A PHYSIOLOGICAL DESCRIPTION AND COMPARISON OF A BARBELL AND DUMBBELL COMPLEX AMONG RESISTANCE TRAINED FEMALES

By

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Bachelor of Science in Kinesiology

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Baton Rouge, LA

2020

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
July, 2022

A PHYSIOLOGICAL DESCRIPTION AND

COMPARISON OF A BARBELL AND DUMBBELL

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FEMALES

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ACKNOWLEDGEMENTS

I would like to begin by thanking my advisor and thesis committee for their continued guidance and support throughout my two years of graduate school. To Dr. Doug Smith, Dr. Jay Dawes, and Dr. Michael Trevino, your mentorship over the last few years will always be appreciated. Thank you for generously providing your expertise towards my research in exercise science and for your contribution towards my personal growth and success in academia.

Next, I must thank my family who has been there for me every step of the way. I'd like to acknowledge my mother, Randi and my father, Tim for their consistent support and guidance over the last few years. I must also acknowledge my older siblings, Anja, Linnea, and Nathaniel for their constant encouragement throughout my academic endeavors. I would not have been capable of this accomplishment without the strong support system and steadfast love provided by my family.

Finally, I cannot go without thanking my dear friends for their persistent allegiance to my efforts throughout this journey. To my unnamed mentors, supervisors, and friends, thank you for your contribution to my success at this point of my career.

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Date of Degree: JULY, 2022

Title of Study: A PHYSIOLOGICAL DESCRIPTION AND COMPARISON OF A BARBELL AND DUMBBEL COMPLEX AMONG RESISTANCE TRAINED FEMALES

Major Field: APPLIED EXERCISE SCIENCE

Abstract: The purpose of this study was to examine the acute physiological responses to two modalities of concurrent training and compare findings between a barbell (BB) complex and a dumbbell (DB) complex. Fifteen physically active females ($n = 15$, age = 23 ± 4) performed one round of the Javorek Complex I with both BB/DB then swapped modality so all subjects completed both variations. Acute responses were compared between 15 subjects across two exercise types to determine potential benefits of each. Heart rate (HR), oxygen consumption (VO2), respiratory frequency (RF), tidal volume (TV), minute ventilation (VE), ventilatory equivalents for oxygen (VE/VO2), fraction of expired air (FEO2), metabolic equivalents (METs), total caloric expenditure (EE), time to completion, and load utilized was used for analyses with paired samples t-tests used to identify significant differences between outcome measures and modality to determine the magnitude of any change. Significant differences were observed between modalities in load utilized ($p \leq 0.001$), HR ($p \leq 0.001$), VO2 ($p \leq 0.05$), RF ($p \leq 0.05$), VE ($p \leq 0.05$), VE/VO2 ($p \leq 0.05$ level), FEO2 ($p \leq 0.01$), METs ($p \leq 0.05$), and EE ($p \leq 0.05$). Results of this study present a physiological description of acute responses to complex training with observable differences between BB and DB modalities. These conclusions may be used by coaches and athletes for implementation of complex training for athletic performance enhancement.

TABLE OF CONTENTS

Chapter | Page

I. INTRODUCTION 1

II. LITERATURE REVIEW 4

Aerobic Training 4
Resistance Training 5
Circuit Training 5
Time Restraints 6
Istvan Javorek 6

III. METHODOLOGY 9

Experimental Approach to the Problem 9
Subjects 9
Procedures 10
Materials 10
Session 1: Baseline Measurements and Familiarization 11
Session 2: Data Collection 12
Session 3: Data Collection 13
Statistical Analysis 13

Chapter Page

IV. RESULTS 14

V. DISCUSSION 21

REFERENCES 24

APPENDICES 29
Appendix A – IRB Approval 29
Appendix B – Informed Consent Form 30
Appendix C – Exercise Status Questionnaire 33
Appendix D – PAR-Q+..36

LIST OF TABLES

Table Page

Table 1: Descriptive Characteristics of Sample (n = 15) 10
Table 2: All Variables by Modality 14

LIST OF FIGURES

Figure Page

Figure 1: Exercises and Repetitions by Modality of Complex I 12
Figure 2: Load Utilized and Time to Completion by Modality 15
Figure 3: Comparisons in Heart Rate by Modality 16
Figure 4: Comparisons between Relative Heart Rate Response and Modality 16
Figure 5: Comparisons in Oxygen Consumption by Modality 17
Figure 6: Comparisons in Respiratory Frequency between Modalities 17
Figure 7: Comparisons in Tidal Volume between Modalities 18
Figure 8: Comparisons in Minute Ventilation between Modalities 18
Figure 9: Comparisons in Ventilatory Equivalents between Modalities 19
Figure 10: Comparisons in Fraction of Expired Air between Modalities 19
Figure 11: Comparisons in MET equivalents by Modality 20
Figure 12: Comparisons in Energy Expenditure by Modality 20

CHAPTER I

INTRODUCTION

Regular physical activity is recommended to all individuals to ensure proper maintenance of general health and improved quality of life (Pace, 2000). Exercise prescription must be specific per individual dependent on variables of age, sex, physical ability, pre-existing health conditions, and outcome goals. In most cases, both aerobic activity and resistance training are recommended on a regular basis to maximize health benefits (Kraemer & Ratamess, 2004). Aerobic exercise aims to strengthen the cardiovascular system leading to benefits such as improved endurance, circulation, and decreased risk of development of heart disease (Kyral et al., 2019). Both aerobic and resistance mechanisms can be exercised simultaneously with concurrent training.

Concurrent training is a type of exercise protocol that combines physiological mechanisms of both aerobic and resistance training (Wilson et al., 2012). Recent research suggests this method is an effective mode for development of muscular and strength adaptations, leading to health benefits and increased athletic performance (Methenitis, 2018). Circuit training, high-intensity interval training (HIIT), and combination lifts are all types of concurrent training categorized by effort level, work and rest intervals, number of exercises per set, equipment usage and projected outcome.

A first example of concurrent exercise is circuit training. This consists of several sets of resistance and aerobic exercise performed in sequence measured by repetitions or time interspersed by active rest periods (Seo et al., 2019). This allows for a continuous aerobic component throughout the duration of one training session. Athletes elicit an elevated heart rate but similar strength requirements to those reported during a traditional strength-training session (Alcaraz at el., 2008). In addition, in comparison to a traditional strength training session, higher lactate concentrations, oxygen consumption, and ratings of perceived exertion have been observed during circuit training (Marquez et al., 2017).

Another example of concurrent exercise is high intensity interval training, or HIIT. This exercise type is recognized as a time-efficient modality consisting of brief, intermittent bursts of vigorous activity intercepted by active rest periods (Ito, 2019). It requires high intensity effort with short bouts of rest, resulting in a likely high energy expenditure in a relatively short duration of time. The goal of HIIT is to accumulate activity at an intensity that the participant would be unable to sustain for prolonged periods (i.e. 80-95% of peak oxygen consumption or >90% of maximum heart rate) (Cassidy et al., 2016). Previous studies have observed benefits of HIIT including increased maximal oxygen uptake, aerobic performance, fasting glucose, anaerobic capacity, and overall metabolic health (Atakan et al., 2021). HIIT may also accommodate for limited time, space, and equipment accessibility; these are factors that must be taken into consideration dependent on sport-specific training protocols.

HIIT can also be categorized into multiple types. A combination lift is an example of HIIT consisting of two or more free weight exercises that are combined in a nonstop, continuous movement (Javorek, 1998). There are two specific types of combination lifts: simple and complex. A simple combination lift is defined as two major lifts in combination; while a complex is defined as more than two major lifts in combination (Javorek, 1998). Istvan "Steve" Javorek is known for his creation of barbell and dumbbell complexes. This is one variation of a complex developed to be used by strength and conditioning coaches as a concurrent training modality leading to strong athletic outcomes. However, the benefits of Javorek's complex exercise have not been examined in previous research. In order to measure the effectiveness of complex training, acute physiological responses to this modality must be tested to determine potential benefits of athletic performance enhancement.

The purpose of this study was to examine and compare the acute physiologic and metabolic effects when performing two variations of Javorek's Complex I: barbell and dumbbell utilization among resistance trained females. The results of this intervention may determine the effectiveness of the proposed exercise modality, which may be beneficial for strength and conditioning coaches and fitness professionals in regard to exercise prescription.

CHAPTER II

LITERATURE REVIEW

Review of literature on aerobic, resistance, and concurrent training methods is examined to identify effects of each. Acute physiological responses, muscular and endurance gains, and overall health benefits are comparable between these training types. Concurrent training types such as circuit training, HIIT, and complex training and the benefits proposed with each are referenced for baseline understanding. Propositions made by Javorek on complex training and uses for Complex I are also reviewed, however scientific research on complexes has an overall weak representation in present literature.

