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

By

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Title of Study: A PHYSIOLOGICAL DESCRIPTION AND COMPARISON OF A BARBELL AND DUMBBELL COMPLEX AMONG RESISTANCE TRAINED MALES

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Abstract: **PURPOSE:** The purpose of this study was to provide a physiological description and comparison of a single workout complex based on different modalities (barbell and dumbbell) for male test subjects. **METHODS:** Ten (n=10, age (years): 24.40 ± 4.97, height (cm): 179.86 ± 5.79, weight (kg):88.06 ± 17.41, BMI (kg/m^2): 27.15 ± 4.75) healthy male subjects were used for this three-week study. During week one, anthropometric measures were obtained, subjects estimated maximal aerobic capacity (VO2max) was determined during a Cooper 1.5-mile test and estimated 1 repetition maximum (1RM) values were obtained for determination of 40% 1RM of the upright row utilizing dumbbells and barbells. During week two, test subjects were fitted with a VO2 Master analyzer and heart rate monitor prior to performing either the barbell or dumbbell variation of a resistance training complex, utilizing a load of 40%1RM for the upright row. Metabolic and respiratory data including heart rate response, relative heart rate response, oxygen consumption, respiratory frequency, tidal volume, minute ventilation, ventilatory equivalents for oxygen, fraction of expired oxygen, metabolic equivalents, and energy expenditure were recorded throughout the duration of the workout. During week three, test subjects switched modalities of the workout and performed a single round of the complex workout following the same protocols from week two. **Results:** Significant differences in loads utilized for the barbell and dumbbell complexes were observed ($p=0.002$) with the barbell complex having higher values. Significant differences were also observed in time to completion between barbell and dumbbell complexes ($p=0.001$) with barbell complex time to completion being greater. Significant differences in energy expenditure between barbell and dumbbell complexes were also discovered ($p \leq 0.05$) with the barbell complex displaying overall greater caloric demands.

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CHAPTER I

INTRODUCTION

As a response to different exercise modalities, humans can shift the phenotype of their skeletal muscle, resulting in a change in the store of nutrients, type of metabolic enzymes, contractile proteins, and stiffness of the connective tissue (Joyner and Coyle, 2008). The degree of this shift is the result of the frequency, intensity, and duration of exercise, or combination of exercises, in addition to the individual's age, genetics, gender, nutrition, and training history (Joyner and Coyle, 2008). Endurance training produces adaptations in the cardiovascular system and the musculoskeletal system that support an increase in an individual's exercise capacity and performance (Brooks, 2012). Resistance training (weightlifting) leads to an increase in muscle strength and power because of neuromuscular adaptations, increases in muscle cross-sectional area (CSA), and alterations in connective tissue stiffness (Knuttgen and Kraemer, 1987). Resistance training has been utilized for improvements in general fitness, athletic conditioning, overall improvements in health, and prevention/rehabilitation of muscular and orthopedic injury (Carpinelli and Otto, 1998). Both training modes increase the overall athletic performance of an individual but can also contribute to a delayed onset of a range of metabolic diseases (Cartee et al., 2016). Increases in skeletal muscle tissue, or increases in metabolically active tissue, have been shown to significantly increase the rate of fatty acid oxidation, leading to lower cases of obesity and an overall reduction in BMI (DeFronzo et al., 1981). This can be attributed to increases in insulin sensitivity, as well as observed increases in muscle glucose transport via normal induction of GLUT-4 translocation in the plasma membrane (Kennedy et all., 1999).

Individual modes of resistance training and conditioning have been closely examined, and more recently, research of concurrent training is becoming more accessible, possibly due to the popularization of metabolic conditioning (Plisk, 1991). Hickson was perhaps the first individual to investigate the effects of concurrent training (resistance and endurance training combined) on an individual when compared to either mode of training performed alone (Hickson, 1980). His study was performed in 1980 and laid the groundwork for numerous studies investigating adaptations in strength and cardiorespiratory fitness while undergoing a concurrent training plan. Hickson, through his observations, also coined the concept of an "interference effect" regarding strength development during concurrent training. While training for both strength and endurance, human physiology favors endurance adaptations over progressions in strength. Though improvements in strength can still be observed via concurrent training, these changes are seen to a lesser extent than when performing resistance training only (Vechin et al, 2021). Recent studies, however, have provided evidence supporting varied interference effects from concurrent training, based on specific protocols utilized. Studies have provided insight regarding the reduced impact of the interference effect when high-intensity interval training, such as repeat sprint training and sprint interval training, are combined with resistance training protocols, promoting similar gains in muscle strength, mass, and power to resistance training alone. Additional research is still needed.

Purpose

No research exists related to the physiological description and comparison of barbell and dumbbell complexes. The purpose of this study is to determine if significant differences exist between loads utilized, time to completion, heart rate, oxygen consumption, respiratory frequency, tidal volume, minute ventilation, ventilatory equivalents for oxygen, fraction of expired oxygen, and energy expenditure while performing a single round of the Javorek Complex I, utilizing the 40%1RM of the modalities' upright row. It was hypothesized that no significant differences in load utilized, time to completion, or any other physiological measures would be observed between the barbell or dumbbell complexes utilized in this study.

CHAPTER II

LITERATURE REVIEW

The purpose of this literature review is to provide a brief overview of specific concepts important to this research topic. The topic areas discuss in this review will include endurance training, resistance training, concurrent training, complex training, and overtraining. To better understand complex workouts and concurrent training, an understanding of the individual components of the training styles is required. Complex training, as a variation of concurrent training, combines aspects of resistance training and endurance training modalities into a single workout session, to increase performance at an optimal level (Mikkola et al., 2012). While training these modalities individually throughout a mesocycle, favorable adaptations can be attained for the associated performance variables over time. Concurrent training seeks to improve performance variables for both in a time efficient manner, while reducing overall training times and allowing for increased recovery.

Aerobic Endurance Training

Cardiorespiratory endurance training typically entails long duration bouts of exercise performed at moderate or low training intensities (Seals et al., 1984). This form of training has been shown to improve maximal oxygen uptake, increase insulin sensitivity, and produce favorable alterations in plasma lipoprotein-lipid profiles, leading to a reduction in preventable diseases associated with metabolic syndrome. Though weight loss resulting from endurance training alone is not directly linked to alterations in fat oxidation, moderate intensity aerobic exercise combined with weight loss has been shown to increase oxidative enzyme activities, without an increase in mitochondrial DNA, leading to enhanced lipid oxidation in obese skeletal muscle (Berggren et al., 2004). Shifts in respiratory exchange ratios resulting from elevated VO2max levels also make it possible for individuals to utilize fat as an energy substrate at higher levels of workout intensities, when compared to untrained individuals (Volek et al., 2016). From an athletic perspective, endurance training is correlated to reduced lactate, reduced glucose turnover, spared glycogen, and high-energy phosphate content with reduced phosphocreatine breakdown, all occurring before adaptations increased in mitochondrial potential (Phillips et al., 1995). Despite the benefits of endurance training, the duration of time required to conduct training can often lead to poor adherence to a workout program (Trost et al., 2002).

