RELIABILITY OF CARDIOVASCULAR AND METABOLIC RESPONSE TO HYDRAULIC RESISTIVE EXERCISE pdf

1: Cardiovascular responses to resistance exercise are affected by workload and intervals between sets

Get this from a library! Reliability of cardiovascular and metabolic response to hydraulic resistive exercise. [Carole Anne Jones].

The control of cardiovascular responses during resistance exercise RE is important for patient safety. The HR was checked on a continuous basis by using a cardiotachometer and the SBP was checked at the end of the sets, via a protocol validated by the auscultatory method. Exercise; resistance training; heart rate: Introduction Resistance training causes significant increase in heart rate HR and blood pressure BP 1,2. The adjustment of training variables can control these responses and change the cardiovascular overload during exercise2,3. Previous studies investigated the influence of several variables, such as speed of movement4, number of sets5, the intensity and number of repetitions2,6, the muscle mass involved2,7, the types of exercise1 or training status8. However, there is scarce information about the influence of the rest interval between sets and exercises. Only one study specifically investigated the influence of this variable on HR and BP values9, identifying greater pressure response in sessions with shorter intervals. Ratamess et al10 did not specifically measure the BP, but they did not find significant differences in HR responses to exercise done with different rest intervals. However, the gradual increase in pulse rate throughout the sets was more evident for shorter intervals. It is worth highlighting that these studies9,10 applied fixed rest intervals. So, they did not consider the cumulative effect of muscle fatigue in the course of the sets. In practice, it is possible to notice that different exercises require different execution times, either due to their complexity or due to the required range of motion. We could argue, for example, that if the rest interval were proportional to the exercise execution time, there would be a smaller ratio of decrease in workload due to lower accumulated fatigue. Rest strategies with fixed time may not allow full recovery in consecutive sets, and this may intensify the increase in BP and HR5,9, It may be more appropriate to establish the rest interval according to the exercise execution time or time under tension , depending on the overload with one is working. Unfortunately, it was not possible to find studies that have confirmed this hypothesis, which would be especially important in the context of training programs for patients at risk of cardiovascular complications. Thus, this study investigated the influence of two rest intervals established according to the time under tension, in multiple sets of resistance exercise, performed with different repetition maximums, by normotensive individuals, on acute responses of HR and systolic BP SBP and, consequently, of the rate-pressure product RPP. The following exclusion criteria were observed: Determination of workloads - 6 and 12 repetition maximum RM Four visits were required for conducting the tests that established the workloads associated with the execution of 6 RM and 12 RM on the leg press, as well as for checking the reliability of the results obtained. The horizontal leg press was chosen because it involves large groups of muscles and, therefore, it supposedly has greater impact on blood pressure values. Moreover, it is an exercise that is easy to do, which is often included in exercise routines prescribed for patients with cardiovascular disease. Every day, the subjects could make up to 5 attempts to successfully complete the tests, with an interval of 5 min between each attempt. The tests of 6 RM and 12 RM were conducted on different days, with an interval of at least 48 h in between. The subjects were verbally stimulated so as to keep the high level of stimulation during the exercises. The weights used were previously weighed on a precision scale. If it was not possible to determine the workload associated with 6 RM or 12 RM by the 5th attempt, a new date was scheduled, also after an interval of at least 48 h. Experimental protocol Once the 6 RM and 12 RM workloads had been determined, the subjects underwent 4 random protocols of exercises, in an order defined in a counterbalanced way. Each session took place on a specific day, with a total of other 4 visits to the laboratory, with intervals of 48 hours in between. All subjects performed the following procedures: The subjects were instructed to observe the following recommendations before the exercise sessions: Before performing the protocols, the subjects remained seated for 10 minutes, in a calm and quiet environment. Then, the HR and BP at rest were measured and the average HR of the last two 2 minutes was

