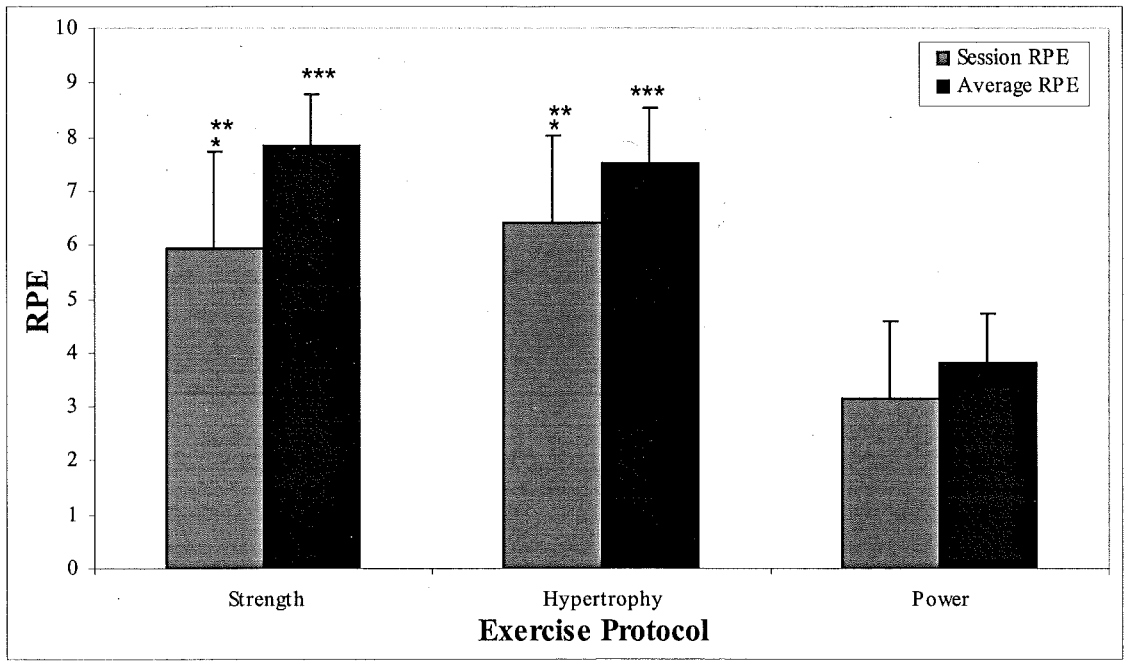

Figure 4.1. Rating of perceived exertion (RPE) values for the different types of resistance training.
* Denotes significant difference ($p \leq 0.05$) between RPE values.
** Represents significant difference ($p \leq 0.05$) between session RPE values of strength and hypertrophy to power.
*** Represents significant difference ($p \leq 0.05$) between average RPE values of strength and hypertrophy to power.

4.2 DIFFERENCES BETWEEN EXERCISES

Average RPE values for each of the five exercises for all three modes of resistance training workouts were compared to the session RPE. Both the strength and hypertrophy RPE values were higher when compared to the power RPE values as displayed in Figure 4.2. Both protocols had similar ratings for the bench pull and leg extension but the bench press and squat exercise had higher RPE ratings in the strength workout. Subjects perceived the shoulder press exercise to be higher in the hypertrophy workout. A significant difference ($p \leq 0.05$) was revealed in all average RPE values of all exercises in the strength protocol when compared to session RPE values. No difference was found in average bench press RPE values for both hypertrophy and power. Average RPE values for squat exercise showed no difference for hypertrophy but had a significant difference ($p \leq 0.05$) in the power protocol. A significant difference ($p \leq 0.05$) existed for all other exercises in the hypertrophy protocol. No significant difference was revealed in all other exercises except for leg extension exercise for the power protocol.