Resistance Training

Resistance training is associated with increases in maximal isometric force production, one repetition maximum values, cross sectional area of targeted muscle groups, and serum testosterone levels leading to greater overall health, fitness, and athletic performance (Ahtiainen et al., 2003). Resistance training can also produce favorable and significant adaptations in the neural drive sent to trained muscles. These adaptations are associated with increases in motor unit discharge rates, decreases in the recruitment-threshold force of motor units, and a similar input-output gain of motor neurons (Del Vecchio et al., 2019). Adaptations or changes resulting from a resistance training protocol are dependent on specific program design or focus of training, including factors such as volume, load, intensity, duration, and rest (Deschenes and Kraemer, 2002). Resistance training becomes increasingly important as an individual ages. Studies have shown that a resistance training program can combat muscle loss (sarcopenia) and associated physiological problems, such as bone loss, metabolic decline, fat gain, diabetes, metabolic syndrome, and all-cause mortality (Westcott, 2012). Research has shown significant increases in resting metabolic rate after several weeks of resistance training in previously sedentary populations. Resting energy expenditure has been found to increase 5-9% in individuals undergoing a resistance training program. Improvements in overall health can be attributed to the fact that skeletal muscle is metabolically active and necessitates more energy at rest for normal tissue maintenance. Repair of microtrauma caused by resistance training can also use a relatively large amount of energy and last for up to 72 hours following a single bout of exercise. Much like endurance training, the time requirements for traditional strength training are often perceived as a barrier to exercise adherence (Trost et al., 2002). Therefore, finding time-efficient training methods to simultaneously develop these physical attributes is of importance to many strength and conditioning practitioners, personal trainers, and gym-goers.

Concurrent Training

Concurrent Training is generally defined as the training of a particular muscle group by utilizing strength and endurance modalities during the same training period (Mikkola et al., 2012). It has been shown to increase maximal isometric concentric force production, muscular hypertrophy, VO2max, and power output in individuals undergoing an appropriate frequency of training (load and volume). Though significant increases in athletic performance have been attributed to concurrent training, a decrease in rate of force production at higher velocities has been observed, leading to reductions in power (Mikkola et al., 2012). During a twenty-one-week training period, Mikkola et al. observed moderate volume concurrent training leading to interference in development of rapid force production in multi-joint and isolated unilateral isometric actions than resistance training alone. This was supported by reductions in angle specific maximal isokinetic torque at fast contraction velocities, but no reductions at slower velocities (Dudley and Djamil, 1985). It was suggested that a reduction in training load or frequency could potentially reduce the interference effect observed, as power production during the squat exercise utilizing a load of 60% 1RM at a frequency of once per week led to increases for individuals undergoing a concurrent training program (Izquierdo et al., 2005).

Circuit training is a form of concurrent training first introduced by R.E. Morgan and G.T. Anderson of the University of Leeds, England in 1953 (Klika and Jordan, 2013). The researchers investigated 9-12 exercise protocols, performed at moderate intensity (40-60% 1RM) for repetitions or designated time durations, with very little associated rest. The workout circuits were designed to improve overall strength endurance, while simultaneously increasing components of aerobic fitness and were deemed high intensity circuit training, or HICT. The main goal of this research was to identify a fast and efficient way individuals could lose excess body weight (fat), increase VO2max, and build strength using a minimal amount of equipment. Since the introduction of circuit training, many styles of concurrent training aimed at simultaneously developing muscular and cardiorespiratory fitness have gained popularity, with each style of training utilizing a unique intensity, volume, and intra-rest period based on the desired outcomes of training (Al-Haliq, 2015). For example, the Army Physical Fitness Test (APFT) examines aerobic and muscular endurance of soldiers following completion of Army Physical Readiness Training (APRT) (Heinrich et al., 2012). Though APRT leads to improvements in aerobic and resistance training variables, Heinrich et al. reference arguments that the APFT does not adequately test combat preparedness based on variables like mobility, strength, and anaerobic fitness. Heinrich et al. performed research examining a new training program deemed Mission Essential Fitness (MEF) utilizing circuit training familiarizing soldier's bodies to movements consistent with their operational environments to achieve enhancements in general fitness. MEF with circuit training was shown to significantly increase performance variables for both strength-endurance and cardiorespiratory endurance, as well as improvements in resting heart rate and heart rate maximum during physical activity and functional movement screening (Heinrich et al., 2012). In an additional study, circuit training was found to match the level of hypertrophy, while imposing a greater cardiovascular load than traditional strength training leading to beneficial adaptations in both cardiovascular function and exercise endurance (Alcaraz et al., 2008).

Complex Training

Complex training is a specialized circuit style workout, specifically designed to increase strength, as well as the endurance characteristics of an athlete and the development of this training methodology is credited to Coach Istvan Javorek (Javorek, 1988). While working as the head coach of the Clujana Sports Association in Cluj, Romania, he began to develop an efficient method for performing consecutive workout modalities that would change the monotony of a workout and at the same time have a greater influence on the neuromuscular system. Coach Javorek developed the Barbell and Dumbbell Complex I and II to be used as lightweight warmups, or a portion of a complete workout utilizing increased loads and intensities.

Originally, Javorek composed his workouts to be utilized during training seasons for athletes, but the principles can be applied to a much wider group if guidelines and form are adjusted. For the preparatory phase of training, it is suggested to perform Complex I, utilizing 60% 1RM for the upright row, every day for two to three sets. As the preparatory phase comes to an end, workouts should be limited to three days per week, with four to five total sets being performed. During the competition phase, the athlete should utilize Complex I as a warm-up, by preforming two sets every day, with an additional three days dedicated to heavier weight workouts for three sets. Javorek recommends discontinuing heavy complex training four weeks before competition, to allow for proper recovery. Complex I is to be performed with a foot raise, to the toes, during the last phase of the high pull snatch and squat push press. This can be omitted for individuals utilizing a load above 60% 1RM, as prescribed for weightlifting conditioning. As training phases progress, special attention should be paid to the quality of lifts performed and the weight being used. If a reduction in quality or quantity of lifts is observed, the individual should reassess the 1RM for the upright row and adjust accordingly. Additionally, frequency of workouts may need to be adjusted to avoid possible overtraining.

