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Ryan T. Mitchell

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DETERMINING THE IMPACT OF ANTHROPOMETRIC FACTORS ON ROCK CLIMBING PERFORMANCE

A Masters Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Health Promotion and Wellness Management

By

Ryan T. Mitchell

July 2016

DETERMINING THE IMPACT OF ANTHROPOMETRIC FACTORS ON ROCK CLIMBING PERFORMANCE

Kinesiology

Missouri State University, July 2016

Master of Science

Ryan T. Mitchell

ABSTRACT

The purpose of this study was to determine whether anthropometric factors have an effect on overall performance in rock climbing between three different difficulties of rock walls. Fourteen, recreational rock climbers participated in this study (Age- 21.93+/-2.62y, Height- 176.8+/-11.1cm, Weight- 73.4+/-18.7kgs, % Fat- 21.02 +/- 6.41, BMI- 23.36+/-4.59). The anthropometric tests included: push-ups, sit-ups, pull-ups, vertical jump, and sit and reach. Immediately following these tests, the participants climbed the three different rock walls for approximately 10 minutes. The data collected is represented through the average number of climbs, distance traveled, and an RPE scale, to determine overall performance. A stepwise regression test showed some anthropometric variables were significant predictor on climbing success. However, the specific anthropometric variables differed based on the level of difficulty of the wall.

KEYWORDS: anthropometric factors, auto-belay, body composition, perceived exertion, performance, recreational rock climber, rock climbing, strength to weight ratio

This abstract is approved as to form and content

____
Scott R. Richmond, PhD
Chairperson, Advisory Committee
Missouri State University

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Approved:

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CHAPTER 1: INTRODUCTION

Overview

There are numerous ways individuals can be active and engage in physical activity. The American College of Sports Medicine (ACSM) states that a program of regular exercise should include: cardiorespiratory, resistance, flexibility, and neuromotor exercise training *beyond* activities of daily living to improve and maintain physical fitness and health (n. pag.). With this being said, the ACSM recommends that most adults engage in moderate-intensity cardiorespiratory exercise training for at least 30 minutes a day on at least 5 days per week for a total of at least 150 minutes per week, vigorous-intensity cardiorespiratory exercise training for at least 20 minutes a day on at least 3 days per week, or a combination of moderate- and vigorous-intensity exercise to achieve a total energy expenditure of at least 500-1000 MET minutes per week (Garber, n. pag.). However, most individuals fail to meet these recommendations and tend to live a more sedentary lifestyle.

According to the Centers for Disease Control and Prevention (CDC), about one in five (21%) of all adults meet the 2008 Physical Activity Guidelines through ACSM (n. pag.). These inactive adults have a higher risk for early death, heart disease, stroke, type 2 diabetes, depression, and some cancers (CDC, n. pag.). The World Health Organization (WHO) reports physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally (n. pag.).
With these numbers being so drastic, it is important for individuals to engage in physical activity. The question then becomes, how can individuals meet ACSMs

recommendations, while also enjoying activities not considered “traditional exercise” but still demanding of miscellaneous strength, endurance, and caloric cost? Different field tests have been performed, such as cycling, rowing, and different forms of High Intensity Interval Training (HIIT) to show that these activities can meet ACSMs recommendations. Athletes pursue jumping higher, running faster, and becoming more explosive increases their overall performance. When thinking about this, strength-to-weight ratio becomes a potential factor. This means how much force one can exert during an exercise divided by your body weight; thus, the heavier a person is, the stronger they need to be in order to increase their overall performance. Certain body weight sports, such as rock climbing, may require one to increase their strength without gaining body weight. We can look at strength to weight ratios to see if this holds true and if a higher ratio can in fact increase ones performance.

Rock climbing has increased its popularity throughout the past decade and seems to peak people’s interest (Rodio et al., 224-228). Rock climbing is both an adventurous and peaceful activity that is suitable for all ages. Rock climbing has been shown to help increase both cardiovascular and muscular endurance; however, no standards have been made for strength to weight ratios in regards to rock climbing performance. Since rock climbing is gaining popularity, is there a relationship between traditional fitness tests/variables and climbing performance?