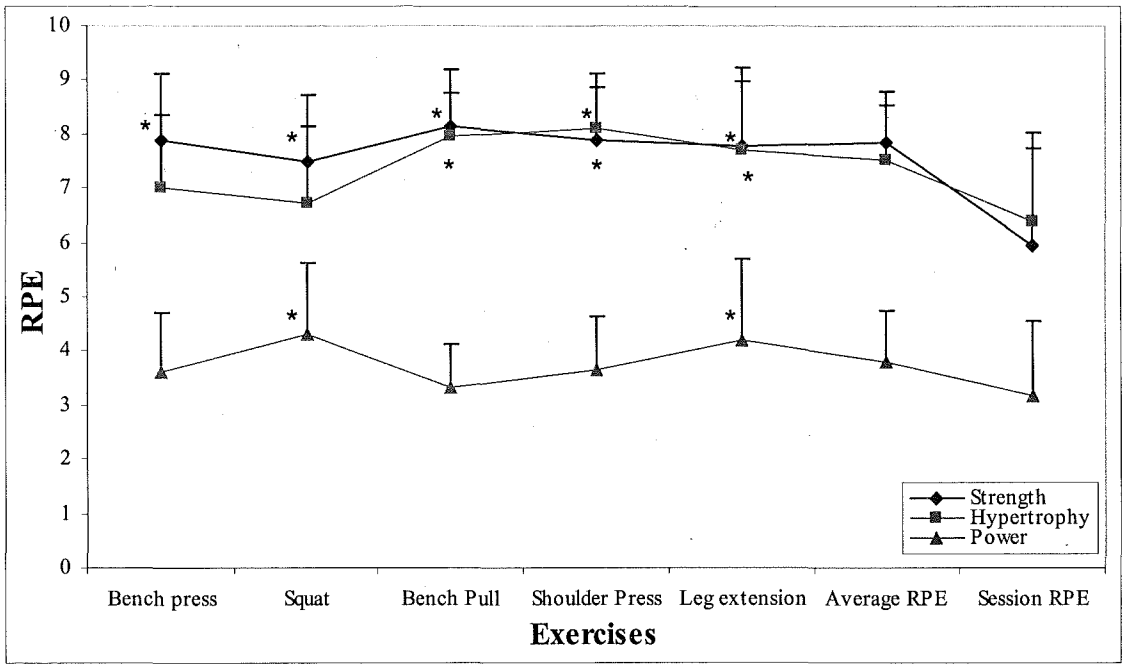

Figure 4.2. Rating of perceived exertion (RPE) values during resistance exercises for different types of resistance training.
* Denotes significant difference ($p \leq 0.05$) between average RPE values of exercises and session RPE.

4.3 DIFFERENCES OF SESSION RPE BETWEEN TIME INTERVALS

The within-subjects repeated measures ANOVA revealed a significant difference ($p \leq 0.05$) between the average session RPE values at the five minutes post and tenth minute post when compared to thirty minute post (Figure 4.3). All other session RPE values had no significant difference when compared to the thirty minute mark.

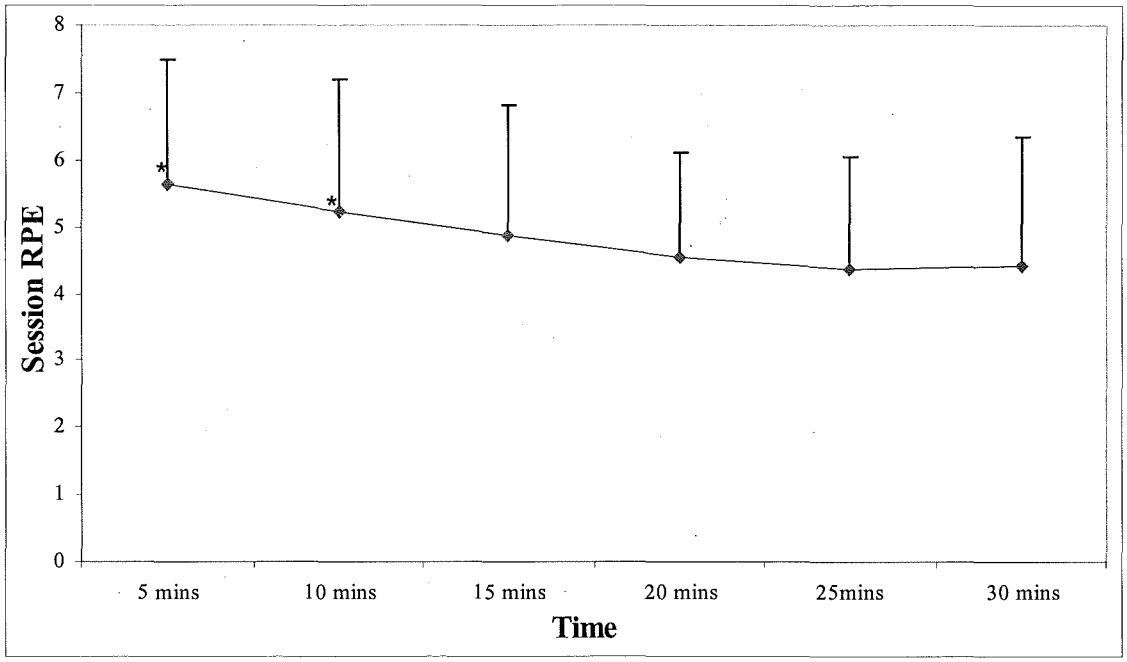

Figure 4.3. Session rating of perceived exertion (RPE) values at different time intervals.
* Denotes significant difference ($p \leq 0.05$) between average RPE values.

CHAPTER FIVE
DISCUSSION

5.1 SUMMARY OF RESULTS

RPE values for both the strength and hypertrophy protocol had significantly higher values when compared to power workout but no significant difference was found between these two protocols (Figure 4.1). Significant differences existed for the RPE values of both the strength and hypertrophy protocols but no significant difference was found in the power workout.