recorded, and the average of two measurements of BP made in the same period was also recorded. After the warm-up, the subjects rested for 5 minutes and started the exercise. The cardiovascular variables were measured at rest and during the exercise, by using the same equipment, as described below: The standard of measurement followed the recommendations of the 5th Brazilian Guidelines on Hypertension12, with the measurements always made by the same observer, both at rest and during the exercise. The BP was measured in both arms and the largest measure was considered, in case of difference. For measuring the BP, the recommendations previously validated for measurement during resistance exercises13,14 were observed, as detailed in Box 1. In general, the valve opened before the end of the set, in order to record the systolic value between the last but one repetition and last repetition. A pilot measurement was made to determine the SBP peak value, so as to increase the pressure of the cuff to an approximate value of 30 mmHg higher, before the opening of the valve. The subjects were instructed not to curl their arms and to keep the left arm, used for the measurement, in supination, with elbows slightly flexed and supported on proper support. The measurements were made by the same trained observer, who was unaware of the purposes of this study. Determination of the rest intervals between sets The duration of rest intervals between sets took into account the duration of the sets. The execution of the exercise was timed and the result was multiplied by three or 5, for determining an interval that would be in accordance, respectively, with the ratios of 1: To determine the execution time of the set, a progressive digital timer was used. The timer was started when the feet support platform moved and the timer was stopped when the platform touched its base at the end of the set. The timer allowed restarting the measurement in a simple way, by using the same button used to interrupt such timer, thereby allowing the definition of precise intervals. To make it easier to view the rest period 1: Therefore, for analysis purposes, we adopted the lowest values obtained for these variables during the rest periods prior to exercise. It is also important to highlight that the double of repetitions maximum 6 RM and 12 RM was not related to the same proportion of variation in the absolute work load weight in kg. It was found that the influence of the number of sets systematically consisted in an increase in cardiovascular responses. On the other hand, the rest interval had the opposite influence and it even offset the cumulative effect of the sets in some cases, particularly with respect to SBP. We also compared the absolute variations in each situation, considering the peak values recorded between the first and third sets. With regard to HR, for 6 RM protocols, the variation in the sets with an interval of 1: As to the 12 RM workload, there was no significant difference in the variation in HR in sets with an interval of 1: The variations in SBP between the 1st and 3rd sets were influenced by the rest interval, regardless of the load. In protocols with 6 RM, the variations for the intervals of 1: For protocols of 12 RM, the variation with the interval of 1: The results for SBP proved to be more sensitive to manipulation of the three training variables, considered separately or in combination. Figure 3 shows the results for the post hoc tests referring to the standard deviation. The variation between the first and third sets performed with an interval of 1: When we applied a longer interval 1: Discussion This study compared the responses of HR, SBP and RPP during consecutive sets of resistance exercise, performed with different numbers of repetitions maximum and rest intervals, considering that these rest intervals were based on the total execution time of each set. Both HR and SBP increased significantly in the course of the sets, regardless of the intensity and rest interval. However, the cardiovascular responses associated with the horizontal leg press were minimized by manipulating the rest time: The longer rest interval was also associated with lower rise in HR and SBP during the sets, in the two pre-determined intensities. Thus, the exercise done with longer rest interval caused less cardiovascular stress for both intensities tested. This difference can be attributed to the time under tension in each set one minute in the study conducted by Gotshall et al5 versus 24 seconds in this study , but also, and perhaps mainly, to the BP measurement. As we known, even though the auscultatory method is suitable for comparing different resistance-exercise protocols, when such method is used on an inactive limb, it may underestimate absolute pressure values14, In other words, the auscultatory method is extremely useful in practical situations and it has proved valid and reproducible to indicate differences in BP responses to resistance exercise. Thus, this method is a useful strategy to develop training sessions with lower