Procedural Elements of the Study

The purpose of this study is to determine if a relationship exist among anthropometric factors and rock climbing performance in adult, recreational rock climbers. The hypotheses are as followed: 1) we predict that as a person's anthropometric factors decreases, rock climbing performance will increase (Directional); 2) we predict that increased anthropometric factors and rock climbing performance are related (Non-directional); and 3) there is no significant relationship between anthropometric factors and performance while rock climbing (Null). The limitations of this study could include a number of reasons such as: facility availability, participants recruited may not accurately represent the desired study population or experience, participants have control over their physical performance, and time commitment allowed for participants. The delimitations of the study include sample population, years of experience, duration of testing, height and difficulty of rock wall, and strength variables chosen. The assumptions of this study are that all individuals give their best effort throughout the entire study and participants accurately state their Rating of Perceived Exertion (RPE).

Definitions

Anthropometric Factors- measurement of the human individual.

Auto-belay- an automatic belay device that eliminates the need for a human be-layer.

Body Composition- difference between fatty and muscular mass in the body.

Body Mass Index (BMI)- a person's weight in kilograms (kg) divided by their height in meters (m) squared (kg/m^2).

Exercise- organized activity requiring physical effort, carried out especially to sustain or improve health and fitness.

Hand Dynamometer- an instrument for measuring the force of muscular contraction especially of the hand.

High Intensity Interval Training (HIIT)- system of organizing cardiorespiratory training which calls for repeated bouts of short duration, high-intensity exercise intervals intermingled with periods of lower intensity intervals of active recovery.

Recreational Rock Climber- an individual who typically rock climbs on a monthly basis.

Perceived exertion- how hard you feel like your body is working. Determined through RPE scale.

Performance- the action of performing a task in terms of how successful it was completed.

Physical activity- any bodily movement produced by skeletal muscles that requires energy expenditure.

Rock Climbing- the sport or pastime of climbing rock faces, especially with the aid of ropes and special equipment.

Rating of perceived exertion (RPE)- scale ranged from 6-20 measuring physical activity intensity level.

Strength to Weight Ratio- the maximal force you can exert during a particular exercise divided by your body weight.

Significance of the Study

Although minimal research has been done trying to determine if anthropometric factors have an effect on performance while rock climbing, this present study further examines different strength variables and performance while rock climbing, along with its perceived exertion. This present study also looks at the challenges of added difficulty to different rock climbing walls.

CHAPTER 2: LITERATURE REVIEW

Physical Inactivity

The CDC reports that less than half (48%) of all adults meet or can't exceed ACSM guidelines (n. pag.). It shows that these inactive adults have a higher risk for early death, heart disease, stroke, type 2 diabetes, depression, and some cancers (CDC, n. pag.). With the expansion of rock climbing as a sport for everybody, it seems a logical development to use the positive aspects of rock climbing as a therapy for mental illnesses (Mermier, et al., 224-228). Physical inactivity may not only cause physical damage, but can also cause a mental and financial burden. Depression stands out as one of the most common diseases worldwide with a one-year prevalence of 3.2 %, according to the WHO World Health Survey 2007 (n. pag.). These studies on therapeutic climbing suggest that there might be positive effects on anxiety, ADHD, depression, cognition, self-esteem, as well as in the social domain (Luttenberger, et al., 1-10).

Physical inactivity can also cause financial burdens of higher medical costs resulting from people being physically inactive. Population levels of physical activity inadequate to meet current guidelines can place a health burden on the U.S. population that results in higher health care expenditures (Carlson, et al., 315-323). Carlsona explored the health care cost between adults who report to either being active or physically inactive and discovered that about $90 billion of health care expenditures per year associated with inadequate levels of physical activity (315-323).