In Figure 4.2, average RPE values of each exercise were compared to the session RPE values. As shown in the graph, all exercises for the strength protocol had a significant difference when compared to the session RPE. Only three exercises in the hypertrophy protocol and only two exercises in the power protocol had significant differences when compared to the session RPE.

During the familiarisation, session RPE was recorded in a slightly different way. Instead of taking it at the thirty minute mark, the participants were instructed to start recording the RPE from the fifth minute mark after the end of the workout. RPE was collected at every five minute interval for thirty minutes. Results indicated a significant difference between the first two time intervals when compared to the thirty minute mark (Figure 4.3).

5.2 EFFECTIVENESS AND VALIDITY OF THE SESSION RPE

The purpose of the study was to evaluate the effectiveness of using the session RPE scale to measure physical effort during different types of resistance training exercises and to examine the validity of this scale in rating the entire resistance training sessions of different workouts and intensities. Differences were found between session RPE values of strength and hypertrophy protocol when compared to the power protocol. Both the strength and hypertrophy protocol had workouts at a higher intensity of 90% and 70% of 1-RM respectively. The power protocol workout intensity was set at 50% of 1-RM. The results are comparable to other studies using resistance training models (Day

et al., 2004; McGuigan et al., 2004). Thus this study supports other studies that have found the RPE as a valid method for monitoring resistance training (Gearhart et al., 2002; Day et al., 2004; McGuigan et al., 2004; Sweet et al., 2004). Research by Day et al. (2004) studied the reliability of session RPE scale assessing exercise intensity during high, moderate, and low intensity resistance training. The high intensity protocol consisted of four to five repetitions at 90% of a subject's 1-RM, moderate intensity exercise consisted of ten repetitions at 70% of 1-RM and low intensity fifteen repetitions at 50% of 1-RM. Average RPE and session RPE were found to be a similar, demonstrating the ability of session RPE to quantify resistance training intensity (Day et al., 2004). McGuigan et al. (2004) studied the reliability of the session rating of perceived exertion scale in monitoring resistance exercise intensity, in addition to measuring the salivary cortisol responses. Results indicated a significant difference between session RPE value between intensities (high-intensity 7.1 vs. low-intensity 1.9) ($p<0.05$). The authors concluded the session RPE method was a valid and reliable method to monitor and quantify resistance exercise of low and high intensity (McGuigan et al., 2004).

In the present study, the number of repetitions for both the strength and power protocol was set at five. The results showed that with the repetitions set to the same number, it was the intensity of a workout that influenced RPE. These results further validate the findings of Gearhart et al. (2002), in which, it was found that the measured RPE for active muscle were greater for high intensity protocol than low intensity protocol for all exercises. They also found that performing a few repetition using heavier weights was perceived to be more difficult than lifting lighter weight with more repetitions (Gearhart et al., 2002).

Several studies have found the Borg scale to be an effective method of quantifying resistance training (Suminski et al., 1997; Gearhart et al., 2002; Lagally et al., 2002; Day et al., 2004; McGuigan et al., 2004; Sweet et al., 2004; Simao et al., 2005). Suminski et al. (1997) examined perception of effort during resistance exercise using RPE for the overall body. The purpose was to observe the effect of lifting different percentages of 1-RM on RPE. Eight men were tested on a single bout of resistance exercises at 70% 1-RM and the same exercise at 50% of 1-RM. RPE was obtained immediately after each exercise using the Borg CR-10 scale. It was found that perception of effort increased together with the increment in %1-RM lifted, which

suggested that the CR-10 RPE scale maybe a practical way to monitor resistance exercise intensity (Suminski et al., 1997). Lagally et al. (2002) monitored RPE during resistance training in women by having subjects perform 3 sets of the bicep curls exercise. Each performed one set of exercise at 30%, 60%, and 90% of their 1-RM with 12, 6, and 4 repetitions so that the total work would be held constant. RPE-AM and overall RPE was collected after each set. This study also found similar increases in both RPE values when compared to exercise intensity. Sweet and co workers (2004) investigated the ability of the session RPE method to quantify aerobic and resistance training. The results of the present study further support these finding in that higher intensity training such as the strength and hypertrophy protocols are perceived to be more difficult than lower intensity training like power workouts.

