Abstract Presentations

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BIOMECHANICAL ANALYSIS OF A FATIGUE PROTOCOL USING A WEIGHTED SLED: EFFECTS ON PERFORMANCE MEASURES

S. Newell1, N. Fox2, A. C. Fry3, N. Moodie4, D. Wassom5

1The University of Kansas, Lawrence, KS, 2Dynamic Athletics Research Institute, Overland Park, KS, 3The University of Kansas, Human Performance Laboratory, Lawrence, KS, 4Rockhurst University, 5Dynamic Athletics

*Award Eligible - Outstanding Master's Student Podium Presentation

PURPOSE: To introduce a novel fatigue protocol using a weighted sled and to evaluate biomechanical performance changes. METHODS: Four recreationally trained male subjects (age 19±2yr, mass 74.5±8.5kg) and one female subject (age 27yr, mass 66kg) participated in a pilot fatigue protocol utilizing a weighted push sled. Subjects completed a resistance exercise bout consisting of 8 all-out sprints pushing a sled for 40yds with 30lbs of external weight added. Sets were broken up to allow for testing. A 3D Markerless motion capture system was used to collect the biomechanical data. This technology was utilized to decrease set up and testing time per athlete. During the weighted sled sets, time was used to determine performance. For the biomechanical testing, jump height, rate of force development, and net joint torques were used to measure performance.

RESULTS: Each weighted sled push showed a significant time reduction (p<0.05) at every push when compared to the first. Average percent drop from first through eighth was (6%, 8%, 16%, 18%, 23%, 22%, 0%). Box Jump max height achieved also showed significant percent reduction (p<0.05) found at every set of four push jumps compared to the first set. Average percent drop from the first set through the fourth set was (6%, 8%, 13%, 15%). Range of motion at the hips, knees, and ankles at max loading during the box jumps did not significantly change (p>0.05) with drops in performance. Average percent change from the first set through the forth was (Hips: 3%, 3%, 5%, 4%; Knees: 2%, 2%, 4%, 4%; Ankles: 1%, 2%, 2%, 2%). Max joint torques at the hips, knees, and ankles during the box jumps changed significantly (p<0.05) with drops in performance. When comparing joint torques from the first sets to just the fourth sets there is a 51% decrease at the hips, 54% increase at the knees, and 51% increase at the ankles. Rate of force development during the box jumps did significantly change (p<0.05) with drops in performance. When comparing pre testing box jumps to post testing box jumps there was a 58% drop in rate of force development. CONCLUSION: A weighted sled has the ability to drastically induce fatigue. Rate of force development and net joint torques changed significantly during the protocol. These results suggest that as the hips fatigue other joints over compensate, but do not provide the same performance. Further research needs to be done to track more biomechanical markers as well as combined acute physiological responses. PRACTICAL APPLICATIONS: Since the sled allows the athlete to go through a normal range of motion it produces more combined acute physiological responses. PRACTICAL APPLICATIONS: Since the sled allows the athlete to go through a normal range of motion it produces more combined acute physiological responses. PRACTICAL APPLICATIONS: Since the sled allows the athlete to go through a normal range of motion it produces more combined acute physiological responses.

CHANGES IN MEDIAL GASTROCNEMIUS MUSCLE-TENDON INTERACTION FOLLOWING 8 WEEKS OF RESISTANCE TRAINING

J. J. McMahon1, S. J. Pearson1, P. Comfort1

1University of Salford

*Award Eligible - Outstanding Doctoral Student Podium Presentation

It is well documented that muscle and tendon adapts to resistance training by increasing strength, size and stiffness. The effect of such adaptations on subsequent muscle-tendon interaction during functional performance, however, has not been examined. PURPOSE: To determine the effects of loading on medial gastrocnemius (MG) muscle-tendon interaction in order to inform resistance training practice. METHODS: Resistance trained males (n=11, 27.0 ± 4.8 years, 180.8 ± 5.8 cm, 86.3 ± 10.2 kg) performed three single-leg hopping trials (each lasting 15 seconds) on an inclined sled at 2.0, 2.5 and 3.0 Hz in a randomized and balanced order. Three-dimensional motion analysis, ultrasonography of MG and ground reaction forces were collected. For each trial, five consecutive hops performed within ±5% of the prescribed frequencies were analyzed. Sagittal plane joint angles and joint moments were determined via a combination of motion data, force data and inverse dynamics. Ankle joint stiffness was calculated as the ratio of peak joint moment (relative to body mass) to peak joint angular displacement. MG muscle-tendon unit (MTU) length was determined as a function of shank segment length and joint angle data. MG muscle length was calculated as fascicle length multiplied by the cosine of the pennation angle. MG tendon length was determined by subtracting MG muscle length from MG MTU length. The elongation and shortening phase for each component of the MTU was determined based on the peak MTU elongation during the ground contact phase of each hop. Results: The elongation and shortening phase for the MTU was determined based on the peak MTU elongation during the ground contact phase of each hop. The elongation and shortening phase for the MTU was determined based on the peak MTU elongation during the ground contact phase of each hop. The elongation and shortening phase for the MTU was determined based on the peak MTU elongation during the ground contact phase of each hop. Participants performed four sets of 12 repetitions of the calf raise with 67% of 1RM, twice per week for eight weeks before being retested. Dependent t-tests were used to compare pre- and post-training data (p<0.05). RESULTS: 1RM calf raise significantly increased from 82.0 ± 16.4 kg to 93.5 ± 23.0 kg (p<0.05). There were no significant post-training changes in MG muscle-tendon interaction at 2.0 Hz; in contrast there was a significant decrease in MG muscle elongation at both 2.5 Hz (0.6 ± 0.2 mm vs. -1.4 ± 0.2 mm, p<0.05) and 3.0 Hz (-1.3 ± 0.4 mm vs. -2.4 ± 0.6 mm, p<0.05). Equally, there was a significant increase in MG length at both 3.0 Hz (11.5 ± 1.7 mm vs. 13.7 ± 3.0 mm). This was accompanied by a significant (p<0.05) increase in MG MTU elongation at both frequencies (2.5 Hz: 14.6 ± 2.0 mm vs. 16.9 ± 4.1 mm; 3.0 Hz: 9.8 ± 2.1 mm vs. 11.4 ± 3.1 mm), leading to a significant decrease in ankle joint stiffness at both 2.5 Hz (0.29 ± 0.05 Nm/kg/deg vs. 0.25 ± 0.04 Nm/kg/deg, p<0.01) and 3.0 Hz (0.40 ± 0.07 Nm/kg/deg vs. 0.36 ± 0.08 Nm/kg/deg, p<0.05).

EFFECTS OF FATIGUE FROM RESISTANCE TRAINING ON BARBELL BACK SQUAT BIOMECHANICS

D. Hooper1, T. Szivak1, B. Comstock1, C. Dunn-Lewis1, J. Apicella1, D. Looney1, S. Flanagan1, B. Creighton1, H. Luk1, W. J. Kraemer1

1University of Connecticut

*Award Eligible - Outstanding Doctoral Student Podium Presentation

Purpose: Exhaustive resistance training programs that have been previously referred to as ‘extreme conditioning protocols’ have increased in popularity in military and civilian populations in recent years. However, these programs have also been associated with increases in injury. As both cardiovascular and local muscular fatigue have been shown to result in reduced proprioception, the combination of both stimuli in these ‘extreme conditioning protocols’ could be a concern. Further, when these programs are performed with higher loads as well as with complex movements, the possibility of performing such lifts with poor technique should certainly be considered. With the above in mind, the purpose of this study is to assess the alterations in movement patterns that result from ‘extreme conditioning protocols’ and to evaluate if these changes are the mechanism of increased injury rates in such programs. Methods: 12 men (age 24 ± 4.2 years, height 173.1 ± 3.6 cm, weight 76.9 ± 7.8 Kg, body fat percentage 9.0 ± 2.2) and 13 women (age 24.5 ± 3.8 years, height 166.9 ± 8.5 cm, weight 66.1 ± 9.2 Kg, body fat percentage 18.6 ± 4.0) with at least 6 months of resistance training experience performed a resistance training workout. The resistance training protocol was designed to create as much fatigue as possible in order to study a near worst case scenario for ‘extreme conditioning protocols’. 75% 1RM load was used for each of the three lifts; back squat, bench press and deadlift. Subjects began with 10 repetitions of each lift and then reduced the number consecutively by 1 until they reached only 1 repetition. Subjects were instructed to perform all of the repetitions as quickly as possible. If the prescribed repetitions for a set were not able to be performed in one single set (i.e. rest was taken mid-set), the following set was performed at 5% RM less (i.e. 70%). The subjects were instructed to perform the routine with as little load reduction as possible. In order to analyze the impact that fatigue has on movement patterns, a two-dimensional analysis of the barbell back squat was performed using Dartfish (Fribourg, Switzerland). Plasma lactate was measured as an indicator of fatigue via blood drawn from an indwelling catheter immediately before and after the workout. Results: Over the course of the workout knee angle significantly (p<0.05) changed for both men (early 197.4 ± 6.8 vs. late 90.4 ± 5.6) and women (early 103.9 ± 8.1 vs. late 91.7 ± 10.0). Also, hip angle significantly (p<0.05) changed for both men (early 86.7 ± 15.9 vs. late 116.8 ± 72.8) and women (early 87.6 ± 9.1 vs. late 101.5 ± 8.6). Mean blood lactate for men before the protocol (Pre) was 1.48±0.30 mmol·L-1 and immediately after the workout (Post) was 14.21±2.19 mmol·L-1. Mean (Pre) blood lactate for women was 1.44±0.42 mmol·L-1 and (IP) was 10.06±2.50 mmol·L-1. Conclusions: These changes serve as a potential avenue to explain the increased injuries seen in ‘extreme conditioning protocols’. A potential cause for said increased injury risk could be that exercises are being performed with changes in technique, as
fatigue has been associated with reductions in proprioception. This study showed that alterations in technique do occur in ‘extreme conditioning protocols’ but a long term study would be required to see if these changes are contributing to increased injury. Ultimately, this study has documented the changes that occur in an exhaustive resistance training program that represents a near worst case scenario. Practical Applications: If movement patterns change during a resistance exercise, particularly under heavy loads, it seems in the interest of athlete safety that this workout design is performed with less technical exercises (such as resistance machine exercises) to keep potential injury risk at a minimum while still seeing the positive adaptations associated with such program design.

Thursday, July 11, 2013, 9:15 AM - 9:30 AM

MONITORING NEUROMUSCULAR FATIGUE AND RECOVERY IN SEMI-PROFESSIONAL RUGBY UNION PLAYERS

N. Gill1, D. McMaster2, D. Smart3, J. Cronin4, M. McGuigan5

1All Blacks - New Zealand Rugby Union, 2Sports Performance Research Institute New Zealand, 3Hight Performance Sport New Zealand, 4Sports Performance Research Institute New Zealand - AUT University, 5AUT University

PURPOSE: In elite rugby, the rigors and demands of a match and competition can have acute and accumulative effects on neuromuscular performance; various monitoring methods can be utilized to detect system fatigue and recovery. Vertical jump peak power is commonly used track and quantify neuromuscular fatigue and recovery following rugby matches. Few studies have fully assessed the accumulative effects of a rugby competition on vertical jump performance; furthermore, previous research has monitored the changes in the peak power derivatives (i.e. force at peak power and velocity at peak power) and their contribution to fatigue and recovery. The aim of the current study was to track the time course changes in vertical jump peak power, force at peak power and velocity at peak power to monitor the amount of acute and chronic neuromuscular fatigue and the weekly recovery rates in semi-professional rugby union players throughout a competitive season. METHODS: Vertical jump performance of eighteen semi-professional rugby union players (age = 23.9 ± 2.9 yr; height = 184.4 ± 7.2 cm; body mass = 103.1 ± 12.4 kg) was monitored at regular time points between games (pre [58 ± 2 hr] and post [41 ± 10 hr]) across a nine week period. Two body mass countermovement jumps (CMJ) and a portable force plate were used to measure peak power, velocity at peak power and force at peak power. RESULTS: There were small decreases in post-game peak power (-2.3%) and velocity at peak power (-2.7%) in comparison to baseline values; while differences between baseline and pre-game were trivial (<1%). Small increases in CMJ peak power and velocity at peak power (2.9 - 3.7%) from post-game to pre-game were observed; whereas the pre- vs. post- game force at peak power changes were trivial (-0.5%; ES = 0.08). There were small increases in peak power (2.4 ± 2.6%) and velocity at peak power (5.9 ± 4.1%) and small decreases in CMJ force at peak power (-3.7%; d=0.40) from the first two weeks of competition to the last two weeks. Large and very large correlations were observed between velocity at peak power (r = 0.62), peak power (r = 0.72) and the number of hours post-match jump testing took place. There were also moderate correlations (r = 0.47 – 0.52) between enhanced pre-game CMJ performance and match outcome (expressed as a positive or negative value based on score differential). CONCLUSION: The results suggest that fluctuations in peak power were most-likely due to decreases and increases in velocity and not force, therefore velocity produced at peak power appears to be the limiting factor for assessing peak power decay and recovery rates. Neuromuscular performance (peak power) may be diminished for up to 110 hr post match from a neuromuscular fatigued state. PRACTICAL APPLICATIONS: The rate/amount of post-game fatique (i.e. decrease in peak power and velocity at peak power) in proportion to the week prior and baseline may be used to guide daily and weekly training loads throughout the season. Peak power output can be maintained and under the right training stimulus even improved throughout a competitive season. ACKNOWLEDGEMENTS: The investigators would like to thank the North Harbour Rugby Union staff and players for their support of and cooperation on this project.

Thursday, July 11, 2013, 9:30 AM - 9:45 AM

POWER-LOAD AND VELOCITY-LOAD CURVES: A COMPARISON OF TWO WEIGHT ROOM TESTING MODALITIES

M. T. Lane1, A. C. Fry1, J. Weir1, T. J. Herda2, M. Andre2, A. Hudy3, G. Cain3, L. Bradford2

1The University of Kansas, Human Performance Laboratory, Lawrence, KS, 2University of Kansas, 3University of Kansas / Biomechanics Laboratory, Lawrence, KS

*Award Eligible - Outstanding Doctoral Student Podium Presentation

Many strength and conditioning professionals prescribe resistance training based in part on power and velocity characteristics of the individual. Currently several testing modalities are available for use in the training facility. PURPOSE: To compare tether-based and 3-D camera-based external dynamometers for determining power-load and velocity-load curves for the barbell speed squat exercise. METHODS: Twenty resistance-trained collegiate student-athletes participated in this study (8 female 12 male). Each athlete performed one set of three repetitions at loads of 30, 40, 50, 60, 70, 80, and 90% of their 1 repetition maximum (1 RM) for the barbell parallel speed squat exercise. Each repetition was recorded with both a Weightlifting Analyzer Tendo device (Fittrodyne; Bratislava, Slovakia) and an EliteForm PowerTracker system (EliteForm; Lincoln, Nebraska). The Tendo dynamometer uses a nylon tether attached to the barbell, while the EliteForm PowerTracker uses 3-D video cameras to record barbell movement. The repetition with the highest mean power for each set was used for data analyses. Using mean power data and 2nd polynomial regressions, a power-load curve was calculated for each subject. From these curves, maximum power and barbell load at maximum power were determined. Using mean velocity data and linear regressions, a velocity-load curve was also determined for each subject. Comparisons of data from both dynamometers used paired t-tests (α<0.05) corrected using the Holm-Bonferroni method. Where appropriate, Cohen’s D effect sizes were calculated. Results: Estimated maximum power was significantly different between the two dynamometers (Tendo=676.0±213.4 W, EliteForm=654.1±204.2 W), but the effect size was extremely small (D=0.09). Barbell loads at estimated maximum power were similar (Tendo=83.6±20.8 kg, EliteForm=84.3±22.0 kg). No significant differences were reported for any curve variables for either the power-load (1st, 2nd or 3rd polynomial coefficients) or the velocity-load curves (slope, intercept). Excellent data fit for all regressions was evident from the r2 values (power-load, Tendo = 0.95, EliteForm = 0.85; velocity-load, Tendo = 0.93, EliteForm = 0.95). Conclusion: Previous research has examined whether external dynamometers such as used in the present study provide valid data for barbell exercises. These data demonstrate the comparability of either testing modality for determining more complex measures that are useful for the strength and conditioning professional or coach. Results from the use of 3-D camera technology for these types of measures result in similar power and velocity data to those derived from tether-based technology. Practical Application: Use of the Tendo or the EliteForm external dynamometers will result in comparable power-load or and velocity-load curves resistance-trained college-aged student-athletes. Acknowledgement: This study was supported in part by Nebraska Global LLC.

Thursday, July 11, 2013, 9:45 AM - 10:00 AM

RELIABILITY OF A YOUTH BASEBALL AND TEE BALL HITTING SCALE

A. Walsh1, G. G. Haff1, S. Nephins2

1Edith Cowan University, 2Centre for Exercise and Sport Science, Edith Cowan University

*Award Eligible - Outstanding Master’s Student Podium Presentation

Extended age for exit from tee ball to baseball in Australia has led to issues in the development of key baseball skills. In particular, the development of poor hitting mechanics seems to be more prevalent as a result of this slow transition. To allow for assessment and critique of hitting motor competence a hitting scale was developed using experienced coaches in conjunction with current motor competence scales for striking skills. The scale was comprised of six criterion sections addressing the hands, hips, shoulders, coordination of movement and follow through. PURPOSE: To assess inter and intra rater reliability of a hitting competency scale in youth tee ball and baseball players. METHODS: Ten male participants (age: 11.1 ± 2.02 years) with at least one year of prior tee ball or baseball experience attended three testing sessions. After a baseball specific warm-up, each participant hit 5 balls off a tee followed by 5 balls from “soft toss” with the instruction to “hit the ball up the middle”. Each swing was recorded using two cameras. The rear and side on view video were synced and two coaches used the hitting scale to assess each swing. Intraclass correlation coefficient and coefficient of variation with 90% confidence intervals (90%CI) were calculated for inter and
intra rater reliability. RESULTS: Inter rater reliability was high (ICC=0.98; 90%CI: 0.94-0.99) with low coefficients of variation (CV=3.5%; CI: 2.9-4.4%) for the tee and soft toss (ICC = 0.99; 90%CI: 0.97-1.00)(CV = 2.5%; 90%CI: 2.1-3.1%). Further, intra tester reliability was also high for both tee (ICC = 0.98; 90%CI: 0.95-0.99)(CV = 6.6%; 90%CI: 5.6-8.3%) and soft toss (ICC = 0.99; 90%CI: 0.98-1.00)(CV = 4.5%; 90%CI: 3.7-5.6%). CONCLUSION: The results demonstrate the hitting scale used in this study is reliable between sessions and between assessors (or coaches). Further, the use of either a tee or soft toss to assess hitting competency using this scale is similarly reliable. PRACTICAL APPLICATIONS: The high reliability between the sessions and drills demonstrate that the scale is reliable for grading youth baseball swings. The ability to assess this fundamental skill with a reliable scale allows coaches to identify areas to improve in the swing and determine progress of swing mechanics.

Thursday, July 11, 2013, 10:00 AM - 10:15 AM
THE EFFECT OF TRAINING STATUS AND FATIGUE ON MUSCLE LENGTH CHANGE DURING JUMPING
J. Paul1, J. Alley2, C. Goodman2, L. Vasquez2, C. John2, T. Triplett3, T. Erickson4, J. McBride2
1Appalachian State University, 2Appalachian State University/Neuromuscular & Biomechanics Laboratory, Department of Health, Leisure & Exercise Science, Boone, NC, 3Appalachian State University, 4Appalachian State University
*Award Eligible - Outstanding Master’s Student Podium Presentation

The purpose of this investigation was to utilize a novel technique involving the insertion of a Fiber Bragg Grading sensor through the patellar tendon to determine changes in tendon length in a single trained and untrained jumper. Muscle-tendon unit (MTU) function was monitored during the knee extensor muscle fatigue and training induced changes in tendon length. METHODS: Twenty recreationally trained jumper subjects (age = 22.3 ± 2.5 yrs, height = 166 ± 6.0 cm, mass = 61.4 ± 9.3 kg) were recruited. Testing was completed in a counterbalanced order with each subject completing two visits. One visit involved a total of 12 individual counter movement jumps (CMJ), 12 individual static jumps (SJ), 20 sequential CMJ, and 20 sequential SJ. Individual SJ and CMJ were performed before and after the sequential jumps to determine changes in MTU function due to fatigue. RESULTS: The trained individual had a 11% increase in force production, a 26% decrease in patellar tendon length, a 42% increase in muscle fiber length, and a 5.7% increase in jump height. These results demonstrate the changing function of the MTU during fatigue. The trained individual had a 4% decrease in force production, a 92% decrease in patellar tendon length, a 52% decrease in muscle length, and 1.2% decrease in jump height. The large decrease in patellar tendon length, and decrease in muscle length can be explained by the shallow depth of the counter movement jump while fatigued. The ratio of muscle length change to tendon length change in the trained individual was greater than the ratio of muscle length change to tendon length change in the trained individual. This indicates that a trained individual is better able to maintain muscle length during jumping. CONCLUSION: Fatigue impacts MTU function by decreasing the muscle’s ability to maintain length. Increasing change in muscle length and decreasing change in tendon length decreases concentric performance. PRACTICAL APPLICATION: Jump training may influence performance by varying the function of the MTU thus future research should focus on longitudinal study of these variables. ACKNOWLEDGEMENTS: NSCA Senior Investigator Award.

THE EFFECTS OF REACTIVE NEUROMUSCULAR TRAINING VERSUS TRADITIONAL HIP ABDUCTOR EXERCISE ON KNEE KINETICS IN WOMEN DURING A DROP JUMP LANDING
S. K. Lynn1, M. Pittman2, B. Hamedani3, G. J. Noffal4, K. Tsang1
1California State University, Fullerton - Center for Sport Performance - Biomechanics Laboratory, 2Center for Sport Performance, California State University, Fullerton, CA

Purpose: Females experience a higher rate of knee injuries when compared with males, with the anterior cruciate ligament (ACL) being the most common injured structure. A noncontact mechanism accounts for approximately 72% of ACL injuries and these injuries generally occur during dynamic tasks such as landing from a jump. A large knee abduction moment has been identified as a good predictor of ACL injury; therefore, the development of exercise programs that can decrease this abduction moment are warranted. It has been shown that proper functioning of the hip abductor musculature can help in reducing the frontal plane moments on the knee. One novel method of training the hip abductors involves using a proprioceptive technique for isometric stabilization or Reactive Neuromuscular Training (RNT). Therefore, the purpose of this study is to investigate the effects of RNT and traditional hip abductor training in females on the abduction moment at the knee during a drop jump landing task. METHODS: Twenty recreationally trained female subjects (age = 22.3 ± 2.5 yrs, height = 166 ± 6.0 cm, mass = 61.4 ± 9.3 kg) completed the study. Following initial testing, they were split into three groups: Control (C)(n=8), Traditional Hip Abductor Training (THAT)(n=6), and RNT (n=6). Training lasted 8 weeks and subjects performed their exercises 3 times/week. The THAT group performed side lying hip abductions (clams), while the RNT group did single leg Romanian deadlifts with a resistance band around their knee pulling it medially. Subjects were tested pre and post intervention doing a drop jump landing onto an AMTI force plate as an eight camera motion capture system (Qualisys) simultaneously tracked retro-reflective markers strapped securely to the sacrum, thigh, shank and foot. Motion and force data were combined using Visual 3D (C-Motion Inc.) software to calculate the frontal plane knee joint moments. Mean peak external knee abduction moments (Nm/kg) were compared between the C, THAT, and RNT groups using a 2x3 (Pre/Post x Group) mixed-model ANOVA. Results: Results revealed a significant Pre/Post x Group interaction (p<0.05). Post hoc paired samples T-tests then revealed only the RNT group decreased their abduction moment following training (p<0.05). Conclusion: RNT training was able to reduce the knee abduction moment during a drop jump landing task, while standard hip abduction training (side lying hip abduction) did not. PRACTICAL APPLICATION: RNT training may be a valuable tool to use with those athletes prone to valgus collapse related injuries (i.e. ACL injury). Using this method of training to help reduce the abduction moment at the knee would have great potential applications in rehabilitation and in reducing injury prevalence.

Thursday, July 11, 2013, 11:30 AM – 1:00 PM
Poster: 1
THE ACUTE HORMONAL RESPONSE TO THE KETTLEBELL SWING EXERCISE
R. G. Budnari1, J. L. Vingren1, B. K. McFarlin1, A. A. Duplanty1, A. Fernandez1, M. E. Anderson1, D. W. Hill1
1University of North Texas
*Award Eligible - Outstanding Master’s Student Poster Presentation

INTRODUCTION: Kettlebell exercises such as the kettlebell swing have recently been popularized in the strength and conditioning community and have been shown to improve strength, power, and maximal aerobic power. The acute hormonal response moderates physiological adaptations to exercise and is affected by acute program variables such as exercise selection. The appearance of an acute hormonal increase in response to exercise and the magnitude of the response are affected by the amount of muscle mass involved. The kettlebell swing involves a large muscle mass (legs, hips, shoulder, back) and thus might induce a large acute hormonal response. However, no previous studies have evaluated the acute hormonal response to the kettlebell swing exercise. PURPOSE: The purpose of this investigation is to examine the acute hormonal response to a bout of kettlebell swing exercise. METHODS: Ten healthy men (19-30 y, 23.6 ± 3.5 y, 174.6 ± 5.7 cm, 78.7 ± 9.9 kg) who were engaged in resistance training at least twice per week but were inexperienced with kettlebell swings participated in this study. Participants were familiarized with the kettlebell swing exercise during an initial visit. During the subsequent experimental protocol visit, participants performed 12 rounds of 30 seconds of 16-kg kettlebell swings alternated with 30 seconds of...
rest. Heart rate (HR) and rating of perceived exertion (RPE) were measured at the end of every round of swings. Fasted blood samples were collected pre-exercise (PRE), immediately post (IP), 15 minutes post (P15), and 30 minutes post-exercise (P30) and analyzed for total testosterone (TT), growth hormone (GH), cortisol, and lactate concentrations. RESULTS: Participants completed a total of 227 ± 23 swings (average swings per round: 19 ± 2). HR and RPE increased significantly (P < 0.05) throughout the exercise protocol. Lactate concentration was significantly increased at all post exercise time points compared to PRE. TT was significantly increased at IP compared to PRE. GH was significantly increased at IP, P15, and P30 compared to PRE. Cortisol was significantly increased at IP and P15 compared to PRE. CONCLUSION: 12 rounds of 30 seconds of kettlebell swing exercise induced an acute increase in TT, GH, and cortisol concentrations in resistance trained men. PRACTICAL APPLICATIONS: A relatively short duration of exercise (total of 6 minutes of exercise in a 12-minute session) produced an acute increase in hormones involved in muscle recovery and adaptations. Additionally, this exercise protocol induced a large increase in HR and lactate concentration. Thus, the kettlebell swing exercise might provide an effective method for simultaneous endurance and resistance training.