cardiovascular overload. Moreover, the auscultatory method should not be used to accurately establish blood pressure values during resistance exercise. Studies that examine in detail the influence of rest intervals between sets and exercises on the behavior of BP and HR are relatively scarce. It was not possible to find studies that investigated the matter by adopting an approach similar to the one taken in this study. Polito et al9 had young normotensive individuals do 4 sets of 8 RM, separated by fixed intervals of one and two minutes, and they also found higher values of blood pressure for the sequence with the shortest interval. The most pronounced cardiovascular responses at short rest intervals can be associated with lower systemic recovery from the stress generated by the exercise. The accumulation of metabolites, with consequent nerve stimulation via mechanical and chemical receptors, may potentiate these responses In this sense, Ratamess et al10 observed the effects of different fixed rest intervals 30s, one, two, three and five minutes on cardiovascular and metabolic responses throughout the course of 5 sets in two training intensities 5 RM and 10 RM , in the bench press exercise. No difference was found between the rest intervals, considering the peak values of HR in both training intensities. The production of lactate was also higher for shorter rest intervals, which is suggestive of the relationship between accumulated fatigue due to insufficient rest and cardiovascular responses. Our results indicated that the workload can also independently influence the responses of HR and SBP. By comparison with the protocol with a workload of 12 RM, the sets done with 6 RM had less impact on the cardiovascular responses for similar rest intervals. In the present study, there was also a cumulative effect of the sets on HR and SBP responses, with greater increase from the second set onwards, especially for a shorter effort-rest interval. Similarly, Gotshall et al5 had three young and healthy individuals do three sets of 10 RM in the bilateral leg press fixed rest interval of three minutes; speed of three seconds in the concentric and eccentric phases. At the end of each set, the values of SBP and DBP always proved to be significantly higher than the ones observed in the previous sets. Other studies have demonstrated that there is influence of the number of sets on cardiovascular responses2, Two factors may be in the origin of the results referring to the cumulative effect of consecutive sets on cardiovascular responses. The first one would result from the fatigue accumulated due to the shorter rest time The second one takes into account the time under tension: The hemodynamic responses to muscular work in resistance exercises can also be linked to increased sympathetic activity and decreased parasympathetic activity, due to the greater activation of central command and muscle and joint mechanoreceptors The central mechanism involves the transmission of impulses from the motor cortex to the cardiovascular control center. On the other hand, the peripheral mechanism consists of a reflex pathway with multiple control bases The increased peripheral vascular resistance, caused by partial occlusion of blood flow, contributes to an imbalance between supply and demand of O2 in tissue. As a result, the removal of metabolites lactate, hydrogen, phosphate, adenosine, potassium etc is hindered, by the stimulation of chemoreceptors to increase sympathetic nervous activity Finally, the increase in blood pressure could also be influenced by the number of motor units requested. In this case, muscle and joint mechanoreceptors, sensitive to the increase in voluntary strength recruitment of motor units and the load on the joints, inform the cardiovascular control center about the need to modify the cardiovascular responses to regulate the flow The increased peripheral vascular resistance associated with arterial occlusion during exercise is another factor to be considered. The leg press exercise, besides involving several major muscle groups, is also done in a posture that can hinder the perfusion of blood into active muscles, since the course of the main arteries that irrigate such muscles is changed by the hip flexion This problem is even greater during the transition from the concentric phase to the eccentric phase.

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2: News & Research

Increasing the exercise duration per minute or the number of exercise bouts per minute had minimal effects on the mean VO2 and heart rate response to hydraulic resistive exercise.

This article has been cited by other articles in PMC. Hatha Yoga HY can be an alternative to improve physical activity in middle-aged and older women. However, conventional HY CHY exercising may not result in enough training stimulus to improve cardiovascular fitness. The purpose of this study was to evaluate the effect of an intensive HY intervention IHY on cardiovascular risk factors in middle-aged and older women from Northern Mexico. The program adherence, asana performance, and work intensity were assessed along the intervention. The IHY program did not modify any anthropometric measurements. Yoga is an ancient Indian philosophy based on diverse breathing, stretching, and meditation exercises. The "physical" part of Yoga Hatha consists of several stretching and strength-building exercises of varying degree of difficulty called asanas. In complementary alternative medicine, Hatha Yoga HY has proved to reduce stress and pain muscle and systemic. Our aim was to study the effects of an intensive HY IHY practice over cardiovascular fitness, and anthropometric and biochemical parameters in middle-aged and older women from Northern Mexico. Seventeen healthy and physically active middle-aged The inclusion criteria were as follows: Thirteen women four and nine, middle-aged and older respectively complied with these criteria and finished the study. A sports physician performed a routine physical examination including an electrocardiogram to guarantee the health status of each participant, before and during the IHY. Each participant signed a written and informed consent, and the Ethics Committee of the Autonomous University of Chihuahua Mexico , as stated by the Helsinki declaration, approved the study protocol. All participants attended the laboratory twice on week 1, between Subjects were asked to avoid any sort of heavy physical activity 24 h before the study. On day 1, anthropometric and food consumption data were registered. On day 2, blood pressure BP and a forearm blood sample were taken. Having finished the IHY intervention, a general evaluation was once again performed as previously mentioned. Intensive Hatha Yoga intervention All participants had been already practicing a CHY during the past 3 years prior to the study 90 min, three times per week. Their min conventional routine included 30 min of a low-impact aerobic exercise, 15 min of relaxation in a savasana pose corpse pose , min of asanas, and min of concluding remarks. Each IHY 90 min session consisted of the following: All this included 5 min of pranayamas breath-control exercises and 10 min of meditation in a lotus pose. During the asanas, all participants were encouraged to stretch as fully as possible while not exceeding the limits of their comfort, paying attention to their breathing and trying to relax. No discomfort symptoms or injuries occurred during IHY sessions. The adherence to the program as percentage of IHY sessions completed , asana performance and work intensity were monitored during the study. Asana performance was evaluated with a Likert-type scale by the trainer as follows: The work intensity was recorded with a telemetric heart rate monitor, twice during the program Polar F6; Finland. Anthropometry and body composition Anthropometric indicators and body fat were assessed with an anthropometric kit Rosscraft Tom Kit, Canada by a trained anthropometrist, following the recommendations of the International Society of Advancement in Kinanthropometry ISAK. All data were analyzed with LifeSize software, version 2. They were not taking any vitamin supplement. Nutrient intake was assessed by the h recall method in three nonsequential days including one weekend. Appropriate food models, dishware, and containers were used to improve size estimation. All dietary records were coded daily, and later analyzed for energy and macronutrient composition. The Diet Balancer software, version 1. The environmental barometric pressure was measured by a fortin-type mercurial barometer Princo ; USA , and the temperature and relative humidity by a mason-type hygrometer Taylor S mason hygrometer; Canada. Exhaled gases during exercise were analyzed with the breath-by-breath system facemask system. VO2max was determined by the exercise protocol reported by Skiner. VO2max and maximal heart rate HRmax were defined as the highest O2 consumption and heart rate values, both recorded at the end of the exercise test.