5.3 SESSION RPE AND DIFFERENT EXERCISE PROTOCOLS

The present study did not keep the external exercise work performed consistent between the workouts. Variation was allowed in the amount of work performed for all the different training protocols. The hypertrophy protocol, where participants performed 10 repetitions at 70% of their 1-RM, had the most total work performed followed by the strength protocol performed at 90% of 1-RM with 5 repetitions and the power protocol performed with 5 repetitions at 50% of 1-RM had the least work performed. The lowest intensity protocol (i.e. power protocol) produced the lowest RPE values but the other two protocols had similar ratings for the both values of RPE as no significant difference was found. As indicated in the findings, there was no difference between the strength and hypertrophy protocols even though the hypertrophy protocol had a higher total work. This also indicates that intensity of training does influence RPE when one considers that the strength protocol had a higher intensity level and it was completed with lower repetition when compared to the hypertrophy protocol. Many studies have found that greater tension development, which requires an increase in motor unit recruitment and firing frequency, will be required for a muscle force to overcome a heavy load (Noble & Robertson, 1996; Gearhart et al., 2001; Kraemer & Ratamess, 2004). As explained by Gearhart et al. (2002), to achieve greater motor unit recruitment, the motor cortex sends stronger signals to the sensory cortex thus giving rise to an increase in perception of effort. It is been agreed by various studies that these corollary signals could be the main cause of the variation in RPE of altering intensities (Noble &

Robertson, 1996; Suminski et al., 1997; Gearhart et al., 2002; Lagally et al., 2002; Day et al., 2004; Lagally et al., 2004).

5.4 AVERAGE AND SESSION RPE

It was hypothesised that there would be no significant difference between the average rating of perceived exertion and the session RPE. The findings in this study showed a difference between the two RPE values of both the strength and hypertrophy protocol but no difference was found for the power protocol. This study differed from similar studies in certain aspects. Day et al. (2004) and McGuigan et al. (2004) both found no difference between the average and session RPE values. Both studies concluded that the session RPE was a reliable and valid method for quantifying resistance training intensity. Both studies concluded that the session RPE measurements which were provided 30 minutes after an entire workout were precise at measuring intensity as the sum of actual RPE measurements, taken after each set of each exercise. During this present study, it was found that only the RPE values of the power protocol had similar results with the above mentioned articles, but results were different for the other two protocols. Despite the large amount of knowledge and use of the RPE scale during various modes of exercise, the session RPE method is still a relatively new instrument. The accuracy of the session RPE values to correspond with the average RPE given throughout the training session for the power protocol found in this study supports this method as valid in quantifying the entire bouts of a resistance training intensity. The session RPE values were consistently lower than the average RPE values for the strength and hypertrophy workouts. Another study by Sweet et al. (2004) investigated the ability of the session RPE method to quantify aerobic and resistance training. They found that the RPE of lifting only was comparable to average RPE but there was a difference in between the average and session RPE values. These findings were comparable to the present results in that, there was a difference between the two RPE values for strength and hypertrophy protocols.

Several factors could have influenced these differences. In the present study, RPE values were taken at each of the 3 sets (per exercise) as compared to only 2 sets in McGuigan et al. (2004) study and 1 set in Day et al. (2004) study. As explained by Sweet at el. (2004), the second set of exercise was often perceived to be more difficult than the first set. Subsequently, the third set would be more difficult than the second set

attributing to a higher perceived exertion. A study by Woods et al. (2004) found similar results despite manipulating the rest intervals between the sets. Statistical analysis showed a significant increase in the RPE measurements given between all three sets of each exercise. Measuring RPE for the third set did increase the average RPE for any given resistance training intensity. A study done by Rhea, Alvar, Ball and Burkett (2002) comparing the number of sets of equal intensity for eliciting strengths found that three sets of weight training were superior to one set. It was concluded that because multiple sets elicit greater strength gains, weight training with multiple sets put a greater stress on the neuromuscular system. The increase in stress in the neuromuscular system would in-turn increase the perception of effort.

The type of subjects used could also affect the results. Compared to Day et al. (2004) which seemed to contain pure strength-training individual with only six months experience, this study had a subject criteria where they were required to have at least one year of resistance training experience. Subjects in the current study might have perceived both the strength and hypertrophy protocol to be more difficult during the workout itself. However due to the fact that these subjects have been training longer, their recovery from these workouts may have been faster, thus leading to lower session RPE values. Due to the adaptation of their body from overloading over the months of consistent training (Kraemer & Ratamess, 2004), their recovery from the intense loading of the two protocol may have been faster when compared to the subjects in the Day et al. (2004) study.

The same subjects performed all three protocols but as explained above no difference was found for the power protocol. This protocol was completed with a lower intensity and volume but exercises were performed explosively. Linnamo et al. (2000) indicated in his study that these exercises seem to facilitate the function of the neuromuscular system rather than produce fatigue. Subject perceived this protocol to be the easiest among all protocols. The fact that subjects had a significant amount of weight training experience and with this protocol being relatively light, subjects rated both ratings very similarly as indicated by our results. Linnamo and colleagues (2000) noted that a power protocol does produce lesser fatigue compared to a pure strength protocol. Since this protocol does not produce as much fatigue as the other two higher intensity protocols, this may have influenced the subjects to have a lower perception of both values of RPE.