Aerobic Training

Aerobic exercise is defined as any activity that uses large muscle groups and is maintained continuously and rhythmically in nature (Pollock et al., 1998). Aerobic processes rely on oxygen extraction from inhalation for conversion into energy during exercise. Examples of aerobic activity include jogging, dancing, swimming, or any prolonged activity that requires consistent effort of the cardiovascular and pulmonary systems. This type of activity causes increases in heart rate and breathing rate, utilizing mechanics of the cardiovascular and pulmonary systems of the human body. Muscle groups activated by this type of exercise rely on aerobic metabolism to supply energy for the body in the form of adenosine triphosphate (ATP) from amino acids, carbohydrates, and fatty acids (Patel et al., 2016). Consistent practice of aerobic activity leads to endurance enhancement and improvement cardiovascular system to uptake and transport oxygen throughout the body (Millstein, 2013). Aerobic capacity is measured by the maximal oxygen uptake (VO2max) during large muscle mass exercise, which represents the capability of the human body to metabolize oxygen for energy expenditure (Poole & Jones, 2017). Aerobic activity is known to improve VO2max, leading to improved endurance performance and stamina. Over time, improvements seen in cardiopulmonary muscle oxidative function leads to lower resting heart rate and blood pressure as well as decreased risk of cardiovascular, metabolic, and pulmonary disease (Miele & Headley, 2017).

Resistance Training

Resistance training consists of exerting skeletal muscle force against a factor of resistance such as body weight or external forces such as fitness equipment (dumbbells, barbells, kettlebells, medicine balls, exercise machines, etc.) (Hughes et al., 2018). Repeated movements against a resistance with progressive overload using free weights or machines lead to strength increases and muscle hypertrophy (Holtermann et al., 2007). Resistance training may benefit the general population in body fat reduction, increased basal metabolic rate, decreased blood pressure and cardiovascular demands to exercise, improved blood lipid profiles, glucose tolerance and insulin sensitivity, increase muscle and connective tissue cross-sectional area, improve functional capacity, and relieve low back pain. (Kraemer et al., 2002). Specific to sports performance, this type of training can improve muscular strength, power and speed, hypertrophy, local muscular performance, motor performance, balance, and coordination (Kraemer et al., 2002).

Circuit Training

Previous studies have determined circuit training may be utilized for athletic performance enhancement with improvements in strength and cardiorespiratory fitness variables (Ramos-Campo et al., 2021). It consists of a variation of exercises performed in a circuit measured by repetitions or time interspersed by active rest periods. Circuit training proposes advantages to athletic improvement by encompassing all necessary factors of exercise on specific time restraints. Previous research confirms HIIT training as an alternative to moderate- or low-intensity continuous exercise with potentially higher acute physiological outcomes (Engel et al., 2018). Past studies have demonstrated improved health outcomes including muscular endurance, strength, and maximal oxygen consumption (Ito, 2019).

Time Restraints

Modern methods are being introduced in athletic training protocols to accommodate for time constraints and limitations to equipment and facility access. Circuit and concurrent training provide similar benefits to traditional endurance and strength training while requiring a shorter duration of time. Theoretically, performance variables such as power (rate of muscular force development), aerobic capacity, muscular endurance, and muscular strength can be improved with very little time commitments and relatively low equipment requirements.

Modern circuit training was originally introduced by R.E. Morgan and G.T. Anderson in 1953 at the University of Leeds in England where researchers attempted to produce similar outcomes of athletic enhancement in a relatively short duration of time (Klika & Jordan, 2013). Their study analyzed muscular strength and aerobic endurance outcomes performing moderate intensity exercises (40-60% 1-RM intensity) with very little rest. Positive results of this study popularized the idea of circuit training, introducing advances in training protocols and exercise technology advancements aiming to develop the most efficient method of athletic enhancement.

Istvan Javorek

Istvan "Steve" Javorek supports this theory in his presentation of utility of combination lifts and complexes. He aims his purpose for complex exercises to change the monotony of a basic workout while simultaneously having greater influence on the neuromuscular system, increase the workout load and intensity, stimulate the skeletal muscular system, increase the cardiovascular benefits of the free-weight program, and make the program more dynamic and efficient (Javorek, 1988). By combining multiple types of lifts into one exercise movement, both modes of aerobic and resistance exercise are activated by stimulating the cardiovascular system, increasing heart rate and breathing rate, all while skeletal muscles are working to produce force. Performance of this activity can lead to added benefits of athletic ability, such as power output and stamina. Javorek presents that the number of combination exercises is unlimited, depending on a coach's knowledge and creativity, the availability of the equipment, and the goals of the coach and athletes (Javorek, 1998). Various types of combination lifts may be implemented into a training program dependent on athletic goals and physical assumptions of sport.

Javorek argues the importance of complexes for enhancement of athletic performance regarding specific endurance, muscle tone, a good muscular coordination, and a perfectly balanced, well-developed, harmonious musculature (Javorek, 1988). Javorek has coached multiple bronze and silver medalists of weightlifting in the 1984 Olympics and designed conditioning programs for multiple world-record holders in trach and field as well as 1988 Olympic silver and gold medalists. He claims to have had such very good overall improvements in all athletes tested utilizing Complexes I and II (Javorek, 1988).

Javorek's Complex I is comprised of five resistance exercise movements to be performed in a non-stop, continuous order as listed for six repetitions each: upright row, high pull snatch, behind the head squat push press, behind the head good morning, and bend over row. This equates to thirty repetitions for each set. The goal is to complete all six repetitions of all five lifts without setting down the equipment or resting. By performing a set number of repetitions of multiple high intensity lifts continuously, the aerobic component is assumed to be applied which leads to a higher energy expenditure for duration to completion. Complex I can be varied into two options: barbell (BB) and dumbbell (DB) variations. Depending on type of equipment utilized (barbell or dumbbells) should determine which complex variation is performed.

Javorek presents the main purposes for this complex was to try and give more variation to a workout, to change the same day-to-day workout routines, to “shock” an athlete’s muscles after a hard competition season and to stimulate the muscular growth or endurance in the preparatory period, and to build up a specific endurance and cardiovascular capacity (Javorek, 1988). Javorek presents several examples where utilizing Complex I has shown very good overall improvement in all the athletes that were tested.

CHAPTER III

METHODOLOGY

Experimental Approach to the Problem

To determine the physiological demands associated with the barbell (BB) and dumbbell (DB) complexes selected for this study, crossover design was used. Fifteen (n=15) female subjects were randomly assigned to one of two groups (G1 and G2). Subjects then performed either a barbell or dumbbell complex while physiological data was collected via heart rate (HR) monitoring and a VO2 analyzing device. Subjects met one-on-one with the researcher for three sessions over a three-week duration with at least 48 hours between sessions. Week one consisted of subject baseline measurements and familiarization, while data collection took place during sessions two and three. G1 performed the BB complex while G2 performed the DB complex during week one and groups crossover during week two. This data was then analyzed to quantify and compare the physiological demands of the BB and DB complex performed.

Subjects

A sample of physically active female subjects were used for the study (n = 15, age = 23 ± 4, body mass = 65.34 ± 6.27 kg, body mass index = 23.86 ± 1.79). All subjects had at least one year of resistance training experience and were currently training at least twice per week (estimated VO2max = 41.91 ± 1.63, estimated HRmax = 197 ± 4.00). No subjects in the study had a current musculoskeletal injury or injury within the past 6 months, respiratory illness, metabolic, neurologic, or cardiovascular disease. All subjects were assessed during familiarization to ensure ability to perform one round of Javorek Complex: BB and DB variations with proper technique. Prior to participation, all subjects signed an informed consent form and completed a health history questionnaire to ensure eligibility and address any safety concerns related to exercise.

Table 1: Descriptive Characteristics of Sample (n = 15)			
Age	Minimum	Maximum	Mean ± SD
Age (yrs)	19	33	23 ± 4
H (cm)	155	176	165.44 ± 5.99
BW (kg)	53.80	75.89	65.34 ± 6.27
BMI	21	28	23.86 ± 1.79
Est. HRmax (bpm)	187	201	197 ± 4
Est. VO2max (ml.kg.min)	38.69	44.17	41.91 ± 1.62

<u>Procedures</u>

All sessions took place indoors in the human performance lab and the applied neuromuscular physiology lab at Oklahoma State University. Subjects completed an informed consent form and health history questionnaire prior to session one.

Materials

This study utilized the VO2 Master Mask (VO2 Master Health Sensors, Inc., Vernon, BC, Canada) and the TICKR Heart Rate Monitor (Wahoo Fitness, Atlanta, GA, USA) for heart rate and ventilatory measurements during testing. The VO2 Master showed an acceptable validity and test-retest reliability for most intensities tested during an oxygen consumption and ventilation assessment when compared to a criterion measure from the Parvomedics TrueOne 2400 metabolic cart (Parvomedics, Inc., Salt Lake City, UT, USA) (Vondrasek et al., 2020). This previous study presents the VO2 Master as an acceptable measuring tool for acute heart rate and metabolic data collection during a complex exercise.