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Biochemical analysis A forearm blood sample was collected 15 min before the exercise protocol in a sited and relaxed position into heparinized tubes. Hematocrit, hemoglobin, glucose, and lipid determinations were analyzed within the next 30 min after blood collection. The microhematocrit was evaluated using a microcentrifuge, and the hemoglobin content was quantified by the Drabkin method. Blood glucose and lipid concentrations were adjusted for the changes in the plasma volume microhematocrit. Statistics Data were analyzed using the statistical program SAS system software, version 8. IHY did not influence any of anthropometric variables and except for BMI, all other anthropometry variables were similar between middle-aged and older groups [Table 1]. Table 1 Effects of intensive Hatha Yoga program in middle-aged and older women Parameter1.

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3: Evaluation of acute cardiorespiratory responses to hydraulic resistance exercise.

Heart rate ranged from b Â· min-1 (% of TMmax) for the leg extension exercise to b Â· min-1 (% of TMmax) for the squat exercise. Hydraulic circuit resistance exercise results in an average caloric expenditure of kJ Â· min-1 (kcal Â·min-1).

Next Page This section reviews a variety of research studies which have been conducted regarding physical activity and multiple sclerosis, and is divided into four categories: Effects of Physical Activity on Persons with Multiple Sclerosis Despite the improvements in physical fitness and quality of life that persons with multiple sclerosis attain from engaging in exercise programs, limitations such as cardiovascular dysautonomia and neurological problems can affect the degree of improvement. Some studies have uncovered the effects of cardiovascular dysautonomia. During the exercise, heart rate, blood pressure, and RPE rate of perceived exertion were measured continuously. Results showed that in some cases, subjects with multiple sclerosis could not elicit an increase in arterial pressure response, most likely because of autonomic dysfunction. Other studies have highlighted the benefits of physical activity despite limitations. They concluded that these improvements were not directly correlated to degree of neurological deficiencies. They measured levels of physical activity in 17 subjects with multiple sclerosis 10 had the relapsing remitting and 8 had the chronic progressive clinical presentations and 15 control subjects with an accelerometer TriTrac-R3D and a questionnaire 7-d RQ self reported recall questionnaire. Though the study did confirm that subjects with multiple sclerosis demonstrated lower degrees of physical activity compared to controls, subjects with multiple sclerosis also demonstrated the following peripheral changes in muscle: Such qualities are equivalent to those of healthy subjects after deconditioning and indicate that problems in muscle functioning caused by disuse may be reversed with muscle training. When cardiovascular training has been used to improve function of specific muscle groups, the results have not been as positive. Gait analysis and tests of maximal Vo2max were administered pre and post the exercise program. Though aerobic fitness improved, no clinically significant improvements in gait were achieved: Measurement In , the same team examined maximum aerobic capacity in 9 subjects with multiple sclerosis EDSS and 9 control subjects on recumbent leg ergometers on land and in water. They determined that some persons with multiple sclerosis depending on level of impairment could attain maximum aerobic capacity without side effects, whereas those with more physical impairments would need more adjustments, such as for leg cycling Ponichtera et al. In , Ponichtera et al. Regarding measurement of strength capacities, Pepin et al. The results showed that it is possible to get consistent reliable responses to this exercise, despite motor dysfunction. The MVC reliability estimates were 0. The authors, however, did question the replicability of their findings for subjects with higher EDSS levels. Recently, Schwid et al. Maximal voluntary isometric strength, motor fatigue, and static fatigue were tested and retested by different exercise and strength tests in 2 distinct sessions, in order to measure test-retest reliability. Results showed that though subjects with multiple sclerosis had more fatigue for sustained contractions, repetitive contractions, and ambulation, motor fatigue was different from weakness since the fatigue was not correlated with weakness from individual muscles. This suggests that strength and motor fatigue can be quantified reliably. In , Kent-Braun et al. They measured the peak force generated from a maximal voluntary isometric contraction during 3 sessions and determined that for mildly impaired persons with multiple sclerosis, muscle fatigue during exercise is not related to metabolic, but to activation failures. It was observed that decreases in force during exercise were because of peripheral, not central mechanisms. In and , the same team studied electrically-stimulated exercise training for subjects with multiple sclerosis and discovered that the fatigue during exercise is because of muscle intrinsic, not metabolic, properties Kent-Braun et al. Motivation to Exercise Because of the chronic and relapsing characteristics of multiple sclerosis, adherence to an exercise program for participants with multiple sclerosis can be difficult. Subjects responded to a range of instruments measuring these qualities. They found that subjects with benign sensory and relapsing remitting multiple sclerosis, more than those with progressive multiple sclerosis, were more likely to commit to physical