An additional consideration to be made for complex workouts, involves the sex of the individual performing the activity. Women are typically more fatigue resistant than men when undergoing isometric contractions at a similar intensity, though fatigue outcomes are dependent on contraction type, intensity, and muscle group examined (Hunter, 2014). Men experience greater levels of sympathetic activation than female counterparts potentially reducing time to exhaustion and muscle voluntary contraction (Hunter, 2009). However, men exhibit lower anxiety, salvatory cortisol levels, heart rate, and blood pressure when exposed to the same environmental conditions as females, leading to less impact on overall performance. Men do exhibit larger muscle cross-sectional area, leading to increased metabolic demand as well as higher levels of blood profusion during sustained contractions, further adding to the complexity of sex related differences (Clark et al., 2005). The reduction in blood supply not only limits the amount of oxygen available to the working muscle group but can also cause an accumulation of metabolites exacerbating peripheral afferent feedback and inhibition, reducing voluntary activation (Gandevia et al., 1996). Reductions in metabolite accumulation can be attributed to the reduction in blood lactate concentration observed in females, as well as lower reductions in ATP concentrations following moderate bouts of exercise (Esbjornsson-Liljedahl et al, 1999). Blood flow restriction in males can also be attributed to greater densities of type II muscle fibers, reducing the number of β2 receptors associated with type I fibers and responsible for vasodilation (Hogarth et al, 2007). Type II muscle fibers do however exhibit faster calcium kinetics, generate greater power, and have reduced times for shortening and relaxation, leading to higher performance during shorter, more intense bouts of exercise (Schhiaffino & Regiani, 2011). Hormonal differences between the sexes tend to favor females regarding fatigue resistance. Females, because of higher circulating estrogen levels, oxidize more fat and lower levels of carbohydrate during moderate to high intensity exercise (Maher et al., 2010). The afore mentioned factors should be considered when planning the intensity and duration of complex exercises to help facilitate performance outcomes and exercise adherence, depending on the desired adaptations (both specific and general) and the individual taking part in the workout. A comprehensive evaluation of the loads and intensities utilized by different training strategies should be considered to define the precise training protocols to produce desired training outcomes for a specific group or population, as different groups will have varied levels of physiological and phycological responses to training (Hawley, 2008). While this study provides valuable insight regarding the physiological description and comparison of two styles of complex workouts, the practical application of this information to a more diverse population of individuals, both in sex and activity level, warrants further investigation.

Overtraining

An important factor in any training program, is the potential for and/or risk of overtraining. Overtraining can be summarized as an imbalance in training frequency, intensity, or duration combined with an insufficient amount of time to properly recover. This phenomenon can be impacted by several external factors including, but not limited to, social, educational, occupational, economical, nutritional, and travel influences (Lehmann et al., 1997). Overtraining is characterized by a glycogen deficit, catabolic imbalance, neuroendocrine imbalance, amino acid imbalance, and an autonomic imbalance (Lehmann et al., 1997). These factors, individually or combined, can reduce overall athletic performance, increase fatigue, negatively alter mood state, increase rate of infections, and suppress reproductive functions (Lehmann et al., 1997).

Lehmann et al., 1997 reports a variety of implications to be considered with overtraining. In endurance activities, it has been found to decrease concentrations of blood glycoproteins and alter lipid metabolism. Length of blood fatty acids were shown to decrease, while the total amount of fatty acid was unchanged, suggesting overtrained endurance athletes experience changes in the liver synthesis of long-chain fatty acids. This alteration in carbohydrate/lipid metabolism results in a higher usage of amino acids for energy, which is more than likely associated with protein catabolism. This shift from typical energy stores (carbohydrates and lipids) to molecular pools of protein from skeletal muscle is a main indicator of overtraining syndrome and leads to significantly reduced work capacity (Petibois et al., 2003). Research indicates increases in maximal strength of the lower muscle groups accompanied by overall reductions in mean power observed in jumping and sprinting performance. These results could be due to increases in muscular hypertrophy, leading to increased maximal force production, while the reduction in maximal power is likely a result of overall fatigue and rate of force production (Bell et al., 2020). As an individual participates in a training program, two after-effects that positively or negatively influence performance are fitness and fatigue (Chiu and Barnes, 2003). As complex workouts are incorporated into an individual's programming, like any other methodology or modality, frequency, duration, and intensity should be scaled to allow for positive adaptation based on stressors experienced, while allowing for proper recovery to maximize the effects of the training session on microcycle, mesocycle, and macrocycle levels (Chiu and Barnes, 2003). A benefit of the complex workouts developed by Javorek are their highly adaptive nature of programming (Javorek, 1990). As an individual progresses through training seasons or personal abilities, workouts can be scaled in load utilized, volume of sets, or frequency of performance, while keeping the ratio of sets between exercises the same. Javorek recommends checking heart rate periodically upon waking, before a workout session, before the complex, and following the complex to better track physical conditioning. Additionally, scaling the intensity of the load utilized should always be taken from the most difficult exercise in the combination, in the case of Complex I the upright row.

While other forms of circuit and concurrent training have been investigated, currently no research exists on the physiological demands of performing barbell and dumbbell complexes. Furthermore, it is unclear as to whether utilizing different training modalities has a different physiological impact on the intensity of a complex. As an approach to this problem, subjects in this study were tested utilizing 40%1RM of the upright row, during two separate (barbell and dumbbell) variations of the complex developed by Javorek.

CHAPTER III

METHODS

Experimental Approach to the Problem

To determine the physiological demands associated with barbell and dumbbell complexes selected for this study a randomized, counterbalanced, crossover design was used. Collection of baseline measures for heartrate and VO2max were obtained, as well as basic anthropometric measurements, including height, weight, and body mass index (BMI). The independent variables measured for the study were the intervention, Javorek Barbell Complex I and Javorek Dumbbell Complex I, while the dependent variables observed included heart rate (HR), oxygen consumption (VO2), respiratory frequency (Rf), tidal volume (TV), minute ventilation (VE), ventilatory equivalents for oxygen (VE/VO2), fraction of expired oxygen (FeO2), metabolic equivalents (MET), and energy expenditure (EE).

Subjects

Subjects included ten (n=10, age: 24.40 ± 4.97, height (cm): 179.86 ± 5.79, weight (kg):88.06 ± 17.41, BMI: 27.15 ± 4.75) healthy male volunteers. All subjects were required to have at least one year of resistance training experience and were currently participating in a resistance training program at least twice per week, were free of musculoskeletal injury, and had not experienced an injury in the past six months based on their information reported on the health history questionnaire. Additionally, subjects completed a health history questionnaire prior to the commencement of this investigation to determine their eligibility for participation. Individuals with known respiratory, metabolic, neurological, or cardiovascular illness or disease were not allowed to participate in this investigation. Furthermore, all subjects voluntarily participated in the investigation and were allowed to withdraw from the study at any time without penalty. All procedures outlined in this investigation were approved by a University Institutional Review Board (IRB-22-91) prior to the start of the study.

Procedures

Testing occurred over a three-week time frame. Week one served as a familiarization period for subjects and during this week, the researcher determined the one repetition max for the upright row, utilizing barbells and dumbbells, as recommended by Javorek (Javorek, 1988). This was estimated by completing a 4-6 repetition maximum and based on the Training Load Chart made available by the National Strength and Conditioning Association (NSCA) (Landers, 1984).

To maintain consistency and increase safety during the study, subjects performing the barbell complex did not execute the barbell behind the head good morning movement. The modified order of movements used during the barbell complex was identical to those used in the dumbbell complex and are as follows: upright row, high pull snatch, behind the head squat push press, bent over row, and high pull snatch. The exact protocol for the Javorek Dumbbell Complex I and the modified version of the Javorek Barbell Complex I are displayed in Tables 3.1 and 3.2.