5.5 SESSION RPE OF STRENGTH AND HYPERTROPHY SESSIONS

Even though there was no significant difference between the session RPE values of strength and hypertrophy protocol, the strength protocol session RPE values had a slightly lower value of 5.9 ± 1.8 than the hypertrophy protocol which had a value of 6.4 ± 1.6. As mentioned previously, the hypertrophy protocol had the highest total work done of the all the protocols. The amount of work done could have attributed to this slightly higher session RPE value. Moreover, subjects that volunteered for this experiment were more prone to exercising with high-intensity, low repetition training similar to the strength protocol. Therefore when performing a moderate-intensity high-repetition or a hypertrophy protocol, the total workload combined with a very short rest period of 1-minute between sets, may have induced more fatigue thus leading to a slightly higher session RPE value.

5.6 AVERAGE RPE DURING EACH EXERCISE AND SESSION RPE

The RPE measurements taken after each exercise varied widely depending on the type of resistance exercise performed during the different protocol. These results were similar to previous findings by Day et al. (2004), McGuigan et al. (2004), and Sweet et al. (2004). All resistance training exercises were perceived to be more difficult than the session RPE across all protocols but not all exercises for all three protocols had significant differences. Many factors could have influenced differences in RPE measurements such as motor unit recruitment, muscle groups, order of exercises, and energy expenditure. Resistance training exercises like squats and bench press use larger muscle groups than shoulder press and bench pulls. These large muscle groups require a large number of motor units to be recruited (Baechle & Earle, 2000; Fry, 2004; Kraemer & Ratamess, 2004). Larger muscles have higher energy expenditure and metabolic needs, thus making the perception of effort more evident (Sweet et al., 2004). Exercises that use a range of motion through multiple-joints may increase RPE. Single-joint large muscle exercises like leg extensions (Kraemer & Ratamess, 2004) can also increase RPE as shown in Figure 4.2. This could be due to the large amount of lactic acid that builds up in the muscle (Baechle & Earle, 2000) and influences the perception of effort

(Lagally et al., 2004). The order of exercise could also alter the RPE. If the squat exercise was performed first as compared to last in a training session, the RPE value may have been lower. Fatigue of the muscles would increase closer to the end of a training session than at the start (Bird et al 2005; Simao et al., 2005). As mentioned by Tan (1999), and Kraemer and Ratamess (2004) these multiple-joint large muscles exercises are recommended to be performed early in the workout. In this study, the workouts were split between upper body and lower body exercises with the multiple-joint larger muscle group exercises performed first. The ratio between pressing and pulling of strength of agonist and antagonist muscles can also influence RPE. A study done by Baker and Newton (2004) found that differences in strength ratio between pressing and pulling exist up to 15% in some individuals. These differences as explained by Baker and Newton (2004) could be due to body types, pre-existing injuries, or training history that predisposes some athletes to either excel or perform poorly during strength activities. Subjects that only work on their agonist muscles like bench press may rate them lower during testing when compared to doing antagonistic work like bench pulls. RPE can also be influenced by different fibre types. Muscles with more fast-twitch fibres can produce strong and fast contractions using the anaerobic system and are better equip to perform quick high-intensity movements (Baechle & Earle, 2000; Bird et al., 2005). These muscles allow individuals to lift heavy resistances at lower repetitions with a lower perception of effort compared to slow-twitch fibres. But when performing lower intensity higher repetition resistance training, RPE may be higher because these fast-twitch muscles do not make good use of the aerobic system. Lower RPE values may also be a result of muscles using slow-twitch fibres when using low intensity, high repetition protocols. Even though both these fibres are genetically determined, depending on the level of aerobic and anaerobic fitness of an individual, can take on certain qualities or make better use of the different systems (Sweet et al., 2004).

5.7 SESSION RPE AT DIFFERENT TIME INTERVALS

In this study, session RPE was measured at five minute time intervals for thirty minutes during the familiarisation session. As explained previously, RPE was collected from the fifth minute point after the end of the workout. RPE was collected at every five minute interval for thirty minutes. Results indicated a significant difference between the first two time intervals when compared to the thirty minute mark. These results further

confirm the suggestion of Foster (1998), that session RPE should be taken 30 minutes after the end of a workout so as to avoid particularly difficult or easy elements near the end of the resistance exercise session from distorting the entire rating of the session. The aim of the session RPE was to provide a rating of perceived effort for the overall resistance training workout sessions and to simplify the myriad of exercise intensity cues. Many factors could have influenced variations in the RPE measurements such as motor unit recruitment, energy expenditure, recovery, and the type of resistance training exercise performed i.e. large muscle group versus small muscle group (Gearhart et al., 2002; McGuigan et al., 2004).