Poster 2

ACUTE HORMONAL RESPONSES TO SUPER-SLOW OR TRADITIONAL RESISTANCE EXERCISE IN MEN
A PILOT STUDY

P. R. Dietz1, A. C. Fry1, M. J. Andre1, Z. Graham1, M. T. Lane1
1The University of Kansas, Human Performance Laboratory, Lawrence, KS, 2University of Kansas

Various methods of resistance training have gained in popularity such as super-slow resistance exercise (i.e., 10 s concentric and eccentric phases) where movement velocity is purposely slow. Because of the slow movement, there are limitations to the loads that can be lifted (e.g., <50% 1 RM). PURPOSE: The purpose of this project was to determine the acute hormonal responses to traditional and super-slow resistance exercise protocols in healthy college age men. METHODS: Three healthy resistance-trained men served as subjects (X±SD: age = 24.7±3.8 yrs, Hgt = 1.79±0.03 m, BW = 96.5±8.4 kg, 1 RM squat = 197.7±6.4 kg, 1 RM bench press = 140.3±15.0 kg). Each subject performed 3 testing sessions in random order; one control session where no exercise was performed, and two different free weight resistance exercise sessions, a traditional protocol and a super-slow training protocol. The traditional protocol consisted of 3 x10 at 70% 1 RM loads for the parallel squat and the bench press exercises. Inter-set rest intervals were 1 min, with 2 min between exercises. The super slow training protocol consisted of 1x10 at 28% 1 RM loads for the parallel squat and bench press exercises. Inter-set rest intervals were 1 min, with 2 min between exercises. Serum samples collected from a superficial antecubital vein 15 min pre exercise (Pre) and 5 min post exercise (Post) were analyzed for total testosterone, cortisol, and immunoreactive growth hormone (IR GH;22 kDa). Lactate (LHa) was sampled via finger-stick at the same times. Serum samples were collected at identical times during the control session. All testing was performed between 1630-1900 hrs, with times held constant for each subject to minimize diurnal variations. ELISAs were used to determine circulating concentrations for each hormone. RESULTS: This study lists the hormonal responses (X±SD) for each exercise protocol. * indicates > 2 SD different from pre value; † indicates > 2 SD different from control value. The acute responses for growth hormone, cortisol, and lactate increased for both protocols; whereas only the traditional protocol increased testosterone. All sessions were completed in 9 – 11 min. Volume-loads (reps x wgt.) were 6840.2±625.2 kg for the traditional protocol induced a large increase in hormones involved in muscle recovery and adaptations. Additionally, this exercise protocol induced a large increase in HR and lactate concentration. Thus, the kettlebell swing exercise might provide an effective method for simultaneous endurance and resistance training.

Poster 3

THE EFFECT OF DIFFERENT FREQUENCIES OF WHOLE BODY VIBRATION ON SALIVARY TESTOSTERONE AND CORTISOL LEVELS IN COLLEGE AGED MALES

B. Parker1, R. Wood2, T. Matthews2, V. Paolone2
1University of Rhode Island, 2Springfield College

*Award Eligible - Outstanding Doctoral Student Poster Presentation

PURPOSE: Hormone levels have been shown to be an important factor in development of strength, power, and athletic performance. The use of WBV has been shown to increase testosterone levels and decrease cortisol levels thereby placing the body in a primarily anabolic state. The purpose of the current study was to examine the hormonal effects of different frequencies of Whole Body Vibration (WBV) as measured via salivary testosterone and salivary cortisol levels. METHOD: Eleven physically active male subjects (20.18 ± 12.5 yrs; 84.23 ± 18.73 kg) completed the protocol. All subjects completed one accommodation session, during which the subjects stood on the vibration platform with no stimulus (0 Hz) for 10 min bouts with 1 min of rest between each bout for a total of 19 min on the platform. Unstimulated saliva samples were collected in 1.5 ml aliquots prior to standing on the platform followed by samples at 0-min Post, 15-min Post, and 30-min Post. Subjects underwent three additional sessions at a randomly selected frequency (30 Hz, 40 Hz, or 50 Hz). Collection of saliva was identical for all subjects at all sessions. A total of two 4 x 4 repeated measures factorial analysis of variance (ANOVA) was utilized to examine the differences or interactions that existed for the following dependent variables: salivary testosterone and salivary cortisol. RESULTS: Mean salivary testosterone level at 50 Hz (160.81 ± 4.26 pg/mL) was significantly (p < .05) lower than mean testosterone at 0 Hz (190.12 ± 10.43 pg/mL). Mean salivary cortisol level at 15-min Post WBV (0.37 ± 0.06 ug/dL) and 30-min Post WBV (0.31 ± 0.05 ug/dL) was significantly (p < .05) lower than mean cortisol at baseline (0.45 ± 0.06 ug/dL). CONCLUSIONS: In the current investigation, it was hypothesized that at a higher frequency of WBV, motor unit recruitment would increase as it would with a progressive overload. This would result in the recruitment of a greater number of muscle fibers, which would enable greater hormone-tissue interaction, a precursor to anabolism. Furthermore, it was hypothesized that as frequency of WBV increased, thereby increasing the gravitational load, both testosterone and cortisol would increase based on the increased recruitment of muscle fibers. Perhaps the stimulus of WBV in the current investigation was not sufficient enough to elicit the hormonal response one would expect with greater training volume. Because salivary cortisol levels decreased in the current investigation, the hormonal response to the WBV failed to produce a general stress response as well as a response commonly seen in exercise. In addition, the decrease in salivary testosterone levels indicated that the stimulus provided by WBV in the current study was not sufficient enough to produce increases in testosterone as would normally occur following a bout of resistance training. PRACTICAL APPLICATIONS: Vibration training is relatively new and, therefore, guidelines for WBV exercises and protocols have yet to be standardized. Further research needs to be conducted to determine the most effective protocols for this form of training and in the specific arena of athletic performance toward which the technology is being targeted.

Poster 4

EFFECTS OF HIGHER AND LOWER RESISTANCE EXERCISE VOLUME ON SERUM TESTOSTERONE AND SKELETAL MUSCLE ANDROGEN RECEPTOR, MYOSTATIN, AND MGF MRNA EXPRESSION

M. Spillane1, N. Schwarz1, D. Willoughby1
1Baylor University

*Award Eligible - Outstanding Doctoral Student Poster Presentation

Testosterone (TEST) has shown the ability to augment muscle protein synthesis through a variety of biochemical and molecular interactions. Higher and lower volumes of resistance exercise have been demonstrated to differentially elevate endogenous levels of TEST. As a result, the ability of acute resistance exercise with higher (HV) and lower volumes (LV) to alter key regulators of skeletal muscle mass [androgen receptor (AR), myostatin, and mechano growth factor (MGF)] needs to be elucidated. PURPOSE: To examine the effect resistance exercise with either HV or LV on serum TEST levels as well as the subsequent effects on skeletal muscle AR, myostatin, and MGF mRNA expression. METHODS: 9 resistance-trained (a minimum of 3 exercise sessions/wk for 1 yr) men (18-25 yrs) performed 2 separate resistance exercise bouts. One bout consisted of a HV routine (lower-body only (5 sets of 5 reps, 90-95% 1-RM)) of bilateral knee extensions, whereas the second bout consisted of a HV routine (upper-body (4 sets of 10 reps, 80-85% 1-RM)) of bench press, seated row, and overhead shoulder press as well as lower-body with bilateral knee extensions (5 sets of 5 reps, 90-95% 1-RM)). Exercise
sessions were held one week apart in a randomized cross-over design. Serum free and total TEST were measured immediately prior to and after exercise, and at 5 hr, 1 hr, 2 hr, 3 hr and 24 hr after exercise. Muscle biopsies were performed immediately prior and after, 3 hr, and 24 hr after exercise. Separate (2 x 4) & (2 x 7) [Session x TEST] ANOVA with repeated measures were performed with significant between-group differences determined by Tukey's post Hoc TEST. RESULTS: No significant main effects for time or group (p > .05) were observed for total and free TEST indicating no changes in response to resistance exercise or between LV and HV. However, a trend was observed (p=0.066) for an increase in free TEST with HV. In addition, no significant main effects for time or group (p > .05) were observed for skeletal muscle AR, myostatin, and MGF mRNA expression. CONCLUSIONS: Even though previous research has shown serum TEST to be greater for HV resistance exercise, these studies typically used untrained participants. The results presented herein are contradictory, perhaps due to using resistance-trained participants, and suggest that resistance exercise volume does not affect serum TEST which may have a subsequent effect of the skeletal muscle expression of the AR, myostatin, and MGF genes. PRACTICAL APPLICATIONS: Acute HV (upper and lower body resistance exercise) in resistance-trained individuals may not result in the greater TEST response typically seen with untrained individuals. This suggests that training may involve other biochemical and molecular signaling mechanisms which regulate muscle protein synthesis and contributes to increases in muscle hypertrophy and strength.

COMBAT-INDUCED POST-TRAUMATIC STRESS DISORDER RESULTS IN BLUNTED ACUTE ENDOCRINE RESPONSES TO HEAVY RESISTANCE EXERCISE: A CASE STUDY
D. R. Wilson1, A. C. Fry1, M. J. Andre1, Z. A. Graham1, P. R. Dietz2, M. T. Lane
The University of Mississippi, 1The University of Kansas, Human Performance Laboratory, Lawrence, KS

PACING STRATEGIES IN ELITE WOMENS FIELD HOCKEY
A. White1, N. MacFarlane1
1University of Glasgow

THE ACUTE EFFECTS OF A PERFORMANCE MOUTHPIECE ON WHOLE BODY REACTION TIME TO BALANCE PERTURBATIONS
C. Allen1, J. Lundahl2, H. Chander2, C. Zachary3, N. Dabbs2, J. C. Garner2
1The University of Mississippi, 2University of Mississippi

PACING STRATEGIES IN ELITE WOMENS FIELD HOCKEY
A. White1, N. MacFarlane1
1University of Glasgow

PURPOSE: It has been previously shown that the intensity of team sport competition decreases from the first to second half. However, field hockey rules allow unlimited substitutions that allow players frequent rest periods during the game. Therefore, we hypothesise that elite female hockey players can maintain constant intensity levels throughout a game. METHODS: 15 female field hockey players (mean±SD; age 25±3yrs; body mass 64.0±5.8 kg; maximal oxygen consumption 52.9±7.5 mL.kg.min−1) were studied (giving forty player analyses over five games). Physical activity was recorded using a 5-Hz global positioning system. Full game analysis procedures were used to report data. RESULTS: Table 1 shows that average duration of 1st half was significantly less than 2nd half (36mins [36 to 37mins] versus 38mins [37 to 39mins]; Mean [95%CI] p < 0.001). Markers of intensity – distance covered, meterage, player load, efforts over 14km.hr−1, 18km. hr−1 and 25km.hr−1 and maximum velocity were all similar (p > 0.05). CONCLUSION: Unlike most other popular team sports, field hockey allows unlimited in-play substitutions. This can mean players entering and leaving the game two or three times in one half and allows for more rest time. The results from this study show that intensity, as shown by selected markers, is maintained throughout the game. This demonstrates that pacing strategies influence the intensity of game play in elite level field hockey. PRACTICAL APPLICATION: This study demonstrates that the intensity of game play is influenced by pacing strategies and as a consequence the use of such strategies must be considered when planning conditioning sessions for athletes in sports with rolling substitutions.
Poster: 8
MUSCLE ACTIVITY DURING PUSH-UP VARIATIONS OF DIFFERING STABILITY
M. Breau1, D. Bellar2, L. Judge3
1University of Louisiana at Lafayette, Lafayette, LA, 2Ball State University, Muncie, IN

This study investigated the activity of the pectoralis major and triceps brachii muscles during a push-up done three different ways was monitored. The first was a standard push-up performed on the floor. The second was with the hands placed in straps that were suspended from above and the feet placed on a stable platform, and the third was with the hands and feet suspended in straps. METHODS: For this investigation, the participants were seven college-aged males (BF=32.5 ± 2.5%) trained in the technique of a push-up. The pectoralis major and the triceps brachii (lateral head) muscles were monitored using EMG. The data was recorded and amplified, low pass filtered and then iEMG signals over one concentric representative phase were quantified. RESULTS: Data were analyzed via repeat measures Anova. The results of the analysis from the iEMG of the Tricep by treatment were significant (F=4.12, p=0.043). The iEMG signal was the highest from the fully suspended position followed by the hands only suspension with the lowest signals from the standard push-up. These results were similar to those from the pectoralis major muscle (F=22.96, p=0.007). The conclusion from the fully suspended push-up. CONCLUSION: The fully suspended position resulted in the highest iEMG signals, followed by the hands only suspension and then the standard push-up. PRACTICAL APPLICATION: It is important to strength and conditioning professionals to understand that the triceps and the pectoralis muscles seem to be more active the more unstable the push-up gets, so strength coaches should consider adding instability into similar movements to enhance muscle activity. ACKNOWLEDGEMENTS: The authors would like to acknowledge the contributions of TruFit LLC to the current project.

Poster: 9
EFFECTS OF BLOOD FLOW RESTRICTION EXERCISE DURING ISOMETRIC CONTRACTIONS ON NEUROMUSCULAR RECruItMENT PATTERNS
T. Cayot1, A. Shawi1, C. Silette1, E. Garmyn1, B. Scheuermann1
1University of Toledo

*Muscular hypertrophy has been demonstrated using blood flow restriction (BFR) exercise at resistance intensities of 20%-40% of an individual's maximal voluntary contraction (MVC), similar to the results observed for resistance training at a much higher percent of MVC. Current literature indicates that BFR exercise elicits a greater neuromuscular recruitment compared to free flow (FF) exercise at similar resistance intensities for dynamic exercise; however, the effects of BFR exercise on isometric muscle contraction has not been previously examined. PURPOSE: To investigate the effect of BFR exercise on neuromuscular recruitment patterns using surface electromyography (EMG) during various BFR conditions. METHODS: Healthy, recreationally active, college-aged, male subjects (n=4; age 26±3.2 years; weight 88.5±12 kilograms) performed four repetitions of an isometric knee extension exercise at 90° of knee flexion for each resistance intensity (20% MVC, 40% MVC, 60% MVC, 80% MVC). Subjects performed the exercise during three BFR conditions including control (CON), immediate occlusion (IO) and pre-occlusion (PO). Each participant performed three maximal voluntary isometric contractions (100% MVC) at 90° of knee flexion for each BFR condition. The external occlusion pressure (1.3 x SBP) remained constant throughout each of the five sessions and was applied to the subject's upper thigh on his dominant leg using a pressure cuff (Hokanson, CS5, 6.5 cm). The external occlusion pressure was applied immediately prior to the onset of exercise (IO), for five minutes prior to the onset of exercise (PO), or not applied during exercise (CON). Neuromuscular recruitment patterns of the vastus lateralis and vastus medialis were measured via surface EMG techniques (sampling rate = 2,000 Hz; band-pass filter of 10-500 Hz). The EMG signal for each isometric contraction was root mean square (RMS) and the root mean square (RMS) for each muscle group was then calculated. The RMS data was normalized as a percentage of an isometric MVC during CON BFR conditions. Maximal force and the actual force generated at each target MVC was measured using a force transducer connected to the subject's ankle using a cable. RESULTS: One-way ANOVA was used to analyze any potential difference in neuromuscular recruitment patterns (RMS) between BFR conditions for each of the target resistance intensities. Statistical significance was set at a priori of p<0.05. No significant difference (p>0.05) in neuromuscular recruitment patterns were observed between BFR conditions at any of the target resistance intensities. CONCLUSION: The effects of BFR exercise are specific to the type of contraction since the neuromuscular recruitment pattern during BFR exercise appears to be different between isometric and isotonic exercise. The results of previous studies suggest that isotonic exercise is associated with an increase in neuromuscular recruitment with BFR exercise however, an increase in RMS was not observed during isometric exercise with BFR. PRACTICAL APPLICATIONS: If using BFR exercise to promote an increase in neuromuscular recruitment, it would be suggested to perform isotonic BFR exercise compared to isometric BFR exercise.

Poster: 10
THE RELATIONSHIP BETWEEN AROUSAL LEVELS AND GOLF PUTTING DURING THREE DIFFERENT CONDITIONS: A PILOT STUDY
A. Elumalai1, D. Szymanski1, J. Parks1
1Louisiana Tech University

*Award Eligible - Outstanding Master's Student Poster Presentation

Arousal is a major aspect of many learning theories and is closely related to concepts such as anxiety, attention, agitation, stress, and motivation. Arousal level is one of the most powerful factors to affect the performance of the players. PURPOSE: To determine if there is any a connection between arousal levels and putting in different settings. Another purpose of this study was to define the way for future research in determining the relationship. METHODS: 6 NCAA Division 1 golfers (handicap < 3) were used in this study. All subjects signed an informed consent according to the university's Institutional Review Board. Subjects’ characteristics were age 20.2 ± 1.5 yr and played for the same division under the same coach and practice conditions. The participants were instructed to wear the Zephyr device while putting. Zephyr HxM BT heart rate monitor it detects the time between two of the distinctive, large, upward “R” spikes during the QRS complex of heart rate, and the Mind Meter tracks the arousal levels by recording the subtle changes in the R-R interval between each heartbeat. In the first session, on a flat putting green surface the participants were randomly assigned 5 puts each from 3 distances -3, 6, and 9 feet from the hole. The data from the Mind Meter was recorded before, during, and after each putt. In the second session, the participants were assigned 5 puts each from 3 distances located from 5 different positions - uphill lie, downhill lie, side hill lie from right to left, side hill lie from left to right, and flat surface outside on the practice greens at Squire Creek. In the third session, the arousal levels were raised by changing the emotional factor of the golfers by exposing them to a competition for a prize, at Squire Creek. The accuracy of the puts was monitored by measuring the number of accurate puts and distance between the ball and hole in case of a missed putt. RESULTS: The average of arousal levels during the makes and misses was used to determine the relationship between different settings and arousal levels. There was little or no correlation among the different settings and optimum arousal levels varied in the players. CONCLUSIONS: The results suggested that each player had an individualized optimum arousal level during different settings whether they made or missed the hole. The findings of this pilot study indicated that definitive results regarding the optimum arousal levels and different setting required a larger sample size and more data in each setting. For the best performance the athletes may need individualized zones of optimum arousal levels. PRACTICAL APPLICATION: Players can improve the success of their game during competitions by using Zephyr HxM BT heart rate monitor to determine the arousal levels when they putt affecting the consciousness and the Mind Meter is used to determine the relationship of arousal levels and putting in athletes of different categories.

Poster: 11
PRELIMINARY INVESTIGATION INTO THE SUITABILITY OF AN ALTERNATIVE FORM OF COUNTERMOVEMENT JUMP TEST ANALYSIS FOR ATHLETE FATIGUE MONITORING
R. Gathercole1, B. Sporer2, T. Stellingwerff2, G. Sleivert2
1University of Victoria, BC, Canada/CSI-Pacific, Victoria, BC, Canada; 2Canadian Sport Innovation Centre, Victoria, BC, Canada, 3University of Victoria, BC, Canada

*Award Eligible - Outstanding Doctoral Student Poster Presentation

Countermovement jump (CMJ) test is an athlete monitoring tool used to examine neuromuscular (NM) function and fatigue state. There is uncertainty though as to which components of CMJ performance are most sensitive to post-exercise fatigue. Here we assess the suitability of the CMJ test for the detection of post-exercise fatigue, examining an alternative form of CMJ analysis based on jump traces (aCMJ) compared to more typical CMJ-derived.
measures (ACMJ). METHODS: 7 elite skateboard athletes (4M, 3F) performed 6 CMJ tests prior to and 30 min following repeated stair climbs to fatigue. CMJ was evaluated using the Ballistic Measurement System (BMS; Fitness Technology, Australia). 20 ACJM variables based on time, work and single-points during the jump were analysed using custom-designed software, with raw jump data extracted from the BMS. ACJM variables (6 reported): Time: eccentric (EccT), concentric (ConT), total jump duration (TotT); Work: area under the force-velocity trace (FV-AUC), total area under the PT curve (PT-AUC). Single-point: force at zero velocity (F0/V0), ACJM variables: jump height (JH), peak power (PP), peak velocity (PV), peak and mean force (PF, MF). ‘Outlier’ jumps were removed using standardised procedures. Coefficients of variation (CV) were calculated for each pre- and post-variable to examine whether variability of each variable would permit detection of fatigue-induced changes. RESULTS: Significant differences pre- to post-exercise (p-value) were observed for ACJM variables for time (EccT: +0.075, 0.042; ConT: +0.085, 0.048), work (PV-AUC: ±523±31, 0.047) and single point (F0/V0: ±158, 0.031), while ACJM variables PF (-1200, 0.032) and MF (-400, 0.007) were also significant. All other ACJM and TCMJ variables were not significantly different. CONCLUSIONS: Compared to TCMJ, the use of ACJM variables appear better suited to the detection of NM fatigue. The ACJM variables relate to how the CMJ is performed rather than TCMJ, which focuses on the CMJ output. Rather than a decreased capacity to produce a jump output (i.e. jump height, peak power), these findings suggest that fatigue expresses itself as an altered CMJ movement pattern. Fatigue state may therefore be better identified through examination of how the CMJ is performed (i.e. ACJM). The lack of change in PT-AUC suggests that similar work was performed during the CMJ. However the speed and timing of this work appeared decreased and delayed significantly. PRACTICAL APPLICATIONS: These results indicate that although fatigue may not ultimately influence end NM output, it appears to alter NM strategy, decreasing the speed-efficiency of movement. Given the importance of speed and timing in many sports, this has a number of important implications. These results suggest that a practical test such as the CMJ can be used to examine changes in NM movement strategy but that TCMJ analysis may not be as suitable for the monitoring of fatigue state as ACJM variables.

Poster: 12

VASTUS MEDIALIS OBLIQUE AND VASTUS LATERALIS ACTIVATION DURING CLOSED KINETIC CHAIN EXERCISES

B. Gatzke¹, M. Fauth¹, W. Ebben²

¹UW-LaCrosse, ²Ohio State University Medical Center, ¹UW-Parkside

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

PURPOSE: The quality of the activation of the vastus medialis oblique (VMO), as well as its ratio of activation with the vastus lateralis (VL) have been proposed to be important in the reduction of patellofemoral pain syndrome and to improve patellar tracking. However, research has yet to quantify how resistance training exercises activate these muscles in order to compare the activation of the VM or the VM to VL ratio (VM:VL). The purpose of this study was to compare VM activation and VM:VL using surface electromyography during four closed kinetic chain resistance exercises. METHODS: Sixteen women (mean±SD age = 21.9±2.17 years; height = 169.39±7.54 cm; body mass = 66.08±9.91 kg) who participated in either NCAA Division I, club, or intramural sports, as well as lower body resistance training volunteered and provided informed consent. Independent variables included the type of resistance training exercise and the muscle action (eccentric or concentric) for the vastus medialis oblique (VMO) and the VM:VL. Test exercises included the squat, deadlift, step up, and lunge, each performed with a 5 repetition maximum load. Dependent variables included the root mean square (RMS) EMG expressed as a percentage of the MVIC. Data were evaluated with a repeated measures ANOVA to test main effects of RMS EMG for the VM and VM:VL for each exercise assessed. Bonferroni adjusted post hoc analyses were used to assess the specific differences in muscle activation between each exercise. RESULTS: Significant main effects representing differences in VM RMS EMG between the resistance training exercise were found for the eccentric phase (p=0.003) and concentric phase (p=0.014). The squat resulted in 36.9% greater eccentric VM activation than the deadlift and step up, while the lunge produced 48.0% more activation than the deadlift. The lunge resulted in 22.1% greater concentric VM activation than the squat and 38.5% greater activation than the deadlift. The step up produced 24.3% more concentric VM activation than the deadlift. No significant differences were found for VM:VL for the eccentric (p=0.61) or concentric (p=0.26) phase. CONCLUSION: Exercises with the greatest VM activation may help reduce patellofemoral pain and improve patellar tracking. However, no differences in VM:VL were found in the exercises assessed. PRACTICAL APPLICATION: Training with exercises such as the squat and lunge offers more VM RMS EMG activation during the eccentric phase, while the lunge and step up offer the greatest VM RMS EMG activation during the concentric phase, compared to the other exercises assessed.