Table 3.1 Javorek Dumbbell Complex I

DB Up on Toes Upright Row	x 6 Reps
DB Up on Toes High Pull Snatch	x 6 Reps
DB Up on Toes Squat Push Press	x 6 Reps
DB Bent-Over Row	x 6 Reps
DB Up on Toes High Pull Snatch	x 6 Reps

Table 3.2 Javorek Modified Dumbbell Complex I

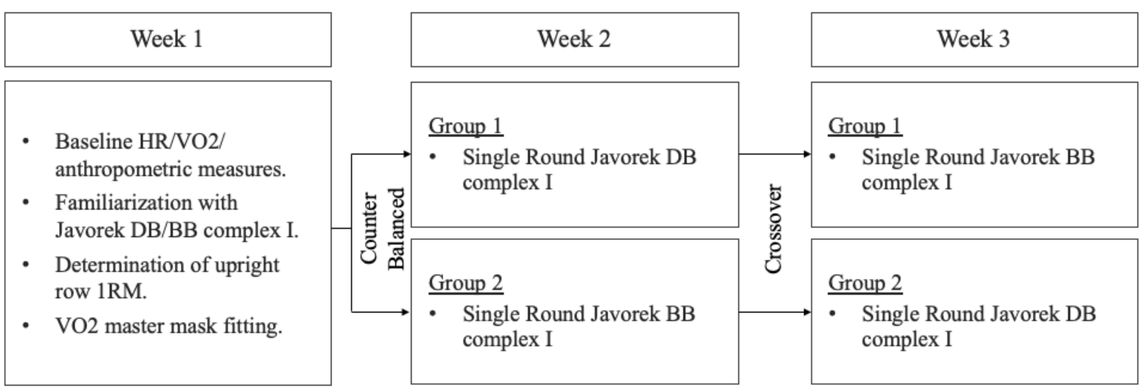
BB Up on Toes Upright Row	x	6 Reps
BB Up on Toes High Pull Snatch	x	6 Reps
BB Up on Toes Behind the Head Squat Push Press	x	6 Reps
BB Bent-Over Row	x	6 Reps
BB Up on Toes High Pull Snatch	x	6 Reps

Experimental Trials

During week two, test subjects were randomly split into one of two groups. Upon arrival, test subjects warmed up by performing a submaximal treadmill walk/jog for three minutes, followed by movement specific exercises using a load <40% 1RM. Following the warmup, one group performed Javorek Barbell Complex I, while the other group performed the modified Javorek Dumbbell Complex I, with each group utilizing the predetermined load of 40% 1RM for the upright row. Heartrate and VO2 were monitored continuously as each participant performed one round of their workout by the VO2 Master analyzer (VO2 Master Health Sensors Inc., Vernon, British Columbia, CA) and Wahoo TICKR HR monitor. Interclass correlation coefficients for the VO2 Master are greater than 0.99, and minimum detectable changes are less than 3.5% for VO2 and 1.5% for VE. The researcher applied and fastened the VO2 Master analyzer and Wahoo TICKR HR monitor to the test subjects prior to engaging in the workout protocol to maintain consistency. The researcher also ensured both devices were properly connected to a smartphone via the VO2 Master App and after calibration protocols were completed, data collection began for the test subject's respective workout. Movements performed within the Javorek complex were completed at a consistent pace, without rest or setting the barbell or dumbbells down until the end of the entire round of work. Metabolic and respiratory data including total volume oxygen consumption (VO2 mL/min), tidal volume (L), respiratory frequency (bpm), ventilation (L/min), fraction of expired oxygen (% FeO2), and total energy expenditure (kcals) were recorded throughout the duration of the workout. Monitoring equipment was thoroughly sanitized after the completion of each round/warm-up.

During week three of the study, subjects switched from barbell to dumbbell, or vice-versa, and executed the Javorek Complex I in the same manner it was performed during week two. Measurements of metabolic and respiratory data were collected in the same manner as week two during this portion of the study. During testing on Week 2 and Week 3, subjects form was closely monitored during the Javorek complexes being tested. If the movements were not performed in a correct and safe manner, the complex workout was stopped, additional instruction was provided, and subjects performed an additional round following a 5-minute passive rest period.

Figure 3.1 Experimental Design by Week



Statistical Analysis

For statistical analysis of data, a series of paired samples *t*-tests were performed, to investigate a single group with two separate trials. SPSS was used as a cross-platform software program for conducting analysis. Independent variables for the study included both Javorek

Dumbbell Complex I and the modified Javorek Barbell Complex I. Dependent variables included load utilized (lb.), time to completion (sec.), heart rate response (HR), relative heart rate response (%HR), oxygen consumption (VO2), respiratory frequency (Rf), tidal volume (TV), minute ventilation (VE), ventilatory equivalents for oxygen (VE/VO2), fraction of expired oxygen (%FeO2), metabolic equivalents (MET), and energy expenditure (EE). Standard statistical measures were used for calculation of means and standard deviations. Alpha level (α) for all tests were set at $p \leq 0.05$.

CHAPTER IV

RESULTS

Descriptive results for anthropometric measurements and cardiorespiratory fitness results for all participants including minimum, maximum, and mean values (± standard deviations) are presented in Table 4.1.

Table 4.1 Descriptive Characteristics of Sample (n=10)

	Minimum	Maximum	Mean Std. Deviation
Age (years)	20.00	34.00	24.40 ± 4.97
Height (cm)	172.00	189.00	179.86 ± 5.79
Bodyweight (kg)	61.20	112.10	88.06 ± 17.41
BMI	18.00	34.00	27.15 ± 4.75
Est. Heart Rate Max (bpm)	186.00	200.00	195.60 ± 4.97
Est. VO2max (mL/kg/min)	21.98	49.81	36.07 ± 8.79

Results of paired samples *t*-tests showed significant differences in loads utilized for the barbell and dumbbell complexes (p=0.002), with the barbell complex displaying significantly higher values. Additionally, significant differences in time to completion between barbell and dumbbell complexes were also observed (p=0.001), with the barbell complex having a significantly higher value. Comparisons in load utilized and time to completion by modality are presented in Table 4.2.