Based on the data, the session RPE method appears to be an effective method in monitoring intensities agreeing with previous studies by Gearhart et al. (2002), Day et al. (2004), McGuigan et al. (2004), and Sweet et al. (2004). The session RPE values were found to be consistent as intensities increase as with the different protocols. The session RPE values only consistently matched the average RPE values for the power protocol but not for the strength and hypertrophy protocols. Unfortunately due to time constraints, the reliability of these protocols could not be completed. Future research needs to be completed investigating the reliability of session RPE in monitoring these different protocols, which could be done with a second trial of the same procedure. Furthermore, the experimental protocol done during the familiarisation session did not measure a resistance training session but a resistance training strength testing protocol. The measurements for the RPE for each subject were recorded only after the completion of each exercise.

5.8 CONCLUSION

In conclusion, it appears that the session RPE method appears to be an effective method in monitoring intensities. The results of this study have also shown that the session RPE is a useful tool of measuring the different intensities of different resistance training sessions. The RPE values clearly indicated the different intensities of the different resistance training protocol. As it was hypothesised the power protocol had the lowest session RPE values but the hypertrophy session had a slightly higher session RPE value than the strength protocol contradicting the second hypothesis. It was also found in this study that the session RPE values did not correspond with the average RPE values for strength and hypertrophy protocol but both RPE values did correspond for the

power protocol. Furthermore, there was a significant difference between the session RPE values at difference time intervals and session RPE values at thirty minutes mark. Overall, the session RPE scale was shown to be effective in measuring physical effort during different types of resistance training exercises and valid in rating the entire resistance training sessions of different workouts and intensities. Many studies done agree with the present findings that the session RPE technique is an easy to use and reliable method. Moreover, it was consistent with physiological indices of intensities of exercise training

5.9 PRACTICAL APPLICATION

To obtain optimal results from a successful periodized exercise plan, the monitoring of exercise training load and intensity during resistance training is vital (Baechle & Earle, 2000; Day et al., 2004). Before designing and completing a successful periodized plan with different exercise protocols, an accurate measurement of the intensity of testing protocols would be required. Thus, the results of this study have shown the session RPE method to be an easy and accurate method for monitoring resistance training. This method will further benefit athletes and coaches in assessing and monitoring resistance training. The session RPE method provided after each testing session would allow coaches to assess the intensity levels which correspond to the level of the testing program. Coaches would also be able to compare the previous session RPE values and analyse if there were increases or decreases in intensity. They can also follow up on previous data to look for signs of fatigue or even overtraining. Having collected session RPE value once after 30 minutes would be easier than having multiple measures of RPE throughout the workout and rest period. Coaches would also be able to use session RPE method to evaluate the intensities of resistance training testing protocols.

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APPENDICES

Appendix A

Information Letter to Participants

INFORMATION LETTER TO PARTICIPANTS

Research Project: Monitoring Different Types of Resistance Training Using Session Rating of Perceived Exertion.

Chief Investigators: Favil Singh and Dr Mike McGuigan
19.160 Joondalup Campus
Tel: (08) 63042118
Email: favil79@yahoo.com.sg or
m.mcguigan@ecu.edu.au

Thank you for expressing interest in this research project. The reason for providing you with the following information is to fully inform you of the purpose and the nature of this study.

You are invited to participate in a research project that will evaluate the effectiveness of using the session RPE scale to measure physical effort and the validity of this scale in rating the entire resistance training session of different workout types and intensities.

If you agree to participate in the study, you will be asked to report to the gymnasium in Room 19.133, Joondalup campus on four separate occasions. The initial gymnasium visit will be used to familiarise you with 1) the testing and exercise apparatus, 2) the testing and exercise procedures that will be employed in the study, 3) the measurement of the one repetition maximum (1- RM) for each of the 5 different exercises, and 4) measurement of session RPE at five minute intervals for thirty minutes after the completion of the entire workout. The 1-RM is defined as the most amount of weight you can lift maximally in one lift. The actual exercises and testing for the main component of the study will be conducted over three separate sessions with each session performed at least 48-72 hours apart. Measurements will be taken during and after 30 minutes of the entire resistance training exercise session. Each session will take approximately 60-minutes. You will be required to perform three different resistance training workout sessions: A strength, hypertrophy and power exercise workout sessions. You will perform 5 different exercises (Bench press, squat, shoulder press, bench row and leg extension). The exercises and measurements will take place at the rehabilitation gymnasium located at Joondalup campus.

The principle outcome measures will be RPE measured after every set of every exercise and session RPE which will be measure at the end of the workout session. These measurements will be done using a Borg scale of ratings from 0-10. A rating of 0 is associated with the least effort and the highest rating of 10 refers to maximal effort. For the session rating of perceived exertion (RPE) you will be asked to rate how hard the entire exercise session will be.