Poster: 13

EFFECTS OF ECCENTRIC-INDUCED MUSCLE DAMAGE ON THE TIME COURSES OF RECOVERY FOR PEAK TORQUE AND RATES OF TORQUE DEVELOPMENT

N. D. Jenkins¹, D. A. Traylor¹, T. J. Housh², H. C. Bergstrom³, K. C. Cochran³, R. W. Lewis, Jr¹, R. J. Schmidt¹, G. O. Johnson¹, J. T. Cramer¹

¹University of Nebraska-Lincoln

*Award Eligible - Outstanding Master’s Student Poster Presentation

INTRODUCTION: Molina and Denadai (Clin Physiol Funct Imaging, 32: 179-184, 2012) recently reported differences in the time courses of recovery between peak torque (PT) and peak rate of torque development (pRTD) after eccentric-induced muscle damage in the leg extensors. Less is known about rate of torque development (RTD) recovery in commonly measured time intervals of 10, 50, and 200 ms or whether differences exist in the forearm flexors. PURPOSE: Examine the time courses of recovery for PT and RTD at peak, 10, 50, and 200 ms for up to 72 h after eccentric-induced muscle damage in the forearm flexors. METHODS: Eighteen men (mean±SD age = 22±3 yrs; body mass = 81±16 kg; height = 185±16 cm) completed six sets of ten maximal isokinetic eccentric muscle actions at 30°·s⁻¹ on an isokinetic dynamometer. Maximal voluntary isometric contractions were measured before (PRE), immediately after (POST), and 24, 48, and 72 h after the eccentric exercise. Serum concentrations of creatine kinase (CK) and lactate dehydrogenase (LDH) were measured at the same time points. PT, pRTD, and RTD at 0-10 (RTD10), 0-50 (RTD50), 0-100 (RTD100), and 0-200 ms (RTD200) were calculated as the negative of the first derivative of the torque signal. PT and RTD variables were normalized as a percentage of PRE. RESULTS: MeanCK (±SD) increased (p<0.05) from 138 (±175) to 6,457 (±12,769) IU·L⁻¹ and LDH increased (p<0.05) from 116 (±29) to 199 (±196) IU·L⁻¹ from PRE through 72 h. PT and all RTD variables decreased at POST (p<0.05). PT and RTD200 remained lower than PRE through 72 h (p<0.05). pRTD remained lower than PRE through 48 h (p<0.05), but was not different from PRE at 72 h (p>0.05). RTD10 and RTD100 were lower than PRE through 24 h, but were not different from PRE at 48 and 72 h (p>0.05). RTD50 decreased at POST, but was not different from PRE at 24 h (p>0.05). Normalized PT was greater than pRTD, RTD10, and RTD50 at POST (p<0.05); however, normalized PT was less than pRTD (p<0.05), pRTD, RTD10, and RTD50 at 72 h. In addition, RTD50 was greater than RTD100 (p<0.05) and RTD100 was greater than RTD200 (p=0.04) at 48 h; RTD10 was greater than RTD200 (p=0.01) at 72 h; and RTD50 was greater than RTD100 (p=0.02), RTD200 (p=0.02), and PT (p=0.02) at 72 h. CONCLUSIONS: Eccentric-induced muscle damage caused greater relative decreases in pRTD, RTD10, and RTD50 than PT at POST, while pRTD (84%PRE), RTD10 (97%PRE), and RTD50 (117%PRE) all recovered to a greater extent than PT (72%PRE) at 72 h. RTD50 recovered the quickest by 24 h, whereas RTD200 responded similarly to PT and never returned to PRE levels during the 72 h recovery. PRACTICAL APPLICATIONS: For sports such as kicking, sprinting, or jumping that are associated with explosive rates of force development, performance may suffer greater decrements initially from exercise-induced muscle damage, but may subsequently recover quicker and to a greater extent than maximal strength within 72 h.

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GENDER ANALYSIS OF HAMSTRONG AND QUADRICEPS ACTIVATION RATIOS DURING BILATERAL AND UNILATERAL JUMP LANDINGS

K. Laskowski¹, J. Endisch¹, L. Garceau², W. Ebben²

¹UW-Parkside, ²Marquette University

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

PURPOSE: Low hamstrings to quadriceps activation ratios (H:Q) may increase the likelihood of knee injury, including the rupture of the anterior cruciate ligament (ACL). Women experience 2 to 8 times more ACL injuries than men. Thus, gender differences exist. However the research is mixed with respect to gender differences in knee joint muscle activation during jump landings, and its potential role in these types of injuries. Therefore, this study evaluated gender differences in H:Q of college athletes, during jump landings. METHODS: Subjects include 12 women (age = 19.8±1.4 years; height = 175.49±5.9 cm; weight = 73.21±10.57 kg) and 8 men (age = 20.8±0.9 years; height = 189.71±5.80 cm; weight = 8710±7.70 kg). Subjects were evaluated using electromyography (EMG) to quantify rectus femoris, vastus lateralis, vastus medialis, lateral hamstring, and medial hamstring activation during bilateral countermovement jumps (BCMJ) and unilateral countermovement jumps (UCMJ). Data were normalized to a maximum voluntary isometric contraction (MVIC) and expressed as an aggregate of hamstring and quadriceps muscles, forming the H:Q. Data were analyzed using a one-way ANOVA to examine gender differences in EMG during the jump landings. RESULTS: During UCMJ, men produced a H:Q ratio of .59 ± .31 whereas...
women had a H:Q ratio of .35 ± .18, which was significantly different (P = 0.039). During the BCMJ jump landing, men demonstrated H:Q of .66 ± .23 whereas the ratio of women was .46 ± .21 which was trending toward a significance difference (P = 0.075). CONCLUSION: Women demonstrate lower mean H:Q ratio during BCMJ, and significantly lower H:Q during UCMJ, representing less hamstring and more quadriceps activation during jump landings, compared to men. Thus, gender differences in muscle activation strategies are present and the magnitude of the differences is more pronounced in the single leg, and thus more intense, jump landing condition. PRACTICAL APPLICATION: Strength and conditioning coaches should train women athletes with the goal of increasing hamstring strength, and thus improving their H:Q. ACKNOWLEDGEMENTS: The authors wish to thank the research participants.

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ELECTROMYOGRAPHIC AMPLITUDE VERSUS AVERAGE CONCENTRIC AND ECCENTRIC SQUAT FORCE RELATIONSHIPS
M. Luera1, M. S. Stock1
Texas Tech University

*Award Eligible - Outstanding Master’s Student Poster Presentation

The relationship between signal amplitude and force is one of the most frequently studied s in electromyography (EMG) research. This is largely due to the desire among researchers and clinicians to study the relative effort of individual muscles during a contraction. However, all of the previous authors that have examined this have done so for single-joint strength tests. PURPOSE: This study examined the linearity of the EMG amplitude versus concentric and eccentric squat force relationships for the vastus lateralis (VL). METHODS: Fourteen resistance-trained men (mean ± SD age 22 ± 2 years) participated in this study. Forty-eight hours following a familiarization session, the subjects performed submaximal concentric and eccentric isovelocity squats in 10% increments (i.e., 10%, 20%, etc.). The durations of both the concentric and eccentric muscle actions were set to four seconds, and an electromyographer placed over the lateral aspect of the right knee ensured that all squats were performed through an 80° range of motion. Bipolar surface EMG signals from the VL were collected for all trials. The average force value (N) and the amplitude (µV RMS) of the EMG signal were determined for the middle portions of the concentric and eccentric muscle actions for each subject. Linear regression analyses were used on an individual subject basis to examine the effects of individual differences in mean and max GM EMG activity when compared to women at all time points for all conditions. There were no significant differences in mean and max GM EMG activity between the GA exercise and the DW condition. There were also no main effects of time (pre and post condition). CONCLUSION: The findings suggest that a non-injured, athletic population may be able to properly activate the GM without any additional stimulation. The resistance training experience of this varied greatly but all had at least 6 months prior training experience. Future studies should examine if there is a relationship between resistance training and GA, but it is possible that resistance trained athletes can adequately strengthen the GM through the course of normal training and subsequently would have no problems recruiting the GM. PRACTICAL APPLICATIONS: Strength & conditioning professionals have limited time with athletes. When coaching a resistance trained athletic population, the results of this study suggest strength & conditioning professionals should reallocate time spent on GA assessment and treatment protocols that will enhance performance.

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RELIABILITY AND VALIDITY OF THE MANUAL SIDE-LYING HIP ABDUCTION GLUTEUS MEDIUS ACTIVATION ASSESSMENT IN THE STRENGTH AND CONDITIONING FIELD
J. Nicoll1, R. S. Nadell1, D. L. Hatfield1
University of Rhode Island

*Award Eligible - Outstanding Master’s Student Poster Presentation

INTRODUCTION: The gluteus medius (GM) is an important hip stabilizer muscle. Non-activation of the GM is related to increased risk of injury of lower limbs and reduced running speed and efficiency. Many strength and conditioning coaches (SCC) incorporate glute activation (GA) assessment and exercise into practice to activate and strengthen the GM. One widely used field test of GA is the manual side-lying hip abduction test (MLHA). However, previous research suggests inter-rater reliability of this assessment test is low. Despite this poor reliability and absence of substantial research supporting MLHA as a valid test of GA, many SCCs continue to utilize this test as an assessment of GA. PURPOSE: Thus, the purpose of this study was to determine SCC inter-rater reliability and validity using MLHA as a GA assessment in athletes. METHODS: Nine men (age: 20.7 ± 2.1 yrs; body mass: 86.0 ± 12.9 kg; height: 177.5 ± 13.1 cm; body fat percent: 12.66 ± 4.0) and thirteen women (age: 20.2 ± 1.4 yrs; body mass: 73.7 ± 15.6 kg; height: 165.1 ± 12.8 cm; body fat percent: 22 ± 4.2) volunteered to participate in this randomized, cross-over study. Each participant was tested for GA using manual field tests (Cook Hip Lift and a Side-lying Abduction Test) and EMG, prior to and after performing one of two warm-up exercise conditions: a standard dynamic warm-up (DWA) or common GA exercises. Statistical significance was set at p≤0.05. RESULTS: As expected, men exhibited significantly greater mean and max GM EMG activity compared to women at all time points for all conditions. There were no significant differences in mean and max GM EMG activity between the GA exercise and the DW condition. There were also no main effects of time (pre and post condition). CONCLUSION: The findings suggest that a non-injured, athletic population may be able to properly activate the GM without any additional stimulation. The resistance training experience of this varied greatly but all had at least 6 months prior training experience. Future studies should examine if there is a relationship between resistance training and GA, but it is possible that resistance trained athletes can adequately strengthen the GM through the course of normal training and subsequently would have no problems recruiting the GM. PRACTICAL APPLICATIONS: Strength & conditioning professionals have limited time with athletes. When coaching a resistance trained athletic population, the results of this study suggest strength & conditioning professionals should reallocate time spent on GA assessment and treatment protocols that will enhance performance.
were no significant correlations between MLHA scores and mean or maximum EMG activity at any time point. Inter-rater reliability between the coaches MLHA scores was low (Cronbach Alpha=0.201 and ICC=0.284.) Test-retest reliability for the EMG was high (Cronbach Alpha=0.864 and ICC=0.809.) CONCLUSION: The athletic population being evaluated were very well trained and did not have any GA dysfunction. Although MLHA scores reported by the coaches indicated GA in the participants, the coaches still reported significantly different MLHA scores. Previous studies have reported a similar lack of reliability in a physical therapy setting with a sedentary population. Electromyography activity has been reported to be a valid and reliable measurement of GA and reliability of EMG in the current study was high. However, it is expensive and impractical tool for SCCS to use, hence the need for reliable field assessments. The results of this study indicate that MLHA is neither a reliable nor valid field assessment tool in resistance-trained athletic population. PRACTICAL APPLICATION: Currently, any training SCCS get for common field assessments is through workshops and/or self-learning. Professionals in the field should be cautious when suggesting and/or implementing new assessment techniques; taking into account reliability and validity of the assessment and the population they will be performing the assessment on.

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TIBIAL ACCELERATION IN DISTANCE RUNNERS IN REDUCED BODY WEIGHT CONDITIONS

B. J. Rickert¹, M. F. Moran¹, B. Greer¹
¹Sacred Heart University

*Award Eligible - Outstanding Master's Student Poster Presentation

Seventy-two percent of all athletic stress fractures are the result of running, with nearly half occurring in the distal end of the tibia. PURPOSE: The purpose of this study was to investigate the relationship between the level of body weight (BW) in an unloader treadmill and tibial acceleration (TA). Research reports that increased vertical ground reaction force during running is positively correlated to peak TA. METHODS: Fifteen collegiate cross country runners (9M; 20.4 ± 4.2 yrs; 60.1 ± 12.6 kg) granted informed consent and participated in the present study. Following a 10-minute familiarization run on an unloading differential air pressure treadmill each subject started at 100% BW and ran at a consistent velocity for three minutes during each of nine stages which progressively decreased at 5% intervals until 60% BW for a total of 37 minutes. During the last 30 seconds of each stage, TA and heart rate (HR) were measured. TA was assessed with a skin-mounted uniaxial accelerometer attached to the lower third of the anterior tibia and data were recorded via computer data collection system and processed with custom-written data processing code. HR data was collected via a heart rate monitor. A repeated measures analysis of variance with Bonferroni post-hoc comparison was used to analyze the data. Significance level was set at p<0.05. RESULTS: There were no significant differences between TA from 100% BW (10.59g) to any level of unloading (60%-95%). Mean peak tibial acceleration initially increased with the levels of unloading (95%-75%) before dropping below 100% BW TA levels at 70%. Mean peak-to-peak TA was significantly less (p=0.021) at 60% BW (16.55g) as compared to 100% BW(18.56g). CONCLUSION: Tibial accelerations are not directly related to level of BW on an AGTM. PRACTICAL APPLICATIONS: Based on the present study, a runner rehabilitating from a tibial stress fracture/reaction should begin rehabilitation at BW levels below 60% BW to maintain stress levels below normal. By running at these reduced BW levels, the runner better maintain aerobic fitness while still rehabilitating from a tibial stress fracture as opposed to traditional rehabilitation protocol which is rest.

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CONSISTENCY OF PANORAMIC ULTRASOUND IMAGING TO EXAMINE MUSCLE SIZE AND QUALITY

J. G. Rosenberg¹, E. D. Ryan¹, E. J. Sobolewski², B. J. Thompson², M. J. Scharville², G. E. King¹
¹The University of North Carolina at Chapel Hill, ²Oklahoma State University

*Award Eligible - Outstanding Master’s Student Poster Presentation

The popularity of ultrasound (US) devices to examine muscle architecture has increased due to its ease of use and portability. New panoramic imaging capabilities have allowed researchers to quantify both muscle size through cross-sectional area (CSA) measurements and muscle quality using echo intensity (EI) analyses of a single image. Although these techniques seem promising, the consistency of these assessments warrants further evaluation. PURPOSE: The purpose of the present study was to determine the test-retest reliability for CSA and EI assessed from a single image using the panoramic US technique. METHODS: Sixteen healthy, recreationally active participants (10M; 20.9 ± 2.3 yrs; height, 173.7 ± 6.9 cm; mass, 74.2 ± 9.7 kg) volunteered for this investigation. Participants visited the laboratory on 2 separate occasions separated by 2 - 7 days at the same time of day (± 2 hrs). During all measurements, participants were examined in the prone position with their leg fully extended and right foot securely attached to a vertical post at a 90° joint angle between the foot and leg. To ensure the probe moved perpendicular to the skin and along the transverse plane during each scan, a custom made probe support composed of high-density foam padding was positioned perpendicular to the longitudinal axis of the leg. The probe was moved parallel to the skin, with the probe tip remaining stationary within the transverse plane. The panoramic US imaging device was applied to the skin to reduce possible near field artifacts and enhance acoustic coupling. Transverse measurements of the MG were obtained using a portable B-mode US imaging device. All US imaging analyses were performed using Image-J software. Test-retest reliability for CSA and EI were determined using Model 2.1 to determine the intraclass correlation coefficients (ICCs), standard error of measurement (SEM), and minimum difference (MD) values per the recommendations of Weir (2005). Systematic error was examined using separate one-way repeated measures analyses of variance (ANOVAS). RESULTS: The reliability statistics for CSA and EI are presented in this study. CONCLUSIONS: The ANOVAs indicated no systematic error between days. Relative consistency was acceptable with ICC values of 0.914 and 0.720 for CSA and EI, respectively. Absolute consistency was also acceptable with SEM values (expressed as a percentage of the mean) of 5.83% and 3.68% for CSA and EI, respectively. Minimal changes to be considered real for CSA and EI were 1.995 cm² and 7.298 a.u., respectively. These findings demonstrate that the panoramic US imaging technique may be a reliable technique for simultaneously measuring muscle size and quality. PRACTICAL APPLICATIONS: Future studies may use panoramic US imaging to examine the influence of aging, disease, and training on muscle size and quality.

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TEST-RETEST RELIABILITY OF PEAK AND AVERAGE CONCENTRIC AND ECCENTRIC ISOVELOCITY SQUAT FORCE

J. Shields¹, M. S. Stock¹, M. Luera¹
¹Texas Tech University

*Award Eligible - Outstanding Master’s Student Poster Presentation

Strength and conditioning professionals are interested in knowing whether small changes in force production are meaningful. A recent development in strength testing technology allows subjects to perform multiple trials at the same time when movement velocity is controlled. Terminology “isovelocity” testing, the duration for both the concentric and eccentric phases, as well as the range of motion, can be pre-determined by the tester. PURPOSE: The primary purpose of this investigation was to examine test-retest reliability statistics for peak and average force during maximal concentric and eccentric isovelocity squats. The secondary purpose was to assess whether analyzing data for solely the middle portion of the range of motion improved the trial-to-trial consistency. METHODS: Seventeen resistance-trained men (mean ± SD age = 21 ± 2 yrs, body mass = 81.1 ± 8.1 kg) participated in this study. The subjects visited the laboratory on two occasions separated by 48 hours. For each trial, the subjects performed three maximal concentric and eccentric squats using a standardized range of motion, and the repetitions with the highest force values were selected. The duration was set to four seconds for both the concentric and eccentric phases. Data analyses included determining the peak and average force values throughout the entire ranges of motion, as well those excluding the one second acceleration and deceleration phases (i.e., the middle two seconds). Statistical analyses included the p-values for eight separate paired-samples t-tests, 95% confidence intervals (CI) for each mean difference, intraclass correlation coefficients (ICCs [models 2.1 and 3.1]), standard errors of measurement (SEMs [calculated as the square root of the mean square error]), and minimal differences (MDs) needed to be considered real between the trials. RESULTS: There were no mean differences between the trials for the eight variables examined in this study. The ICCs ranged from 0.676 to 0.848. When expressed as a percentage of the mean value for both trials, each of the variables showed SEMs of less than 11%. DISCUSSION: The results of the present study demonstrated moderate-to-high test-retest reliability for the peak and average force values obtained from maximal concentric and eccentric isovelocity squats. The data for the concentric repetitions were more reliable than those for the eccentric repetitions, and similar levels of consistency were shown when the entire force curve was analyzed as opposed to only the middle of the range of motion. PRACTICAL APPLICATIONS: It is in the best interest of practitioners to...
A COMPARISON OF THE ACUTE EFFECTS OF CONCENTRIC VERSUS ECCENTRIC EXERCISE ON STRENGTH AND FORCE STEADINESS

X. Ye1, T. W. Beck2, J. M. DeFreitas1
1The University of Oklahoma, 2University of Oklahoma

Purpose: The current study was designed to assess body fat (%BF), height (HT), and mass (WT) in four women’s NCAA-D1 sports: basketball (BB), lacrosse (LAX), soccer (SOC), and volleyball (VB). The secondary focus was to compare differences in %BF, HT, and WT across sport positions. Methods: Athletes from BB (n=63; age=20.3±1.1yr; HT=176.3±6.7cm; WT=71.0±9.6kg), LAX (n=103; age=20.0±1.2yr; HT=166.3±6.9cm; WT=64.0±7.2kg), SOC (n=91; age=19.6±1.1yr; HT=165.5±7.0cm; WT=61.1±6.5kg), and VB (n=51; age=20.0±1.0yr; HT=176.5±6.9cm; WT=68.9±7.7kg) served as subjects. Body composition was analyzed though use of air displacement plethysmography (BodPod, Cosmed). Sport positions were categorized as follows: BB – Forward (FOR), Guard (GRD); LAX – Attack (AT), Midfield (LMF), Defense (LDF), Goalkeeper (LGK); SOC – Forward (SFOR), Midfield (SMF), Defense (SDF), Goalkeeper (SGK); VB – Defensive Specialist/ Libero (DSL), Middle Blocker (MBL), Outside Hitter/Right Side (OH), Setter (SET). Analysis of variance (ANOVA) compared HT, WT, and %BF by sport and by position within each sport. Alpha level was set at p<0.05. Results: The %BF for BB (20.5±6.3%) was lower (p=0.001) than LAX (24.4±5.2%), SOC (23.4±5.1%), and VB (25.5±4.4%). BB and VB were taller (p=0.001) than SOC and LAX. Mass was greater (p=0.001) for BB and VB compared to LAX and SOC. Within BB, GRD (17.9±6.1%) had lower (p=0.001) %BF than FOR (22.9±5.6%). BB FOR were taller (p=0.001: 181.6±3.8cm vs. 171.2±4.6cm) and heavier (p=0.001: 76.2±8.8kg vs. 66.7±4.9kg) than GRD. Within LAX, LMF (21.4±6.4%) had lower (p=0.001) %BF than LDF (27.2±5.4%) and LGK (29.2±6.4%). AT (23.3±5.2%) had lower %BF than LDF (p=0.009). LGK were taller than AT (p=0.032: 167.6±7.5cm vs. 162.9±7.8cm), LDF (67.6±7.9kg) were heavier (p=0.001) than LMF (61.7±4.8kg) and AT (60.2±5.6kg). LGK (74.5±7.5kg) were heavier (p=0.001) than LMF, AT, and LDF (p=0.015). Within SOC, the SGK (72.9±7.8cm) were taller (p<0.05) than SFOR, SMF, and SDF. Within VB, MBL (183.9±1.2cm) were taller (p=0.001) than DSL (176.3±5.3cm), OH (177.9±2.9cm), and SET (175.8±2.7cm). DSL was the shortest (p=0.001) VB position. Conclusion: BB consists of short runs, cutting, jumping, and stopping; actions that favor having a low %BF. Due to sport demands and position demands, it was expected that perimeter players (GRD) would have lower %BF than FOR, and that BB would have less %BF than LAX, SOC, and VB. SOC and LAX had similar body compositions that entail long, recurring runs up and down the pitch, which place a high demand upon the cardiovascular system. The AT and LMF positions of LAX require precision passes and dodges following long sprints with abrupt stopping and restarting. AT and LMF cover more distance in a game than LDF or LGK, which may explain their lower %BF. BB posted the highest %BF, which may be more a reflection of sport demands than fitness level. BB requires the utilization of quick, reactive, multi-directional movements in a limited space. VB athletes tend to have more similar body types across sport position than other sports. Practical Applications: To make comparisons across sports or sport positions is difficult due to the lack of published data and differing sport demands. Values can be expected to vary from NCAA divisions to athletic conferences. Monitoring an athlete’s body composition is crucial because major changes in %BF can be indicative of health concerns.
ASSOCIATION OF BODY COMPOSITION AND AEROBIC FITNESS ON HEART RATE VARIABILITY AND RECOVERY IN BLACK MEN

R. L. Herron1, S. J. Carter1, H. Williford2, M. Esco3

1The University of Alabama, 2Auburn University Montgomery

*Award Eligible - Outstanding Doctoral Student Poster Presentation

Heart rate variability (HRV) and heart rate recovery (HRR) are indicators of cardiovascular autonomic modulation and are noninvasive measures used to observe physiological changes associated changes in health status or fitness. Previous researches have indicated relationships between body composition, cardiorespiratory fitness, HRR, and HRV, though the extent of this link remains unclear. Few studies have considered the interaction of race regarding health related physical fitness and autonomic modulation. PURPOSE: The purpose of this study was to determine the extent of variation in HRV and HRR that could be accounted for by cardiovascular fitness and various measures of body composition, while controlling for race. METHODS: Fifty adult Black men (22 ± 3 yr) participated in this study. Each subject rested in the supine position while HRV was recorded for a 5-min period. To measure HRV, the frequency domain was used to transform the electrocardiogram into a power spectrum. The normalized area under the power spectrum was designated by the norm-referenced VO2max measure (> 0.05). The stepwise regression procedures showed only SF to account for the variation in HFnu (R2 = 0.20, P < 0.05) and LF: HF (R2 = 0.30, P < 0.05). The regression also revealed that WC was the only variable to account for variation in HRR (R2 = 0.20, P < 0.05). CONCLUSIONS: The results of the investigation suggest that Black men with higher aerobic fitness exhibited greater HRV. This relationship appeared to be a result of more favorable profiles of body composition seen in the higher fit group. PRACTICAL APPLICATIONS: The results of this study underscore the importance of body composition when examining the relationship between physical fitness and cardiovascular-autonomic control in Black men. According to these results, lifestyle interventions should be designed to improve aerobic fitness and body composition to fully enhance cardiovascular-autonomic control in this population.