activity and spiritual growth practices These findings underscore the importance of encouragement and support for participants with multiple sclerosis in a physical activity program, particularly those participants with a higher disability status.

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4: Metabolic responses during hydraulic resistance exercise

Thirteen college-age men underwent a treadmill (TM)-graded [latin capital V with dot above]O2max exercise test on 1 d and a min hydraulic resistive exercise circuit on a following day. Seven exercises were performed in the following order: leg extension, bent-over row, bicep curl, squat, upright row, bench press, and behind-neck press.

Ventilatory responses during submaximal exercise in children with Prader-Willi Syndrome. Pediatr Exerc Sci, 27, The use of magnetic resonance imaging to characterize abnormal body composition phenotypes in youth with Prader-Willi syndrome. Hormonal and metabolic responses to a single bout of resistance exercise in Prader-Willi Syndrome. Horm Res Pediatr, 87, Quality of life in children with Prader Willi Syndrome: Parent and child reports, Research in Developmental Disabilities, 57, Association between physical activity and bone in children with Prader-Willi syndrome, Journal of Pediatric Endocrinology and Metabolism, 29 7 , A characterization of movement skills in obese children with and without Prader-Willi Syndrome, Research Quarterly in Exercise and Sport, doi: Cytokine responses to acute intermittent aerobic exercise in children with Prader-Willi Syndrome and nonsyndromic obesity, Pediatric Exercise Science, 27, Endocrine response to acute resistance exercise in obese versus lean physically active men, European Journal of Applied Physiology, 6 , Hormonal and metabolic responses to endurance exercise in children with Prader-Willi Syndrome and non-syndromic obesity, Metabolism, 64, Hormonal and metabolic responses to a resistance exercise protocol in lean children, obese children, and lean adults, Pediatric Exercise Science, 26, Patterns of habitual physical activity in youth with and without Prader-Willi Syndrome. Research in Developmental Disabilities, Journal of Obesity, DOI: Hormone Research in Paediatrics, 79 5 , Oral Presentations Castner, D. Cytokine responses to acute intermittent exercise in children with Prader-Willi Syndrome and nonsyndromic obesity. Lower levels of motor proficiency in children with Prader-Willi Syndrome compared to obese controls. Hormonal responses to resistance exercise in children and adolescents with Prader-Willi Syndrome and non-syndromal obesity. Physical activity in individuals with PWS: Why is it so important and what can you do as a parent? Bone metabolism and physical activity in Prader-Willi Syndrome. Andrea won 2nd place and qualified for the state competition. Obesity and Physical Activity: What, Why, and How? Foundation in Fullerton, CA. Parental role in physical activity among children with Prader-Willi Syndrome. Endocrine and Metabolic Differences. Research Presentations Pallante, P. Qualitative assessment of the implementation of a week game-based at-home intervention for young children. Six-month sustained improvement in motor proficiency in youth after a week home-based intervention. Parents perceptions on the implementation of a game-based physical activity curriculum at-home for children ages years old with and without Prader-Willi syndrome. Comparison of motor proficiency in children with Prader-Willi syndrome versus typically developed children. Assessing motor proficiency in children with autism spectrum disorder. The relationship between metabolic syndrome markers, cytokines, and physical activity in obese youth with and without Prader-Willi syndrome. Home-based physical activity positively affects cardiometabolic risk factors in children with and without Prader-Willi Syndrome. Parental outcomes of a home-based physical activity intervention targeting families of your with and without Prader-Willi syndrome. Process evaluation of the implementation of a home-based physical activity curriculum in children with and without Prader-Willi Syndrome. Metabolic syndrome markers and physical activity in obese youth with and without Prader-Willi Syndrome. Sedentary behavior is negatively associated with hip bone mineralization in youth with Prader-Willi Syndrome. Implementation of a home-based physical activity curriculum in children with and without Prader-Willi Syndrome. Energy expenditure in children with Prader-Willi Syndrome during walking. Indices of adiposity by weight status in children with and without congental obesity. Assessing quality of life in youth with Prader Willi Syndrome: The relationship between efficacy and social control in youth with and without Prader-Willi Syndrome. Acute response of testosterone to muscular endurance resistance exercise in obese vs. Active Play At Home: Poster Presentation at the National Strategic Summit: Body fat patterning in congenital obesity caused by