Session 1: Baseline Measurements and Familiarization

Height (cm) and body weight (BW [kg]) of each subject was recorded upon arrival to session one for body mass index (BMI) calculation using BW(kg)/H(cm)^2. To analyze aerobic fitness, subjects completed a 1.5-mile treadmill test wearing a HR chest strap monitor and peak HR was recorded. Time to completion (s) was utilized to estimate maximum oxygen consumption via VO2max (ml/kg/min) = 88.020 – (0.1656*BW[kg]) – (2.767*time[min]).

After a period of rest, a multiple repetition maximum (MRM) test for an upright row using both BB and DBs was conducted to determine load utilization for testing. Because the upright row is generally considered the weakest movement of Complex I, it has been recommended that intensity should be determined based on this lift (Javorek, 1990). The subject performed a 3-4 RM for upright row using both a BB and DB, then a training load chart was utilized to estimate 40% of the estimated 1-RM for this particular exercise (Landers, 1984). These loads were utilized for all testing sessions.

Proceeding all fitness tests, the subjects were introduced to the testing protocols through instruction and demonstration of the researcher. The subject practiced both variations (BB and DB) of Complex I to prepare for the first testing session during week two. The researcher answered questions and cued correct technique until the subject performed both versions of Complex I properly. A list of each of the exercises performed during the BB and DB complex, in sequential order, are displayed in Figure 1.

Figure 1: Exercises and Repetitions by Modality of Complex I	
Barbell	Dumbbell
BB Upright Row x 6	DB Upright Row x 6
BB High Pull Snatch x 6	DB High Pull Snatch x 6
BB Behind the Head Squat Push Press x 6	DB Behind the Head Squat Push Press x 6
~~BB Behind the Head Good Morning x 6~~	DB Bent Over Row x 6
BB Bent Over Row x 6	DB High Pull Snatch x 6
BB High Pull Snatch x 6	

Originally, Javorek included 6 repetitions of good mornings in the BB variation of Complex I. To ensure consistency of repetitions and sets of both groups and both variations, the good morning was excluded from the BB variation of Complex I. This modification allows for a more accurate and direct comparison between groups.

Session 2: Data Collection

During week two, G1 performed the BB complex while G2 performed the DB variation for the first data collection session. Test subjects warmed up via submaximal treadmill for three minutes. Two devices analyzing respiration and HR were applied and calibrated by the researcher. A VO2 Master Mask was applied over mouth and nose for metabolic analysis and the TICKR Heart Rate Monitor chest strap was fastened across the chest. The researcher then ensured both devices were properly connected via Bluetooth to a smartphone using the VO2 Master mobile application and properly calibrated as the final step before testing.

With researcher's vocal cue and position spotting, the subject performed a single round of Complex I. The subject was encouraged to keep a consistent pace, work at vigorous effort, and take no rest until the end of the set.

For each modality (BB and DB) load utilized (40% 1-RM [lb.]), time to completion (s) and the following average (avg) and maximum (max) variables were recorded for analysis: heart rate (HR avg and HR max [bpm]), relative heart rate (%HR avg and %HR max), oxygen consumption (VO2 avg and VO2 max [mL/kg/min]), respiratory frequency (RF avg and RF max [bpm]) minute ventilation (VE avg and VE max [L/min]), ventilatory equivalents for oxygen (VE/VO2 avg and VE/VO2 max), fraction of expired oxygen (%FE O2 avg and % FE O2 max). Metabolic equivalents (METs) and total energy expenditure (EE [kcal]) was calculated via EE = (time to completion [min])*(MET*3.5*BW[kg]) and recorded for analysis.

Session 3: Data Collection

During week three of the study, groups performed a crossover and switched from barbell to dumbbell (or vice-versa). Subjects executed Complex I in the same manner in which it was performed during week two using the different modality (e.g., BB or DB). Procedures were repeated from the first testing session and the same measurements were recorded each session. During testing sessions, subject's technique was closely monitored during the exercise performance to ensure proper lifting technique and safety.

<u>Statistical Analysis</u>

A paired samples t-test is performed using SSPS as a cross-platform software program for conducting analysis. Factor I will consist of the visit or condition, while factor two will be the time within each visit (post-workout). Independent variables for the study include both Javorek Dumbbell Complex I and the modified Javorek Barbell Complex I. Dependent variables include metabolic outcome variables in response to exercise. Standard statistical measures will be used for calculation of means and standard deviations. Alpha level (α) for all tests was set at $p \leq 0.05$.

CHAPTER IV

RESULTS

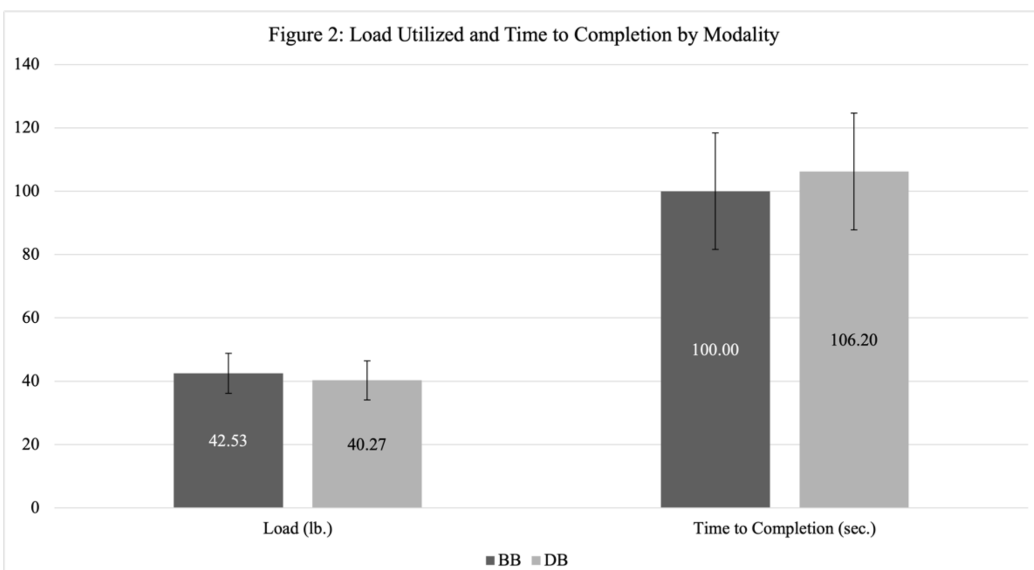
All data from the initial sample (n = 15) was used for statistical analyses and are included in the results. All descriptive data for both BB and DB complexes is displayed in Table 2.

Table 2: All Variables by Modality		
Variable	BB	DB
Load Utilized (40% 1-RM) (lb)	42.53 ± 6.3	40.27 ± 6.14
Time to Completion (s)	100.00 ± 18.38	106.20 ± 18.42
HR avg (bpm)	156.60 ± 11.38	161.60 ± 9.9
HR max (bpm)	174.93 ± 12.45	177.47 ± 11.93
% HR avg	79.5% ± 5.66%	82.06% ± 5.24%
% HR max	88.88% ± 7.31%	90.17% ± 7.02%
VO2 avg (mL/kg/min)	33.89 ± 2.45	35.31 ± 3.06
RF avg (bpm)	31.69 ± 0.77	34.79 ± 4.42
RF max (bpm)	33.95 ± 3.47	37.37 ± 4.04
TV max (L)	3.2 ± 0.76	3.22 ± 0.54
VE avg (L/min)	85.97 ± 15.92	101.13 ± 19.13
VE max (L/min)	105.89 ± 23.48	122.07 ± 27.22
VE/VO2 avg (mL/kg/min)	26.08 ± 4.01	28.26 ± 3.59
VE/VO2 max (mL/kg/min)	31.56 ± 5.67	30.23 ± 4.63