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SPORT-SPECIFIC TRAINING EFFECT ON YOUNG MALE BASKETBALL AND SOCCER PLAYERS

T. Jallai4

4University of Tartu, Estonia

*Award Eligible - Outstanding Doctoral Student Poster Presentation

PURPOSE: The technical and physiological demands of basketball and soccer games vary greatly. The purpose of this study was to compare anthropometrical characteristics, body composition, total body mineral density (BMD) and areal bone mineral density (aBMD), postural control and vertical jumping performance characteristics in young male players. METHODS: Nine high school basketball (BB) (age, 16.4 ± 0.5 years; height, 185.5 ± 6.7 cm; weight, 81.9 ± 9.9 kg; % body fat, 17.4 ± 8.3%) and nine high school soccer (S) (age, 16.0 ± 0.1 years; height, 178.9 ± 8.2 cm; weight, 68.1 ± 7.6 kg; % body fat, 13.6 ± 5.9%) players volunteered for the study. All athletes were considered healthy and had a history on average of 8 years of specific training in their sport, 5 times per week and/or 9 hours per week. Bi- and unipedal static balance testing was performed on the force platform for 30 s. The vertical jumping tests included 3 sets of squat jumps, countermovement jumps and drop jumps (40 cm). Body composition and BMD was determined by dual X-ray absorptiometry (DXA). The proximal part of the femur was measured in four regions: neck, Ward’s triangle, trochanter and shaft. Standard statistical methods were used for the calculation of means, standard error of the means (±SE) and standard deviation (±SD). A Student unpaired t-test was used to measure differences between groups. Pearson’s product-moment correlation was determined between anthropometrical, postural control and vertical jumping characteristics. Significant statistic was accepted at p<0.05. This study was approved by the Institutional Review Board at The University of Tartu, Estonia. RESULTS: Statistical differences between the groups were found in body mass (p = 0.004), lean body mass (p=0.014), body mass index (p=0.039), BMD (p=0.0003), right femur aBMD (p=0.025), and unipedal static balance results (right leg, p=0.001; left leg, p=0.003). No significant differences were found in age, height, years of training, training load, body fat percentage, bipedal static balance or power development per 1 kg of body mass in vertical jump results. Interestingly, there was no statistical difference in left femur aBMD between BB and S group. This means, that soccer players experienced higher mechanical loads on their left leg. BMD was considered within normal range, but higher than the age-matched normative population means value (German data): BB group on average of 116.1 ± 8.4% and S group 107.0 ± 4.0%. No significant correlation was observed between static balance and vertical jumping characteristics. The BMD showed large association with subjects age (r=0.56, p<0.01), height (r=0.53, p<0.05), body mass (r=0.62, p<0.01), and lean mass (r=0.84, p<0.01). CONCLUSION: First, regular participation in basketball and soccer practices has a positive effect on BMD in young males. Second, sport-specific training effect on aBMD differs from sport to sport, and in skeletal regions. PRACTICAL APPLICATION: This study illuminates the necessity for strength and conditioning professionals to consider the demands of different sports, and what effect unequal force distributions may have on the skeletal integrity of the athlete. Side-to-side, or contralateral comparisons are recommended for young athletes specializing in one sport. This study also emphasizes, that muscular power and postural control are separate capabilities, and need to be developed through different training methods.

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THE RELATIONSHIP BETWEEN AEROBIC POWER, FAT FREE MASS, AND CROSSFIT PERFORMANCE

B. Kliszczewicz1, R. Snar2, M. Esco3

1Auburn University, 2Auburn University Montgomery, 3Auburn University Montgomery

*Award Eligible - Outstanding Doctoral Student Poster Presentation

CrossFit is a fast growing sport of fitness that not only serves as a form of competition but as a form of general exercise training. Little is known about this conditioning program or what factors may influence performance. PURPOSE: The purpose of this study was to examine variables that may influence the performance of semi- to well-trained subjects on a named CrossFit workout. METHODS: 7 men and 3 women (mean age = 27.2 ± 9.6 yrs) who have trained in CrossFit for at least 3 months participated in the study. Each subject had body fat percentage (BF%) assessed with the use of dual-energy x-ray absorptiometry (DEXA). Subjects then performed a graded exercise test on a treadmill to determine maximal oxygen consumption (VO2max). All subjects performed the named CrossFit workout called “CINDY”, which consisted of as many rounds possible of 5 pull-ups, 10 push-ups, and 15 air squats in 20-min, which is occasionally performed in competition. Pearson product correlations were performed to determine the relationship between the laboratory (i.e., BF% and VO2max) and performance (i.e., rounds of CINDY completed) variables. RESULTS: The participants had a mean (± SD) BF% of 16.6 (± 7.9%), a mean (± SD) VO2max of 52.9 (± 6.4) ml/kg/min and a mean (± SD) rounds of CINDY completed 17.6 (± 3.4). There was a significant correlation found between BF% and the number of rounds of CINDY completed (r= -0.84, p < 0.01). Conversely, there was no relationship between VO2max and CINDY performance (r= 0.02, p > 0.05). CONCLUSION: The findings of this study suggest that BF% is a relatively strong predictor of CINDY performance. Conversely, there was no relationship between VO2max and performance, probably because CINDY is primarily a muscular endurance-based workout. Due to the many different types of routines within this unique sport, further investigation is necessary to better understand the relationship between overall physical fitness and CrossFit performance. PRACTICAL APPLICATION: This study demonstrates the importance of BF% in relation to rounds completed of CINDY. However, the significance of VO2max for CrossFit performance remains unclear.
EVALUATION OF MUSCLE QUALITY RELIABILITY AND RACIAL DIFFERENCES IN BODY COMPOSITION OF OVERWEIGHT INDIVIDUALS

M. N. Melvin, A. E. Smith-Ryan1, H. Wingfield1, M. Woessner2, S. Fult2
1University of North Carolina at Chapel Hill, 2University of North Carolina Chapel Hill, 3University of North Carolina

*Award Eligible - Outstanding Master's Student Poster Presentation

It has been shown that physiological differences in muscle density and pennation angle exist between black and white athletes. Echo intensity (EI) may detect these differences in muscle integrity. Purpose: The purpose of this study was to investigate the reliability of ultrasound measures of muscle cross sectional area (mCSA) and echo intensity (EI) of the vastus lateralis (VL) in overweight subjects. A secondary purpose was to evaluate racial differences in EI, mCSA, and body composition. Methods: Thirty-three overweight subjects (Age: 39±11 yrs, Ht: 174±10.0 cm, Wt: 94.2±15.1 kg, %fat: 32.4±7.1%) were stratified by race: black (B; n = 10) and white (W; n = 23). Muscle CSA of the VL was determined from a panoramic scan of the VL using a GE logiq-e B-mode ultrasound (GE Healthcare). The ultrasound probe was held perpendicular to the tissue and swept across the skin at equal pressure from the lateral VL border to medial fascia separation. Echo intensity was determined from the panoramic scan of the VL by grayscale analysis using Image-J software. Fat mass (FM), lean mass (LM), and %fat were determined using dual-energy x-ray absorptiometry (DXA). Reliability of mCSA and EI was evaluated using intra-class correlation coefficients (ICC), standard error of the measurement (SEM), standard error of the measurements as a percentage of the mean (SEM%), and minimum difference (MD). One-way analysis of variance was used to identify racial comparisons. Results: For mCSA, ICC(2-1), SEM, SEM% and MD were 0.87, 2.12, 12.65% and 5.89, respectively. For EI, ICC(2-1), SEM%, and MD were 0.74, 4.58, 9.20%, and 12.69, respectively. Between black and white subjects, there were no significant differences (p=0.144-0.519) for the body composition variables FM: (B: 33.4±9.6 kg; W: 28.9±6.9 kg) LM: (B: 63.9±15.9 kg, W: 59.0±10.5 kg), and %fat: (B: 35.7±8.3 %, W: 31.6±6.6 %) or for mCSA (p=0.841; B: 16.6±3.9 cm2, W: 16.0±5.1 cm2). However, EI was significantly lower (p=0.018) for black (45.7±10.3) than white (53.5±7.2). Conclusions: Ultrasound measures of mCSA and EI are reliable in overweight subjects. There were no significant differences in mCSA or DXA body composition measurements between the black and white overweight individuals, but there was a significant difference in EI. Lower EI in overweight black individuals may suggest that black athletes have decreased intramuscular adipose and connective tissue, decreased pennation angle, and increased muscle density when compared to overweight white athletes. Practical applications: These results suggest that EI may be a better indicator of obesity-related health risks than DXA %fat. Measurements of EI in overweight athletes may provide better risk indicators for sarcopenia, obesity and metabolic syndrome, which may help identify and guide treatment interventions. Acknowledgements: Supported by funding from the Nutrition Obesity Research Center (PO3DK056350).

EVALUATION OF MUSCLE QUALITY RELIABILITY AND RACIAL DIFFERENCES IN BODY COMPOSITION OF OVERWEIGHT INDIVIDUALS

POSTER: 27

RELATIONSHIP OF REGIONAL AND TOTAL LEAN MASS TO ISOINERTIAL LIFTS IN COLLEGE FOOTBALL PLAYERS

R. Schumacher1, J. Ramatowski1, B. Mann2, J. L. Mayhew1
1Truman State University, 2University of Missouri

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

One-repetition maximum lifts (1RM) have long been the choice of strength and conditioning specialists to evaluate strength potential of college football. In addition, body dimensions and lean body mass have been used as adjunct elements to assist in identifying strength potential. Purpose: To evaluate the relationship of regional and total lean mass to IRM isoinertial performances in college football players. Methods: 66 NCAA Division II college football players (age = 20.4 ± 1.2 yrs, height = 181.5 ± 6.6 cm, body mass = 97.8 ± 17.6 kg) were evaluated for IRM performances in bench press (BP), squat (SQ), deadlift (DL), and hang clean (HC). Players also performed maximal bench repetitions with a constant load (NFL-225 test). In addition, regional lean tissue mass was determined for arms, trunk, legs, and total body from dual-energy X-ray absorptiometry (DXA; lunar?...). Results: BP was significantly related to SQ (r = 0.389, p<0.001), DL (r = 0.614, p<0.001), and HC (r = 0.328, p<0.001). DL was significantly related to HC (r = 0.513, p<0.001) but not to SQ (r = 0.147, p = 0.26). SQ was negatively related to HC (r = -0.569, p<0.001). Factor analysis produced 2 strength components, with BP and DL accounting for 48.3% of the total variance, and SQ and HC accounting for 39.3%. Regression analysis indicated that only total lean mass was moderately predictive of BP (r = 0.53, SEE = 161 kg) and DL (r = 0.55, SEE = 217 kg). Regional lean mass did not significantly predictive of SQ or HC. NFL-225 repetitions were highly related to IRM BP (r = 0.93, p<0.001) and, to a lesser degree, to SQ (r = 0.43, p<0.001), and DL (r = 0.46, p<0.001). Regional and total lean masses made no significant (p>0.80) contribution to lift prediction beyond NFL-225 repetitions. Repetitions were not significantly related to HC (r = 0.19, p = 0.19). Conclusion: Regional and total lean masses appear to make relatively small contributions to the prediction of IRM strength performances in college football players. Major lifts may be independent of one another, suggesting a lack of strength generalizability with less than 38% common variance among the lifts. Practical Applications: Strength and conditioning professionals have the potential to construct an array of strength tests to evaluate regional or total body strength. Neither regional nor global body composition appears to be of much value in identifying specific or total strength performance in college football players.

SELF DIRECTED LEARNING, DEPRESSION, ANXIETY, AND STRESS IN ULTRA-ENDURANCE ATHLETES

B. Gentry1, L. Van Ginder2, T. J. Piper3, C. McMillian2
1Western Illinois University, 2Western Illinois University, 3Western Illinois University, Department of Kinesiology, Major of Exercise Science

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

Purpose: The purpose of this study was to investigate the self-directed learning characteristics and the levels of depression, anxiety, and stress present in ultra-endurance racing participants. Methods: Fifteen participants (male=13, female=2, mean age=30.7±9.36 years, age range=20-47) enrolled in the event were surveyed using the Oddi Continued Learning Inventory (OCLI) and the Depression, Anxiety, and Stress Survey (DASS). Subjects’ prior frequency of training leading up to the race just over 2.5 days per week (M= 2.67±0.89) with a range of average training sessions from 30-60 minutes to +120 minutes. Subject’s average longest training session in preparation for the race exceeding 500 minutes in total (M= 516.67±477.47 minutes) with scores ranging from 90 minutes to 1800 minutes. Subject’s education level ranged from High School to Bachelor’s Degree, mean falling between an Associate’s and Bachelor’s Degree. The official title of the event was “The Suck” and consisted of a wide range of challenges and obstacles with no specific emphasis on one discipline of fitness. This event was 36 hours in duration. “The suck” is a military term that defines any situation where conditions are undesirable and is a testament to the dedication of those who endure it. Results: The overall results of the OCLI scores ranged from 101-149. The average score among the racers was 127 (M=127±13.3). These results are consistent with past research utilizing the OCLI, indicating that these participants possess a high level of SDL. Results from the DASS for depression ranged from 0-4, for anxiety 0-22, for stress 0-16. For depression the average was 1.067 (M=1.067±1.6), for anxiety the average was 4.267 (M=4.267±6.5), for stress the average was 9 (M=9±5.8). These results showed low levels of depression, anxiety, and stress prior to the race in these participants. Conclusion: This study showed that those that participate in ultra-endurance obstacle races tend to be self-directed learners and have low levels of depression, anxiety, and stress prior to the race. Practical Applications: Considering the level of SDL present in these participants it is clear that these are individuals who take control of their individual training goals and are purposeful in their learning. The participants showed very low levels of depression, anxiety, and stress, which concludes that these individuals were mentally prepared for a high demanding race.

ENDURANCE TRAINING PREVALENCE AND PREFERENCE AMONG COMPETITIVE MOUNTAIN BIKERS

S. M. Mitchell1, M. Richardson2, J. C. Higginbotham2, H. Gary2, J. Wingo2, S. Usdan1, R. Henderson2
1University of South Alabama, 2University of Alabama

*Award Eligible - Outstanding Doctoral Student Poster Presentation

VO2max has been identified as a physiological contributor to mountain bike performance. Research supports endurance training (ET) as a modality for increasing VO2max. While studies have examined the physiological parameters associated with successful riding, little is known about how competitive mountain bikers train to increase performance. Purpose: Therefore, the purpose of this study was to identify the prevalence of traditional ET among competitive mountain bikers in their effort to improve performance. Methods: Forty competitive mountain bikers (mean ± SD, age 25.75 ± 9.12 years) responded to an online survey...
training survey. Participants for this study were recruited by contacting groups whose members are competitive mountain bikers (i.e., NCAA university teams, university sports club teams, sponsored teams, professional teams). The survey assessed several types of training, including ET. Major responses were examined to determine the reliability of the training survey.

Cronbach's alpha value for reliability was 0.82. RESULTS: In-Season: Proportion of respondents participating in ET during the in-season was 97.5%. Seventy-two percent of riders reported trail riding only, 28% used a stationary cycle ergometer to complement trail riding, and no riders reported using a cycle ergometer only for ET sessions. Mean number of weekly trail riding endurance sessions was 2.5 (SD=1.44) sessions. Workout sessions per week on a stationary cycle ergometer were 1.75 (SD=0.79) sessions. Paired samples t-test revealed a significant difference between the weekly number of trail sessions and cycle ergometer sessions (t=2.65, df=10, p=0.02). Off-Season: Proportion of respondents participating in ET during the off-season was 82.5%. The percentage of riders who participate in ET during the in-season was significantly greater than that during the off-season (z=2.58, p=0.005). Fifty-two percent reported trail riding only, 33% reported trail riding and a cycle ergometer, and 12% reported using a cycle ergometer only for ET sessions during the off-season. Median number of weekly endurance sessions spent trail riding was 2 sessions. Median number of workout sessions per week on a cycle ergometer was 2 sessions. A Wilcoxon signed rank test revealed no significant difference between the weekly number of endurance trail sessions and cycle ergometer sessions during the off-season (z=0.30, p=0.78). CONCLUSION: Among respondents, 97.5% reported participating in ET during the in-season, while 82.5% reported participating in ET during the off-season. Based on the perception that mountain biking is an aerobically based event, these results may not seem surprising. A greater percentage of riders chose trail riding as a modality for endurance training and more sessions of trail riding were conducted per week during the in-season when compared to a cycle ergometer. These results suggest that riders may prefer to train on equipment specific to competition. There is also the possibility that riders simply enjoy riding their bikes on a trail and choose to trail ride for training. PRACTICAL APPLICATION: There is evidence that riders may have a preference for trail riding rather than cycling as a workout modality.

OFF-PAR

ACUTE EFFECTS OF STATIC STRETCHING, DYNAMIC STRETCHING, AND FOAM ROLLING PRIOR TO SIT AND REACH TEST, VERTICAL JUMP, AND STANDING LONG JUMP

M. Genin, R. Rozenek, D. Young, L. Wilson

Poster: 32

California State University Long Beach, CSULB, Northern Arizona University

*Award Eligible - Outstanding Master’s Student Poster Presentation

PURPOSE: It has been suggested that a warm-up consisting of dynamic stretching may have a greater benefit in exercise performance when compared to static stretching. These two modes of warm-up have not yet been compared to self-myofascial release with the use of a foam roller. There has been insufficient research on the effect of foam rolling, however claims by fitness professionals and coaches assume that this modality may have an effect on performance. Identifying a relationship between self-myofascial release and performance would be of great benefit to those utilizing this modality. The purpose of this study was to examine the acute effects of static stretching, dynamic stretching, and foam rolling prior to the sit and reach test, vertical jump, and standing broad jump. METHODS: Seventy-two college-aged, untrained subjects (38 males, 34 females) performed static stretching (SS), dynamic stretching (DS), self-myofascial release with a foam roller (FR), and no warm-up prior (C) to the sit and reach test (SR), vertical jump (VJ), and standing broad jump (SBJ). This was a randomized, within-subject study. The order of the warm-up protocols and tests were randomly assigned. The first session consisted of the warm-up protocols and jump tests familiarization. The testing was performed in four visits, once or twice per week. Each testing session began with a general warm-up of easy jogging for five minutes at a self-selected pace. Immediately after the jog the subject performed three trials of the SR, followed by one of the four warm-up interventions including (a) SS, (b) DS, (c) FR, or (d) C. Subjects then performed three SR trials immediately after the experimental condition. Three trials of both the VJ and SBJ tests were performed in random order after the second set of SR trials. A post-test questionnaire was administered at the end of each of the four testing sessions to gain subjective feedback about the warm-ups. RESULTS: Data was analyzed using a one-way repeated measures analysis of variance. The difference in pre and post warm-up SR measurements were statistically significant (p = 0.000) following SS, DS, and FR in comparison to C. There were no significant effects in VJ height (p = 0.995), or in SBJ length following any of the warm-up protocols (p = 0.820). CONCLUSIONS: The findings of this study show that SS, DS, and FR did not improve vertical jump, or standing broad jump performance over the control. There were significant improvements in the sit and reach test between pre and post-test measurements following SS, DS, and FR when compared to C. Factors that may have influenced these results include duration and intensity of the warm-up protocols, training status of the subjects, as well as using different performance measures. It was concluded that SS, DS, and FR have no acute effects on jump performance, but may increase slow back and hamstring flexibility. PRACTICAL APPLICATIONS: Static stretching, dynamic stretching, and foam rolling may be beneficial prior to exercise where flexibility is pertinent to performance. However, these methods of warm-up may not be beneficial prior to power exercises that including jumping. More research on foam rolling prior to endurance and strength performance is recommended.
PURPOSE: The purpose of this study was to identify important performance predictors of race time (RT) for a men and women cross country conference championship race. METHODS: Four female (age=21.5±4.8yrs; height = 67±3.5in; weight = 123±41lbs) and six male (age=18.2±1.6yrs; height = 70±2in; weight = 165±12lbs) collegiate runners that participated in a NAIA D-1 level conference championship volunteered for the study. Participants reported for testing within one week of the championship race. Following a 10min warm up period on a cycle ergometer, athletes were assessed for lower body strength by the squat jump (SJ), lower body neuromuscular power by the vertical jump (VJ), static trunk endurance by the prone (PP), right (RP)and left (LP) plank hold times, and passive ankle range of motion by right (RDF) and left (LDF) passive ankle dorsiflexion (PAD). SJ: Hands were placed on the hips, and the participants achieved/held a parallel squat for 4 sec before jumping. VJ: Participants were permitted to use a countermovement and arm swing. Athletes performed as many jumps as necessary until two successive jumps were no longer higher than the best recorded score. A 30 sec rest was observed between all jump assessments/attempt. All jump assessments were conducted on a contact mat (Just Jump, Probotics, Huntsville, AL). Following a 3 min rest, the plankling assessments were conducted with the PP first followed by the RP or LP; the order of the RP and LP alternated with each participant. Participants were given one chance to correct during each plank and 1 min rest between bouts of planking. PAD was conducted after the plankling assessments. Participants placed the knee of the selected leg against the wall while sliding the heel away from the wall until just before the heel lifted. Distance from the posterior side of the heel to the wall was recorded for both legs utilizing a tape measure placed on the floor perpendicular to the wall. PAD scores were normalized to the participants’ height. The difference (DD) between PAD scores for the right and left leg was calculated. Men’s race distance was 8k (28.1±0.24min) and the women’s 5k (20.5±0.5min). The relationships between the predictor scores and RT were assessed using a Pearson (r) product-moment correlation coefficient. RESULTS: For the men, strong and moderate strength relationships existed between race time and the SJ (r = -0.69), VJ (r = -0.52), DD (r = -0.45), LDF (r = -0.54), and RDF (r = -0.72). For the women, strong and moderate strength relationships existed between race time and the SJ (r = -0.69), VJ (r = -0.63), PP (r = -0.70), RP (r = -0.75), LP (r = -0.79), DD (r = 0.73), and RDF (r = -0.50). CONCLUSIONS: Male and female collegiate cross country athletes could improve running performance by increasing leg strength (SJ), neuromuscular power (VJ), and passive ankle range of motion. Female athletes may also improve running performance through an increase in static trunk endurance. PRACTICAL APPLICATION: For both the male and female athletes an increase in lower body strength and muscular power could provide improved running economy, while increased PAD could create greater impulse from longer foot contact time. Female collegiate cross country athletes might benefit from static trunk training possibly to provide better force transfer from hip extensors and hip abductors through the lower extremity into the running surface.  