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Prader-Willi Syndrome. Participation, preferences, perceived barriers and perceived benefits of physical activity in children with PWS: Post-exercise heart rate recovery in youth is not influenced solely by adiposity. Post-exercise heart rate recovery in children: Interactions between adiposity and exercise intensity. Aerobic exercise capacity in youth with Prader-Willi Syndrome. Relationship between heart rate recovery values and body composition in children and adolescents.

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5: Research | Physical Activity and Health Research Laboratory

Katch FI, Freedson PS, Jones CA. Accurate evaluation of the acute responses to resistance exercise training depends on the stability of the criterion measures. This is particularly true for maximal effort exercise where continuous "all-out" effort for each repetition is encouraged. The present study.

Advanced Search Abstract The metabolic, cardiovascular, and neural cost of eccentric muscle contraction is less than that of concentric contraction, but the strength and neural adaptations in eccentric contractions are significantly greater following resistive exercise. Subjects were tested for concentric and eccentric three-repetition maximum, maximal isokinetic eccentric and concentric and isometric force, and associated electromyographic activity of selected thigh muscles before and after 7 consecutive days of exercise training of the left knee extensors. The increases in muscle strength were achieved by increased muscle activation, but the strength gains were independent of the changes in antagonistic muscle coactivity. Because the strength gains occurred after a short period of exercise at a relatively low intensity and cardiovascular demand, the prescription of exercise with an eccentric overload appears suitable for elders, individuals deconditioned as a result of an injury, and the chronically diseased. THE large age-related loss of muscle strength is well documented 1. Strength loss with age has serious health consequences because it is linked to sarcopenia, that is, loss of muscle mass and muscle function 2. In several studies it has been demonstrated that strength loss may be related to a loss of balance, risk of falling, and to a general impairment of locomotion 1 3 4. Because aged skeletal muscles retain their responsiveness to mechanical stimuli in terms of strength gains, muscle activation, and muscle hypertrophy 4 5 6 , it is important to identify the most effective exercise modalities to remedy, offset, or perhaps reverse age-associated strength loss. To this aim we sought to exploit a unique property of aged muscle. A few studies have also demonstrated that eccentric strength gains following resistive training are much greater than concentric or isometric strength gains in elderly 10 11 and young adults 12 Because skeletal muscles produce significantly greater force during an eccentric contraction than they do during a concentric one and because the critical stimulus for strength gains and muscle hypertrophy is the magnitude of mechanical stress 12 13 14 , it is conceivable that an exercise program composed of a larger than usual eccentric component may lead to greater strength gains. There is some evidence to support this hypothesis. Overloading the eccentric phase during resistive exercise has several potential benefits for the aged. The metabolic cost of eccentric exercise at the same absolute load is less than concentric exercise 16 , as is the cardiovascular stress in the aged In addition, significant isometric strength gains occur at a fraction of the metabolic cost during eccentric compared with concentric cycling The large increases in eccentric strength and electromyographic activity after eccentric exercise training in young subjects may also signify the potential for strength gains in the aged 10 11 Therefore, we hypothesized that by emphasizing eccentric contractions, eccentric overloading will lead to rapid strength gains at low cardiovascular stress in elderly subjects. The purpose of the study was to compare the effects of 7 days of eccentric overload and standard resistive exercise training on strength, cardiovascular stress, and muscle activation in elderly women. Methods Subjects and Design Subjects were 30 ostensibly healthy 26 Caucasian, 4 African American women who had not exercised more than once a week during the 3 years preceding the study. All subjects were right leg dominant based on a ball-kicking test. This approval letter and a medical questionnaire were used to determine whether a subject would qualify for the study. Subjects were excluded who had more than two risk factors for coronary artery disease 20 , a history of falls, osteoporosis, osteoarthritis, orthopedic or neurological conditions i. Subjects underwent an initial test, 7 consecutive days of exercise training, and a final test. The tests involved an assessment of leg strength, using a three-repetition maximum 3RM protocol, and isokinetic and isometric quadriceps strength and associated surface electromyography EMG. Testing Protocols Voluntary isometric and isokinetic strength. Voluntary isometric and isokinetic eccentric and concentric quadriceps strength of the left leg were measured on a dynamometer Kin-Com H, Chattecx, Inc. These tests