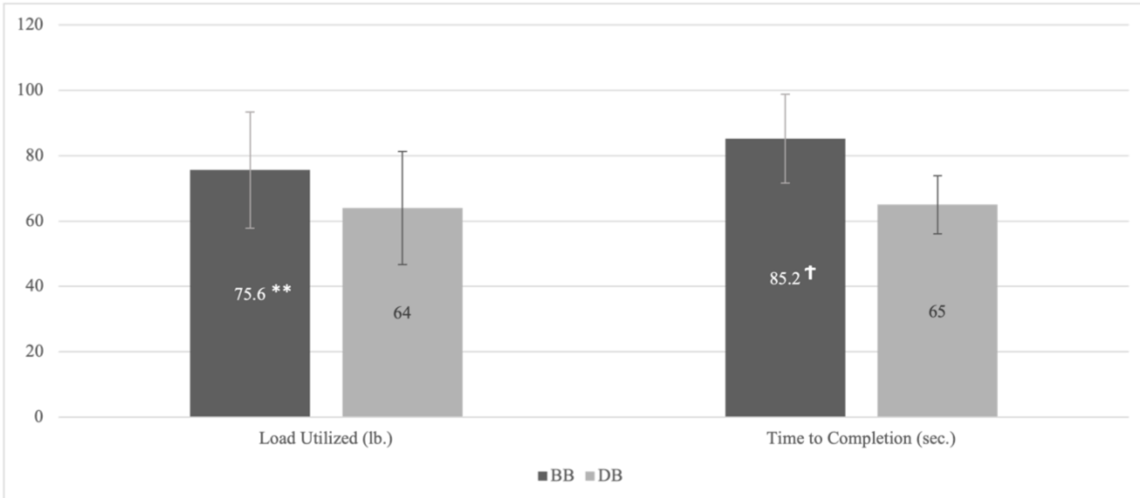
Paired samples *t*-tests also revealed significant differences in energy expenditure between the barbell and dumbbell complex (p=0.001), with the barbell complex having a significantly higher value. No other significant differences were observed in variables by modality ($p > 0.05$).

Table 4.2 Comparisons of all Variables by Modality

Variable	Barbell (BB)	Dumbbell (DB)
Load Utilized (40% 1-RM) (lb.)	75.60**	64.00
Time to Completion (sec.)	85.20 Ϯ	65.00
HR avg (bpm)	141.62 ± 14.90	142.46 ± 43.21
HR max (bpm)	163.50 ± 18.99	148.90 ± 30.12
% HR avg	72.42% ± 7.52%	72.99% ± 22.79%
% HR max	83.64% ± 9.78%	76.18% ± 15.57%
VO2 avg (mL/kg/min)	31.53 ± 9.49	29.86 ± 6.88
VO2 max (mL/kg/min)	47.26 ± 12.72	41.69 ± 8.40
Rf avg (bpm)	35.91 ± 6.46	36.79 ± 6.59
Rf max (bpm)	46.68 ± 9.88	47.46 ± 5.77
TV avg (L)	2.25 ± 1.19	1.99 ± 0.26
TV max (L)	3.18 ± 1.64	2.54 ± 0.34
VE avg (L/min)	75.36 ± 25.43	70.54 ± 14.41
VE max (L/min)	115.09 ± 33.71	99.91 ± 19.10
VE/VO2 avg (mL/kg/min)	29.26 ± 5.00	28.50 ± 4.76
VE/VO2 max (mL/kg/min)	36.41 ± 5.46	32.85 ± 6.11
% FeO2 avg	16.07 ± 0.86	16.03 ± 0.74
% FeO2 max	17.02 ± 0.68	16.68 ± 0.66
MET avg	9.01 ± 2.71	8.53 ± 1.97
MET max	13.50 ± 3.63	11.91 ± 2.40
EE (kcal)	17.05 ± 3.78Ϯ	13.17 ± 2.16

* = ≤ 0.05, ** = p ≤ 0.01, Ϯ = p ≤ 0.001

Figure 4.1 Comparisons in Load Utilized (lb.) and Time to Completion (sec.) by Modality