Poster: 34

EFFECTS OF PNF STRETCHING FOLLOWING CRUSHED ICE VERSUS WETTED ICE ON HAMSTRING FLEXIBILITY

M. Miller1, J. Troiano1, C. Larsen1, R. Ramirez, W. Holcomb2
1Western Michigan University, 2The University of Southern Mississippi

Award Eligible - Outstanding Master's Student Poster Presentation

Flexibility, which is the ability to move freely through a full range of motion (ROM), is desired to improve performance and decrease the likelihood of muscle injury. Proprioceptive Neuromuscular Facilitation (PNF) stretching is recognized as the most effective stretching technique to improve flexibility. In addition, cryotherapy has been shown to enhance stretching for greater improvements in flexibility. Recent research has shown that wetted ice (ice bag with added water) is a superior form of cryotherapy. However, no study was found that combined either crushed or wetted ice with PNF stretching on hamstring ROM. PURPOSE: To determine which type of cryotherapy agent, crushed or wetted ice bag, would produce the greatest gains in hamstring ROM when followed by PNF stretching. METHODS: Fifteen healthy subjects aged 22.6 ± 1.8 years with no history of lower leg pathologies or sensitivity to cryotherapy volunteered to participate. Each subject underwent three testing sessions with treatment order counter-balanced. The three treatment conditions were: crushed ice bag (crushed ice), wetted ice bag (wetted ice) and no ice bag (no ice). The crushed ice consisted of 2500mL of ice placed in a 9.5in by 18in mil polyethylene Cramer® bag with the air removed to increase density of ice to 703±21mL, weight = 45±12lbs. Fifteen healthy subjects aged 22.6 ± 1.8 years with no history of lower leg pathologies or sensitivity to cryotherapy volunteered to participate. Each subject underwent three testing sessions with treatment order counter-balanced. The three treatment conditions were: crushed ice bag (crushed ice), wetted ice bag (wetted ice) and no ice bag (no ice). The crushed ice consisted of 2500mL of ice placed in a 9.5in by 18in mil polyethylene Cramer® bag with the air removed to increase density of ice to 703±21mL, weight = 45±12lbs.
PERCEIVED RECOVERY IN MAXIMAL EFFORT STRENGTH TRAINING USING POWERLIFTS

N. T. Theilen1, B. L. Campbell2, M. C. Zourdos3, J. M. Oliver4, J. Wilson4, J. O’Halloran4, N. Asher2

1University of South Florida, 2University of South Florida/Exercise and Performance Nutrition Laboratory, 3Florida Atlantic University, 4Department of Kinesiology, Texas Christian University, Fort Worth, TX, 5University of Tampa

Fatigue is manifested following an acute bout of powerlifting (squat, deadlift, and bench press). One’s perception of recovery may correlate to the individual’s ability to complete work in the form of powerlifting training. The perception of recovery following intense training using all three powerlifts has not yet been investigated. PURPOSE: To assess the perceptual levels of acute neuromuscular fatigue caused by each powerlift as a result of maximal effort strength training sessions with each powerlift. METHODS: Twelve resistance trained males (22.8 ± 2.6 years; 171.1 ± 6.7 cm; 83.0 ± 12.6 kg) participated in a randomized crossover design with 3 conditions: Squat (SQ), Bench Press (BP), and Deadlift (DL). A Perceived Recovery Scale (1-10 scale on subjective performance ability) was used prior to each session to assess individual fatigue. Baseline measures of perceived recovery were recorded 1 week prior to training. Subjects trained the Monday of 3 consecutive weeks using each power lift separately (1 lift per week). Perceived recovery measurements were assessed at 24, 48, and 72 hours following each training session. Recovery measures were compared to baseline measures to assess fatigue. Data was analyzed via repeated measures ANOVA (p<.05). RESULTS: SQ: perceived recovery significantly decreased following squat training at all three time periods as compared to baseline (Baseline = 8.5; 24 hours = 5.9 [p = 0.013]; 48 hours = 6.3 [p = 0.003]; 72 hours = 7.2 [p = 0.033]). BP: Perceived recovery significantly declined at 24, and 48 hours following BP training as compared to baseline (Baseline = 8.5; 24 hours = 6.7 [p = 0.007]; 48 hours = 5.6 [p = 0.003]). No significant differences in perceived recovery at 24, 48, and 72 hours following intense squat and BP training as compared to baseline. DL: no significant differences in perceived recovery at 24 and 72 hours following intense DL training as compared to baseline. Perceived recovery significantly declined only at 48 hours following the deadlift intervention (Baseline = 8.5; 48 hours = 6.6 [p = 0.002]). CONCLUSIONS: Perceived recovery was significantly decreased for 24, 48, and 72 hours following intense squat training. Perceived recovery was significantly decreased at 24, and 48 hours following intense BP training. Perceived recovery was significantly decreased at 48 hours following intense DL training. PRACTICAL APPLICATIONS: There was a significant decrease in the subject’s perceived recovery status after squat training for a longer period than BP and deadlift training. Because perceived recovery and the ability to perform physical work may be correlated, individuals may need to consider the effects of each powerlift on perceived recovery and how it may affect subsequent training or performance days following training. ACKNOWLEDGEMENTS: This investigation was supported by Dymatize Nutrition Sport Performance Institute.
Poster: 39

EFFECTS OF ACUTE RESISTANCE EXERCISE AND SHORT-TERM TRAINING ON BIOACTIVE PROLACTIN RESPONSES IN MEN
S. Flanagan1, C. Dunn-Lewis1, B. Comstock1, D. Hooper1, T. Szivak1, D. Looney1, W. DuPont1, E. Webster1, A. Bryce1, H. Luk1, D. Dombrowski1, C. Giaccino1, D. McDermott1, R. Staron1, W. J. Kraemer1

1University of Connecticut, 2Ohio University

PURPOSE: Over the years little has been know about the role of prolactin in men. Few data exist as to the responses of the larger prolactin molecule molecule bioactivity with a bioassay. The purpose of this study was to determine if the bioactive prolactin molecule was differentially sensitive to resistance exercise or with short term training adaptations. METHODS: Sixteen men n=21; mean ±SD: age 21.7± 2.9 years, 176.6± 6.4 cm participated in an 8-week were randomly assigned of one of three groups including two progressive resistance training programs i.e., low rep n=9 performing 3-5 repetitions maximum (RM) for four sets of each exercise with 3 min rest between sets and exercises or a high repetition group (high rep, n=7) performing 20-28 repetitions RM for two sets with 1 min rest or a non-exercising control group (con n=5). Lower body workouts were performed (leg press, squat, and knee extension) were performed 2 days/week for the first 4 weeks and 3 days/week for the final 4 weeks. The programs were designed to be equal in volume (resistance X repetitions X sets). Blood was sampled pre and immediately post-workout pre and post-training. Bioactive prolactin (large form) was determined via a rat lymphoma cell line Nb-2 bioassay. Each assay 96 well Croning culture plate contained one 12 point standard curves-two rows for human prolactin. Each curve was proceed with a well of nacked FCS, serving as a maximal growth control or background. The serum samples were analyzed in duplicate with 2.5 ul pipetted into each well. In addition, to the sample a 17.5 ul of assay media for a 1.8 dilution needed to keep the sample reading within the standard curve was also assayed. The last row of each plate contained 20 ul of B7 rat prolactin as an internal standard. Each plate was incubated for 24 hours at 37 and 5% Cos in the incubator. After 24 hours, the samples were pulsed with a mixture of 50 ul 3H thymidine per 2 ml of assay media warmed up to 37 C and incubated in the incubator for 16 hours. Following the incubation period, cells were harvested on glass/paper filter mats and allowed to dry overnight and counted on a Betaplate Scintillation counter and subsequent values determined via computer interface. Data were analyzed using a two-way analysis of variance with repeated measures and Tukey post-hoc test when appropriate. Significance was set at P ≤ 0.05. RESULTS: Prolactin (ng/L-1): 5-5 RM Pre-Training: Pre-EX:12.5±3.1 Pre-Post: 26.8±8.2 Post-Training Pre-EX: 23.2±5.7 Post-EX: 64.±5.4; 20-28 RM Pre-Training: Pre-EX 8.7±2.3 Post-Ex 27.2±4.5 Post-Pre-Training 116.6±6.3 Post-EX 27.4±8.8; No Exercise Control Group Pre-Training: Pre-EX 11.7±1.4 Post-EX 13.3±2.1 Post-Pre-Training Pre-EX 14.2±1.7 Post-EX 13.3±4.1. Prolactin concentrations significantly increased after exercise in the exercise groups and the post-exercise values were significantly greater than control group. The post-exercise, post-exercise prolactin concentrations in the higher intensity 3-SRM group was significantly greater than the low intensity group (20-28 RM). CONCLUSION: Prolactin concentrations in the blood are susceptible to both exercise stress and high intensities of resistance exercise with short-term training. The differential response comparing the heavy to the lighter loading paradigms may well be due to immune and cytokine interactions due to potentially greater muscle tissue use and damage/repair phenomenon. PRACTICAL APPLICATIONS: This study verifies that inherent differences physiologically of heavy and light resistance exercise programs and can be seen in the early phases of a resistance exercise in men.

Poster: 40

RELIABILITY OF THE TURNING POINT CORE TRAINER AS A MEASURE OF PEAK UPPER TORSO ROTATIONAL VELOCITY, PEAK PELVIC ROTATIONAL VELOCITY, AND PEAK PELVIC TORSO SEPARATION ANGLE
B. J. AlSarraf1, J. Brown1, M. A. Waller1, P. Eisenman4 , C. Hicks-Little3

1Department of Physical Education and Sport, College of Basic Education in Kuwait, 2University of Utah, 3Adams State University, 4Department of Exercise and Sport Science, University of Utah, Salt Lake City, Utah, 5University of Utah, Salt Lake City, Utah

INTRODUCTION: Pelvic and upper torso rotational velocities are important contributors to the velocity that is imparted to balls during the volleyball spike, golf drive, and baseball batting, but the sequencing of pelvic and upper torso rotation is even more important for imparting high velocity to a ball. Therefore, being able to readily assess pelvic and upper torso rotational velocities as well as the sequencing of pelvic and upper torso rotation would be helpful for evaluating athletes and the efficacy of core strength training programs. The Turning Point Core Trainer (TP), is a devise designed to quantify axial rotational velocities and the sequencing of pelvic and upper torso rotation; however, reliability data are yet to be published. The purpose of the current study was to establish preliminary evidence for the internal-consistency reliability of the TP as a measure of select trunk rotational actions (TRA). METHODS: Fourteen Division I female collegiate volleyball players from the University of Utah volunteered for this study (age 20.9±2.8 years, height 181.6±7.7 cm, weight 72.9±12.5 kg, BMI 22.0±3.0 kg/m², body fat 22.0±6.5 %, playing experience 3.2±1.4 years). This study was approved by the Institutional Review Board at the University of Utah. Each player, after a 10 minute self-selected warm-up, completed 3 practice trials, and then executed a total of 10 TRA in the TP at zero resistance. A 30 second rest period separated trials. The TP was used to assess Peak Upper Torso Rotational Velocity (PUTRV) and Peak Pelvic Rotational Velocity (PPRV) in °/s for each TRA. The peak difference in the rotation angle of the pelvis and upper torso about the body’s global x-axis was recorded in degrees and termed the Peak Pelvic Torso Separation Angle (PPTSA). STATISTICAL ANALYSIS: Internal consistency reliability of the TP was assessed by Cronbach’s alpha Coefficients (α), measurement precision was determined by coefficient of variation (CV), and standard error of measurement (SEM) was used to determine between subject variations. The stability was determined by using a two-way factor mixed (participants random and trials fixed) repeated measures factorial ANOVA. Statistical significance set at p < 0.05. All data analyzed using PASW Statistical software 18.0 (IBM Inc., Chicago, IL). RESULTS: The results of this study suggest that the TP is a valid and reliable test of the core. The hypothesis that the TP has excellent internal consistency reliability and support the use of the TP for assessing rotational variables as part of a sports conditioning program.

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SHORT-TERM STRENGTH ADAPTATIONS IN YOUNG ADULTS ELICITED BY MINIMAL AND OVERLOAD RESISTANCE TRAINING INTENSITIES
S. Dorgo1, R. J. Reed-Jones3, N. G. Murray4, P. V. Ambati1

1University of Texas at El Paso

Previous research showed that morphological changes affect muscular strength only after six weeks of training and that short-term strength increases are primarily due to neuromuscular adaptations. It is hypothesized that early strength increases may be elicited through the practice of resistance training movements with little overload. PURPOSE: To compare the short-term strength changes with three groups of untrained young adults training with: a) overload resistance (OR); b) minimal resistance (MR); and 3) no active training (Control). METHODS: Thirty-nine untrained adults, (mean±SD age: 23.5±5.9; BMI: 25.4±5.2) with no experience in resistance training were assigned to the OR, MR, or Control groups using blocked randomization. The experiment focused on two multi-joint exercises, the bench press and the back squat. Subjects’ strength was assessed by the one repetition maximum (IRM) tests and by an isometric bench press test with relevant force plate data collected. Subjects completed two training sessions weekly with three sets of ten repetitions of each exercise. The OR group used 75% of their latest measured IRM, while the MR group used a weightless 5 ft PVC pipe for both exercises. Subjects in the control group were asked to refrain from training. Pre-training, after following the testing protocol all subjects were re-rated every two weeks. Strength data were analyzed using a general linear mixed model and alpha level was set at p<0.05. RESULTS: There were no initial strength differences between the groups for the IRM bench press (p=0.9419), 1 RM squat (p=0.9564), or isometric bench press tests (p=0.06381). From pre- to post-test for the IRM bench press the OR group improved 10.2% (p<0.0001), the MR group improved 5.4% (p<0.0000), while the control group showed only minimal (2.4%) and non-significant (p=0.0725) improvement. A significant group by time interaction (p<0.0001) was observed suggesting a different improvement pattern across the groups. For the IRM back squat the OR group improved 12.1% (p<0.0001), the MR group improved 10.3% (p<0.0001), while the control group showed only minimal (5.2%) but significant (p=0.0415) improvement. A significant group by time interaction (p=0.0291) was also observed, confirming the different improvement pattern trains the groups. Experimentally based tests were not registered every two weeks. Previous research showed that morphological changes affect muscular strength only after six weeks of training and that short-term strength increases are primarily due to neuromuscular adaptations. Yet, practicing resistance training movements without any training load appears to provide sufficient training stimulus to elicit initial strength changes in untrained subjects. It appears that strength improvement is test-specific, as improvements in IRM bench press did not transfer to significant isometric bench press strength improvement for any group, although the overload resistance group showed a positive trend. PRACTICAL APPLICATION: Practicing multi-joint exercises – particularly for multi-joint movements - with minimal or no resistance overload may provide a safe and effective method of achieving initial strength adaptations in untrained individuals.
HEAD ACCELERATION WHILE DRIVING A LATE MODEL STOCK CAR

W. Ebben\textsuperscript{1}, E. J. Petushke\textsuperscript{2}, L. Garceau\textsuperscript{2}
\textsuperscript{1}UW-Parkside, \textsuperscript{2}Michigan Technological University, \textsuperscript{1}Marquette University

PURPOSE: Head and neck injuries are among the most common injuries in stock car racing. Strengthening the affected muscles may help prevent some of these injuries and help stabilize the head to resist fatigue associated with racing. The purpose of this investigation was to quantify sagittal and frontal plane head acceleration, and determine whether or not these accelerations change over the course of the race. METHODS: A male stock car driver participated in this investigation (height=183.0 cm; body weight=88.4 kg; age=46 years). Testing included a 10 lap heat race on a 0.54 kilometer asphalt race track. Lap times were competitive and averaged 16.7 seconds, as calculated via video analysis. A 50 g triaxial accelerometer (BSE, Biopac Systems, Inc., Goleta, CA, USA) was used to acquire data, which were collected using a multi channel acquisition system (MP 36R, Biopac Systems, Inc., Goleta, CA, USA) remotely powered using a manufacturer supplied DC battery pack with data streamed continuously to a battery powered portable laptop computer. All components were configured inside a late model stock car (Lefthander Chassis, Rockford, IL, USA). Data were acquired at 1000 Hz for the entire duration of the race. Data were processed using low pass filter with a cutoff frequency of 20Hz based on power spectral density analysis of the frequency content using the Hamming procedure (Acqknowledge 4.1 Biopac Systems, Inc., Goleta, CA, USA). Peak accelerations were analyzed during race track corner 1 entry, mid corner, and corner 2 exit and were characterized as units of normal gravitational force whereas 1 g = an acceleration of 9.8 m/s\textsuperscript{2}. Data were analyzed for the first and ninth lap. RESULTS: Sagittal plane negative acceleration during corner 1 entry was -0.40 ± 0.08 g's on lap 1 and -0.47 ± 0.15 g's on lap 9, which were not significantly different (P > 0.05). Sagittal plane positive acceleration during the exit from corner 2 was 0.75 ± 0.03 g's during lap 1 and 0.83 ± 0.11 g's on lap 9 which were also not significantly different (P > 0.05). However, mid corner frontal plane lateral acceleration was 1.65 ± 0.03 g's on lap 1 and 2.16 ± 0.08 g's on lap 9, representing a significant (P = 0.006) difference. CONCLUSION: Asphalt late model stock car racing produced mid corner lateral head accelerations as high as 2.16 g's. This lateral head acceleration increased positive acceleration during the exit from corner 2 was 0.75 ± 0.03 g's during lap 1 and 0.83 ± 0.11g's on lap 9 which were also not significantly different (P > 0.05).

INCREASED IN A MODIFIED SIT-UP COMPARED WITH A TRADITIONAL SIT-UP DUE TO TRUNK KINEMATICS

F. A. Gardin\textsuperscript{1}, S. Leigh\textsuperscript{1}, C. R. Bellon\textsuperscript{1}, W. Sullivan\textsuperscript{1}
\textsuperscript{1}Montclair State University

PURPOSE: Core strength is a focus of many training programs and the sit-up is a cornerstone of many of them. The traditional method of performing a sit-up is criticized for its use of the hip flexors, and an increased risk of lower back strain. A modified version of the sit-up may increase the relative contribution of the abdominals by focusing on trunk flexion over hip flexion. The purpose of this study was to determine differences in abdominal and hip flexor muscle activation and trunk kinematics between the traditional sit-up and a modified sit-up. METHODS: Eighteen males completed two training sessions and then a testing session consisting of performing two styles of sit-ups; a traditional sit-up according to US Army regulations, or a modified sit-up with the instructions “push your lower back into the floor and pull yourself up with your abdominals”. During testing subjects completed repetitions of both sit-up styles for 30 seconds each with 10 minutes rest inbetween. Muscle activation of the rectus abdominis (RA), external oblique (EO), and rectus femoris (RF) was recorded using electromyography (EMG). Trunk kinematics were measured using 2-D videography. EMG data were filtered and normalized. Maximum and mean activation, and integrated EMG (iEMG) were calculated for one repetition of each sit-up style and over the middle 10-second time window of each sit-up style. Trunk flexion was calculated as upper trunk relative to lower trunk. Hip flexion was calculated as lower trunk relative to thigh. Statistical comparisons were made using a repeated measures design with $\alpha = 0.05$. RESULTS: Muscle activation and trunk kinematics were significantly different between sit-up styles. Max and mean activation and iEMG of the RF were greater during 10 seconds of the traditional sit-up than the modified sit-up. Max and mean activation of the RF were greater during one rep of the traditional sit-up than the modified sit-up. iEMG of the RF, RA, and EO was greater during the modified sit-up than the traditional sit-up. The increase in iEMG of the RF from traditional to modified sit-up was significantly less than the increase in iEMG of the RA and EO. Peak trunk flexion was greater in the modified sit-up than the traditional sit-up. Peak hip flexion was greater in the traditional sit-up than the modified sit-up. CONCLUSION: Our data suggest that RF muscle activation decreases during a modified sit-up and so the relative contribution of the RA and EO increases. The workload of the contributing muscles, as measured by iEMG, increased for all muscles during the modified sit-up when comparing by rep. This increase was due to an increased time per rep. The RF workload increased less than the RA and EO workload. These results show the greater emphasis on the abdominals in the modified sit-up. Our data suggest that the traditional sit-up has a focus on hip flexion and the modified sit-up has a focus on trunk flexion. Trunk flexion is associated with a greater contribution from the abdominals, and may decrease lower back load. PRACTICAL APPLICATION: EMG is a powerful tool to drive exercise selection. The modified sit-up maybe a better exercise selection when the goal is to train the abdominal muscles, because it increases the workload of the abdominal and hip flexor muscles, and increases the relative contribution of the abdominal muscles. The modified sit-up emphasizes trunk flexion over hip flexion, which may decrease lower back load and decrease injury risk.
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CHANGES IN WINDMILL PITCH MECHANICS OVER TIME
S. Konz
Marshall University

PURPOSE: Baseball rosters list more pitchers than softball rosters. Baseball pitcher rotations give pitching staff recovery time. Softball teams are not afforded those options for their pitchers. Softball athletes pitch multiple sessions on consecutive days or multiple outings within a day. No studies investigated kinematic changes over a session or match period of the study. We investigated changes in mechanism occurring through a game. METHODS: 14 female college windmill pitchers competing in the 2009 Big XII Softball Championships in Oklahoma City, OK comprised the pool for this observational study. IRB waived consent due to public domain. Standard procedures for 3D motion capture and calibration occurred. Five pitches for each subject were evaluated. The 5 pitches selected to be digitized were determined by the total pitch count for each athlete: the 10%, 35%, 60%, 85%, and 100% marks of total pitches thrown. Digitizing occurred from set position through ball release. A 24-point model represented the softball-glove-pitcher system. The positions of the throwing arm at 1, 2, 3, 5, 6, 9, 12 o’clock and release were used for comparison. Athletes were separated into 2 groups by pitch count. The average number of pitches was 41. Group 1 threw more and Group 2 threw less than 41 pitches. Linear regressions determined the influence of the variables on the independent variable. RESULTS: An analysis investigated the influence of stride factors on release velocity. The results explained 55.2% of the variance (R²=0.305, F(15)=7.26, P<0.01). Stride length (p = .008) was longer and stride angle (p=.011) was wider for athletes in Group1 compared in Group 2. A regression compared the relationship between hip and shoulder around the z-axis factors on release velocity. The results explained 52.6% of the variance (R²=0.277, F(3)=7.28, P<0.01). Ball velocity at 12 o’clock (p=.019) and shoulder angle in the z-plane (p=.023) were significant in relationship to release velocity compared joint angles around the y-axis to release velocity. The results explained 77.6% of the variance (R²=0.601, F(12,25)=2.113, P<0.01). A final analysis was run focusing on differences between the two groups at ball release related to previous significant factors. The results explained 72.4% of the variance (R²=0.524, F(15)=3.303, P<0.10). Shoulder angle at of the throwing arm (p=.005), hip angle of the stride leg (p=.037), and ankle angle of the stride leg (p=.024) were significant between the groups. CONCLUSIONS: As pitch counts go up above 45, windmill athletes lengthen and widen their strides to maintain velocity production. A longer and wider stride at release provides a lower release velocity due to a decrease in momentum. An interesting component related to stride is the impact of stride leg hip FLEX/EXT angle and stride leg ankle PF/DF angle. A larger angle of the stride ankle and stride hip at 12 o’clock is not an optimal contributor to high release velocity. A larger shoulder angle around the z-axis at release is not optimal for release velocity. However, greater shoulder angle at 12 o’clock contributes to higher release velocity. The velocity of the ball at 12 o’clock affects the overall release velocity. PRACTICAL APPLICATIONS: Protocols to address muscle strength of the upper extremity at 12 o’clock would be helpful. Limiting appearances or lower pitch counts help to preserve athlete health.

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ACUTE AND ACCUMULATED FATIGUE MEASURED BY STRETCH-SHORTENING CYCLE FUNCTION IN YOUTH RUGBY UNION PLAYERS DURING A 7-WEEK COMPETITION CYCLE
R. S. Lloyd, J. Oliver, A. Whitney, M. De Ste Croix
1Cardiff Metropolitan University, 2University of Gloucestershire

PURPOSE: Rugby union involves high intensity intermittent exercise, which is known to induce neuromuscular fatigue. Exhaustive high-intensity exercise is specifically known to negatively affect stretch-shortening cycle (SSC) function, in particular stiffness properties of the lower limbs [1]. Fast and slow expressions of SSC can be measured via countermovement jumps (CMJ), reactive strength index (RSI) and leg stiffness respectively [2]. Despite existing research highlighting the fatigueing effects of competitive rugby league match play on CMJ performance [3], little is known about the acute and accumulated fatigue of rugby union match play. We investigated changes in CMJ height, reactive changes in CMJ height, RSI and leg stiffness were generally able to demonstrate significant reductions in performance from pre- to post-match (P < 0.05). Accumulated fatigue was observed via significant reductions in pre-match CMJ height in weeks 4 and 7, and before week 7 for leg stiffness compared to baseline (P < 0.05). While accumulated fatigue experienced by week 7 was associated with further acute post-match reductions in CMJ height, leg stiffness failed to show further acute changes. CONCLUSION: Data indicate that all measures of SSC function were able to determine acute neuromuscular fatigue following competitive match play; CMJ height consistently showed the greatest performance decrement pre-to-post-match and might be the most suitable test to measure acute fatigue. Both CMJ height and leg stiffness showed evidence of accumulated fatigue across the competition block, however, the accumulated fatigue led to different acute post-match responses between the two measures by week 7. PRACTICAL APPLICATIONS: For the long-term monitoring of neuromuscular fatigue in youth rugby union players, it is imperative that an accurate baseline measurement, which reflects a well-rested state, is obtained. It is recommended that within a competitive cycle, coaches should consider monitoring both slow and fast indices of SSC via regular measurements of CMJ height and leg stiffness. This is because while both measures are sensitive to detecting acute and accumulated fatigue, the acute responses become movement-specific where fatigue has accumulated. REFERENCES: [1] Kuitunen et al. Scand J Med Sci Sports 17: 67-75, 2007. [2] Lloyd et al. J Sports Med Phys Fitness 51: 595-602, 2011. [3] McLellan et al. J Strength Cond Res 25: 1030-1039, 2011.

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THE RELATIONSHIPS AMONG THE SLOPES OF THE MECHANOMYOGRAPHIC AMPLITUDE-FORCE PATTERNS OF RESPONSE AND THE FATIGUE INDEX FOR THE LEG EXTENSORS
M. Cooper, T. J. Herda
1University of Kansas, 2University of Kansas / Biomechanics Laboratory, Lawrence, KS

*Award Eligible - Outstanding Master’s Student Poster Presentation

Purpose: The purpose of this study was to examine the slopes from the mechanomyographic amplitude (MMGav) vs. force relationships for the vastus lateralis (VL) and rectus femoris (RF) and correlations between the slopes from these relationships and the fatigue index from 50 maximal concentric isokinetic muscle actions of the leg extensors. METHODS: Forty healthy subjects (females, n = 23, age, 20.5 ± 1.7 years; height, 1.69 ± 0.08 m; weight, 67.3 ± 8.9 kg; males, n = 17, age, 21.2 ± 3.0 years; height, 1.80 ± 0.08 m; weight, 81.9 ± 13.6 kg) volunteered to participate in the study. Participants performed 10 contractions of the leg exten- sions at 180°/s to elicit 50% of their maximal voluntary contraction (MVC). MMG (m·s⁻²) signals were recorded from the RF and VL muscles. Simple linear regression models were fit to the natural log-transformed MMGav vs. force relationships. The slope (b term) was calculated for each relationship. Subjects also performed 50 repeated maximal concentric isokinetic muscle actions at 180°/s. The individuals fatigue index was calculated as [(Initial Peak Torque – Final Peak Torque)/Initial Peak Torque]*100. Pearson’s product moment correlations (r) were calculated among the fatigue indexes, MMG RF b terms, and MMG VL b terms. Multiple regression was also performed to determine if the b terms from the MMG VL and RF could be used to predict the fatigue index. The alpha level was set at α=0.05. RESULTS: The b terms from the MMGav vs. force relationships for the VL (r = 0.417) and RF (r = 0.386) were both significantly correlated (P=0.01, P=0.05) to the fatigue index, however, the correlations would be considered small. In addition the b terms from the VL and RF were correlated (P=0.01) with each other (r = 0.688). Multiple linear regression indicated that the b terms from the VL and RF only accounted for 19% of the variance in the fatigue index. Conclusions: Previous research has demonstrated that the fatigue index is related to muscle fiber type composition and the b terms have also been reported to be influenced by muscle fiber type composition. The higher b terms indicate a later onset of rate coding as a primary mechanism of increasing force, which has indicated that the muscle has a larger percentage of type II fiber. We would therefore expect higher b terms to be correlated with higher fatigue indexes due to the high fatigability of type II fiber. Although there were significant relationships between the fatigue index and slopes from the MMGRMs vs. force relationships for the VL and RF in the present study, the correlations would be considered small. In addition, the slopes from these relationships only accounted for 19% of the total variance in the fatigue index. Practical Applications: The log-transformed MMGav model was unable to account for a large enough percentage of the variance in the fatigue index to be considered an acceptable method for the prediction of leg extensor fatigability.
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CAN MUSCULOTENDINOUS STIFFNESS OF THE POSTERIOR MUSCLES OF THE HIP AND THIGH PREDICT MUSCLE POWER OUTPUT IN FEMALE ATHLETES AND SIZE-MATCHED CONTROLS?