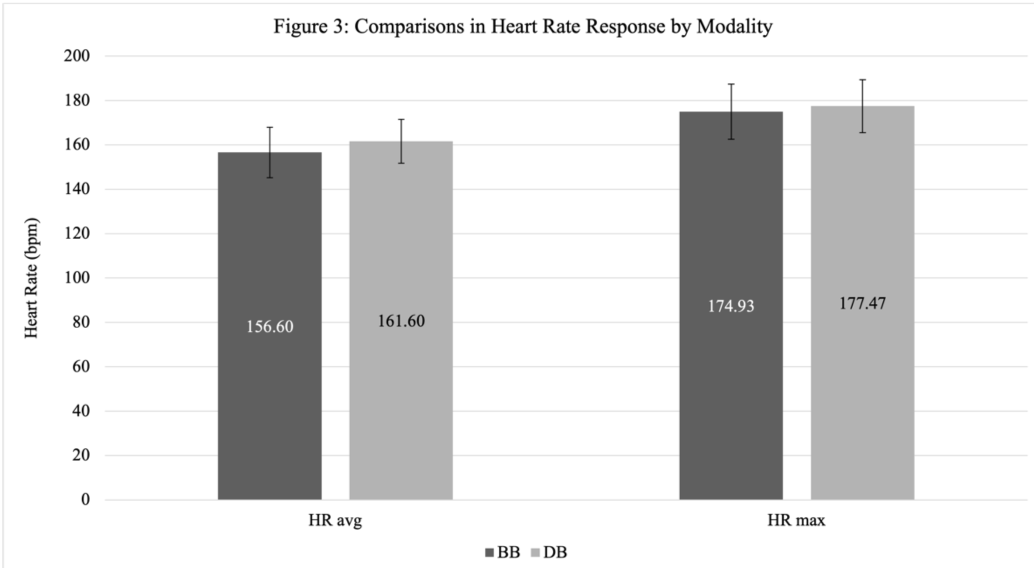
% FEO2 avg	15.64 ± 0.78	16.30 ± 0.73
% FEO2 max	17.21 ± 1.01	17.14 ± 0.89
MET avg	9.68 ± 0.7	10.09 ± 0.88
MET max	11.42 ± 1.45	11.11 ± 0.92
EE (kcal)	18.29 ± 3.53	15.84 ± 3.03

The table presents significant t-variables in load utilized ($p \leq 0.001$), HR avg ($p \leq 0.001$), HR max ($p \leq 0.001$), %HR avg ($p \leq 0.001$), %HR max (≤ 0.001), VO2 avg ($p \leq 0.05$), RF avg ($p \leq 0.05$), RF max ($p \leq 0.01$), VE avg ($p \leq 0.05$), VE/VO2 avg ($p \leq 0.05$ level), %FEO2 avg ($p \leq 0.01$), MET avg ($p \leq 0.05$), and EE ($p \leq 0.05$).

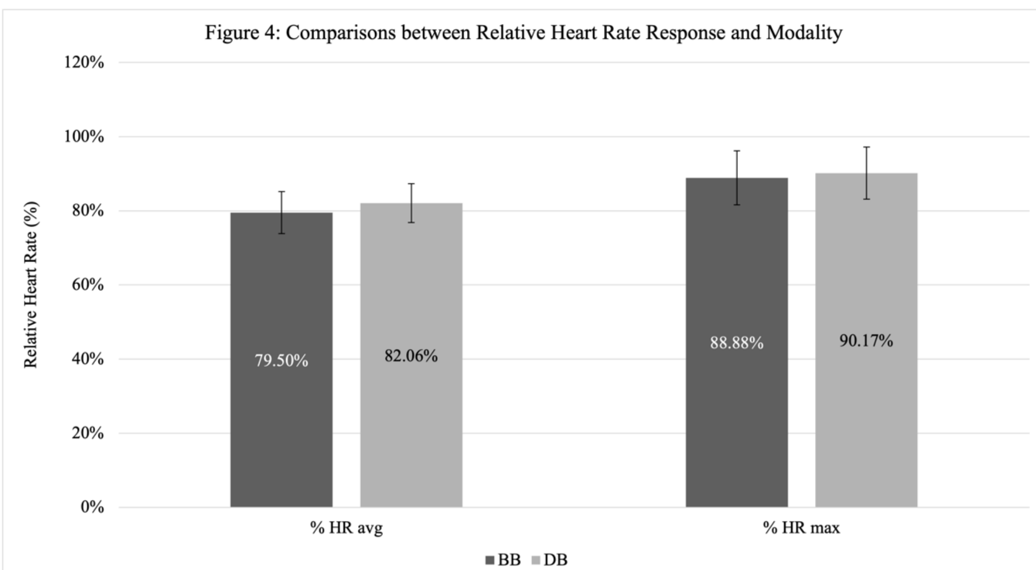
The paired samples t-tests indicated significant differences in load utilized (BB = 42.53 ± 6.30 lb., DB = 40.27 ± 6.14 lb., $p \leq 0.001$) between complex modalities with overall higher loads with BB. Furthermore, no significant differences were observed for time to completion between BB and DB complexes (Figure 2).



Significant differences were observed in HR avg (BB = 156.60 ± 11.38, DB = 161.60 ± 9.90, $p \leq 0.001$) and HR max (BB = 174.93 ± 12.45, DB = 177.47 ± 11.93, $p \leq 0.001$) (Figure 3).

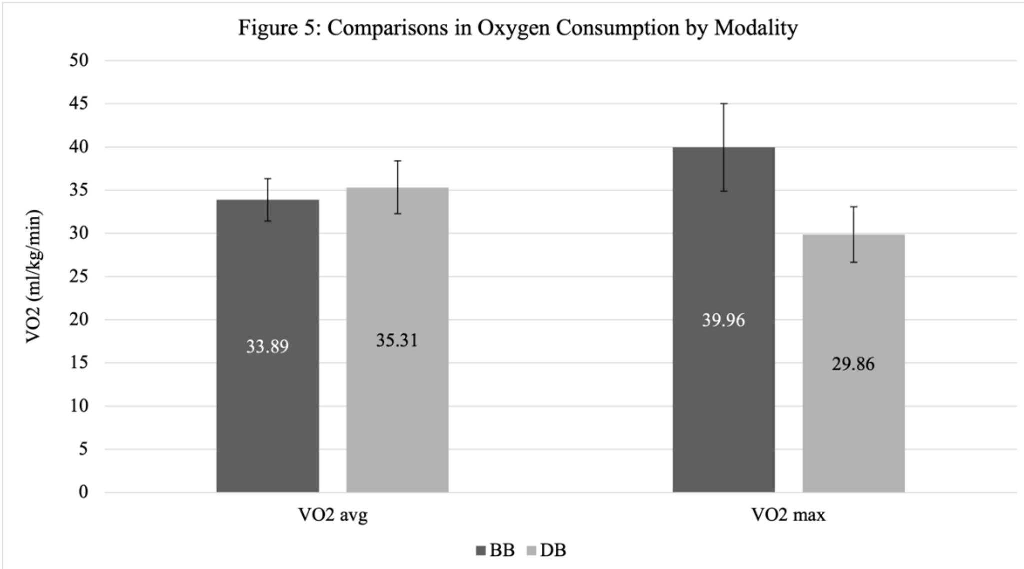


Significant differences were observed in %HR avg (BB = 79.5% ± 5.66%, DB = 82.06% ± 5.24%, $p \leq 0.001$) and %HR max (BB = 88.88% ± 7.31%, DB = 90.17% ± 7.02%, $p \leq 0.001$) between modalities with overall greater responses using DBs (Figure 4).

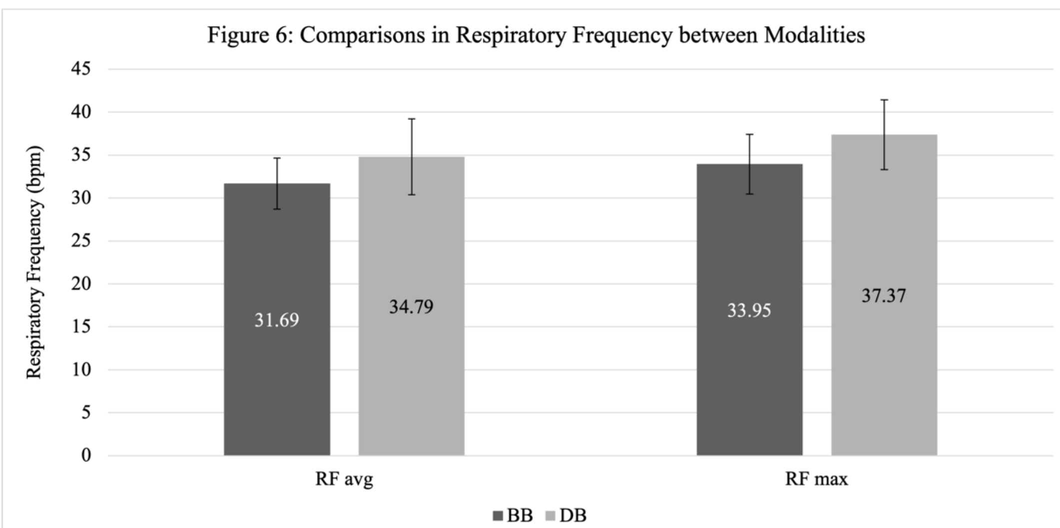


Significant differences were also observed between VO2 avg by modalities (BB = 33.89 ± 2.449, DB = 35.31 ± 3.06, $p \leq 0.05$) with overall higher average oxygen consumption with DBs