Background Research

With physical inactivity contributing as a leading cause of many illnesses and diseases; it is important for individuals to be aware of what they can do in order to be physically active. Different activities, such as Rock Climbing, could be a different form of exercise or physical activity to achieve the recommended amount of physical activity. Rodio et al. (2008) explored whether non-competitive rock climbing fulfills sports medicine recommendations for maintaining a good level of aerobic fitness (359-364). They looked at the physiological profile of 13 rock climbers and recorded data through a metabolimeter, which is a modified calorimeter that measures rate of basal metabolism. They found that noncompetitive rock climbing has proved to be a typical aerobic activity with the intensity of exercise comparable to that recommended by the ACSM to maintain good cardiorespiratory fitness (Rodio, et al., 359-364). Indoor rock climbing also has been revealed as a good activity to increase cardiorespiratory fitness and muscular endurance (Mermier, et al., 224-228).

Based on the measurement of aerobic and anaerobic metabolism during climbs of routes with different levels of difficulty, the main findings of this investigation were: (a) the aerobic and anaerobic alactic systems are the main energy systems required during indoor rock climbing, and (b) training status, route difficulty and upper body power do not directly influence the contributions of the energy systems (Bertuzzi, et al., 293-300). This indicates that both elite and recreational rock climbers were using both anaerobic and aerobic energy sources during the activity. These results brighten our awareness of rock climbing meeting ACSMs aerobic and anaerobic recommendations.

The physiological effects of rock climbing seem to vary. To assess if climbing routes, different in steepness and/or displacement, but not in difficulty, would affect the physiological responses (Garber, n. pag.). Garber et al. took expert climbers and used maximal graded exercise tests to determine their maximal physiological capacity using a portable metabolic device (Garber, n. pag.). Comparing four routes with the same difficulty but different steepness and/or displacement indicated that (a) routes with an upward displacement caused the highest peak and average heart rate; (b) routes with a vertical displacement on overhanging wall were physiologically the most demanding; (c) the traverse is physiologically the less demanding (Garber, n. pag.).

As rock climbing meets ACSM recommendations for exercise and the sport in general is growing in popularity, we need to identify what the best indicators of potential successful performances and overall ease of completing the activity. One thought is to explore different physiological characteristics such as strength-to-weight ratios. There is minimal research available in regards to strength-to-weight ratios and performance in rock climbing, therefore body weight field tests may be a better resource. Webster et al. explored the relationship between preservice teachers' health related fitness and movement competency in gymnastics (203-217). The teachers were tested on their muscular strength/endurance, flexibility, body composition, and several gymnastics skills. The pushup and curl-up tests were used to test muscular strength/endurance, the back-saver sit-and-reach test was used to test flexibility, and a bioelectrical impedance analyzer was used to test body composition (Webster, et al., 203-217). Teachers were then tested on their form at different skill stations. The results of this study suggest muscular strength, especially core (abdominal) strength, could be an important factor in a teacher's ability to competently demonstrate certain fundamental skills in educational gymnastics (Webster, et al., 203-217).

In order to better understand strength-to-weight ratios, Bishop et al. compared height, weight, and skinfold measurements of subjects compared different army based obstacle courses in an effort to determine if there was a relationship existed between strength-to-weight ratio and overall performance (1108-1114). The R' between Indoor Obstacle Course Test (IOCT) scores and body weight was 0.06 and that between IOCT scores and percentage of body fat was 0.08 indicated that there is not much of a difference between the two (Bishop, et al., 1108-1114). All cohort analyses suggested that, for male subjects, body weight had only a small impact on the performance score distribution and the IOCT is fit for purpose as a fair repeatable system for assessment of physical performance (Bishop, et al., 1108-1114).

Instrumentation

Along with strength-to-weight ratio, hand grip strength is an important part in rock climbing. Hand grip strength is determined by using hand dynamometers. Mathiowetz et al. (2002) tested and dynamometers reliability, who compared the Jamar and Rolyan hydraulic dynamometers to determine their concurrent validity with known weights as well as their interinstrument reliability and concurrent validity for measuring grip strength (201). Thirty males and thirty females were tested using the two different dynamometers. Results demonstrated that the Jamar and Rolyan dynamometers have acceptable concurrent validity with known weights and strong concurrent validity and these data indicates that Jamar and Rolyan dynamometers measure grip strength equivalently and can be used interchangeably (Mathiowetz, 201).