* = ≤ 0.05, ** = p ≤ 0.01, Ť = p ≤ 0.001

Figure 4.2 Comparisons in Heart Rate Response (HR) by Modality

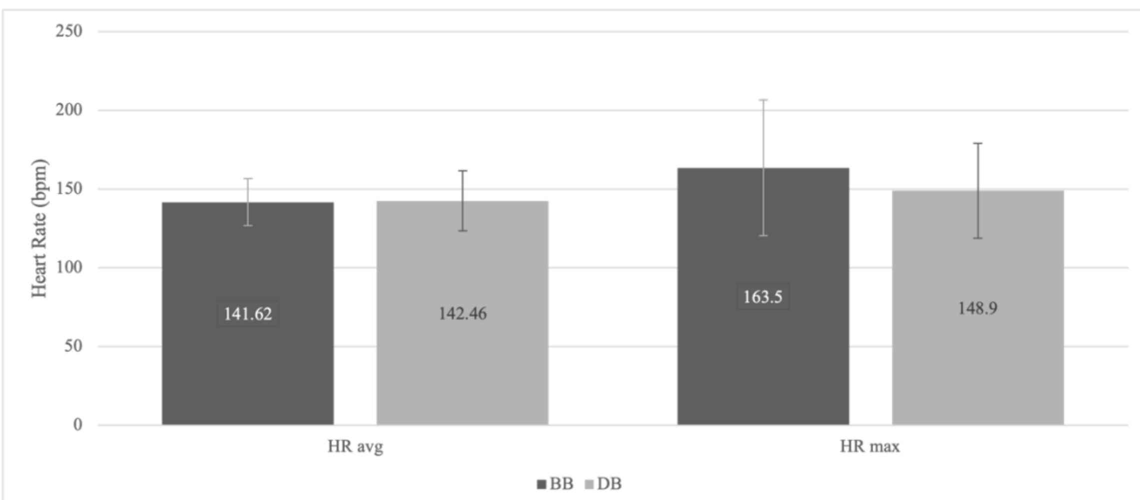


Figure 4.3 Comparisons in Relative Heart Rate Response (%HR) by Modality

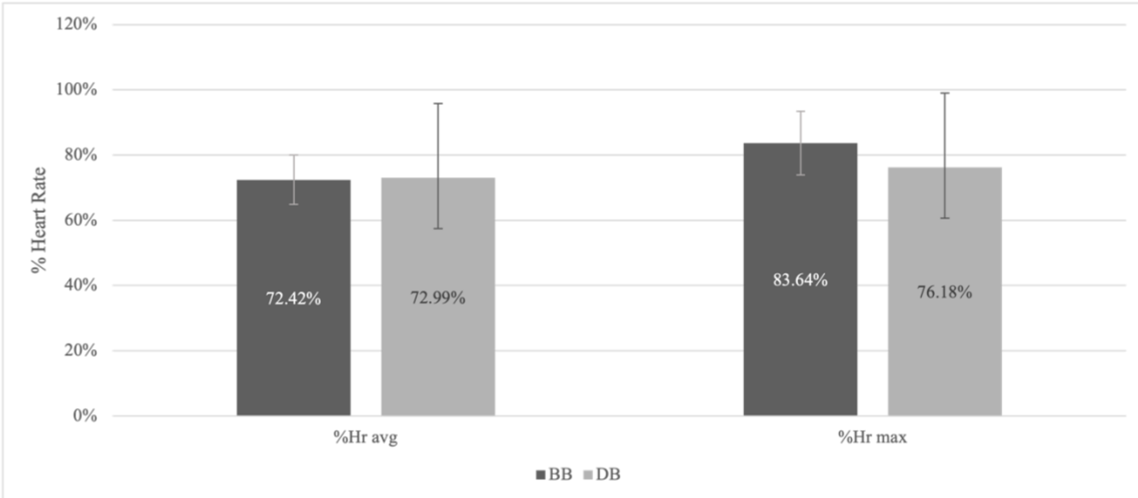


Figure 4.4 Comparisons in Oxygen Consumption (VO2) by Modality

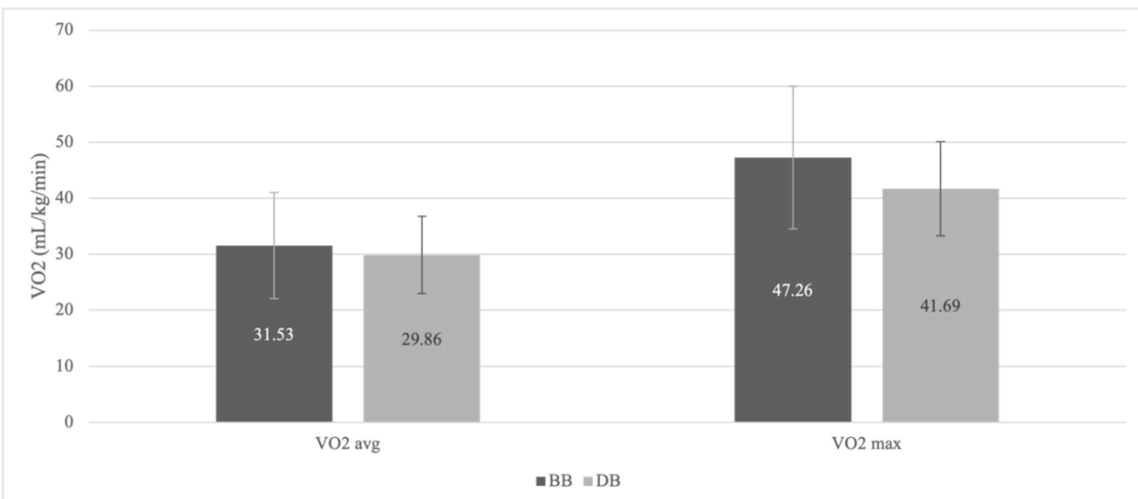


Figure 4.5 Comparisons in Respiratory Frequency (Rf) by Modality

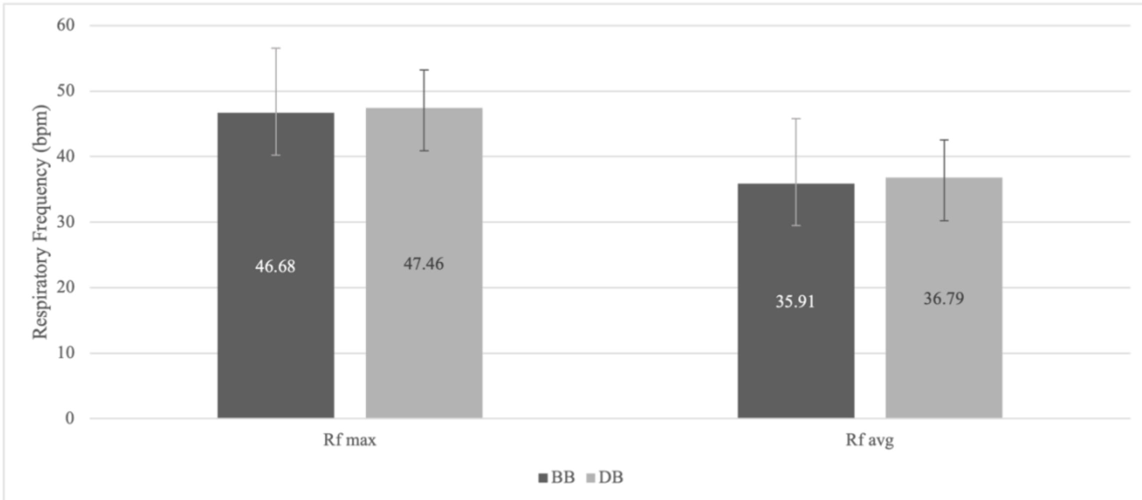


Figure 4.6 Comparisons in Tidal Volume (TV) by Modality

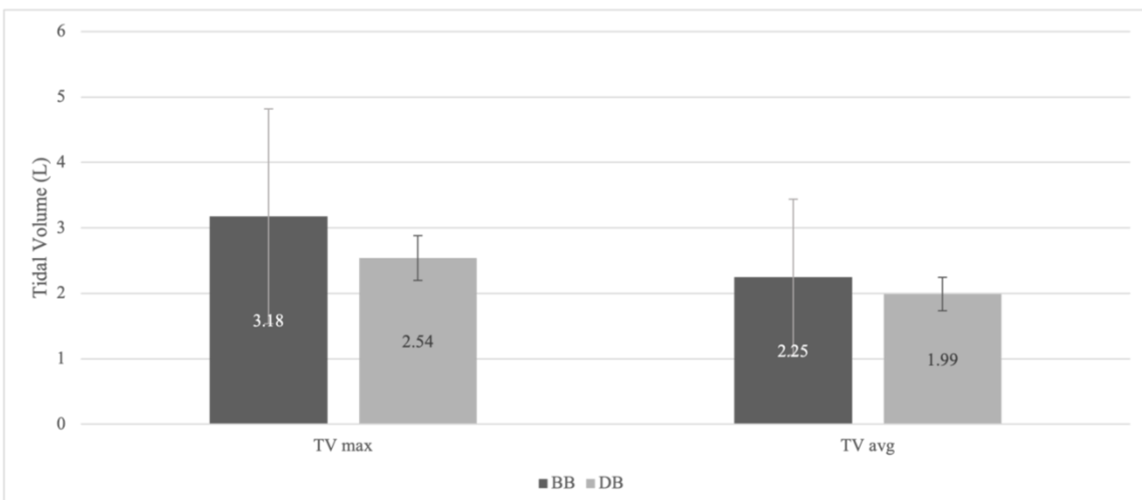


Figure 4.7 Comparisons in Minute Ventilation (VE) by Modality

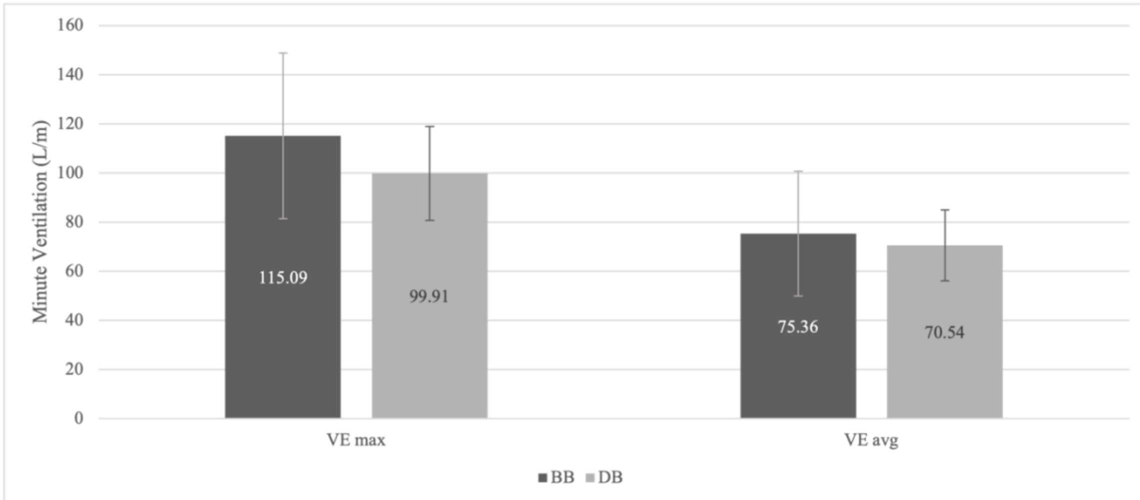


Figure 4.8 Comparisons in Ventilatory Equivalents for Oxygen (VE/VO2) by Modality