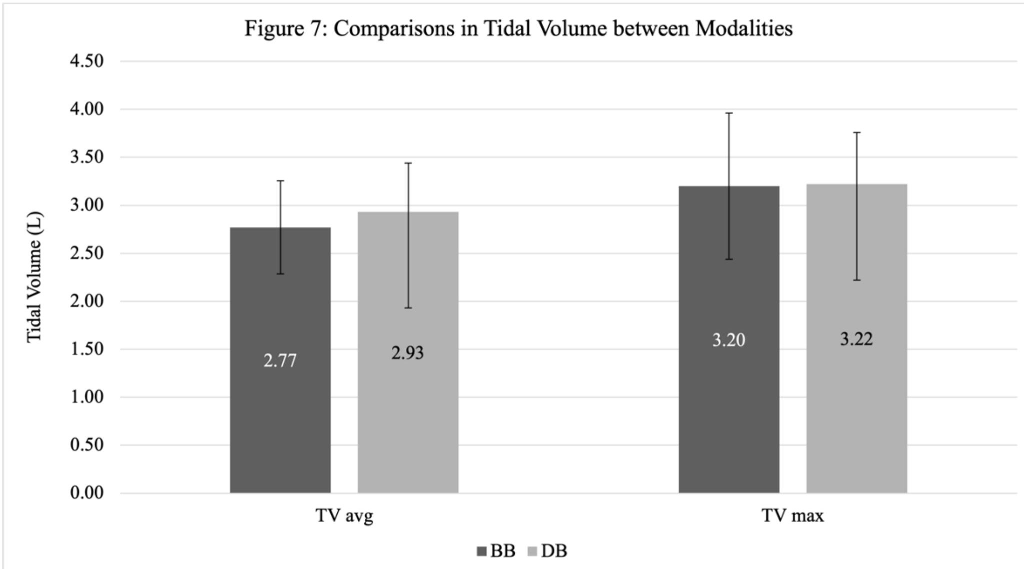
(Figure 5). No significant differences are observed for VO2max between BB and DB complexes.



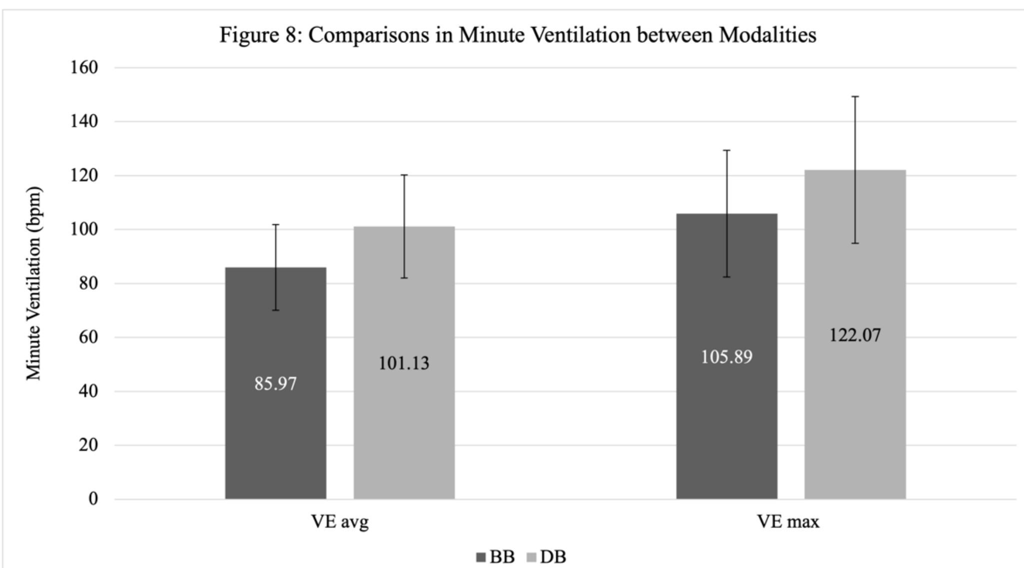
Significant differences are observed in the between RF avg (BB = 31.69 ± 0.77, DB = 34.79 ± 4.42, $p \leq 0.05$) and RF max (BB = 33.95 ± 3.47), DB = 37.37 ± 4.04, $p \leq 0.01$) for each modality with overall higher values with DB (Figure 6).



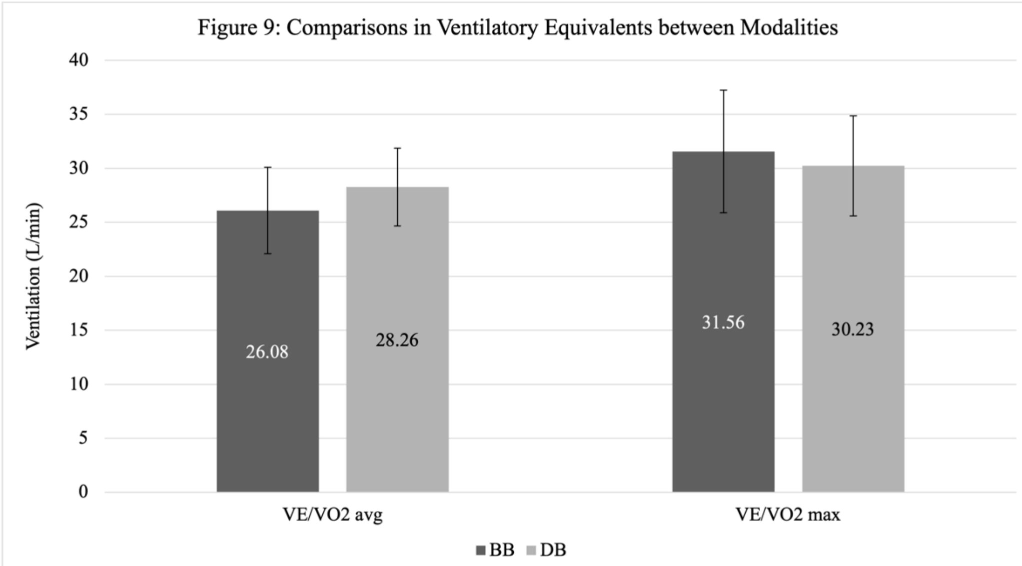
There are no significant differences observed comparing tidal volume between modalities (Figure 7).



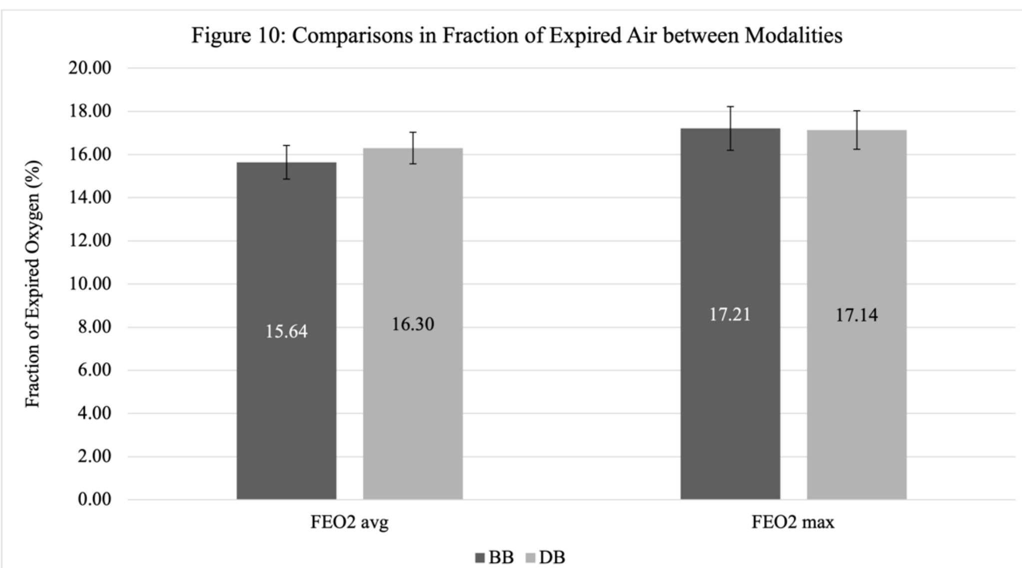
Significant differences are observed between average minute ventilation (BB = 85.97 ± 15.92, DB = 101.13 ± 19.13, $p \leq 0.05$ and modality (Figure 8). Results showed an overall higher VE avg with DBs. No significant differences are observed for VE max between complexes.



