TMU-Joint Institutional Review Board

Title: Energy expenditure during acute and chronic resistance exercises in healthy population

Approval Number: N202004023

Date: 2020/06/02

Study Protocol and Statistical Analysis Plan

Participants

The present study is a single-blinded, randomized controlled trial and will perform at Taipei Medical University Hospital in Taiwan. Experiment will be conducted under a protocol approved by the Joint Institutional Review Board of Taipei Medical University with registration number (N202004023). All experiments in this research will be performed in accordance with the relevant guidelines and regulations at Taipei Medical University.

Potential participants will recruit and test at Taipei Medical University Hospital. Participants (n= 30) eligible according to the following criteria will be recruited and will consent to take part into two groups untrained (no weight training experience) and trained group (weight training experience of two months) into stage 1 and stage 2. Conditions for inclusion: 1) male and female young healthy participant and athletes having strength training experience minimum of 2 months, 2) skeletally mature, between 20-40 years of age, 3) able to understand and comply with study requirements, 4) able to understand and give informed consent, 5) not having any metabolic, systematic, musculoskeletal disease or injury, 6) no recent surgical procedure which can hinder exercise training, 7) not taking medication specially sedatives, anti-depressant, or anti-hypertensive etc, 8) physically fit according to Physical Activity Readiness Questionnaire (Par-Q). Exclusion: 1) age below 20 or above 40, 2) having any metabolic, systematic, musculoskeletal disease or injury, 3) recent surgical procedure

Experimental Protocol and Design

The study will use cortex Metalyzer for oxygen consumption (VO2), treadmill or bicycle for incremental fitness testing, ECG electrode for heart rate (bpm), sphygmomanometer for blood pressure (mmHg), blood lactate meter for blood lactate level (mmol/L), body weight scale & fat monitor for body mass index and fat percentage, lean body mass, habitual activity status, dynamometer for maximal muscle strength, and Noraxon wireless channels for surface electromyography.

The exercises will be dumbbell bent over row, dumbbell deadlift, dumbbell lunge, dumbbell shoulder press, and dumbbell squat. Each participant will perform a 1RM bent over row, deadlift, lunge, shoulder press, and squat to assess the maximum load that they could lift for each exercise. Each participant will be given a maximum of 3-5-sets to achieve their maximum 1RM. Briefly, subjects will perform a warm-up

consisting of 8–10 repetitions using a light weight, 3–5 repetitions using a moderate weight, and 1– 3 repetitions using a heavy weight. After the warm-up sets, subjects will be tested for 1RM strength by increasing the resistance on subsequent attempts until the subject was unable to complete an attempt using proper technique through a full range of motion. Between each set, the participant will be given 4- minutes rest. Participants will perform one repetitions with each load to minimize muscle fatigue. Between the 1-RM bent over row, deadlift, lunge, shoulder press, and squat there will be a 10-15-minute rest period where the participants will be allowed to walk, perform light dynamic-movements, and consume small amounts of water.

Each participant will visit the Taipei Medical University Hospital on five-eight separate occasions where testing and data collection will take place in the department of Physical Medicine and Rehabilitation & cardiac function Department, Taipei Medical University Hospital. A total of 5-8 tests will be conducted within 10-20 days, each taking about 1 to 1.5 hours. All participant will not eat a meal 2-4 hours before physiological testing, to avoid alcohol and caffeine ingestion for 24 hours before testing, and to refrain from strenuous exercise for 24-48 hour before testing.

VO2 testing: During the first visit, the participant's weight and height, physical health status with Physical Activity Readiness Questionnaire (Par-Q) along resting heart rate, systolic and diastolic blood pressure will be measured. Following this, participants will perform an incremental Treadmill or bicycle VO2max test to provide an indication of aerobic capacity. To measure O2 consumption, expired air will be recorded breath-by-breath through Cortex Metalyzer 3B (Cortex Inc, Leipzig, GmbH). The gas sensor will be calibrated automatically before every test. Prior to commencing, participants will be provided an explanation of the Borg Rate of Perceived Exertion Scale (6-20 RPE scale). The participants will be asked to provide their RPE at the end of each minute of the test. Participants will be designated ECG electrodes to determine heart rate during the exercise protocol. The protocol will utilize in this study begin at 8km/h at an incline of three degrees which will continue for five minutes, after which the speed and incline will increase by one km/h and one degree every minute. Once the speed will reach 12 km/h (after the 9th minute), the speed will remain constant, however, the incline will continue to increase by one degree every minute. The treadmill VO2max test will be stopped when two of three occurred; a respiratory exchange ratio (RER) $\geqslant$ 1.1, a HR within 10 beats or over their theoretical aged-predicted maximal HR (220-age), an expression of RPE $\geqslant$ 16/20 defined VO2max as the highest volume of O2 that can be consumed during an exercise bout per unit of time; thus, the highest O2 consumption measurement of

the treadmill test was recorded as the participants VO2max. Upright bicycle stress testing protocol includes; having the subject pedal the bicycle at approximately 60 revolutions per minute (rpm) against 25 watts of resistance. The resistance will be increased by 25 watts at the beginning of each two minute stage and test will continue until exhaustion.