The Borg Rating of Perceived Exertion (RPE) is on a scale numbered from 6-20 (Appendix A). The RPE scale reports the research subjects self-perceived feelings of effort, strain, discomfort, and/or fatigue experienced during both aerobic and resistance training (ACSM, n. pag.). Diafas at al. evaluated the reliability of RPE while using a Kayak ergometer (n. pag.). Each stage of this study lasted for 3 minutes, with the power output requested of the subjects increasing by 40 W each stage. During the last 15s of each stage the subject's RPE, final heart rate and mean power output over that stage were recorded (Diafas, et al., n. pag.). Significant mean differences in work output were seen at all but RPE 17. The data supports the validity of the RPE scale as a measure of physiological strain among competitive male kayakers (Diafas, et al., n. pag).

Rock climbing is highly dependent on leg strength and ability to support body weight. Therefore, body weight specific exercises that assess leg strength or power should play a greater role in climbing performance. Cizauskas at al. explored the impact of vertical jump performance on leg muscle strength, muscular performance and body balance (n. pag.). The subjects under investigation had to perform jumps of two types: a) maximum jump from an initial standing position, with the subject trying to achieve the highest possible jump, b) maximum jump from an initial standing position, with the subject trying to perform the jump as fast as possible (Cizauskas, n. pag.). These tests are commonly used to evaluate a individual's jump force and the physical abilities related to it (dynamic force, spring, coordination). A lower vertical jump height could indicate a decrease of muscle contraction capacity since jump height also depends on the magnitude (intensity of muscle capacity) of power achieved. It is believed that men prevail in force over women because of their greater muscle mass and muscle capacity, as well as males possessing higher proportion of muscle mass. The muscle force of women during physical loading; however, is less subject to fatigue than that of men (Cizauskas, n. pag.).

CHAPTER 3: METHODS

Sampling Procedures

The sample population for this study was 14 adult, recreational, male and female rock climbers (mean +/- S.D.= Age- 21.9+/-2.6y, Height- 176.8+/-11.1cm, Weight- 73.4+/-18.7kgs, % Fat- 21.0 +/- 6.41, BMI- 23.3+/-4.5). The term “recreational” was defined as an individual who typically rock climbs on a monthly basis.

This study focused on using non-probability convenience sampling of paying patrons at the rock climbing center. All testing occurred at Zenith Rock Climbing Center which allowed selection of participants who meet the specific requirements for this study. This study was approved by the Institutional Review Board (IRB) through Missouri State University (3/22/16, study # 16-0371).

Anthropometric Measures

Descriptive statistics on participants for sex, age, height, weight, percent fat, and BMI were recorded. Percent fat was assessed via bioelectrical impedance (TANITA BF-350, Tokyo, Japan). Prior to testing, each participant signed informed consent (Appendix B) which lists the purpose, procedures, risks, and benefits of the study.

Participants were volunteers only. Each participant was tested for the following tests: handgrip dynamometer, vertical jump, pull-ups, push-ups, sit-ups, and flexibility using a sit-and-reach test. Each participant performed each test one at a time.

Immediately following these tests, the climbing portion of the study, which was held at Zenith Climbing Center in Springfield, MO was done. Each climb trial took no more than 40 minutes.

The handgrip dynamometer was adjusted based on the participant's comfort and hand. The participant started with the device straight above their head and squeezed the device while lowering it to their side. This was performed six times (three times with each hand) and the best scores from each hand was recorded.

The vertical leap was measured by how high the participant can jump along a wall. The participant stood straight, vertically towards the wall, and extend their arm as high as they against the wall. Tape was placed above where their top fingertip extends. The participant was then given an additional piece of tape that they placed as high as they can against the wall without raising heels off the floor. Vertical jump was measured as the distance between the initial reach height and the highest point of the tape placed while jumping. The best score was recorded in inches.

Pull-ups was then conducted on a standard military pull-up machine. Participants can hold the bar either overhand or underhand based off of their preference. The participants then grabbed the bar and started with arms totally extended and then begin the test until fatigued. Full elbow extension and chin raising above the bar was required in order for the pull-up to count.

A one-minute sit-up test was done with participant's knees at a 90-degree angle. Participants were allowed to have their feet held as desired. Arms were crossed across their chest and starting with their shoulders touching the floor. Full range sit-ups were performed and the completed number was the participants score in one minute.