1Oklahoma State University

Musculotendinous stiffness (MTS) measures the passive mechanical properties of a muscle-tendon unit and is expressed as the ratio (Nm/mm) of the curvilinear relationship between passive torque (Nm) and joint angle (°) displacement. Greater MTS has been associated with improvements in rate of force development and consequently, may be an effective predictor of muscle power output during high explosive-type movements (i.e., vertical jump). PURPOSE: To examine the efficacy of MTS of the posterior muscles of the hip and thigh to predict muscle power output in female athletes and size-matched controls. METHODS: Ten highly-trained NCAA Division I female soccer athletes (mean±SD, age=19±1yr; mass=65±5kg; and height=166±5cm) and eleven recreationally-trained size-matched controls (age=20±2yr; mass=63±9kg; and height=162±2cm) performed three countermovement vertical jumps (CMJ), followed by two passive straight-leg raise (SLR) assessments using an isokinetic dynamometer programmed in passive mode to move the foot toward the head at 5°/s. CMJ height and estimated peak power output (Pmax) were measured during the CMJs using a jump mat and linear velocity transducer. For each SLR, participants lied in a supine position with the knee- and ankle-joints immobilized with custom-built stabilizing apparatuses. All assessments were performed on the right leg, while the left thigh and ankle were secured with restraining straps. Bipolar surface electromyographic (EMG) amplitude of the biceps femoris was sampled during each SLR. MTS was calculated during each SLR as the slopes of the initial linear portion (phase 1) as well as the second steeper portion (phase 2) of the angle-torque curve. RESULTS: There were no differences between groups for age, height, and mass (P>0.05). The athletes exhibited greater MTS, CMJ height, and Pmax than the controls (P=0.004–0.036). There were no group-related differences for range of motion (ROM) or EMG amplitude (P>0.05). MTS increased from phase 1 to phase 2 (P<0.001); however, EMG remained unchanged across the ROM (P>0.05). There were significant positive relationships observed between MTS of both phases and CMJ height and Pmax (r=0.483–0.827; P<0.001–0.027). CONCLUSIONS: These results suggest that during the passive SLR assessments, MTS was greater for the athletes than controls despite no differences between groups for anthropometric measurements, EMG amplitude, or ROM. In addition, the athletes demonstrated higher Pmax and CMJ height than the controls, which also significantly correlated with MTS at phases 1 and 2. PRACTICAL APPLICATIONS: MTS of the posterior muscles of the hip and thigh is an effective predictor of muscle power output in NCAA Division I female athletes and size-matched controls. MTS may serve as an additional performance measure to help coaches recruit and identify powerful athletes of all sports. Unfortunately, a universally accepted method to assess core stability has not been developed. It is widely accepted that several measurements must be used to thoroughly assess core stability. Through a thorough literature search we have found 3 clinical assessments and 35 tests which have been used for core stability related testing. Most researchers have used a subset of these outcome variables. Furthermore, it is unknown whether gender differences in core stability exist. Therefore, the purpose of our study was to determine gender differences when performing three clinical assessments associated with core stability and 35 tests related to five individual components of core stability. METHODS: Participants included 18 college-aged males and females who had not suffered an orthopedic injury in the past year. The participants provided informed consent as approved by the Institutional Review Board, prior to testing. The three clinical assessments consisted of the Star Excursion Test and the Frontal Plane Projection Angle of the knee during a single leg squat and drop. The 35 specific core stability related tests were grouped into five categories: strength, muscular endurance, flexibility, motor control, and function. To determine gender differences, one-tailed independent t-tests were used for each clinical assessments and tests related to core stability. RESULTS: No significant gender differences were identified with all three clinical assessments. After adjusting for body weight, males were significantly stronger in the isometric strength tests for trunk flexion, t(34) = 2.24, p = .02, and squat, t(34) = 2.73, p < .01, as well as the second steeper portion (phase 2) of the angle-torque curve. Males performed significantly better in a thirty second squat test, t(34) = 2.06, p = .02, and the hop tests for speed, t(34) = 4.93, p < .01, and distance, t(34) = 3.78, p < .01. CONCLUSIONS: Males performed better on measurements assessing core strength, muscular endurance and function, while females demonstrated better motor control. No differences were observed for the clinical assessments and the flexibility tests. PRACTICAL APPLICATIONS: Current clinical assessments may not be sensitive enough to test differences in core stability between college-aged male and female. Further, college-aged males and females perform differently on tests which evaluate individual components related to core stability. These results indicate males and females may require different core stability training regiments to offset specific core stability impairments.

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INTER-TESTER RELIABILITY OF THE FUNCTIONAL MOVEMENT SCREEN ACROSS DISCIPLINES

E. P. Scibek, S. Edmond, M. F. Moran

1Sacred Heart University, 2University of Medicine and Dentistry of New Jersey, 3Sacred Heart University

PURPOSE: The Functional Movement Screen (FMS) is a widely used battery of tests developed to assess the quality of fundamental movement patterns by movement science professionals. Previous studies have established the inter-tester reliability of the FMS for different levels of expertise and within disciplines, but none have examined inter-tester reliability across disciplines. The purpose of this study was to examine the inter-tester reliability of the FMS across the three movement science disciplines: athletic training (AT), physical therapy (PT) and exercise science (EX). METHODS: Three testers, one from each discipline, evaluated 28 NCAA Division I male athletes. Each athlete performed the seven tests of the FMS, which includes the Deep Squat (DS), Hurdle Step (HS), In-Line Lunge (IL), Active Straight Leg Raise (ASLR), Trunk Stability Push-Up (PU), Rotary Stability (RS), and Shoulder Mobility (SM) tests along with clearing tests for the PU, RS, and SM tests. Frontal plane and sagittal plane video was assessed by each of the three testers. To determine inter-tester reliability, Intraclass Correlation Coefficients (ICC) were calculated across all 3 testers as well as between the disciplines for each of the 7 tests of the FMS and the overall FMS scores. The scores were considered good if ICC > 0.75, moderate if ICC = 0.5–0.75 and poor if ICC < 0.5. RESULTS: When the data from all three testers were combined there was at least moderate reliability on 4 of the 7 tests as well as the overall FMS score, with SM (ICC = 0.917) scoring the highest and HS (ICC = 0.283) the lowest. The SM test was the only test that had good reliability with the HS, IL, and PU tests being comprised of linear explosive-type movements (i.e., vertical jump).

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MALES AND FEMALES PERFORM DIFFERENTLY ON MEASUREMENTS RELATED TO CORE STABILITY

A. Waldhelm1, L. Li2

1University of the Incarnate Word, 2Georgia Southern University

PURPOSE: Enhancing core stability has become a popular training intervention for athletes of all sports. Unfortunately, a universally accepted method to assess core stability has not been developed. It is widely accepted that several measurements must be used to thoroughly assess core stability. Through a thorough literature search we have found 3 clinical assessments and 35 tests which have been used for core stability related testing. Most researchers have used a subset of these outcome variables. Furthermore, it is unknown whether gender differences in core stability exist. Therefore, the purpose of our study was to determine gender differences when performing three clinical assessments associated with core stability and 35 tests related to five individual components of core stability. METHODS: Participants included 18 college-aged males and females who had not suffered an orthopedic injury in the past year. The participants provided informed consent as approved by the Institutional Review Board, prior to testing. The three clinical assessments consisted of the Star Excursion Test and the Frontal Plane Projection Angle of the knee during a single leg squat and drop. The 35 specific core stability related tests were grouped into five categories: strength, muscular endurance, flexibility, motor control, and function. To determine gender differences, one-tailed independent t-tests were used for each clinical assessments and tests related to core stability. RESULTS: No significant gender differences were identified with all three clinical assessments. After adjusting for body weight, males were significantly stronger in the isometric strength tests for trunk flexion, t(34) = 2.24, p = .02, dominate hip extension, t(34) = 1.91, p < .05, and dominate, t(34) = 2.73, p < .01, and non-dominant, t(34) = 3.99, p < .01, hip abduction. Significant strength differences for trunk extension, non-dominant hip extension, and bilateral hip external rotation were not noted. Also, males performed significantly better in a one minute sit up test, t(34) = 3.85, p < .01. Males had significantly longer hold times for two of the four muscular endurance tests, right, t(34) = 2.73, p < .01, and left, t(34) = 1.98, p = .03, side plank tests. Differences were not observed for the trunk flexion or trunk extension endurance tests. There were no significant differences identified with all 11 flexibility tests. The results of the motor control tests revealed females exhibited significantly better single limb balance with, t(34) = 2.52, p < .01, and without vision, t(34) = 4.27, p < .01. For the functional tests, males performed significantly better in a thirty second squat test, t(34) = 2.06, p = .02 and the hop tests for speed, t(34) = 4.93, p < .01, and distance, t(34) = 3.78, p < .01. CONCLUSIONS: Males performed better on measurements assessing core strength, muscular endurance and function, while females demonstrated better motor control. No differences were observed for the clinical assessments and the flexibility tests. PRACTICAL APPLICATIONS: Current clinical assessments may not be sensitive enough to test differences in core stability between college-aged male and female. Further, college-aged males and females perform differently on tests which evaluate individual components related to core stability. These results indicate males and females may require different core stability training regiments to offset specific core stability impairments.
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**CROSS-VALIDATION OF A 3D MARKERLESS MOTION CAPTURE SYSTEM AGAINST VIDEO AND A 3D MARKER MOTION CAPTURE SYSTEM**

D. Wassom, A. C. Frye, N. Moodie

1Dynamic Athletics, 2The University of Kansas, 3Human Performance Laboratory, Lawrence, KS, 4Rockhurst University

**PURPOSE:** The purpose of the study was to compare the knee joint angle calculated from 3 different collections methods and evaluate the validity of 3D Markerless motion capture. METHODS: One male participant was used for data collection. The subject did 15 controlled squats in both a 3D marker and markerless motion capture collection space. These collections were separated due to the fact the environments are incompatible for simultaneous use. Furthermore, during another testing session 15 separate squats were collected simultaneously with 3D markerless capture and video. Only the left legs of the videoed squats were used for data analysis between 3D Markerless motion capture and video. To control the movement protocol a standardized box was used to control depth of the squat and well as standardized distances to the box and distance between feet. The software specifically identified the peak joint angle of the squats as the indicator of when values were measured. The subject paused at the bottom of the squat before rising to allow for proper time for video to be taken. RESULTS: The analysis showed there is no significant difference between the 3D markerless system and the marker based system for the right (t[15]=0.1017, p>0.05) or left (t[15]=0.0801, p>0.05) knee angles. The mean angles and standard deviation values for 3D Markerless system being (R: 93.56°; +/-0.86°) and the marker system collection capture were (R: 92.95°; +/-1.45°). CONCLUSIONS: The results of the present study indicate that angles can be successfully measured by the 3D markerless motion capture system. Further research should be done to validate other joints. PRACTICAL APPLICATION: The use of a 3D Markerless motion system may be beneficial in reducing set up time for an individual and results of the present study indicate that angles can be successfully measured.

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**THE EFFECT OF SHOULDER POSITION ON THE THICKNESS AND FORCE PRODUCTION OF THE INFRASPINATUS**

D. Witt, N. Talbott, S. Belen, E. Thompson

University of Cincinnati

**Purpose:** Activity of the infraspinatus is critical for proper shoulder mechanics during the many shoulder movements performed by throwers, swimmers, tennis players and other athletes. When injured, the infraspinatus must be assessed and appropriate exercises initiated. Two commonly utilized positions and movements for these assessments and exercises are 1) resistance of external rotation with the arm in a neutral position; and 2) resistance of external rotation with the arm in elevated to ninety degrees in the plane of the scapula (scaption). The purpose of this study is to determine if the infraspinatus force production and thickness significantly change when the shoulder is moved from a neutral position to a position of ninety degrees of scaption. METHODS: Ten shoulders from five healthy subjects were tested using ultrasound imaging (USI). With the subject sitting, the shoulder was placed in a neutral position and the mid-third of the spine of the scapula. Measurements were repeated as the subject performed a maximal isometric external rotation contraction against a stable dynamometer and, after resting, a maximal isometric external rotation contraction against manual resistance applied through a hand held dynamometer. Force was recorded during each contraction and a corresponding ultrasound image stored. The process was repeated with the shoulder in a position of 90 degrees of elevation in the scapular plane. All measurements and images were taken three times. Ultrasound images were analyzed off line with linear measurements of the infraspinatus recorded for each contraction. RESULTS: The isometric force when pushing against a stable dynamometer significantly varied between positions decreasing from 19.9lbs when the shoulder was in a neutral position to 13.1lbs when the shoulder was in 90 degrees of scaption. A similar pattern was noted when pushing against manual resistance with force production decreasing from 272lbs in a neutral position to 19.4lbs in the scaption position. Although linear thickness of the infraspinatus did increase approximately 30% from the rest to the resisted conditions, no significant differences were found in the thickness in the different positions. Conclusions: Force exerted by the infraspinatus was greater in a neutral position when manual resistance was applied. Changes in infraspinatus thickness, as measured by USI, did not significantly change between the rest and the resisted conditions, regardless of shoulder position. PRACTICAL APPLICATIONS: If maximal force production is a goal, it would be more advantageous to exercise the infraspinatus in a neutral position than in a position of scaption and to utilize manual resistance. Monitoring infraspinatus thickness with USI is not supported as a measurement of increased force production.
ANTHROPOMETRIC DIFFERENCES AMONG NCAA DIVISION I ATHLETES BY TRAINING BIAS AND MEASUREMENT TYPE


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**PRESEASON AND POSTSEASON BODY COMPOSITION DOES NOT CHANGE RELATIVE TO PLAYING TIME IN DIVISION I FEMALE BASKETBALL PLAYERS**

A. L. Shim¹, E. Ladwig¹, J. Yom¹, P. Cross¹, J. Beebe¹

¹The University of South Dakota

**PURPOSE:** Body composition has gained a great deal of recognition in a range of sports with regards to optimal physical performance. As the level of body fat increases, work capacity diminishes. The excess fat serves as deadweight and does not assist the delivery of oxygen to muscles during exercise. The importance of maintaining a low body fat is particularly stressed in high intensity sports such as basketball, in which the metabolic demands are especially high. The purpose of this study was to determine if pre-season and postseason body fat percentages (BF%) change relative to playing time in Division I women’s basketball players.

**METHODS:** Subjects for the study included 11 National Collegiate Athletic Association (NCAA) Division I female collegiate basketball athletes over the age of 18 from a Midwest public university. The subjects underwent pre-season and postseason air displacement plethysmography to get an accurate measure of body fat percentages. RESULTS: Data analyses looked for changes between preseason and postseason body fat percentage. A Pearson’s Correlation was performed to determine if changes in preseason and postseason BF% changed relative to playing time. Body fat percentage varied across preseason and postseason (average increase BF%: 1.83%) but such a difference was not significant (t1,10 = -1.89, p = .088). A significant relationship was found between postseason (average decrease in BF%: -1.83%) but such a difference was not relative to playing time. PRACTICAL APPLICATIONS: Body fat tracking should be utilized in-season, and to pre-season to gauge on the nutritional and physical performance level of female basketball athletes, regardless of the amount of playing time subjected to each participant.

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**UTILITY OF BMI TO CORRECTLY CLASSIFY PERCENT BODY FAT IN OVERFAT INDIVIDUALS**

A. E. Smith-Ryan¹, H. Wingfield², M. Woessner², M. N. Melvin², D. Fukuda³, S. Fultz²

¹University of North Carolina Chapel Hill, ²University of North Carolina, ³University of North Carolina at Chapel Hill, ⁴Creighton University

Body mass index (BMI) is often used as a field-based assessment of health status and obesity. Limitations exist when utilizing BMI in heavy populations, such as football lineman and field competitors. Assessing obesity-related risk factors accurately in these athletes could prevent future health-related comorbidities. PURPOSE: To assess the accuracy of BMI to detect obesity when compared to a four-compartment (4C) body composition criterion. A secondary purpose was to evaluate the ability of BMI to detect differences in blood glucose, lipids and insulin.

**METHODS:** Forty-six men (M = 19) and women (W = 27)(Mean ± SD: Age: 37.4 ± 11.6 yrs; Ht: 172.7 ± 10.0 cm, Wt: 94.2 ± 16.4 kg, %fat: 33.2 ± 5.4%) with a BMI of ≥ 25kg/m² were assessed for body composition using a 4C approach. The Wang-4C model was used to calculate percent body fat (%fat): [FM = 2.748(BV) – 0.699(TBW) + 1.129(Mo) – 2.051(BM)], where body volume (BV) was measured from air displacement plethysmography, total body water from bioelectrical impedance spectroscopy, and total bone mineral content (Mo) derived from dual-energy x-ray absorptiometry. Subjects were categorized as overweight (OW; BMI ≥25kg/m²) or obese (OB; BMI ≥30kg/m²) and compared against the age- and sex-matched %fat criterion classification as normal (%fat < 19 for M; ≤33 for W); OW (%fat 19-27% for M; 33-40% for W) or OB (%fat >27% for M; and >40% for W). Receiving operating characteristics (ROC) analyses were used to determine optimal OW and OB BMI cutoff points by taking into account the best combination of sensitivity and specificity values when compared to 4C %fat. The kappa statistic was used to test the agreement between BMI and %fat.

**RESULTS:** The diagnostic agreement between BMI and %fat for OW and OB was poor for both men (kappa: 0.123) and women (kappa: -0.125). BMI had poor specificity to detect OB men (36%) and women (16%). Greater specificity occurred for the OW population (93%). BMI misclassified 79% of men and 37% of women. According to the ROC, BMI is not a useful tool to assess overfatness (AUC=0.471; p=0.853) in men. A BMI of 27.0kg/m² would be more accurate for identifying OW men. For women, BMI may be useful for %fat classifications (AUC=0.699; p=0.005) with 25.5kg/m² providing 100% specificity for OW women. Independent samples t-tests indicated significant differences in fasting blood glucose and insulin for only OB women, as defined by %fat. Standard BMI was unable to detect differences in glucose or insulin. **CONCLUSIONS:** The kappa statistic for men and women suggests that classifications are not similar for BMI and %fat. More so, sensitivity and specificity results suggest that BMI may be practical for OW women, but not accurate for OW men. This data also demonstrates that higher BMI cutoffs are needed for OW men and women to positively identify excess fat and associated comorbidities. PRACTICAL APPLICATIONS: Athletes with higher %fat have been shown to have a greater prevalence of obesity, resulting in associated health-risks. Because these athletes also have greater muscle mass, BMI may mask obesity. While direct measurements of %fat may not be feasible, utilizing 27 and 25.5kg/m² as BMI cutoffs for men and women may be more effective for detecting health risks in larger athletes. Direct measurement of metabolic syndrome markers, rather than BMI, is still recommended. **ACKNOWLEDGEMENTS:** Supported by the Nutrition Obesity Research Center (P30DK056350).

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**ACCURACY OF FOOT-TO-FOOT BIOELECTRICAL IMPEDANCE ANALYSIS IN COLLEGIATE FEMALE SOCCER PLAYERS**

R. Snarr¹, J. Verdy¹, M. Esco¹

¹Auburn University Montgomery, ²Auburn University at Montgomery, ³Auburn University Montgomery

With a strong correlation between sports performance and body composition, assessing body fat percentage in female athletes is crucial. Bioelectrical impedance analysis (BIA) is an inexpensive field measure that can be used to predict body fat percentage (BF%). However, these types of measures raise questions as to the accuracy and reliability of predicting BF% in female athletes, who typically tend to have a higher lean body mass and lower percentage of body fat when compared to general population females. **PURPOSE:** The purpose of this investigation was to cross-validate foot-to-foot BIA (FF-BIA) for predicting BF% in female collegiate athletes by using dual energy x-ray absorptiometry (DXA) as the criterion. **METHODS:** Eighteen female collegiate soccer players (mean age = 21.5 ± 1.86, height = 65.89 ± 2.22 inches, weight = 142.8 ± 16.22 lbs.) volunteered to have their BF% measured in this study. For each of the athletes, FF-BIA was used to predict body composition and compared to DXA for criterion purposes. **RESULTS:** The mean body fat percentage acquired from FF-BIA was 23.47 ± 5.84, while the mean DXA BF% was 27.41 ± 4.23. The mean values were significantly different (p > 0.05). FF-BIA did not significantly correlate with the DXA (r = 0.28, p = 0.26) and had a standard error of estimate (SEE) of 4.18%. **CONCLUSION:** The findings suggest that FF-BIA significantly underestimates BF% in female soccer athletes by 3.94% compared to the DXA and resulted in a high SEE. **PRACTICAL APPLICATIONS:** Before using FF-BIA, practitioners should be cautious of underestimating body fat percentage in female athletes, especially considering a large SEE. Since body composition has a strong correlation with sports performance, a more accurate method of predicting BF% in female athletes may be warranted. In addition, misclassifying a female athlete’s body composition could increase the risk of an eating or body image disorder. Therefore, body fat prediction in female soccer players via FF-BIA should be performed with caution.
PREDICTION OF STANDING LONG JUMP POWER IN NCAA DIVISION I FOOTBALL PLAYERS

B. Mann1, M. Bird2, P. Ivey3, T. Jackson4, K. Stump5, B. Daniels6, J. L. Mayhew5, S. Sayers4

1University of Missouri, 2Truman State University, 3University of Missouri, 4Physical Therapy Department, University of Missouri

The vertical jump is a popular measurement for determining leg power. The application of force in a single plane allows convenient determination of power using a force plate. Various prediction equations exist to estimate power from combinations of vertical jump height, body mass, and standing height. Despite the popularity of the standing long jump (SLJ), limited research has explored the prediction of power from this test. PURPOSE: To determine the feasibility of estimating SLJ power from jump distance and selected anthropometric dimensions in NCAA Division I-A football players. METHODS: 58 players (Height = 184.9 ± 6.6 cm; weight = 102.5 ± 18.1 kg) were measured during an off-season winter conditioning program. Measurements included height, body mass, total lower extremity length (TLE), and shank length (SL). TLE was measured from the greater trochanter to the floor. SL was measured from the joint space of the knee to the floor. Thigh length (TL) was calculated as the difference between TLE and SL. Leg ratios of TLE/HT and TL/SL were also calculated. Players completed general and specific warm-ups before performing 2-3 maximal familiarization trials of SLJ. Following a minimum of 5 mins rest, each player performed 2 maximal SLJ trials from a force plate. Each trial was separated by approximately 1 min rest. Vertical and horizontal forces were sampled at 1000 Hz and used to calculate power in each direction. SLJ power was calculated from the resultant force and velocity vectors. Best SLJ and peak power were used for analysis.

RESULTS: The 2 SLJ trials were not significantly different (265.2 ± 25.9 and 268.2 ± 25.9 cm, p = 0.07) and highly reliable (ICC = 0.944). Peak power from the 2 trials were not significantly different (5.068 ≥ 939 and 5.131 ≥ 905 W, p = 0.34) and highly reliable (ICC = 0.926). Standing height (r = 0.40), weight (r = 0.36), FLL (r = 0.43), TL (0.38), and best SLJ (r = 0.52) were significantly related (p<0.05) to peak power. Only weight (r = 0.47) was significantly related to SLJ range; all other measurements had correlations only between -0.15 to 0.04. Step-wise multiple regression selected SLJ range and weight as the only significant variables to predict peak power: Power (W) = 32.49 SLJ (cm) + 39.69 Weight (kg) – 7608 (R = 0.86, SEE = 488 W, CV% = 9.3%). SLJ contributed 56.8% to the known variance, while weight contributed 43.2%. CONCLUSION: This is the first study to estimate power production from a standing long jump in athletes. Although football players produce an average SLJ that was 13% greater than previously measured in recreationally active subjects, their peak power was significantly greater due largely to their greater average weight. SLJ and body mass are similar contributors to power generation in football. PRACTICAL APPLICATIONS: SLJ and weight can be used as effector predictors on SLJ power in major college football players.