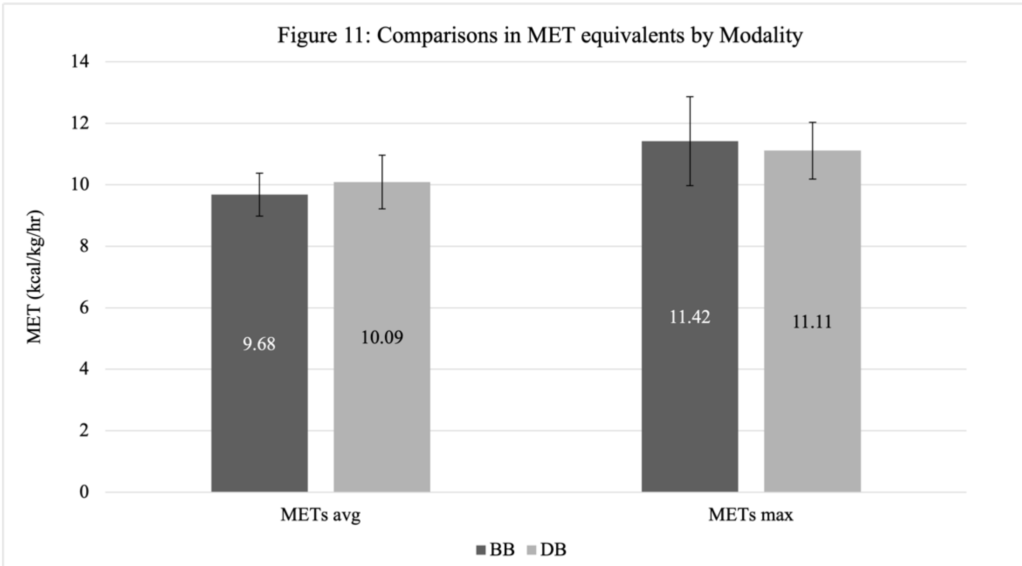
Significant differences in average ventilatory equivalents for oxygen are seen between modalities (BB = 26.08 ± 4.01, DB = 28.26 ± 3.59, $p \leq 0.05$ level) (Figure 9). Results show greater VE/VO2 avg using DBs as compared to BBs. No significant differences are seen between modality and VE/VO2 max.



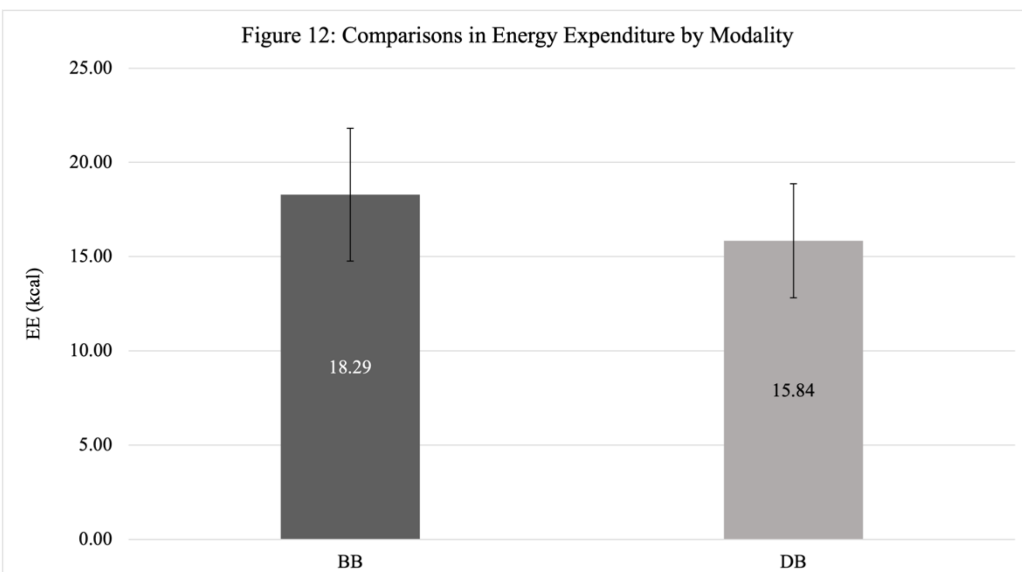
The results show significant differences between average fraction of expired air (BB = 15.64 ± 0.78, DB = 16.30 ± 0.73, $p \leq 0.01$) and modality. FEO2 avg is significantly higher with DBs (Figure 10). No significant differences are seen between maximum fraction of expired air and modality.



Significant differences are observed in average METs by modality (BB = 9.68 ± 0.70, DB = 10.09 ± 0.88, $p \leq 0.05$) with overall higher METs using DBs (Figure 11). This group shows no significant differences in maximum MET values.



Observable differences are noted between energy expenditure and modality (BB = 18.29 ± 3.53, DB = 15.84 ± 3.03, $p \leq 0.05$) (Figure 11). EE (kcal) was greater overall with BBs as compared to DBs.



CHAPTER V

DISCUSSION

This study aimed to analyze the acute physiological effects of complex training when comparing between barbell and dumbbell modalities. The main finding of this study indicated that there were significant differences between modalities in all variables measured besides time to completion and tidal volume. The DB complex resulted in greater heart rate, oxygen uptake, respiratory frequency, ventilation, and fraction of expired oxygen, and METs compared to the BB modality. The BB complex resulted in significantly higher caloric energy expenditure than the DB complex. The results of this study can be used by coaches to implement complex training into their programs dependent on performance outcome goals.

It was discovered that subjects, on average, were able to lift greater loads when performing the BB variation of the modified Javorek complex (Figure 2). This may be due to the unstable nature of carrying two dumbbells as opposed to one barbell. The BB and DB complex may differ biomechanically affecting the stress on the working muscles throughout the movement (Frost et al., 2010). For example, gripping two hands on one BB omits the opportunity for asynchronized movement of the upper extremities as compared to lifting one DB in each hand. This potential for unequal torque with DBs requires increased muscle activation of the stabilizer muscles and may contribute to the observed differences in load utilized between the two modalities (Farias et al., 2017). Therefore, the demands placed on stabilizer muscles should be considered when using DBs for sports specific training protocols.

While the DB complex had overall lower loads utilized and therefore lower intensities than BB, all heart rate and respiratory responses were significantly greater compared to the BB modality. The dumbbell modality elicited elevated HR responses versus the barbell modality (Figures 3 and 4). Furthermore, the lighter load with the dumbbells allows for increased movement velocity by the athlete (Reid et al., 2015). This higher movement velocity with DBs likely contributed to elevated HR responses and respiratory rates, causing higher aerobic responses compared to using BB (Figure 6).

In addition, elevated oxygen consumption, minute ventilation, ventilatory equivalents for oxygen, and fraction of expire air were seen with DBs (Figures 5, 8, 9, and 10). Considering the resistance trained sample, it is likely that VO2 increases were seen with increased HR due to positive correlations between these variables during exercise (Gastinger et al., 2009). Greater METs were also observed with DBs versus BBs (Figure 11). Metabolic equivalents are measured based on the relative oxygen cost of the activity, so it is also suggested here that higher METs are observed with an increase in relative VO2 (Jette & Blumchen, 1990).

The final significant observation to consider is greater energy expenditure with BBs compared to DBs (Figure 12). Total work is represented as the product of repetitions and load utilized (Hong et al., 2010). Because both modalities had equal total repetitions (5 exercises x 6 reps = 30 total reps) using higher loads increases work demands which likely contributes to the EE findings.

Limitations of this study utilized a population of resistance trained females (n=15), so physiological differences in sex and fitness level should be considered in further research since these are both factors that affect acute responses to exercise. Furthermore, while the sample reported resistance training experience, a majority of the sample had no experience with complex training or specific lifts used in this particular complex. A 1-RM test requires experience and true perception of performing to maximum effort. Because a majority of this sample was newly familiarized with Olympic movements such as the upright row, researchers were unable to determine if the baseline 1-RM determination test elicited a true one repetition maximum of the lift. A final limitation to note is the generalization that acute physiological responses lead to long-term athletic enhancement with continued training. Further research on this topic should test longitudinal performance outcomes to analyze potential benefits with complex training.

Quantifying acute physiological responses to two complex modalities allows for comparison of physical demands between the two. As shown in previous literature, regular exercise leads to improvements in muscular strength, endurance and power, aerobic capacity, and metabolic efficiency (Whaley et al., 2006). Athletes and coaches may be limited by time restraints and equipment accessibility. Both BB and DB complexes elicited physiologic outputs that may lead to long-term benefits when training with both modalities. Considering the short duration of time necessary for one round of Complex I and the basic equipment requirements, this may aid in exercise adherence and training feasibility for athletes. Finally, complex training with modality variation may be used as an effective training method for endurance and strength enhancement.