A one-minute push-up test was conducted. Full range push-ups will be done in order for it to count. Hands should be at least shoulder width apart and the chest must be at least a fist away from the ground. Women were allowed to do modified push-up from the knees and could switch during the test. The total number of push-ups in one minute was recorded.

A sit-and-reach test was conducted from a flexibility board in order to test flexibility. Participants must have their shoes off and feet inside the board and knees could not be bent. Hands must lie on top of each other and the participants will slide the metal lever as far as they can in one fluid motion. This was done two times and the best score was recorded.

Climbing Test

The participants climbed 3 different difficulties of walls. The wall difficulty was ranged from easy (5:6), medium (5:8), to hard (5:9), in this order. These difficulties will be standard and determined by the rock climbing facility and used on an auto-belay machine. These difficulties of the different walls were revealed before the climb. When the participant was ready, they climbed the wall for a total of 10 minutes. If they reached the top before the 10 minutes is completed or if they happen to fall during the trial, they auto-belay down to the bottom and continued to climb until time is up. During each ascent up, time and distance traveled was recorded. At the end of their 10 minutes, an RPE scale was presented to the climber (Appendix A). This will show dichotomous coding. The RPE scale rages from 6-20 and will determine the participants rating of perceived exertion (6= No exertion at all, 20= Maximal Exertion). Once the climber reports their RPE, they will have 3 minutes, but no longer than 5 minute of rest before going on to the next wall. This is because it takes at least 3 minutes for majority of energy to be restored to pre-work levels. Once the 3 minutes is up, the researcher will inform the participant that they can start the next wall or take for time if needed. Once the participants began to climb the next wall, their time began. This same procedure will be carried out with each participant throughout all 3 walls.

Analysis Procedures

This study investigated the variables collected from subjects initial descriptive statistics and percent fat, strength and flexibility tests, along with their reported RPE score with each wall. Descriptive statistics were performed for all participants. A stepwise linear regression analysis was used to determine which factors are the greatest predictors of climbing success (total number of trials and an average compiled score of how far they climbed for each route).

CHAPTER 4: RESULTS

Fourteen participants, nine males and five females (mean +/- S.D.= Age- 21.9+/-2.6y, Height- 176.8+/-11.1cm, Weight- 73.4+/-18.7kgs, % Fat- 21.0 +/- 6.41, BMI-23.3+/-4.5) completed the study to its entirety and were used in the analysis. Male and female data was reported as aggregate. The measurement (mean +/- S.D.) for exercises performed were; sit-ups- 26.50+/-13.05, push-ups- 30.50+/-13.51, sit-and-reach (in)-13.11+/-3.03, right hand grip (kg)- 48.86+/-12.66, left hand grip (kg)- 45.51+/-12.24, pull-ups- 5.36+/-6.51, vertical jump (in)- 16.09+/-2.60. The results for attempts/distance traveled can be found in T1.

The average distance achieved per wall were measured by quarters of height completed (0.25, 0.50, 0.75, or 1). The results of this from the easy wall (5:6) show that BMI was the most significant ($P<0.001$) and sit ups were also significant ($P<0.029$). Height, sit and reach, and vertical jump were also analyzed but did not show significance. The results for the average distance achieved for the medium wall (5:8) shows that BMI was the most significant ($P<0.001$). Sit-ups, push-ups, and sit and reach were also analyzed but did not show any significance. The results for the average distance achieved for the hard wall (5:9) found that both BMI ($P=0.003$) and push-ups ($P=0.007$) were significant.

The results for the total attempts made on the easy wall (5:6) shows that pull-ups were the most significant ($P<0.001$) and age ($P=0.017$) was significant. Push-ups ($P=0.002$), height ($P=0.012$) and sit and reach ($P=0.043$) were all negatively significant. Vertical jump was also in the model but showed no significance. The results for the total attempts made on the medium wall (5:8) revealed that vertical jump (P=0.002) was the most significant. Age (P=0.014) and % Fat (P=0.007) showed negative significance. Height was also in the model but did not show any significance. The results for the total attempts made on the hard wall (5:9) showed that sit and reach showed significance (P=0.040). Age (P=0.015) and height (P=0.015) showed negative significance. BMI, % fat, vertical jump, sit-ups, pull ups, and weight did not show any significance. The RPE (mean +/- S.D.) for each wall was; easy (5:6) = 14.71+/-2.52, medium (5:8) = 16.07+/-1.86, hard (5:9) = 17.71+/-1.27.