SYSTEMATIC REVIEW OF CORE MUSCLE ACTIVITY DURING PHYSICAL FITNESS EXERCISES

J. M. Martuscello1, J. L. Libous1, J. M. Mayer1

1University of South Florida

PURPOSE: Core muscle strength and stability exercises are often prescribed by strength and conditioning specialists for their athletes and clients in order to enhance fitness performance and prevent injury in a variety of activities. However, an evidence-based consensus has not been reached regarding which physical fitness exercises are most effective at stimulating the activity of the core muscles. Furthermore, the scientific literature on this has not been systematically reviewed. Thus, the purpose of this paper was to systematically review the literature on the electromyographic (EMG) activity of three important core muscles (lumbar multifidus, transverse abdominis, quadratus lumborum) during physical fitness exercises in healthy adults to identify evidence-based knowledge. METHODS: Major scientific databases (i.e. CINAHL, Cochrane Central Register of Controlled Trials, EMBASE, PubMed, SPORTdiscus, and Web of Science) were searched for relevant articles using a search strategy designed by the investigators. Physical fitness exercises were partitioned into five major types: traditional core, core stability, ball/device, free weight, and non-core free weight. Strength of evidence was assessed and summarized for comparisons among exercise types. RESULTS: Seventeen studies enrolling 252 participants met the review’s inclusion/exclusion criteria. The key findings of this review with moderate levels of evidence were as follows: 1) lumbar multifidus EMG activity is greater during free weight exercises compared with ball/device exercises, and similar during core stability and ball/device exercises; 2) lumbar multifidus EMG activity is similar during core stability exercise and ball/device exercises; and 3) transverse abdominis EMG activity is similar during core stability and ball/device exercises. No studies were uncovered for quadratus lumborum EMG activity during physical fitness exercises. CONCLUSIONS: This systematic review revealed no evidence to suggest that core-specific exercises (core stability, ball/device) result in greater EMG activity of three major core muscles compared with traditional, multi-joint free weight exercises. PRACTICAL APPLICATIONS: The available evidence suggests that strength and conditioning specialists should focus on prescribing multi-joint free weight exercises for their athletes and clients, rather than core-specific exercises, in order to adequately train the core muscles. Along with providing an adequate stimulus for the core muscles, multi-joint free weight exercises provide additional health benefits that are not associated with core-specific exercises, which further supports the use of free weight exercises versus core-specific exercises.
THE INFLUENCE OF CROSSFIT ON FITNESS IN MEN AND WOMEN

B. Church, C. Jeffery, M. Jones, A. Wheeler, T. Adams, J. Stillwell

1Arkansas State University

PURPOSE: CrossFit is a relatively new type of exercise that has been growing in popularity. This form of exercise aims to improve general fitness through a variety of exercises including both bodyweight training and weight training among other non-traditional methods. The purpose of this study was to compare fitness levels in CrossFit trained individuals with a control group who have exercised with more traditional forms of exercise. A second purpose of this study was to determine the relationship between three common CrossFit exercises: 1-RM deadlift, 1 minute row for distance, and a timed test known as Murph by CrossFit practitioners. METHODS: Thirty seven participants, both male (n = 30) and female (n = 7) participated in the study. Participants were divided into two groups, CrossFit (15 males, 4 females), which regularly exercised according to CrossFit recommendations, and control (15 males, 3 females), which followed traditional exercise as suggested by the American College of Sports Medicine (ACSM). Participants completed the Margaria-Kalamen Power Test, Anaerobic Step Test, and Cooper 1.5 mile run. Means and standard deviations, along with independent t-tests were run based on test group and sex. RESULTS: It was found that male CrossFit participants performed significantly better, t(30) = 2.21, p<.05 (Crossfit: 1395W±379, Control: 1210W±287), than control males on the Maragaria Kalamen Power Test. Although mean scores for CrossFit participants were greater than control for the remaining tests, none reached the significance criterion of p<0.05 in either male or female participants. In addition, no significant correlations were observed between deadlift 1-RM, one minute row, and the timed Murph CrossFit workout. CONCLUSION: Based on these results the CrossFit method of training is just as effective as more traditional methods of aerobic and strength training advocated by the ACSM. Exercise adherence is often a problem with individuals who want to achieve minimum health standards. CrossFit appears to be an additional type of exercise that may be used to help individuals exercise regularly; thus, achieving adequate fitness levels associated with optimal health. PRACTICAL APPLICATION: This was one of the first studies ever on CrossFit and the main results indicated that individuals participating in CrossFit can achieve fitness levels at or above levels compared to the general ACSM recommendation for fitness.

THE IMPACT OF LOW-LOAD TRAINING WITH PARTIAL VASCULAR OCCLUSION ON CYCLE ERGOMETER PEAK POWER

C. Popovici, J. Hokanson

1Physical Education Department, State University of New York at Oneonta,
2Kinesiology Department, State University of New York at Cortland

Increases in muscle hypertrophy have been achieved with the use of low-intensity (<50% 1RM) single joint resistance exercises in conjunction with partial vascular occlusion of active muscle tissues, resulting in strength increases of upwards of 40% of maximal voluntary contractions. Traditionally, similar gains in strength have only been elicited under conditions involving high-intensity resistance training at or above 80% 1RM. Proposed mechanisms for these adaptations include hypoxia-induced additional or preferential recruitment of fast-twitch muscle fibers and a longer exposure of tissues to metabolic acidosis through the shunting of venous return and the accumulation of intramuscular H+ ions. These mechanisms are thought to elicit an exaggerated hormonal response than is traditionally seen when using intensities of <50% 1RM. To date, little research exists examining the potential of occlusion training as a means to improve power output. Based upon the proposed mechanisms responsible for adaptations resulting from occlusion training, such as a preferential recruitment of fast twitch fibers to perform a low resistance task; it would seem plausible that neuromuscular gains can be made. Purpose: Based upon these previous proposals of modified neural recruitment patterns and increased fast twitch involvement during hypoxic conditions created through a disruption to vascular blood flow, this study sought to determine if partial vascular occlusion of working musculature could enhance peak power on a cycle ergometer, measured using 30 second Wingate Test. Method: 21 recreationally active college students were separated into three training groups: A low-load occluded group (LLO)(n=7), a low-load free-flow group (LL)(n=7) and a high-load free flow group (HL)(n=7) and completed a 10 session, 5 week training protocol with additional pre and post Wingate Tests. All groups trained using the same periodized program designed to increase peak power output. Groups trained twice per week. Each session involved short sprint intervals at a maximum cadence ranging in time from 4 to 10 seconds per repetition, with 4 to 8 repetitions per session with 1:6 work to rest ratio. Sessions last approximately 10-15min. HL trained at 95% of the resistance used during Wingate testing (7125% of BW) while the low-load groups (LL and LLO) trained at 45% of their Wingate test resistance (3.375% of BW). LLO participants wore 6x35cm blood pressure cuffs around the proximal segment of the thigh, just below the hip for the duration of the training session. The cuffs were inflated to 180mmHg and the researchers monitored this pressure. Results: Pre and post training Wingate data was compared. Subjects in LLO and HL both improved significantly from pre to post testing in relative peak power (W/kg), 14.4% and14.1% respectively (p > .05), while individuals in LL saw no significant improvement in relative peak power (4.6%). LLO improved significantly over LL (p = .041), while HL’s improvement over LL nearly reached significance (p = .082). Average total work performed during training was calculated (in Watts). After ten training sessions LLO generated an average per person total work output of 8,204W, 58.3% less than HL’s 19,664W (p < .005). Conclusions: Utilizing low-resistance training under partially occluded conditions during sprinting on a cycle ergometer results in significant improvement to relative peak power output as measured during a Wingate Test. Practical Applications: The less overall work needed to produce significant affects in training compared to traditional methods indicates that occluding venous flow can provide an efficient stimulus towards increase muscular power for a specific movement pattern. Due to the minimal amount of work (2 ten minute sessions per week) which resulted in significant improvements to peak-power, this training modality may be attractive to in season athletes, if specific movement patterns can be duplicated under occluded conditions, or as an additional training modality to any power program.
RELIABILITY AND VALIDITY OF A NOVEL FIELD-BASED HAMSTRING STRENGTH TEST FOR ASSOCIATION SOCCER PLAYERS: IMPLICATIONS FOR PREVENTING HAMSTRING INJURIES

J. W. Lee1, P. S. Yung1, H. C. Chan1, K. Chan1

1The Chinese University of Hong Kong

*Award Eligible - Outstanding Doctoral Student Podium Presentation

PURPOSE: Isokinetic knee strength test is considered as a useful method for professional soccer players to identify the risk of sustaining hamstring strains. However, those testing protocols were time consuming and inconvenient. Therefore, a novel field-based strength test for evaluating hamstring strength was designed. The aim of this study is to examine the reliability and validity of this test for soccer players.

METHODS: 30 amateur players (mean age = 17.2 ± 1.27 years; body weight = 62.98 ± 17.52 kg; height = 175.52 ± 5.23 cm) from HKFA 2nd division league participated in this study. The CUHK hamstring strength test included 3 different modes (free mode, 15°mode, and 30°mode). The subjects started in a kneeling position and a helper stabilized the subjects’ legs. Then the subject leaned forward in a smooth and controlled manner, while keeping his back and hips fully extended until the point he has to let go with hamstrings. The free mode was tested for the forward flexion angle which the subjects cannot sustain. The 15° mode and 30° mode were tested for the time that the subjects could hold at 15° and 30° respectively. High speed camera was used to record the performance of the CUHK hamstring strength test. A motion analysis system APAS is used to analyze the tilting angle and angular velocity of knee joint. hamstring peak torque and Hamstring to Quadriceps (H/Q) strength ratio of the isokinetic test in 3 different patterns of speed were used as the criterion for the validity test. The testing protocol included concentric performance of hamstring and quadriceps muscle groups at 60 deg/s (3 repetitions), 240 deg/s (5 repetitions) angular speeds, and the eccentric performance of the hamstrings at 30 deg/s. All sets of testing were separated by 1 minute of rest. Intra-class correlation coefficient (ICC) was used to analyse the reliability between test and retest in all 3 modes of CUHK hamstring strength test. Correlations between the independent and dependent variables were tested to screen for the potential variable which may predict the hamstring strength.

RESULTS: The CUHK hamstring strength test 1 was the most reliable test (R = 0.815) among the CUHK hamstring strength test. This test can predict the hamstring peak torque in concentric performance at 60°/s and 240°/s angular speed. The combination of angle in free mode test and body weight can predict a larger percentage of data.

CONCLUSIONS AND PRACTICAL APPLICATIONS: With a rapidly growing elderly population, it is essential to expand our understanding of the influence of aging on passive properties of the musculotendinous unit. Previous studies have reported inconsistent findings regarding then changes in passive stiffness and very few studies have examined these changes across the lifespan. PURPOSE: The purpose of this study was to examine the effects of aging on the passive stiffness of the plantar flexors in young, middle-aged and old men. METHODS: Sixteen young (mean ± SD: age = 22.2 ± yr), fifteen middle-aged (47±2 yr), and sixteen old (66±4 yr) men performed a passive stiffness assessment of their right plantar flexors on a calibrated isokinetic dynamometer. To determine passive stiffness, the lever arm passively dorsiflexed the ankle at 5° starting at 20° of plantar flexion to the participants maximally tolerated range of motion (MROM) at which point the dynamometer was manually stopped by the investigator and immediately returned to the starting position. The angle-torque curve was gravity corrected for the weight of the footplate and fit with a 4th order polynomial function. Passive stiffness values were calculated as the slope of the angle-torque curve at a common joint angle (10° of dorsiflexion; neutral = 0°) and a relative joint angle (80% of MRROM) using a 200ms epoch. All passive stiffness values were normalized to corrected calf-girth measurements. Neutral and relative joint passive stiffness values were evaluated using two, one way ANOVAs with post hoc Bonferroni corrected independent t-tests. A type-1 error rate of 5% was used to determine statistical significance.

RESULTS: For common angle passive stiffness, the older men exhibited greater stiffness values when compared to the young and middle-aged men (P = 0.017). Similarly, relative angle passive stiffness values were also greater in the older men when compared to the young and middle-aged men (P = 0.017). CONCLUSION: The results of this study indicated that no differences were observed in passive stiffness values between the young and middle-aged men at either a relative or common joint angle; however, both groups exhibited lower passive stiffness values when compared to the old men. PRACTICAL APPLICATION: These findings demonstrated that over the course of the life span, passive stiffness of the plantar flexors increases at old age. However, these changes appear to occur sometime after middle-age (i.e. 47 years) in healthy men. These findings may also highlight the importance of including training interventions in older adults to help reduce passive stiffness.
Phase 2 consisted of a two week overreaching cycle in which volume and frequency were increased followed by a 2-week taper (Phase 3). Muscle mass, strength, and power were examined at weeks 0, 4, 8, and 12 to assess the chronic effects of ATP; assessment of performance variables also occurred at the end of weeks 9 and 10 (the mid and endpoints of phase 2). Additionally, urinary 3-methylhistidine (3-MH) and blood draws following a 12-hour fast for resting testosterone and cortisol, C-reactive protein (CRP), creatine kinase, and creatine were obtained for weeks 0, 8, 9, 10, and 12. Blood draws occurred at the same time of day to avoid diurnal effects. Muscle protein degradation was measured by the ratio of urinary 3-MH:creatinine. A Repeated measures ANOVA was used to assess main effects in all variables. Tukey post hoc was employed to locate where differences occurred. Statistical significance was determined at p < 0.05. Results: There were time, and group x time effects (p<0.05) for strength (12.6% ATP vs 5.9% placebo) power (15.7% ATP vs 11.6% placebo), and muscle mass (9.4% ATP vs 4.9 % placebo), which increased greater in the ATP group. For the overreaching cycle, there were group x time effects for strength and power, which decreased to a greater extent in the placebo group. Muscle damage, assessed by blood CK, and muscle protein degradation were affected by training (Time, p < 0.05). Supplementation with ATP was unable to attenuate the increase in CK during both the initiation of training (weeks 0 to 1) and during the overreaching cycle (weeks 9 and 10). ATP supplementation significantly decreased muscle protein degradation compared with placebo during the overreaching cycle (Trt*time, p < 0.007). Supplementation with ATP did not affect changes in C-Reactive protein, cortisol, or free or total testosterone levels when compared with placebo supplementation. Conclusions: The collective findings of our current study suggest that supplementation with ATP, in combination with high intensity, periodized RT, increases LBM, muscle mass, strength, and power versus a placebo-matched control. Moreover when faced with greater training frequencies, oral ATP may prevent typical declines in performance that are characteristic of overreaching.

Friday, July 12, 2013, 9:30 AM - 9:45 AM

COMPARISONS OF ACUTE NEUROMUSCULAR FATIGUE IN MAXIMAL EFFORT STRENGTH TRAINING USING POWERLIFTS


1University of South Florida, 2University of South Florida/Exercise and Performance Nutrition Laboratory, 3Florida Atlantic University, 4Department of Kinesiology, Texas Christian University, Fort Worth, TX, 5University of Tampa

*Award Eligible - Outstanding Master’s Student Podium Presentation

Purpose: To assess the level of acute neuromuscular fatigue, as measured by a decrease in peak velocity, as a result of maximal effort strength training sessions with each powerlift (squat, bench press, deadlift). Methods: Twelve resistance trained males (22.8 ± 2.6 yrs; 177.1 ± 6.7 cm; 83.0 ± 12.6 kg) participated in a randomized crossover design with three conditions: Squat (SQ), Bench Press (BP), and Deadlift (DL). Subjects’ relative strength included the ability to successfully complete at least 1.5x their bodyweight in the squat exercise. Initially, baseline peak velocity (PV) was measured for each lift at 60% 1RM via a TENDO Power and Speed Analyzer. One training session occurred each Monday for 3 consecutive weeks (1 week for each lift). Each training session consisted of a 1RM of the designated lift followed by 4 sets of 2 repetitions at 92.5% and 4 sets of 3 repetitions at 87.5%. In the days following training sessions, each lift PV was measured at 24, 48, and 72 hours post-training to compare with baseline measures and determine recovery. Data was analyzed using a repeated measures ANOVA (p<0.05). Results: SQ: No significant differences in PV of the SQ and DL following SQ training at each time point compared to baseline. Bench press PV significantly declined following squat training (Baseline = 1.069 m/s; 24 hours = 0.974 m/s [p = 0.019]; 48 hours = 1.015 m/s [p = 0.034]; 72 hours = 0.970 m/s [p = 0.004]). BP: No significant differences in PV of the SQ and DL following BP training at each time point compared to baseline. Bench press PV significantly declined only at 24 hours following BP training (Baseline = 1.069 m/s; 24 hours = 0.985 m/s [p = 0.004]). DL: No significant differences in PV of the DL following DL training as compared to baseline. Squat PV significantly declined at 24 hours following the DL training (Baseline = 1.384 m/s; 24 hours = 1.315 m/s [p = 0.032]). Similar to SQ, PV of the BP significantly declined only at 24 hours following DL training (Baseline = 1.069 m/s; 24 hours = 0.979 m/s [p < 0.001]). Conclusions: Bench press PV was significantly decreased 24-hours following each of the three powerlifts as compared to baseline values. Interestingly, there were no changes in squat and deadlift PV following training of that specific lift. Practical Applications: Regardless of the powerlift trained, bench press PV at 60% was compromised 24-hours later. Therefore, following training of any powerlift, more than 24-hours may be needed to optimize performance in the BP at submaximal intensities. Acknowledgement: This investigation was supported by Dymatize Nutrition Sport Performance Institute.

Friday, July 12, 2013, 10:00 AM - 10:15 AM

HITTING A MOVING TARGET: EFFECTS OF PHYSIOLOGICAL STRESS ON ACCURACY AND RECALL IN POLICE FIREARMS TRAINING

S. Unruh1, B. Goslin1

1Oakland University

*Award Eligible - Outstanding Master’s Student Podium Presentation

Law enforcement firearms qualification and training are measured against static targets and low stress. Yet, real life deadly force encounters involving moving targets and high stress. PURPOSE: Target Focus Shooting (TFS not using the sights) and Isosceles Shooting (IS: using the sights) were examined for hitting a moving target at rest and after exercise stress. METHODS: Thirty-three participants were recruited from two independent groups (n = 22 for TFS and n = 11 for IS). Both groups were fired as often as possible at a moving target using soap-like colored cartridges at a distance of 3.04±0.15 m, once at rest and again after significant exercise stress induced by a 30 s Wingate bicycle test. The Wingate bicycle test involves supra-maximal effort that increases heart rate through muscle fatigue that is comparable to what a police officer may experience during a critical incident. The target moved from right to left at 0.614m/s or a 2 m distance. A recall test was conducted after the post-exercise session for memory of shots
fired and perceived success. Performance was measured by Points (Pts) assigned (Hit (+1); Miss (-2); Did Not Shoot (DNS) (0)); Pts; Rounds Shot (Rnds); Hit/Total % (Hit/Total %). A composite score (CS) was calculated (CS= Pts x Rnds x (1-Hit/Total %) and analyzed by a mixed design ANOVA (p< .05). RESULTS: There was no significant shooting style effect (p = .37), exercise stress had no significant effect (p = .68), and there was no interaction (p = .65). The CS means for the IS style were superior (mean+SD: Pre-Stress 2.0+4.83, Post-Stress 2.63+4.10) to the TFS style (mean+SD: Pre-Stress -1.21+13.17, Post-Stress -0.30+11.45) and both shooting styles deteriorated with exercise stress, but not significantly. Round placement and accuracy was analyzed and the average Hit % at Rest (TFS: 74%; IS: 84%) was higher than Post-Exercise (TFS: 59%; IS: 73%). Post-exercise memory recall of the number of shots and perception of the number hitting the target was quite low (TFS: 29%; IS: 24%). CONCLUSION: Sighted shooting (IS) is best when shooting at moving targets. Exercise stress causes a deterioration of shooting accuracy, but not significantly. PRACTICAL APPLICATION: High intensity exercise causes deterioration in shooting performance. Firearms training should emphasize the use of the weapon's sights, physical fitness, and practice with moving targets for optimal performance.

Friday, July 12, 2013, 10:15 AM - 10:30 AM
TRENDS FROM NFL COMBINE DATA MAY PREDICT PERFORMANCE VALUES OF FUTURE NFL DRAFT PICKS

K. A. Leiting1, B. Gleason1
1East Tennessee State University

*Award Eligible - Outstanding Doctoral Student Podium Presentation

PURPOSE: The purpose of this research is to provide coaches and athletes with minimum performance values to establish as goals for the 2014 NFL Combine. METHODOLOGY: All subjects were invited to compete in the NFL Combine and their data are available to the public. All NFL Combine data from 1999-2012 have been "scraped" from http://nflcombineresults.com/nflcombinedata.php and all draft pick history "scraped" from http://www.nfl.com/draft/history/fulldraft?position on November 27, 2012. All NFL draft picks and their draft pick rank were matched with NFL Combine data from the respective year of the athlete's draft and NFL Combine results. NFL combine data of individuals that were not drafted were not used for analysis. Aggregate data for each year and position and performance variable were graphed and trends were established by applying the derived slope-intercept linear equation. Peak Power is not an NFL Combine assessment but can be derived from NFL Combine data using the Sayers Power Equation. Two standard error of estimate (SEE) was used to determine a cut-off point that became the minimum performance value. The minimum performance value for each position and event for 2014 is provided. Data from 1999-2011 were used to determine already known 2012 performance values as a means of validation. Percent of non-overlapping data was used to assess the percent success rate for this method. The number of participants that achieved a performance value greater than the predicted minimum for 2012 were divided by the total number of participants that were drafted is termed success rate. RESULTS: Minimum performance values for each position for each event for the 2014 Combine are presented. Validation of this method of analysis is presented as a success rate for each position and event. DISCUSSION: This method of analysis has a 69-84% success rate at identifying the minimum performance value depending upon position. To the investigators knowledge there has not been an attempt to identify performance values that increase potential draft selection. It is interesting to note the low success rate for some variables based on position, suggesting not all NFL Combine tests are applicable to every position. PRACTICAL APPLICATIONS: Performance values presented may be used as a goal for strength coaches to help athletes achieve at the NFL Combine in 2014. Achieving performance values greater than the minimum presented may increase an athlete's chance of draft selection. It is suggested that this method of analysis should be continually updated and evaluated to identify minimum performance values for upcoming NFL Combines.

Friday, July 12, 2013, 10:30 AM - 10:45 AM
LOWER-BODY STRENGTH AND POWER INFLUENCE PERFORMANCE IN CHANGE OF DIRECTION TASKS

F. A. Bourgeois1, J. B. Winchester1, R. W. Brem1, F. B. Wyatt1, S. P. Cronin1
1Midwestern State University

*Award Eligible - Outstanding Master's Student Podium Presentation

PURPOSE: Previous studies have examined the relationship lower-body strength and power has with performance in events that require change of direction (COD). However, there is a scarcity of investigations which have considered the influence strength and power have on the magnitude of improvement in COD performance as a result of training. Moreover, interventions selected within the literature are often not representative of interventions used by strength and conditioning professionals. Therefore, the purpose of this study was to investigate the relationship between strength and power and the magnitude of improvement in COD as a result of training. METHODS: Eleven collegiate athletes (age = 20.55 ± 1.214 yr; height = 186.52 ± 6.569 cm; mass = 108.76 ± 17.433 kg) from a Division II American football program participated in the study. Subjects were pre and posttested in vertical jump (VJ), standing broad jump (SBJ), peak force (PF), time to peak force (TPF), rate of force development (RFD), one-repetition maximum back squat (1-RM BS), hexagon test, pro agility test, and T-test. Both absolute values along with data normalized to body mass were used for purposes of comparison. Subjects participated in an 8 week training program designed to increase strength, power, and COD. Tests used to assess COD during pre and posttesting were not used during the intervention. RESULTS: Pretest VJ power showed strong correlation with both absolute change and percent improvement in the T-test (r = 0.59 and 0.58, respectively). A strong correlation was also found between the absolute change in SBJ and the absolute change in the hexagon test (r = 0.53). Pretest Rel PF showed strong correlation with both pro-agility and the T-test (r = -0.5 and -0.58, respectively). Pretest TPF and the hexagon test showed strong correlation (r = -0.51) as did Rel 1-RM BS and the T-test (r = -0.54). Posttest Rel PF revealed strong association with both the pro agility test and the T-test (r = -0.61 and -0.81, respectively) and Rel 1-RM BS showed strong correlation with performance in the T-test (r = -0.6). CONCLUSION: The findings of this investigation suggest that an athlete's ability to express strength and power may influence subsequent adaptation to interventions designed to improve COD. Moreover, adaptations in strength and power may also influence the magnitude of improvement in COD tasks. PRACTICAL APPLICATION: Practitioners may wish to consider sequencing their training to focus on strength and power early in the athlete development process in order to enhance potential adaptations in COD later on in training. In addition, when considering the addition of COD to the training plan, it may be appropriate to maintain focus on increasing strength and power. ACKNOWLEDGEMENTS: This investigation was partially funded by the Midwestern State University Graduate School.

Friday, July 12, 2013, 10:45 AM - 11:00 AM
STRENGTH AS A PREDICTOR OF THE MAGNITUDE OF ADAPTATION FROM POWER TRAINING

R. W. Brem1, J. B. Winchester1, F. A. Bourgeois1, F. B. Wyatt1, S. P. Cronin1
1Midwestern State University

*Award Eligible - Outstanding Master's Student Podium Presentation

Although previous research generated data that suggest stronger individuals produce more power, the effects different strength levels have on the magnitude of power adaptation have not been investigated thoroughly. PURPOSE: To determine if strength levels can be used to predict the magnitude of adaptation that may occur from participating in a training program designed to increase power production. METHODS: The participants in this study were eleven men ([mean ± SD]: age 20.6 ± 1.2 years; height 186.6 ± 6.7 cm; mass 108.8 ± 19.1 kg) who were NCAA Division II American football players. Pretest strength was assessed during performance of an isometric mid-thigh pull (rate of force development (RFD), peak force (PF), and time to peak force (TPF)) and via a one repetition maximum back squat (1-RM BS). Lower body muscular power was tested using the vertical jump (VJ) and standing broad jump (SBJ). Sprint performance was assessed via timing gates in a 36.58 m (40 yard) dash. Correlations were established between pretest strength variables and both absolute and relative pre-post change in power tasks as well as sprint times and the kinetic variables of peak velocity (PV) and acceleration (A) performed for each task. RESULTS: Coast Pretest TFD was significantly correlated with both absolute and percent change of the 9.14 m (0 to 10 yard) sprint time (r = -0.86; r = -0.85), 18.29 m (0 to 20 yard)
sprint time ($r = -0.72$; $r = -0.71$), and 36.58 m (0 to 40 yard) sprint time ($r = -0.61$; $-0.62$). The pretest 1-RM BS was significantly correlated with the absolute change in VJ ($r = 0.64$) as well as relative improvement in VJ ($r = 0.66$). In addition, pretest RFD showed significant correlation with both absolute and percent improvements in acceleration ($r = 0.84$; $r = 0.87$). CONCLUSIONS: Pretest RFD correlated well with the magnitude of improvement in sprint times as well as acceleration. According to these data, pretest RFD was the most common statistically significant predictor of the magnitude of improvement in sprinting. Moreover, 1-RM BS showed meaningful relationships with the magnitude of adaptation in lower body power assessed via VJ. PRACTICAL APPLICATIONS: Practitioners may wish to consider sequencing their training to focus on increasing strength early in the athlete development process in order to enhance subsequent adaptations in power. ACKNOWLEDGMENTS: This investigation was partially funded by the Midwestern State University Graduate School.