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APPENDICES

Appendix A – IRB Approval

Oklahoma State University Institutional Review Board

Date:	04/01/2022
Application Number:	IRB-22-91
Proposal Title:	Total Caloric Expenditure During a 1-Round Bout of Javorek Complex I: Barbell vs. Dumbbell Variation
Principal Investigator:	Tyra Buehner
Co-Investigator(s):	Blake Kincannon
Faculty Adviser:	Doug Smith
Project Coordinator:	Jay Dawes, Michael Trevino
Research Assistant(s):	
Processed as:	Expedited
Expedited Category:	

Status Recommended by Reviewer(s): Approved
Approval Date: 04/01/2022

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which continuing review is not required. As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent, and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a status report to the IRB when requested
3. Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
4. Maintain accurate and complete study records for evaluation by the OSU IRB and, if applicable, inspection by regulatory agencies and/or the study sponsor.
5. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

Appendix B – Informed Consent Form

School of Kinesiology, Applied Health and Recreation

RESEARCH PARTICIPATION INFORMED CONSENT FORM

TOTAL CALORIC EXPENDITURE DURING A 1-ROUND BOUT OF JAVOREK COMPLEX I: BARBELL VS. DUMBBELL VARIATION

Background Information

You are invited to participate in a research study comparing the short-term metabolic effects of performing a single-round bout of Javorek Complex I (a type of submaximal resistance circuit training): Barbell vs. Dumbbell variation. You were selected as a possible participant because you fit the necessary inclusion criteria. We ask that you read this form and ask any questions you may have before agreeing to be in the study. Your participation is entirely voluntary.

This study is being conducted by: Tyra Buehner & Blake Kincannon, College of Education and Human Science, Oklahoma State University, under the direction of Dr. Doug Smith, College of Education and Human Sciences, Oklahoma State University.

Procedures

If you agree to be in this study, we would ask you to do the following things:

- Complete a physical activity readiness questionnaire, informed consent form, and health history form
- If medical clearance is required, one must be obtained from a physician before participating
- Attend 3 one-on-one sessions with the research investigator over a 3-week duration, 1 session per week.
  - Week 1: Session 1 – Familiarization session and pre-assessment protocol
  - Week 2: Session 2 – Testing Day 1
  - Week 3: Session 3 – Testing Day 2
- Session 1 – Familiarization session and pre-assessment protocol
  - Complete height, weight, and body composition tests
  - Perform a 1-RM test for upright row using both dumbbells and barbell
  - Perform a 1.5 mi. treadmill test wearing the chest strap heart rate monitor
  - Familiarize to the testing protocols through instruction and demonstration of the researcher
    - Learn and practice both variations (BB and DB) of Complex I to prepare for the first testing session during week two
- Session 2 – Testing Day 1
  - 5-10 min. warm-up using light load dumbbells and barbells
  - Wear the VO2 Master Mask and chest strap heart rate monitor for duration of complex (2-6 min. dependent upon participant's fitness level)
  - Perform a single-bout of Javorek Complex I: BB or DB variation (dependent on random assignment)
    - Upright Row x 6
    - High Pull Snatch x 6
    - Behind the Head Squat Push Press x 6
    - Bent Over Row x 6
    - High Pull Snatch x 6
- Session 3 – Testing Day 2
  - Repeat of Testing Day 1
  - Participant will perform either BB or DB variation, dependent on random assignment (whichever was not performed the previous week).

Participation in the study involves the following time commitment: 3 sessions of 1-hour or less over a 3-week period (maximum time commitment: 3 hours total)

Participant Inclusion Criteria

Participants are eligible for the study as long as you meet the criteria for inclusion and do not meet the criteria for exclusion.

You are ELIGIBLE to participate in the study if you meet the following criteria:

- 18-35 years of age
- At least 1 year of resistance training experience
- Currently resistance training at least 2 times per week

You are INELIGIBLE to participate in the study if you meet the following criteria:

- Below 18 years of age or above 35 years of age
- Current musculoskeletal injury or injury within the last 6 months
- Respiratory illness, or metabolic, neurologic, or cardiovascular disease

If you are unsure of your eligibility requirements, you may contact the principal investigator of the study for screening.

Risks and Benefits of being in the Study

The study involves the following foreseeable risks: Potential risks associated with the study include injury pertaining to weight-lifting movements and physical activity. All sessions are supervised by a certified personal trainer with CPR/First Aid/AED certifications. As a resistance-trained individual, it is unlikely that you will experience muscle soreness resulting from the trials. Safety of all participants is our number one priority. In order to assist with the offset of these risks, experienced researchers in the field of exercise science will supervise all sessions. Proper form and equipment usage will be ensured to lower risk of injury. In case of injury or illness resulting from this study, emergency medical treatment will be available by the research investigator, emergency response team in the building, and emergency services may be activated at any time. No funds have been set aside by Oklahoma State University to compensate you in the event of illness or injury.

What Steps Are Being Taken to Reduce Risk of Coronavirus Infection?

The following steps are being taken to address the risk of coronavirus infection:

Screening: Researchers and participants who show potential symptoms of COVID-19 (fever, cough, shortness of breath, etc.) will NOT participate in this study at this time.

Physical distancing: Whenever possible, we will maintain at least 6 feet of distance between persons while conducting the study.

Mask/Covering: Researchers will wear and participants will be advised to shield their mouth and nose with a cloth face cover or mask during the study, even when maintaining at least 6 feet of distance. Tissues will be available to cover coughs and sneezes.

Handwashing: Researchers and participants will wash hands before/during the focus group or use a hand sanitizer containing at least 60% alcohol.

Disinfecting materials: We will clean and disinfect surfaces between participants, using an EPA-registered disinfectant or a bleach solution (5 tablespoons of regular bleach per gallon of water) for hard materials and by laundering soft materials. Disinfected materials will be handled using gloves, paper towel, plastic wrap or storage bags to reduce the chance of re-contamination of materials.
Electronics: Alcohol-based wipes or sprays containing at least 70% alcohol will be used to disinfect shared touch screens, mice, keyboards, etc. Surfaces will be dried to avoid pooling of liquids.

Psychological Risks:
Some of the questions asked may be upsetting, or you may feel uncomfortable answering them. If you do not wish to answer a question, you may skip it and go to the next question.

The benefits to participation are: Individuals can learn and practice an exercise modality they may not have been exposed to before. Athletes, as well as the general population can benefit from the results by utilizing Javorek's

exercise modalities to improve cardiovascular health, skeletal muscle mass, and overall athletic performance. The results of this study may support utilizing Complex I as an exercise modality for all individuals.
We cannot guarantee or promise that you will receive any benefits from this study.

Compensation

You will receive no payment for participating in this study.

Confidentiality

The information your give in the study will be stored anonymously. This means that your name will not be collected or linked to the data in any way after analysis by the researcher. Only the researchers will know that you have participated in the study. The researchers will not be able to remove your data from the dataset once your participation is complete.

We will collect your information through paper surveys and fitness assessments. This data will be stored on a database with other participant's information on the researcher's password protected personal computer. When the study is completed and the data have been analyzed, the personal identifiers will be deleted. This is expected to occur no later than April 15, 2022. This informed consent form will be kept for 3 years after the study is complete, and then it will be destroyed. Your data collected as part of this research project will not be used or distributed for future research studies.

It is unlikely, but possible, that others responsible for research oversight may require us to share the information you give us from the study to ensure that the research was conducted safely and appropriately. We will only share your information if law or policy requires us to do so. If the researchers learn that you are abusing, neglecting, going to engage in self-harm/intend to harm another, state law requires the researchers report this behavior/intention to the authorities. Finally, confidentiality could be broken if materials from this study were subpoenaed by a court of law.

Voluntary Nature of the Study

Your participation in this research is voluntary. There is no penalty for refusal to participate, and you are free to withdraw your consent and participation in this project at any time. The alternative is to not participate. You can skip any questions that make you uncomfortable and can stop the survey at any time.

Contacts and Questions

The Institutional Review Board (IRB) for the protection of human research participants at Oklahoma State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator(s), Tyra Buehner, tyra.buehner@okstate.edu or Blake Kincannon, blake.kincannon@okstate.edu. If you have questions about your rights as a research volunteer or would simply like to speak with someone other than the research team about concerns regarding this study, please contact the IRB at (405) 744-3377 or irb@okstate.edu. All reports or correspondence will be kept confidential.

You will be given a copy of this information to keep for your records.

Statement of Consent

I have read the above information. I have had the opportunity to ask questions and have my questions answered. I consent to participate in the study.