Data was screened for accuracy, outliers, and additivity. Two variables had to be removed due to an excessively high correlation (weight was too highly correlated to BMI, and handgrips were too highly correlated to pull-ups) which would lead to suppression. Data was also screened for assumptions including normality, linearity, homogeneity and homoscedasticity. It met linearity and homoscedasticity, but it was difficult to ascertain normality and homogeneity without a greater sample size. The author wishes to acknowledge Emily Klug at the Missouri State University RStats Institute for her assistance with data analysis for this paper along with Zenith Climbing Center located in Springfield, MO.

CHAPTER 5: DISCUSSION

The purpose of this study is to determine whether anthropometric factors have an effect on overall performance in rock climbing between three different difficulties of rock walls. The results of this study indicate that certain anthropometric factors play a role in predicting recreational rock climbing performance. Performance was defined as the average distance achieved (0.25, 0.50, 0.75, or 1) and total attempts made on all three walls which was then compared different anthropometric factors. Previous studies describe rock climbing as a great method for physical activity and meets the standards of ACSMs recommendations (Mermier, et al., 224-228, Rodio, et al., 359-364). In current literature, little information exists relating to how rock climbers can help increase their performance. For all three walls (easy 5:6, medium 5:8, and hard 5:9) BMI is the most significant factor, which was loosely correlated to an individual's physical fitness. This discovery is intuitive because the heavier a person is; the stronger they need to be in order to pull themselves up.

The results of the current study became more diverse when looking at total attempts made on each wall. For the easy wall (5:6) there is a negative significance for push-ups, height, and sit and reach. Our belief is that this may be because the wall was too easy and most participants could reach the top without failure multiple times. It is plausible that anthropometric factors have little or no impact while climbing the easiest rated wall. Vertical jump, percent fat, and age all played a more prominent role in climbing performance with the medium wall (5:8); thus, indicating that general fitness is an important factor. Significance of age was inversely related, indicating that younger participants may have more endurance than older individuals. Finally, with the hardest wall (5:9), age was the most significant factor.

Looking at the exercise testing standards, most, if not all, participants were either classified in either the average or poor categories. Conversely, these subjects were in the excellent categories for grip strength and flexibility. When comparing rock climbing to traditional exercise, we have to understand that it is a different type of activity that most people aren't used to doing. This study indicates that you don't necessarily have to be strong in order to climb a rock wall. We see that their grip strength and flexibility are classified as excellent because rock climbers are used to using their range of motion and have great grip strength in order to climb a wall successfully.

Potential Limitations

There were some potential limitations to this study that may have limited performance during rock climbing. With the sample size only being fourteen, this may not have been large enough to gather the appropriate data. It is also possible that the sample population may not have accurately represented the target population. Our term "recreational rock climber" was an individual who typically rock climbs on a monthly basis, which can be broadly classified or interpreted by the rock climbers as they had vast range of years and technical climbing experience. Climbers with more experience may have been able to climb the walls more easily or more efficiently as compared to those who don't have as much experience. It is possible that heart rate could have helped verify the participants RPE scores.

Duration of the study could also be a potential limitation. Since each person did the whole study in one day, this could have caused a greater increase for fatigue and exhaustion. Having each participant climb 3 different walls with increased difficulty while resting for a minimum of 3 minutes between each wall, may not have been enough time for the participants to rest and recover. Participants may have desired longer rest periods than others and that also might have played a factor in performance. The rest time and progression of climbing walls of our methods was based upon the typical climbing session.

It is also possible that the placement of the rocks on the wall were not accurately placed for the difficulty intended. This may be why we didn't see as many successful climbs for the medium (5:8) and hard (5:9) walls. This could also affect the climbers physiologically and they can become frustrated.