were necessary to assess the changes in muscle strength independent of learning that occur with weight training As a warm-up, subjects rode a bicycle ergometer at 60 rpm for 5 minutes at a resistance of 1â€”2 kg and performed 3 minutes of lower extremity stretching. Crossover shoulder straps, a lap belt, a knee strap, and an ankle cuff were used to minimize extraneous movements. The position of the cuff on the lever arm was adjusted individually to accommodate subjects of different size. The knee angle anatomical zero was set at 3. The weight of the leg was determined at 3. Subjects were not allowed to grasp the seat and kept their hands in their laps. Maximal isometric force was measured at 1. Subjects performed three, maximal effort, 5-second trials with 1 minute of rest between trials. Subjects also performed three, maximal effort, eccentric and concentric isokinetic quadriceps contractions at 1. We used this specific testing speed because it resembled the estimated knee joint angular velocity of the knee extension used during exercise training. Each quadriceps contraction was followed by a hamstring contraction with a 1-second pause between the efforts. There was 1 minute of rest between conditions. The order of isometric and dynamic testing was systematically alternated between subjects. Peak dynamic forces were digitized at 1. The highest force value of the three trials was used in the statistical analyses. Prior to dynamometry, the surfaces of the skin over the belly of the left vastus lateralis, vastus medialis, and the biceps femoris and over the right fibula head were palpated, shaved, and washed with alcohol. We recorded from these two synergistic quadriceps muscles because adaptations may be non-uniform in the quadriceps One ground electrode was placed on the skin over the right fibula head. The transmitter contains a crystal locked dielectric oscillator module, a microprocessor, and an eight-channel, bit analog-to-digital converter. Up to eight channels of digitized EMG signals are transmitted to the receiver over one of 10 radio channels in the to MHz radio frequency range. In the receiver the digitized signals are reconstructed into eight channels of analog data. The lower cutoff filter is a first-order high-pass design, and the upper cutoff filter is a sixth-order Butterworth low-pass design. In the transmitter a proprietary electronic feedback circuit isolates and removes the low-frequency noise component from the signal. The noise component is transmitted to the receiver separately from the EMG-only signals on one of the 10 radio frequency channels. All five signals were then digitized by the Myosoft software at 1 kHz Noraxon Inc. EMG data reduction consisted of the root-mean-square rms conversion of the direct EMG data by a millisecond smoothing window. The trial with the highest force was identified, and in these trials the corresponding peak rms EMG activity was digitized for the three muscles. Biceps femoris coactivity during the quadriceps testing was computed as the quotient of peak rms amplitude of the biceps femoris divided by the peak rms amplitude of the vastus lateralis. Unilateral left leg concentric 3RM and eccentric 3RM of the quadriceps muscle were determined on a separate day relative to the tests administered on the dynamometer. Concentric and eccentric 3RMs were defined as the amount of weight a subject was able to lift or lower three times, respectively. Concentric 3RM was determined first. At a three-count pace, subjects lifted and lowered the weight with one smooth movement during each phase. Next the eccentric 3RM was assessed. The technician manually lifted the weight that was one step below the previously determined concentric 3RM. The subject extended her knee, the technician let the weight go, and the subject lowered the weight at a three-count pace of a metronome from 3 rad to 1. This cycle was repeated until the subject could no longer lower the weight three times in a controlled fashion. No subject did more than six attempts to reach the concentric and eccentric 3RM, respectively. The monitor had a sensitivity of 1 mm Hg, a range of 20â€” mm Hg, and the capability to also record heart rate. The left arm rested on an arm support adjusted to heart level. Subjects sat for 5 minutes after they arrived and a resting blood pressure measurement was taken. A second measurement was taken immediately after the last contraction of the last exercise bout, and after 5 minutes of seated rest following the last contraction. For the second measurement the cuff inflation was timed so that the reading could be done no later than 15 seconds after the last contraction of the last exercise bout. Control subjects reported to the gymnasium three times over the 7-day period for blood pressure measurements. After each blood pressure measurement, subjects rated their perceived exertion on a scale of 6 to 20, with 7 being very, very light and 19 being very, very hard Training Protocol After the resting blood pressure measurement, subjects warmed up