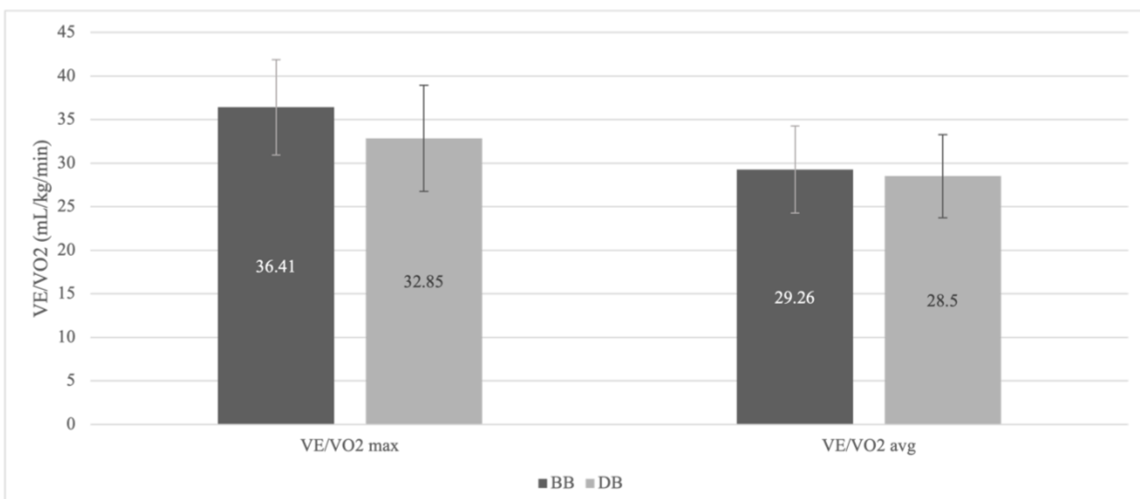


Figure 4.9 Comparisons in Fraction of Expired Oxygen (%FeO2) by Modality

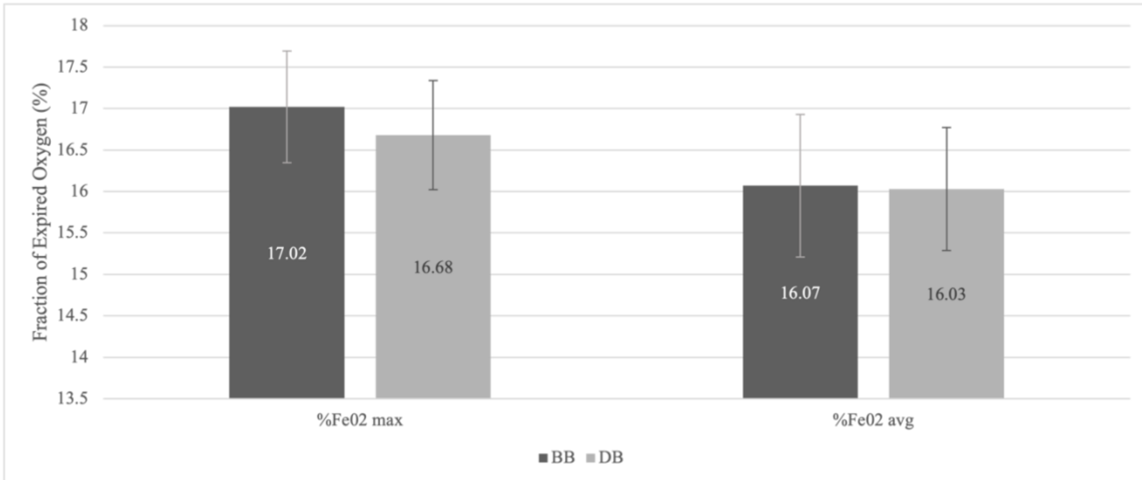


Figure 4.10 Comparisons in Metabolic Equivalents (MET) by Modality

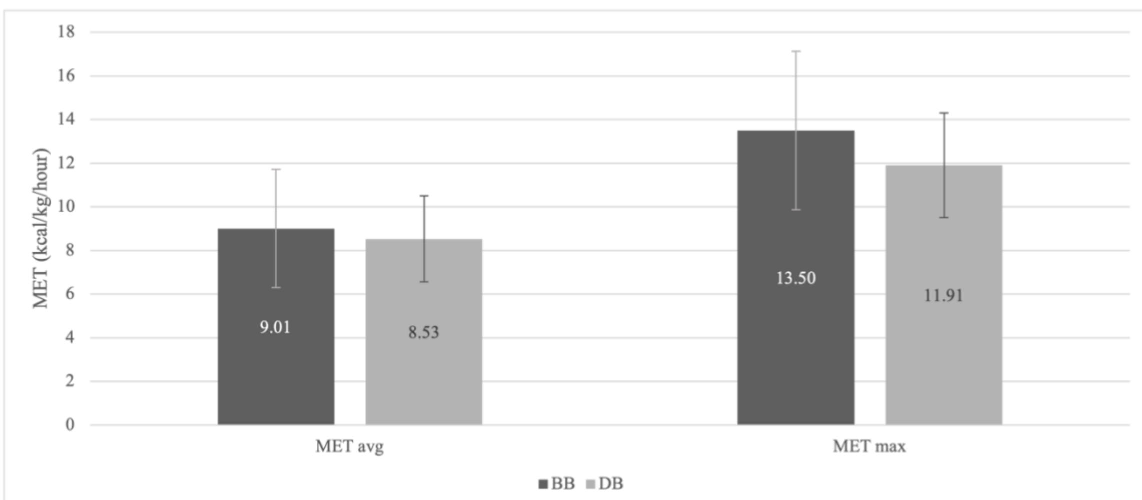
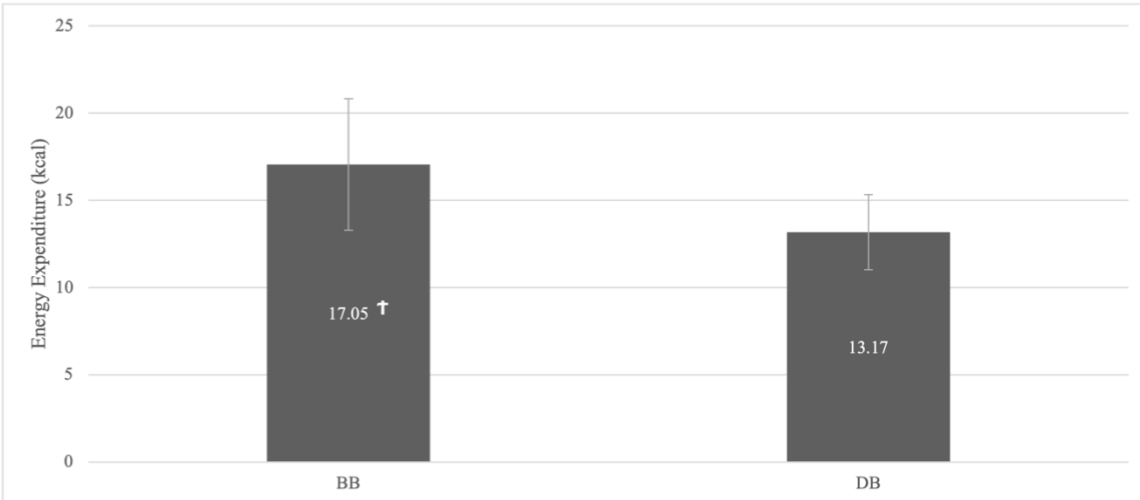