Conclusion

Previous research has shown that rock climbing has increased its popularity and can help increase both cardiovascular and muscular endurance, but minimal research exists available on how to help increase climbing performance beyond fitness. This study demonstrates that there is some significance with anthropometric factors and performance. However, different factors affect the different difficulties of rock wall. We were able to determine that lower BMI, leg strength, and flexibility are key factors in overall rock climbing performance. Resting for at least 3 minutes between climbs can also play a factor in performance since the majority of energy is restored to pre-work levels.

Directions for Future Research

Possible changes for future research could include the following: 1. Perform different anthropometric tests to help determine climbing performance. 2. Perform the anthropometric tests and each individual climb on different days to decrease exhaustions and fatigue. 3. Have a larger sample size. 4. Having all climbers with the same level of climbing experience. 5. Possibly re-evaluate the same participants in the future to determine if their performance has increased over time.

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Table 1- Attempts/distance traveled (mean +/- S.D.)

	Easy (5:6)	Medium (5:8)	Hard (5:9)
Count of Attempts	7.79+/-2.97	5.64+/-2.56	5.00+/-1.84
Avg Distance Traveled	0.88+/-0.25	0.81+/-0.27	0.64+/-0.23

APPENDICES

Appendix A. RPE Scale:

6 No exertion at all

7 Extremely light

8

9 Very light

10

11 Light

12

13 Somewhat hard

14

15 Hard (heavy)

16

17 Very hard

18

19 Extremely hard

20 Maximal exercition

Appendix B. Informed Consent Form

Consent to Participate in a Research Study
Missouri State University
College of Health and Human Services
Determining the Impact of Anthropometric Factors on Rock Climbing Performance.

Introduction

You have been asked to participate in a research study. Before you agree to participate in this study, it is important that you read and understand the following explanation of the study and the procedures involved. The investigator will also explain the project to you in detail. If you have any questions about the study or your role in it, be sure to ask the investigator. If you have more questions later, Scott Richmond, the person mainly responsible for this study, will answer them for you. You may contact the investigator(s) at:

Dr. Scott Richmond, PhD
117 MCDA, Missouri State University
University
(417) 863-8481
ScottRichmond@MissouriState.edu

Ryan Mitchell, B.S.
128 KGSX, Missouri State
(417) 836-6715
Mitchell12@live.missouristat
e.edu

You will need to sign this form giving us your permission to be involved in the study. Taking part in this study is entirely your choice. If you decide to take part but later change your mind, you may stop at any time. If you decide to stop, you do not have to give a reason and there will be no negative consequences for ending your participation.

Purpose

The purpose of this test is to determine whether strength to weight ratios have an effect on overall performance in rock climbing between three different difficulties of rock walls.

Description of Procedures

1. The test you have selected to perform is designed to evaluate strength to weight ratios while rock climbing. Your eligibility to participate will be determined based on guidelines established by the American College of Sports Medicine and the answers provided by you after completing a medical history questionnaire and training history questionnaire. If you are eligible and you chose to participate in the study you will have your height and weight measured.
    a. Strength Tests: handgrip dynamometer, vertical jump, pull-ups, push-ups, sit-ups, and a sit and reach test. Each participant will do each test one at a time. The handgrip dynamometer will be adjusted based on the participant's

preference. The participant will start with the device straight above their head and squeeze the device while lowering it to their side. This will be performed six times (three each hard) and the best scores from each hand will be recorded. The vertical leap will be adjusted to the appropriate height of the participant. The participant will stand under the vertical leap machine and raise one hand in their air as high as they can. The machine will be lowered so that the lowest pedal is touching their tallest finger. The participant will be stationary and will jump on two different occasions. The best score will be recorded. Pull-ups will then be conducted on a standard military pull-up machine. Participants can hold the bar either overhand or underhand based off of their preference. The participants will grab the bar and start with arms totally extended and then begin the test until failure. Full arm extension will be required in order for the pull-up to count. Score will be recorded. Next, a 1 minute sit-up test will be done with participant's knees at a 90 degree angle. Participants may have their feet held if asked. Arms will be crossed across their chest and will begin with their back touching the floor. Full range sit-ups must be performed in order to count. The number of sit-ups within the minute time period will be their score. Then, a 1 minute push-up test will be conducted. Full range push-ups will be done in order for it to count. Hands should be at least shoulder width apart and the chest must be at least a fist away from the ground. Woman may choose to do modified push-up from the knees. The total number of push-ups in 1 minute will be recorded. Finally, a sit and reach test will be conducted from a flexibility board in order to test flexibility. Participants must have their shoes off and feet inside the board. Hands must lie on top of each other and the participants will slide the metal lever as far as they can in one fluid motion. This will be done two times and the best score will be recorded.