for each session by riding a bicycle ergometer for 5 minutes at 1 kg, and then they stretched for a few minutes. Exercise training consisted of five to six sets of 9â€”12 repetitions of unilateral left knee extensionâ€”flexion exercise for 7 consecutive days. There was 3 minutes of rest between sets to avoid overtraining. Subjects exercised on the same Cybex machine that was used for the 3RM testing. Unilateral knee extension was the choice of exercise to isolate the quadriceps muscle group. The training programs were designed so that the total weight lifted by the two groups was similar. The extra load was removed after the lowering phase was completed. As a way to equate total load in the two groups, the eccentric overload subjects performed fewer repetitions. Normally if a subject in the standard group lifted 23 kg of mass, she would perform six sets of 12 repetitions, 23 kg for both the concentric and the eccentric phases, for a total of kg. To equate the load, the paired eccentric overload subject would perform six sets of 9. It was necessary to determine the exact repetition number prior to the workouts for each exercise bout for the eccentric overload subjects. The weight, the number of repetitions, and number of sets performed by each subject were recorded for the seven training sessions. Reliability of the criterion measures was determined in 10 nonexercising control subjects who were tested twice, 7 days apart. The same was done for the EMG measures. Reliability was estimated by a Pearson product moment correlation coefficient, and the differences in the means of the repeated measurements were analyzed with a paired, two-tailed t test. Resting, exercise, and recovery heart rate and blood pressure data were averaged over the 7-day period for each subject, and these mean values were compared with a group eccentric overload, standard, or control by time rest, exercise, or recovery analysis of variance with repeated measures on time. Because eccentric, isometric, and concentric forces are substantially different and an analysis of covariance would misleadingly adjust the post-training scores for these initial differences, these analyses were done on the gain scores i. Next, a group eccentric overload, standard, or control by contraction mode eccentric, concentric analysis of variance with repeated measures on the contraction mode was used to analyze the changes in concentric 3RM and eccentric 3RM. A group eccentric overload, standard, or control by contraction mode eccentric, concentric, or isometric analysis of variance with repeated measures on the last factor was used to analyze the gains in isokinetic and isometric forces as well as the changes in EMG activity. The total mean weight lifted during exercise training was analyzed with a group by contraction mode by time analysis of variance with repeated measures on the last two factors. Results Reliability Repeated measures of 3RM strength, isokinetic eccentric and concentric and isometric forces and the associated measures of vastus lateralis, vastus medialis, and biceps femoris EMG activity and the measures of 3RMs were stable and reliable. Exercise Training Data All subjects completed the study without injury. Table 1 shows the total mean weight lifted and lowered by the two groups. The data were combined over 7 days because we did not observe a substantial increase or decrease in these variables over 7 days. The control subjects did not show significant changes in any of these variables. Changes in 3RM Fig. The change in the control group was 9 N. The concentric 3RM gains were similar in the two groups.

RELIABILITY OF CARDIOVASCULAR AND METABOLIC RESPONSE TO HYDRAULIC RESISTIVE EXERCISE pdf

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