You will be required to perform five basic exercises for three different resistance training workout session. For strength workout session, you will be required to perform 5 repetitions for 3 sets per exercise at a load of 90% of your 1-RM with a 3 minute rest period between each set. The hypertrophy session will require you to perform 10 repetitions for 3 sets per exercise at 70% of your 1-RM with a shorter rest period of 1 minute between sets. The power session requires each resistance exercise to be

performed at a fast lifting speed for 5 repetitions for 3 sets per exercise at 50% of your 1-RM with a 3 minute rest period between sets. For all training protocols, a six minute rest interval is allocated between exercises.

All information collected in this study will be confidential. Only the primary investigator will have access to any information collected and all written documents will be coded so that individual identification of your data will not be possible for anyone else.

The risks associated with this study are minimal. You may experience some fatigue and tiredness during the workout sessions. Some muscle soreness may develop. However, careful consideration will be taken to ensure that this does not take place. Adequate recovery time will be provided between sets, exercises and different workout sessions. Moreover, warm up stretching will be implemented to facilitate addition recovery and further reduce the chances of muscle soreness. However there are no other associated risks as the exercise and recovery sessions will be closely supervised by qualified staff and you will be continuously monitored throughout.

Benefits of this procedure include obtaining information about your maximum lifting capacity for all 5 different exercises and it will provide assistance with the present research study. You should be assured that results that may be presented at conferences or in scientific publications will not include any information that may identify individual participants.

Participation is voluntary and no explanation or justification is needed if you choose not to participate. You are also free to withdraw your consent to further involvement in the research project at any time. If you are interested in participating in the study you will need to complete an informed consent and return it to the principal investigator.

This research project has been approved by the Human Research Ethics Committee of Edith Cowan University.

If you have any questions or require any further information about the research project, please contact Favil Singh at 0416536143, email favil79@yahoo.com.sg or Dr Mike McGuigan at (08) 6304 2118, email m.mcguigan@ecu.edu.au.

If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Human Research Ethics Officer
Edith Cowan University
100 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170
Email: research.ethics@ecu.edu.au

Appendix B

Familiarisation Session RPE and 1-RM Measurement Form

Familiarisation Session
RPE and 1-RM Measurements

Name:_____
Age: _____
Height: _____ (cm)
Weight: _____ (kg)
Sex: _____
Number of months of training experience: _____

Do you have any injuries? (Please list)

_____
_____
_____

Do you have any medical problems? (Please list)

_____
_____
_____
_____

Measurements of One Repetition Maximum and RPE

Exercise	10 reps		5 reps		3 reps		1 rep		1 rep		1 rep		1 rep	
Bench Press														
Squat														
Bench Pull														
Shoulder Press														
Leg Extensions														

Measurement of Session RPE

5 min	
10 min	
15 min	
20 min	
25 min	
30 min	

Appendix C

Informed Consent Form

INFORMED CONSENT

For the study:
Monitoring Different Types of Resistance Training Using Session Rating of Perceived Exertion

Purpose of the study

The purpose of this study is to evaluate the effectiveness of using the session RPE scale to measure physical effort and the validity of this scale in rating the entire resistance training session using different types of workouts and intensities.

Exercise and Measurements

If you agree to participate in the study, you will be asked to report to the gymnasium in 19.133 (Joondalup Campus) on four separate occasions. The initial gymnasium visit will be used to familiarise you with 1) the testing and exercise apparatus, 2) the testing and exercise procedures that will be employed in the study, 3) the measurement of the one repetition maximum (1- RM) for each of the 5 different exercises, and 4) measurement of session RPE at every five minute interval for thirty minutes after the completion of the entire workout. The 1-RM is defined as the most amount of weight you can carry maximally in one lift. The actual exercises and testing for the main component of the study will be conducted over three separate sessions with each session performed at least 48-72 hours apart. Measurements will be taken during and after 30 minutes of the entire resistance training exercise session. Each session will take approximately 60-minutes. You will be required to perform three different resistance training workout sessions: A strength, hypertrophy and power exercise workout sessions. You will perform 5 different exercises (Bench press, squat, shoulder press, bench row and leg extension). The exercises and measurements will take place at the rehabilitation gymnasium located at Joondalup campus. The principle outcome measures will be RPE measured after every set of every exercise and session RPE which will be measure at the end of the workout session. These measurements will be done using a Borg scale of rating from 0-10. A rating of 0 is associated with the least effort and the highest rating of 10 refers to maximal effort

Exercise: You will be required to perform five basic exercises for three different resistance training workout session. For strength workout session, you will be required to perform 5 repetitions for 3 sets per exercise at a load of 90% of your 1-RM with a 3 minute rest period between each set. The hypertrophy session will require you to perform 10 repetitions for 3 sets per exercise at 70% of your 1-RM with a shorter rest period of 1 minute between sets. The power session requires each resistance exercise to be performed at a fast lifting speed for 5 repetitions for 3 sets per exercise at 50% of your 1-RM with a 3 minute rest period between sets. For all training protocol, a six minute rest interval is allocated between exercises.