One Repetition Maximum (1RM) Testing: On the second visit, at least 24-48 hours after session one, participants will perform a 1RM bent over row, deadlift, lunge, shoulder press, and squat to assess the maximum load that they could lift for each exercise. **Familiarization:** Participants will be given a minimum of 24-48 hours to recover from the 1RM testing session before commencing a familiarization session in which a cadence will be introduced to the bent over row, deadlift, lunge, shoulder press, and squat exercises. Each participant will be given a workload of 60% 1RM where they performed 3- sets of 10-repetitions at a cadence of 1.5 seconds-2 seconds down and 1.5 seconds-2 seconds up using an audible metronome. An audible cadence will incorporate to control for potential variation in the participants lifting cadence. Between each set will be a 3-minute rest period and 10-minute rest period between each type of exercise.

Resistance Training Sessions: During stage 1, the participants will perform three resistance training sessions on three separate days, each at the same time of day, which will comprise of the bent over row, deadlift, and lunge protocol; 3-sets of 10-repetitions at 60% 1RM with a cadence of 2-seconds down and 2-second up. Rest periods between sets were 3-minutes, with 10-minutes between exercises. A minimum of 24-48 hours rest interval between resistance training sessions will be required.

During stage 2, the participants will perform six resistance training sessions on three separate days, each at the same time of day, which will comprise of the shoulder press, deadlift, and squat protocol (random order); 3-sets of 10-repetitions at 60% 1RM with a cadence of 1.5 seconds down and 1.5 second up. Rest periods between sets were 2 minutes, with 8 minutes between exercises. A minimum of 24-48 hours rest interval between resistance training sessions will be required.

Blood lactate testing: Blood lactate (Bla) will be obtained during baseline before the start of exercise and within 5 minutes after each exercise for three times. Before blood samples will be collected, asepsis will perform with 70% ethyl alcohol on the distal fingertips of the left/right hand. Puncture will be performed using disposable

lancets, and a suspended drop of blood will be applied to a lactate test strip for analysis on a portable lactometer.

Surface electromyography (sEMG) recording: The sEMG will be recorded by 8-channels Noraxen wireless sensors. The study will include right and left pectoralis major, latissimus dorsi, quadriceps, hamstring, erector spinae, and deltoid muscles respectively.

Outcome Measures:

The energy expenditure models for selected strength exercises will be assessed using the outcome measures of heart rate, blood pressure, blood lactate level, rate of perceived exertion, and surface electromyography (sEMG) with the metabolic equivalent (MET). Initially, the models will be built on few subject's data. Upon getting good correlation index, the study will further proceed to get same models on more number of participants. The energy cost of each of these exercise will be calculated for stage 1 and stage 2 data.

Statistical Analysis: We will use multiple regression and correlation techniques to predict energy expenditure models with the best selected parameters. The physiological parameters and energy cost of study will also be compared between untrained and trained groups. The descriptive statistics will be presented in the form of mean (Standard Deviation). The reliability of each model will be determined by coefficient of correlation (R), coefficient of regression (R2), adjusted R2, standard error of estimation (SEE), p-value, collinearity index VIF, estimate (ß), and confidence interval (CI) etc. The linear relationship for variable by variable will be observed through excel plotting and scatter of data points from straight line. The surface electromyography will also be processed and correlated with cardiorespiratory parameters.

Regression Models and variables: Linear regression is a way to model the relationship between two variables. ... The equation has the form Y= a + b X, where Y is the dependent variable (that's the variable that goes on the Y axis), X is the independent variable (i.e. it is plotted on the X axis), b is the slope of the line and a is the y-intercept.

1. MET (kg/ml/min) = a + b (HRbpm)
2. MET (kg/ml/min) = a + b (BPmmHg)
3. MET (kg/ml/min) = a + b (blood lactatem/mol)
4. MET (kg/ml/min) = a + b (BMI)
5. MET (kg/ml/min) = a + b (body weightkg) + c (body heightm)
6. MET (kg/ml/min) = a + b (body fat %)
7. MET (kg/ml/min) = a + b (muscle strengthN)

8. MET (kg/ml/min) = a + b (sEMGPM) + c (sEMGLD) + d (sEMGQuad) + e (sEMGHams)

9. MET (kg/ml/min) = a + b (HRbpm) + c (BPmmHg) + d (blood lactatem/mol) + e (BMI) + f (body weightkg) + g (body heightm) + h (body fat %) + i (muscle strengthN) + j (sEMGPM) + k (sEMGLD) + l (sEMGQuad) + m (sEMGHams)