Signature:____ Date: _________

Signature of Investigator:____ Date: _________

Appendix C – Exercise Status Questionnaire

SCHOOL OF
KINESIOLOGY, APPLIED
HEALTH AND RECREATION

PRE-EXERCISE TESTING HEALTH & EXERCISE STATUS QUESTIONNAIRE

Name ____ Date______________

Home Address____

Phone Number _______________________ Email ________________________

Birthday (mm/dd/yy)____/_____/_____

Person to contact in case of emergency____

Emergency Contact Phone ______________________

Personal Physician ____________________________ Physician's Phone_______________

Gender________ Age ______(yrs) Height ______(ft)______(in) Weight______(lbs)

Does the above weight indicate: a gain____ a loss____ no change____ in the past year?
If a change, how many pounds?___________(lbs)

A. JOINT-MUSCLE STATUS (✓Check areas where you currently have problems)

Joint Areas
( ) Wrists
( ) Elbows
( ) Shoulders
( ) Upper Spine & Neck
( ) Lower Spine
( ) Hips
( ) Knees
( ) Ankles
( ) Feet
( ) Other_____________________

Muscle Areas
( ) Arms
( ) Shoulders
( ) Chest
( ) Upper Back & Neck
( ) Abdominal Regions
( ) Lower Back
( ) Buttocks
( ) Thighs
( ) Lower Leg
( ) Feet
( ) Other___________________

B. HEALTH STATUS (✓Check if you currently have any of the following conditions)

( ) High Blood Pressure
( ) Heart Disease or Dysfunction
( ) Peripheral Circulatory Disorder
( ) Lung Disease or Dysfunction
( ) Arthritis or Gout
( ) Edema
( ) Epilepsy
( ) Multiply Sclerosis
( ) High Blood Cholesterol or Triglyceride Levels
( ) Allergic reactions to rubbing alcohol

( ) Acute Infection
( ) Diabetes or Blood Sugar Level Abnormality
( ) Anemia
( ) Hernias
( ) Thyroid Dysfunction
( ) Pancreas Dysfunction
( ) Liver Dysfunction
( ) Kidney Dysfunction
( ) Phenylketonuria (PKU)
( ) Loss of Consciousness

** NOTE: If any of these conditions are checked, then a physician's health clearance will required.*

SCHOOL OF
KINESIOLOGY, APPLIED HEALTH AND RECREATION

C. PHYSICAL EXAMINATION HISTORY

Approximate date of your last physical examination______________________________

Physical problems noted at that time____

Has a physician ever made any recommendations relative to limiting your level of physical exertion? _________YES __________NO

If YES, what limitations were recommended?___________________________________

____

D. FEMALE REPRODUCTIVE HISTORY

If you are male, skip to Section E.

Did you begin menses within the past year? _________YES _________NO

Have you had consistent menstrual periods for the last 3 months?

YES_________ NO_________

Date of onset of last menstrual period____

Have you used a hormonal contraceptive within the last 3 months?

YES_________ NO_________

E. CURRENT MEDICATION USAGE (List the drug name, the condition being managed, and the length of time used)

MEDICATION	CONDITION	LENGTH OF USAGE
_____________________	______________________________	_________________
_____________________	______________________________	_________________

F. PHYSICAL PERCEPTIONS (Indicate any unusual sensations or perceptions. ✓Check if you have recently experienced any of the following during or soon after *physical activity* (PA); or during *sedentary periods* (SED))

PA	SED		PA	SED	
( )	( )	Chest Pain	( )	( )	Nausea
( )	( )	Heart Palpitations	( )	( )	Light Headedness
( )	( )	Unusually Rapid Breathing	( )	( )	Loss of Consciousness
( )	( )	Overheating	( )	( )	Loss of Balance
( )	( )	Muscle Cramping	( )	( )	Loss of Coordination
( )	( )	Muscle Pain	( )	( )	Extreme Weakness
( )	( )	Joint Pain	( )	( )	Numbness
( )	( )	Other______________________	( )	( )	Mental Confusion

G. FAMILY HISTORY (✓Check if any of your blood relatives . . . parents, brothers, sisters, aunts, uncles, and/or grandparents . . . have or had any of the following)

( ) Heart Disease
( ) Heart Attacks or Strokes (prior to age 50)
( ) Elevated Blood Cholesterol or Triglyceride Levels
( ) High Blood Pressure

( ) Diabetes
( ) Sudden Death (other than accidental)

H. EXERCISE STATUS

Do you regularly engage in aerobic forms of exercise (i.e., jogging, cycling, walking, etc.)? YES NO

How long have you engaged in this form of exercise? ______ years ______ months

How many hours per week do you spend for this type of exercise? _______ hours

What is your fastest 5 km time? ______________

What is your fasted 10 km time? _____________

What is your fasted mile time? _______________

What is your fasted times at other distances not listed? ____________________________________

Do you regularly lift weights? YES NO

How long have you engaged in this form of exercise? ______ years ______ months

How many hours per week do you spend for this type of exercise? _______ hours

What is your back squat 1 repetition maximum (RM)? _____________

What is your deadlift 1 RM? ____________

What is your power clean 1 RM? ____________

What are your other 1 RMs that are not listed? ____

Do you regularly play recreational sports (i.e., basketball, racquetball, volleyball, etc.)? YES NO

How long have you engaged in this form of exercise? ______ years ______ months

How many hours per week do you spend for this type of exercise? _______ hours

Appendix D – PAR-Q+

2021 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	**YES**	**NO**
1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ______	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ______	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Global Physical Activity Guidelines for your age (https://www.who.int/publications/i/item/9789240015128).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION
If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ______________________ DATE ______________

SIGNATURE ______________________ WITNESS ______________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

2021 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1.	**Do you have Arthritis, Osteoporosis, or Back Problems?** If the above condition(s) is/are present, answer questions 1a-1c	If **NO** ☐ go to question 2
1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐ NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐ NO ☐
2.	**Do you currently have Cancer of any kind?** If the above condition(s) is/are present, answer questions 2a-2b	If **NO** ☐ go to question 3
2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	YES ☐ NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐ NO ☐
3.	**Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm** If the above condition(s) is/are present, answer questions 3a-3d	If **NO** ☐ go to question 4
3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐ NO ☐
3c.	Do you have chronic heart failure?	YES ☐ NO ☐
3d.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐ NO ☐
4.	**Do you currently have High Blood Pressure?** If the above condition(s) is/are present, answer questions 4a-4b	If **NO** ☐ go to question 5
4a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
4b.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐ NO ☐
5.	**Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes** If the above condition(s) is/are present, answer questions 5a-5e	If **NO** ☐ go to question 6
5a.	Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?	YES ☐ NO ☐
5b.	Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	YES ☐ NO ☐
5c.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet?	YES ☐ NO ☐
5d.	Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	YES ☐ NO ☐
5e.	Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	YES ☐ NO ☐

2021 PAR-Q+

6.	**Do you have any Mental Health Problems or Learning Difficulties?** This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome If the above condition(s) is/are present, answer questions 6a-6b If **NO** ☐ go to question 7	
6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
6b.	Do you have Down Syndrome **AND** back problems affecting nerves or muscles?	YES ☐ NO ☐
7.	**Do you have a Respiratory Disease?** *This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure* If the above condition(s) is/are present, answer questions 7a-7d If **NO** ☐ go to question 8	
7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
7b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	YES ☐ NO ☐
7c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	YES ☐ NO ☐
7d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	YES ☐ NO ☐
8.	**Do you have a Spinal Cord Injury?** *This includes Tetraplegia and Paraplegia* If the above condition(s) is/are present, answer questions 8a-8c If **NO** ☐ go to question 9	
8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
8b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	YES ☐ NO ☐
8c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	YES ☐ NO ☐
9.	**Have you had a Stroke?** *This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event* If the above condition(s) is/are present, answer questions 9a-9c If **NO** ☐ go to question 10	
9a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
9b.	Do you have any impairment in walking or mobility?	YES ☐ NO ☐
9c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	YES ☐ NO ☐
10.	**Do you have any other medical condition not listed above or do you have two or more medical conditions?** If you have other medical conditions, answer questions 10a-10c If **NO** ☐ read the Page 4 recommendations	
10a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months?	YES ☐ NO ☐
10b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	YES ☐ NO ☐
10c.	Do you currently live with two or more medical conditions?	YES ☐ NO ☐

PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: ____________________

____

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.

2021 PAR-Q+

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1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐ NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐ NO ☐
2.	**Do you currently have Cancer of any kind?** If the above condition(s) is/are present, answer questions 2a-2b If **NO** ☐ go to question 3	
2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	YES ☐ NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐ NO ☐
3.	**Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm** If the above condition(s) is/are present, answer questions 3a-3d If **NO** ☐ go to question 4	
3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐ NO ☐
3c.	Do you have chronic heart failure?	YES ☐ NO ☐
3d.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐ NO ☐
4.	**Do you currently have High Blood Pressure?** If the above condition(s) is/are present, answer questions 4a-4b If **NO** ☐ go to question 5	
4a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
4b.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐ NO ☐
5.	**Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes** If the above condition(s) is/are present, answer questions 5a-5e If **NO** ☐ go to question 6	
5a.	Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?	YES ☐ NO ☐
5b.	Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	YES ☐ NO ☐
5c.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet?	YES ☐ NO ☐
5d.	Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	YES ☐ NO ☐
5e.	Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	YES ☐ NO ☐

VITA

Tyra Buehner

Candidate for the Degree of

Master of Science

Thesis: A PHYSIOLOGICAL DESCRIPTION AND COMPARISON OF A BARBELL AND DUMBBEL COMPLEX AMONG RESISTANCE TRAINED FEMALES

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