   b. Rock climbing: On subsequent days you will partake in 3 different climbs at a local rock climbing gym. You will be randomly assigned a wall and you will climb each wall for a total of 10 minutes. If you reach the top before the 10 minutes is up, you will be lowered down to the bottom and continue to climb until time is up. If you happen to fall during the trial, you will be lowered to the bottom and continue to climb again until time is up. While performing the climbs, you will connected to a heart rate monitor. There will be a total of 3 trials where each trial will be at least 48 hours apart.

2. The primary investigators for this study are Dr. Scott Richmond, PhD and Ryan Mitchell, B.S., *ACSM-CEP*; they will be responsible for collecting the information for this study.
3. All data and exercise testing data will be collected at Zenith Climbing Center and under supervision of Scott Richmond and Ryan Mitchell.
4. Your total time commitment for participation will be approximately ONE (1) hour over TWO (2) days (0.5hrs/day).

<u>What are the Risks?</u>

During the exercise testing feelings of muscular fatigue, breathlessness, a slight chance of an abnormal blood pressure response, and a risk of heart attack may occur. During testing you will be monitored by trained technicians using guidelines established by the American

College of Sports Medicine. There are risks associated when using a climbing wall, even when a top rope is used.

What are the Benefits?

The benefits involved with participation in this study can include but are not limited to the assessment of your total energy expenditure, which can be utilized to adjust current training routines, and contribution to the scientific body of knowledge.

How will my privacy be protected?

Any information obtained in connection with this study will remain confidential. Only data averaged for several subjects will be disclosed in scientific publications. Your decision whether or not participate will not prejudice you future relationship with the Missouri State University or the Department of Kinesiology at Missouri State University. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without penalty. If you decide later to withdraw from the study you may also withdraw any information which has been collected about you.

Consent to Participate

If you want to participate in this study Determining Whether Strength To Weight Ratios Have An Effect On Performance While Rock Climbing, you will be asked to sign below:

I have read and understand the information in this form. I have been encouraged to ask questions and all of my questions have been answered to my satisfaction. By signing this form, I agree voluntarily to participate in this study. I know that I can withdraw from the study at any time. I have received a copy of this form for my own records.

- If you have any questions write them in the space below under the heading "I have the following questions" and do not sign the consent form before you receive the satisfactory written answer to your questions.

I have the following questions:

____
____
____
____

Initials________________

Answers to questions:

____
____
____
____

Initials ________________

Have your questions been completely answered? YES NO

- If you have no questions, or are satisfied with the answers to the above questions, please continue with this form. **You will be given a copy of this form to keep**.
- I understand that the **Missouri State University** and the **Department of Kinesiology** at **Missouri State University** provides no institutional benefit or financial compensation, including payment of expenses associated with medical treatment, for any injury arising from or attributable to this research.
- YOU ARE MAKING A DECISION WHETHER OR NOT TO PARTICIPATE. YOUR SIGNATURE INDICATES THAT YOU HAVE DECIDED TO PARTICIPATE HAVING READ THE INFORMATION PROVIDED ABOVE. WITH YOU SIGNATURE YOU AFFIRM THAT YOU ARE AT LEAST 18 YEARS OF AGE AND HAVE RECEIVED A COPY OF THIS CONSENT FORM.

______________________________	______________________________
Print Participant Name	Signature of Participant
_______________	______________________________
Date	Phone Number of Participant
______________________________	______________________________
Print Name of Person Obtaining Consent Consent	Signature of Person Obtaining
_______________	
Date	
______________________________	______________________________
Print Name of Witness	Signature of Witness
_______________	
Date	