Figure 4.11 Comparisons in Energy Expenditure (EE) by Modality



* = ≤ 0.05, ** = p ≤ 0.01, Ϯ = p ≤ 0.001

CHAPTER V

DISCUSSION

The purpose of this study was to quantify the physiological demands of a single workout complex based on different modalities (barbell and dumbbell) for male test subjects. To compare the different modalities, the study aimed to determine if significant differences exist between loads utilized, time to completion, HR, %HR, VO2, Rf, TV, VE, VE/VO2, %FeO2, MET, and EE while performing a single round of Javorek Complex I, utilizing 40%1RM of the modalities' upright row. These findings suggest significant differences in load utilized, time to completion, EE, and MET (average and maximum) do exist between barbell and dumbbell complex variations, with the barbell complex exhibiting significantly higher values. These findings support the rejection of the hypothesis that no differences exist in caloric expenditure between barbell and dumbbell variations of the Javorek Complex I utilizing a training load 40%1RM of the upright row.

To quantify the metabolic demands of the barbell and dumbbell complexes, an examination of the %HR and MET levels observed during the study provide insight to the intensity the test subjects experienced while performing the workouts. The HR average and %HR average were both higher for barbell complexes, though test subjects experienced HR maximum and %HR maximum during the dumbbell complexes. Additionally, metabolic equivalents (average and maximum) were higher for the barbell complexes in comparison to the dumbbell complexes. This would indicate a higher workout intensity experienced during barbell complexes.

This is supported by the higher EE recorded during the barbell complexes.

It should be noted that during the familiarization phase of testing, while determining the estimated 1RM for the barbell and dumbbell upright row, only one test subject was able to lift a higher load during the dumbbell modality, meaning all other test subjects performed the barbell complex with a heavier absolute load for their estimated 40%1RM. This different in load could have affected all other variables measured during testing. To normalize this difference, future studies should investigate the complexes utilizing an average of the 40%1RM for the barbell and dumbbell variations to standardize the amount of weight lifted. Additionally, different pacing strategies were observed during the barbell and dumbbell complexes, possibly due to the loads being lifted. To normalize the time to completion between modalities, it could be possible to require test subjects to perform the complexes at a predetermined pace, using a metronome during testing. This could potentially alleviate differences in individual intensities and provide a more equivalent representation of caloric expenditure between modalities.

Limitations during the study were encountered. Javorek originally intended for the complex workouts to be performed every day, for a total of two to three sets, or four to five sets three times per week during the preparatory phase of training for his athletes (Javorek, 1988). During the competition phase, Javorek recommends performing the complexes as a warmup, utilizing low %1RM for two sets every day, with heavier variations performed three times per week for three sets each day. For this study, a single round of the barbell and dumbbell complexes were investigated, utilizing a relatively low weight compared to recommended weights utilized during training in athletic populations. To better understand the cumulative effects of the barbell and dumbbell variations, future studies should investigate multiple rounds of this workout in recreationally trained test subjects and athletically trained subjects. Javorek also recommends utilizing a varied range of %1RM for these complexes, to provide variation in the intensity of the complexes. This study utilized 40%1RM for the upright row, providing a relatively low amount of stress compared to a complex utilizing heavier loads. To better quantify the relationship between exercise intensity and load utilized during a complex workout, a comparison of the examined variables across a range of barbell and dumbbell loads should be investigated. Blood lactate is a variable of interest that was not investigated. Studies suggest the strong relationship between exercise performance and lactate-related variables can be attributed to the peripheral capacity of the musculature to utilize oxygen (Jacobs, 1986). Future studies should incorporate blood lactate response as a measured variable to training modalities to compare values against HR, %HR, and VO2 (maximal and average). This would provide additional insight for quantifying differences in exercise intensity when comparing a single workout complex, utilizing both barbells and dumbbells.

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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 <u>continuing review is not required.</u> 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 – 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 medical clearance form, informed consent form, and health history questionnaire
- 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 VO2 Master Mask and chest strap heart rate monitor
    - Have 0.7 microliter blood droplet drawn from index finger for blood lactate analysis
    - 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)

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Biospecimen Sampling for Research:
Research using biospecimens (saliva, blood, tissues, etc.) is an important way to try to understand human disease and functioning. There are several things you should know before allowing your biospecimens to be studied. A 0.7 microliter blood drop size will be drawn from your index finger for lactate analysis and discarded immediately after data is recorded by research investigator. You have the right to refuse to allow your biospecimen to be studied. You may withdraw your specimen from this study at any time by contacting the Principal Investigator. Information or specimens collected from you will not be used for future research studies or shared with other researchers for future research. All extra biospecimens not needed for this study will be destroyed after analysis is complete.

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.

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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.

Finger Stick:
There is a minor risk associated with this project in that you may experience slight pain when we pierce the skin on your finger; however the puncture and blood collecting equipment are part of the commercially available systems that have been approved by the FDA.

Drawing blood from a finger stick may, in rare cases- cause discomfort, bruising, prolonged bleeding and infection at the site of puncture. To minimize risk, we will swab the site of puncture with alcohol to disinfect the area, use disposable lancet and capillary tubes to collect blood and apply pressure to the puncture site following the blood draw to minimize bruising. We will cover the puncture with an appropriate dressing and provide you with information on how to monitor for signs of infection.

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.

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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: ________

Approved: 04/01/2022
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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.*

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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 – PHYSICAL ACTIVITY READINESS QUESTIONNAIRE PLUS (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.

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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 ☐

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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.

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If you answered NO to all of the FOLLOW-UP questions (pgs. 2-3) about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

- It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- 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 answered **YES** to **one or more of the follow-up questions** about your medical condition:
You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

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 - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- All persons who have completed the PAR-Q+ please read and sign the declaration below.
- 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 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 ______________________

For more information, please contact
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VITA

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