Measurements: The following measurements will be taken:

Perceived Exertion

Ratings of perceived exertion will be acquired at every set of very exercise for all the three different workouts.

Session Rating of Perceived Exertion

The session RPE will be recorded after the entire session of all the three different resistance workouts.

Risk and Ethical considerations

You may experience some fatigue and tiredness during the workout sessions. Some muscle soreness may develop. However, careful consideration will be taken to ensure that this does not take place. Adequate recovery time will be provided between sets, exercises and different workout sessions. Moreover, warm up stretching will be implemented to facilitate addition recovery and further reduce the chances of muscle soreness. However there are no other associated risks as the exercise and recovery sessions will be closely supervised by qualified staff and you will be continuously monitored throughout.

No direct comparisons between different individuals participating in the study will be made at any stage of the testing. Analysis of data will be made on a group basis with means and variance between selected groups being compared. You are therefore not in competition with any other individuals in the study and will in no way be made to feel that your results are inadequate or incorrect.

All personal information and test results recorded will remain confidential and will not be used for any purpose other than the current study. Moreover, no data analysis will include your name or information that may identify you specifically as a subject.

You will be free to withdraw from this study at any stage and for any reason without prejudice. Your involvement is voluntary. You should not feel like you have been pressured or forced to participate. It is also important that you feel that all of your questions or concerns have been adequately addressed. Once you feel like you are fully informed about the methods and potential risks and discomforts associated with this study you will then be given the opportunity to sign an informed consent form.

Requirements

As the study involves an exercise protocol, it is required that you be healthy at the time of testing. It is important you do not have any pre-existing injuries that would hinder your involvement.

If you have any questions or require any further information about the research project, please contact: Favil Singh at 0416536143 or email favil79@yahoo.com.sg or Dr. Mike McGuigan at (08) 6304 2118. If you have any concerns or complaints about the research project and wish to talk to an independent person, you may contact:

Research Ethics Officer
Human Research Ethics Officer
Edith Cowan University
100 Joondalup Drive
JOONDALUP WA 6027
Phone: (08) 6304 2170 Email: research.ethics@ecu.edu.au

Declaration

I have been informed of the procedures involved in this study. I have been fully informed of the nature of the tests and potential risks involved, of which I assume voluntarily. I have been informed that I may withdraw my participation at any time and for any reason without penalty. Benefits of this procedure include obtaining information about my maximum lift in one repetition for 5 different exercises and it will provide assistance with the present research study.

Any information that is obtained in connection with this study and that can be identified with me will remain confidential and will be disclosed only with my permission. I have been informed that the results of this study may be published in scientific literature or presented at professional meetings using grouped data only.

I _____ have read all of the information contained on this sheet and have had all questions relating to the study answered to my satisfaction.

I agree to participate in this study realising that I am free to withdraw at any time, for any reason without prejudice.

I agree that the research data obtained from this study may be published, provided I am not identifiable in any way.

Participant: _____ Date: _____

Investigator: _____ Date: _____

Appendix D

Rating of Perceived Exertion Measurement Form

RPE Measurement Form

Name: _____

RPE Measurement session for Strength protocol; DATE: _____
(3 sets of 5 reps, load of 90%, rest bet sets: 3min, rest bet exercises: 6 min)

Exercise	Weight (kg)	Set 1	Set 2	Set 3
Bench Press				
Squat				
Bench Pull				
Shoulder Press				
Leg Extensions				

Session RPE after 30 minutes: _____

RPE Measurement session for Hypertrophy protocol; DATE: _____
(3 sets of 10 reps, load of 70%, rest bet sets: 1min, rest bet exercises: 6 min)

Exercise	Weight (kg)	Set 1	Set 2	Set 3
Bench Press				
Squat				
Bench Pull				
Shoulder Press				
Leg Extensions				

Session RPE after 30 minutes: _____

RPE Measurement session for Power protocol; DATE: _____
(3 sets of 5 reps, load of 50%, rest bet sets: 3min, rest bet exercises: 6 min)

Exercise	Weight (kg)	Set 1	Set 2	Set 3
Bench Press				
Squat				
Bench Pull				
Shoulder Press				
Leg Extensions				

Session RPE after 30 minutes: _____

Appendix E

Rating of Perceived Exertion Flyer

SUBJECTS REQUIRED

Research Project: Monitoring Different Types of Resistance Training Using Session Rating of Perceived Exertion

You are invited to participate in a research project that will investigate the perceived exertion of a subject on three different types of resistance training.

Requirements: Between the age of 18-35 years. Have at least one years of resistance training knowledge and be familiar with the technique involved with the squat and bench press exercise

If you participate in the study, we will test your one repetition maximum on five different resistance training exercises

Will be required to participate on four separate occasions

For more information contact

Favil Singh

Telephone 0416536143

Email favil79@yahoo.com.sg