Friday, July 12, 2013, 11:00 AM - 11:15 AM
SEGMENTAL CHANGES IN FAT AND SUBCUTANEOUS ADIPOSE TISSUE AFTER A RAPID WEIGHT LOSS INTERVENTION IN WOMEN

J. Moon1, C. Tai1, P. Falcone1, L. Carson1, H. Kim1

1MusclePharm Sports Science Center Research Institute

PURPOSE: Compare subcutaneous adipose tissue (SAT) and segmental fat loss after a rapid weight loss intervention in healthy women. METHODS: Fourteen women participated in the control group (28 +/- 4yr, 67.6 +/- 9.8kg, 167.5 +/- 7.5cm) while twenty-three participated in the diet group (27 +/- 5yr, 69.0 +/- 10.5kg,164.0 +/- 5.5cm). Control group subjects maintained their normal diet; experimental subjects followed a strict 1200 calorie diet for twenty-one days. Regional and SAT fat were collected pre- and post-testing using dual-energy X-ray absorptiometry (DXA) and skinfold calipers (respectively). RESULTS: Significant ($p < 0.05$) reductions in chest, mid-axilla, hip, thigh, subscapular, and triceps SAT thicknesses were observed between pre- and post-testing for the experimental group only ($0.75$ to $0.35$mm). Significant ($p < 0.05$) reductions were also observed for DXA arms, legs, and trunk fat between pre- and post-testing for the experimental group only (186.3 to 1,032.6 g). Reductions in mid-axilla, abdominal, hip, and thigh SAT thicknesses were all correlated with DXA trunk fat ($r = 0.494$ - 0.624). Reductions in hip and thigh SAT thicknesses were correlated with DXA leg fat ($r = 0.449$ - 0.479). CONCLUSION: Both DXA and skinfold-based SAT measurements detected fat loss after a rapid weight loss intervention in healthy women. Subcutaneous adipose tissue measurements of the mid-axilla, abdominal, hip, and thigh appear to be highly correlated with total segmental values measured by DXA. However, SAT measurements of the chest, subscapular, and triceps may independently add to DXA data. PRACTICAL APPLICATIONS: When tracking changes during a diet or exercise intervention in women, valuable data can be obtained from both DXA and SAT measurements independently. Practitioners and researchers should consider SAT as well as segmental fat measurements when tracking body composition changes in women as the exact location of fat stores that will be affected by diet and exercise are unknown and vary by individual. ACKNOWLEDGEMENTS: This investigation was supported by funding from MusclePharm Corporation.

Friday, July 12, 2013, 11:15 AM - 11:30 AM
THE RELATIONSHIP BETWEEN FUNCTIONAL MOVEMENT SCREEN SCORES AND TEAM SPORT-SPECIFIC TESTS IN ATHLETES

R. G. Lockie1, A. B. Schultz 1, C. A. Jordan1, S. P. Berry1, S. J. Callaghan 1, M. D. Jeffries1, T. M. Luczo2

1University of Newcastle / Exercise and Sport Science, 2California State University Monterey Bay / Department of Kinesiology

The Functional Movement Screen (FMS) is comprised of 7 actions: deep squat (DS), hurdle step (HS), in-line lunge (ILL), shoulder mobility, strict straight-leg raise (ASLR), trunk stability push-up (TSPU), and rotary stability. These actions test how the body moves in a proximal-to-distal fashion. The FMS is often used to diagnose movement deficiencies so as to prevent injury. Given that these screening actions can be conceptualized in sprinting and jumping, the FMS may also detect deficiencies in key sport-specific movements. PURPOSE: To determine the relationship between individual FMS scores, as measured by the standard 21-point and research-grade 100-point scales, and team sport-specific performance (multidirectional speed, upper- and lower-body power, flexibility). METHODS: 41 team sport athletes (32 male, 9 female) were tested over 3 sessions. Subjects were assessed in the FMS by 2 exercise scientists in the first session. The final 2 sessions involved team sport-specific tests of: flexibility (bilateral and unilateral sit-and-reach [SAR]); linear (20-meter [m] sprint; 0-5, 0-10, 0-20 m intervals) and change-of-direction speed (505 with turns off both feet; modified T-test with initial movements to the left or right); and upper- (bilateral and unilateral medicine ball chest pass [MBCP]) and lower-body (bilateral and unilateral vertical [VJ], standing broad [SBJ], and lateral [LJ] jump; 5-bound test [5BT]) power. RESULTS: Pearson’s correlation ($r$) analysis ($p<0.05$) found relationships between the FMS scores and athletic tests. A higher standard scale-scored DS related to faster 20-m sprint ($r=-0.321-0.351$), right-foot turn S05 ($r=0.320$), and right-turn T-test ($r=0.367$) performance. The DS, scored by both scales, positively correlated with bilateral VJ and SBJ, left-leg SBJ, 5BT, and LJ off both legs ($r=0.317-0.519$); and MBCP ($r=0.317-0.427$) performance. A higher standard and research-grade scale for the left-leg ILL positively correlated with bilateral VJ and SBJ, and LJ for both legs ($r=-0.310-0.432$). The TSPU positively correlated to the bilateral and unilateral MBCP for both scales ($r=0.347-0.547$). The left-leg HS standard score related to greater SAT ($r=0.316-0.408$); the research-grade score related to slower 505 times ($r=0.327-0.377$), and greater SAT ($r=0.344-0.393$). The ASLR as both scales, related to slower 20-m sprint and 505 times ($r=0.322-0.375$), poorer VJ ($r=-0.311-0.349$), and greater bilateral and unilateral SAT ($r=0.388-0.592$). CONCLUSION: Selected FMS movements, scored by both the standard and research-grade scales, related to performance in team sport athletes. This was most noticeable for the DS, which correlated with multidirectional speed and power. The ILL also related to leg power, while the TSPU provided an indication for upper-body power as measured by the MBCP. These relationships were likely due to similarities between movement mechanics and muscle recruitment. Greater leg flexibility, as measured by the HS and ASLR, related to poorer speed and power. Leg stiffness may be more beneficial for team sport athletes, and a field screen of this should be developed. PRACTICAL APPLICATIONS: Individual FMS actions do relate to team sport-specific performance. The DS, ILL, and TSPU can be used to monitor physical deficiencies that could affect speed and power. The standard scale seems to provide sufficient information to detect movement deficiencies that could affect team sport performance.

Friday, July 12, 2013, 11:30 AM - 1:00 PM
Poster: 2
COMPARISON OF EXERCISE METABOLISMS BETWEEN ATHLETES AND RECREATIONALLY ACTIVE INDIVIDUALS AT THE POINT OF EQUIVALENCE OF CHANGE

G. Gallien1, D. Bellari1, L. Judge2

1University of Louisiana at Lafayette, Lafayette, LA, 2University of Louisiana at Lafayette, Ball State University, Muncie, IN

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

PURPOSE: The current study assessed and compared the number of METs at the Point of Equivalence of Change (PEC) between athletes and recreationally active individuals. PEC is the point at which $\Delta$CO$_2$ production first matches $\Delta$VO$_2$. It was determined by measuring VCO$_2$ and VO$_2$, during a graded exercise test and finding the first point where the two were matched in change per unit time ($\Delta$VO$_2$/$\Delta$CO$_2$). METHOD: Sixteen NCAA Division 1 Track and Field Athletes and fourteen active college aged students participated in a graded exercise test to determine their VO$_2$max. The PEC is determined through the 3rd order polynomial regression of VCO$_2$ and VO$_2$, followed by solving the derivative of this function for a slope of 1. At the PEC, the relative oxygen consumption was converted to METs then compared. RESULTS: A One-Way Analysis of Variance (ANOVA) was used to compare METs at the PEC between groups. There was significant difference between the MET values of the athletes compared to the MET values of the recreationally active ($F=7.384$, $p=0.011$). The athletes had a MET value at the PEC of 9.09 +/- 2.21 as compared to the recreationally active participants having a mean MET of 6.83 +/- 2.34. CONCLUSION: These data suggest that the athletes had significantly elevated metabolisms at the PEC compared to recreationally active individuals. PRACTICAL APPLICATION: Athletic trainers and conditioning coaches should be aware of the differences that exist between exercise metabolisms for athletes and recreationally active individuals. When prescribing moderate intensity exercise for an athletic population, professionals must be conscious of the athletes’ elevated metabolisms during exercise levels that correspond with the PEC, which occurs at a sub-maximal intensity.
NSCA National Conference & Exhibition Abstracts

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Poster: 3
PERSONALITY TRAITS OF ULTRA-ENDURANCE, ULTRA-DEMAND ATHLETES
J. D. Lindfors1, T. J. Piper1, C. S. McMillan1
1Western Illinois University, Department of Kinesiology, Major of Exercise Science

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

The field of Exercise Science, in its continuous expansion, consequently has resulted in new populations of athletes, for which little to no data currently exists. This research begins to investigate a previously unexplored population of athletes known for engaging in high intensity, long duration forms of exercise. PURPOSE: To explore the personality traits of athletes who choose to participate in ultra-endurance events, uniquely characterized by bouts of high intensity, long duration physical activity. Fifteen participants (male=13, female=2, mean age=30.7±9.36yrs, age range=20–47) enrolled in a 15-hour event were surveyed using the Jung Typology Personality test. Prior frequency of training leading up to the race just over 2.5 days per week (M=2.67±0.89) with a range of average training sessions from (30-60 min) to (120 min). Participants’ longest average duration of training session in preparation for the race exceeding 500 minutes in total (M=516.67 ± 477.47min) with scores ranging from 90 minutes to 1800 minutes. Participants’ education level ranged from High School to Bachelor’s Degree; mean falling between an Associates and Bachelor’s Degree. Answers were analyzed and each participant’s survey was assigned a 4-letter type designation of personality based upon the work of Carl Jung’s and Isabel Briggs Myers’ typology. RESULTS: The results of the traits exhibited by the sample of participants within this study shows two areas of high tendency; Intuition and Judgment, as they relate to the descriptions of trait factors of Carl Jung’s Trait Typology Test. CONCLUSIONS: From the results of the 4-letter type designated to each participant, differences in trait dimension average are demonstrated clearly in to specific areas; Intuition and Judging. Also demonstrated are moderate distributions toward Thinking, within the Thinking-Feeling dimension. Slight differences are seen towards Extraversion within the Extraversion-Introversion dimension. The trait dimension of Perceiving was not demonstrated by any of the participants. PRACTICAL APPLICATIONS: This research was conducted for the purpose of gaining insight into a population of athletes that has little to no data collected upon. The results can act as a guide for future research to be conducted, specifically what areas to be aware of in regard to these athlete’s traits. By identifying these and other factors within personality that possibly contribute to participation in such strenuous and demanding exercise, this population can be better understood as well as quantified scientifically.

Poster: 4
METABOLIC, CARDIOVASCULAR, AND PERCEPTUAL RESPONSES TO A THERMOCALoric NUTRITIONAL SUPPLEMENT AT REST, DURING EXERCISE, AND RECOVERY IN MEN
H. C. Bergstrom1, T. J. Housh1, D. A. Taylor2, R. L. Lewis Jr3, K. C. Crochane4, N. D. Jenkins1, R. J. Schmidt1, J. T. Cramer1, G. O. Johnson1, D. J. Housh1
1University of Nebraska-Lincoln, 2University of Nebraska Medical Center

*Award Eligible - Outstanding Doctoral Student Poster Presentation

PURPOSE: This study examined the acute metabolic, cardiovascular, and perceptual responses to a thermogenic nutritional supplement at rest, during low-intensity exercise, and recovery from exercise in men. METHODS: Twenty-one recreationally active men (mean ± SD; age = 23.5 ± 2.6 years; height = 181.3 ± 6.1 cm; weight = 85.5 ± 10.5 kg; body mass index = 26.0 ± 2.4) were recruited for this randomized, double-blinded, placebo-controlled, crossover study. The nutritional supplement capsules included 200 mg caffeine, 100 mg capsicumin extract, 2 mg piperine, 250 mg boswellia serrata extract, 500 mg dried ginger root, 100 mg cinnamon bark, 20 mg niacin, and 500 mg maca root. The placebo capsules were matched in size and appearance and contained microcrystalline cellulose. Each testing session consisted of four phases: 1) 30 min of initial resting measures, followed by ingestion of the placebo or thermogenic nutritional supplement; 2) 50 min of post-supplementation resting; 3) 60 min of treadmill walking (3.2 – 3.9 km·h⁻¹); and 4) 50 min of post-exercise resting. Energy expenditure (EE), oxygen consumption rate (VO₂), respiratory exchange ratio (RER), and heart rate (HR) were recorded during each 10 min averages. During exercise, the rating of perceived exertion (RPE) was recorded every 15 min. Statistical analyses included separate 2-way repeated-measures ANOVAs (condition x time), 1-way repeated-measures ANOVAs, and paired t-tests (p < 0.05). RESULTS: There were no significant differences for any of the measures between the supplement and placebo during the initial 30 min resting or the 50 min post-supplementation time periods. During exercise, VO₂ was 3 to 4% greater for the supplement than the placebo at each 10 min average. In addition, EE was 3 to 4% greater and RER was 2 to 3% less for the supplement than the placebo from 20 to 60 min. There were, however, no differences in HR or RPE between the supplement and placebo during exercise. Post-exercise, VO₂ was 6% greater at 10 and 20 min and 5% greater at 50 min, EE was 10% greater at 10 and 20 min, HR was 4 to 5% greater at 20 and 30 min, and RER was 4 to 6% less from 30 to 50 min for the supplement than the placebo. CONCLUSIONS: The greater EE and VO₂ values for the supplement than placebo during exercise and post-exercise resting indicated that the thermogenic nutritional supplement used in the present study increased the metabolic rate. In addition, the lower RER for the supplement than placebo suggested a shift in substrate utilization and a greater reliance on lipid metabolism. Furthermore, there were minimal changes in HR and the supplement had no effect on RPE. PRACTICAL APPLICATIONS: These findings suggested that the specific blend of ingredients in the thermogenic nutritional supplement, when combined with exercise, may increase the metabolic rate with minimal changes in cardiovascular function and no effect on the perception of effort. Thus, it is possible that the thermogenic supplement used in this study would help dieters achieve a negative caloric balance, increase weight loss, and improve body composition when combined with long duration, low intensity exercise. ACKNOWLEDGEMENTS: This study was supported by a clinical trial grant from General Nutrition Corporation.

Poster: 5
THE EFFECT OF INTERMITTENT TORSO COOLING ON THERMOREGULATION AND PERCEIVED RECOVERY IN BASEBALL CATCHERS
S. H. Bishop1, R. L. Herron2, C. Katica1, G. Ryan1, P. Bishop2
1Texas A&M University-Commerce, 2University of Alabama, 3University of Montana Western

*Award Eligible - Outstanding Doctoral Student Poster Presentation

PURPOSE: A baseball catcher may have to catch in a hot environment for up to 27 innings over the course of a three-game series. Cryotherapy has been shown to reduce heat and cardiovascular strain during activity in the heat. This study investigated the effects of intermittent cooling of the torso on core temperature (Tre) and subjective measures of recovery and exertion during a simulated catching performance. METHODS: Trained college-aged male baseball catchers (n = 6) performed simulated catching in a controlled, hot environment (35 °C, 25% relative humidity). Two series of 3-simulated games were used to evaluate heat strain on thermoregulation and mental acuity in baseball catchers; one series with torso cooling (VC) and one with no cooling (NC). Rectal temperature (Tre), heart rates (HR), perceived exertion (RPE), recovery (PRS) were recorded. RESULTS: A significantly smaller (p < 0.01) mean Tre change was seen in VC (0.58 ± 0.2 °C) when compared to NC (0.98 ± 0.2 °C). RPE was significantly lower and PRS was significantly improved for VC compared to NC (both p < 0.05). Mean recovery HR during VC was significantly lower than NC in the 5th (VC = 84 ± 8 bpm, NC = 90 ± 9 bpm, p = 0.04), 7th (VC = 84 ± 3 bpm, NC = 92 ± 7 bpm, p = 0.02), and 9th (VC = 85 ± 7 bpm, NC = 93 ± 5 bpm, p = 0.01) innings. HR during catching was significantly lower at the end of the VC trials when compared to NC (108 ± 16 bpm versus 120 ± 19 bpm, p = 0.02). CONCLUSION: VC alleviated heat strain, cardiovascular strain, and facilitated perceived recovery in catchers over a simulated three game series performed in hot conditions.

Poster: 6
DOES INGESTING A SODIUM-SODIUM CITRATE BEVERAGE EFFECT HR, VO₂, RER, & BLOOD LACTATE IN PREVIOUSLY HYPOHYDRATED SOCCER ATHLETES IN A HOT ENVIRONMENT DURING AEROBIC EXERCISE?
J. G. Carter1, K. A. Brooks2, J. Dawes2
1Texas A&M University, 2Texas A&M University Corpus Christi

*Award Eligible - Outstanding Doctoral Student Poster Presentation

INTRODUCTION: Research has shown that many athletes are continually in a state of dehydration. This impairs performance, and increases the chance of heat illness occurring. Numerous athletes have experienced some degree of heat illness, resulting in acute discomfort and distortion of their physiological mechanisms. One method that has proven effective in rehydrating athletes is use of a beverage containing sodium to increase fluid absorption and stimulate the thirst mechanism. PURPOSE: The purpose of this study was to determine if ingesting a beverage containing 1,780 mg of sodium and 2,953 mg of sodium citrate would effect HR, VO₂, RER, and blood lactate for previously dehydrated individuals in a heated environment during aerobic exercise. METHODS: Five division one female soccer athletes participated in the study. The subjects had the following descriptive statistics: Age 19 ± 0.7 yr, Height 162.3 ± 4.6 cm, Weight 63.2 ± 8.1 kg, %BF 23.6 ± 9.2%, and VO₂peak 60.2 ± 5.1 ml·kg⁻¹·min⁻¹. The study required subjects (N=5) to
run the experimental protocol twice. Fluid intake was matched for each condition. Prior to running to exhaustion at 70% of their VO\textsubscript{max} on a treadmill in a heated chamber, the subjects were passively dehydrated and lost 2.5% of their body mass. The subjects were given 2 hours to rehydrate via either a placebo (10 mmol Na\textsuperscript{+}L\textsuperscript{-1}) or the supplement (164 mmol Na\textsuperscript{+}L\textsuperscript{-1}). After medical clearance, subjects performed a graded exercise test to determine VO\textsubscript{max}. ACSM equations were used to determine running speed at 70% of VO\textsubscript{max}. Testing conditions consisted of the subjects running at 70% of their VO\textsubscript{max} until exhaustion while in a heated chamber at 90° Fahrenheit. The study employed a double-blind, repeated measure, within subject protocol. The treadmill protocol consisted of a five minute warm-up (3 minutes at 40% of their VO\textsubscript{max} and 2 minutes at 35% of their VO\textsubscript{max}), running to exhaustion at 70% of VO\textsubscript{max} and a 10 minute cool down at 3.0 mph. Every five minutes on the treadmill, variables were assessed. RESULTS: Results for variables at 70% of maximal VO\textsubscript{2} indicated there were no significant differences observed between conditions pre and post exercise. There were no significant differences between conditions for variables at the start or end of the run, and at each 5 minute data collection point throughout the run, there was no significant difference between conditions for BLA and VO\textsubscript{2}. There were no significant differences between conditions for heart rate until the 30 minute mark. At the 30, 35, and 40 minute marks, there was a significant difference in HR (p<0.05), with the supplement trial reporting lower heart rates at each mark. CONCLUSION: Heart rate was lower when hydrated with the sodium supplemented beverage after sustained aerobic exercise at 70% of VO\textsubscript{max} in a hot environment. The ability to maintain a lower heart rate may lead to increased performance through a decreased effect of cardiovascular drift. Notably, all of the subjects performed better on the first treadmill session regardless of the experimental condition (i.e. placebo or high sodium solution). Absolute conclusions cannot be drawn from this study. PRACTICAL APPLICATION: Dehydration should be a major concern for any athlete, especially for those who are performing in hot, humid environments. Preventative methods such as ingesting a sodium solution, frequent weigh-ins, and continual education for the athlete should all be employed to avoid any form of heat illness to the athlete. Practitioners should be aware of the importance of aerobic conditioning for an athlete while exercising in a hot environment. Knowledge of warning signs and symptoms, and taking proper precautions to prevent complications is of importance. Coaches should be aware that athletes who are less conditioned are at higher risk for heat illnesses; therefore, proper training and steps towards acclimatization must be employed prior to training in the heat.

**Poster: 7**

THE EFFECTS OF A PERSONAL OXYGEN SUPPLEMENT DURING VIGOROUS EXERCISE ON RESPIRATORY RESPONSES AND PERFORMANCE

E. Cory\textsuperscript{1}, D. Bellar\textsuperscript{2}, L. Judge\textsuperscript{3},

\textsuperscript{1}University of Louisiana at Lafayette, Lafayette, La, \textsuperscript{2}University of Louisiana at Lafayette, \textsuperscript{3}Ball State University, Muncie, IN

*Award Eligible - Outstanding Undergraduate Student Poster Presentation*

Personal oxygen supplements are becoming more prevalent in the ergogenic market. The effectiveness of such products has yet to be determined. PURPOSE: The purpose of this investigation was to examine the effects a personal 90% oxygen supplement had on a participant's physiological responses and performance after sustained aerobic exercise at 70% of VO\textsubscript{max}, in a hot environment. The ability to maintain a lower heart rate may lead to increased performance through a decreased effect of cardiovascular drift. Notably, all of the subjects performed better on the first treadmill session regardless of the experimental condition (i.e. placebo or high sodium solution). Absolute conclusions cannot be drawn from this study. PRACTICAL APPLICATION: Dehydration should be a major concern for any athlete, especially for those who are performing in hot, humid environments. Preventative methods such as ingesting a sodium solution, frequent weigh-ins, and continual education for the athlete should all be employed to avoid any form of heat illness to the athlete. Practitioners should be aware of the importance of aerobic conditioning for an athlete while exercising in a hot environment. Knowledge of warning signs and symptoms, and taking proper precautions to prevent complications is of importance. Coaches should be aware that athletes who are less conditioned are at higher risk for heat illnesses; therefore, proper training and steps towards acclimatization must be employed prior to training in the heat.

**Poster: 9**

RICE PROTEIN INCREASES LEAN BODY MASS, MUSCLE HYPERTROPHY, POWER AND STRENGTH COMPARABLE TO WHEY PROTEIN FOLLOWING RESISTANCE EXERCISE

S. I. Weiner\textsuperscript{1}, J. M. Joy\textsuperscript{1}, R. P. Lowery\textsuperscript{1}, R. Jaeger\textsuperscript{2}, M. Purpura\textsuperscript{1}, E. Oliveira de Souza\textsuperscript{3}, J. E. Dudeck\textsuperscript{1}, N. Carpenter\textsuperscript{1}, E. Max\textsuperscript{3}, D. Brockunier\textsuperscript{1}, J. M. Wilson\textsuperscript{1}

\textsuperscript{1}University of Tampa Human Performance Lab, \textsuperscript{2}Laboratory of Neuromuscular Adaptations to Strength Training, School of Physical Education and Sport, University of São Paulo, \textsuperscript{3}Dymatize Enterprises, LLC. Farmers Branch, Texas

**Award Eligible - Outstanding Undergraduate Student Poster Presentation**

PURPOSE: Dymatize\textsuperscript{1} XPAND\textsuperscript{2} 2X is a proprietary blend comprised of branched chain amino acids, creatine monohydrate, beta-alanine (CarNoSyn\textsuperscript{3}), quercetin, coenzymated B-vitamins, alanil-glutamine (Stamina\textsuperscript{4}), and natural nitrogen sources from pomegranate and beet root extracts purported to enhance neuromuscular adaptations. However to date, no long-term studies have been conducted with this supplement. The purpose of this study was to investigate the effects of XPAND\textsuperscript{2} 2X on skeletal muscle hypertrophy and lower body strength in resistance trained males. METHODS: Twenty resistance-trained males (21.3 ± 1.9 years) were randomly assigned to consume XPAND\textsuperscript{2} 2X or a placebo of equal weight and volume (food-grade orange flavors and sweeteners) in a double-blind manner, 30 minutes prior to exercise. All subjects participated in an 8-week, 3-day per week, periodized, resistance training that was split-focused on multi-joint movements such as leg press, bench press, and bent-over rows. Ultrasonography measured muscle thickness of the quadriceps femoris, and strength of the leg press were determined at weeks 0, 4, and 8 of the study. Data were analyzed with a 2x3 repeated measures ANOVA with LSD post-hoc tests utilized to determine where differences occurred. RESULTS: There was a significant group-by-time interaction in which XPAND\textsuperscript{2} 2X supplementation resulted in a significant (p < 0.05) increase in strength of the bench press (18.4% vs. 9.6%) compared with placebo after 8 weeks of training. XPAND\textsuperscript{2} 2X supplementation also resulted in a significant increase in quadriceps muscle thickness (11.8 % vs. 4.5 %) compared with placebo (group*time, p <0.05). CONCLUSIONS: These results suggest that XPAND\textsuperscript{2} 2X supplementation can augment adaptations in strength, and skeletal muscle hypertrophy in resistance-trained individuals.
mass, strength and power all increased and fat mass decreased; however, no condition by time interactions were observed (p>0.05). **Conclusion:** Rice protein isolate administration post resistance exercise decreases fat-mass and increases lean body mass, skeletal muscle hypertrophy, power and strength comparable to whey protein isolate.

**Poster 10**

**ELECTROMYOGRAPHIC ACTIVATION OF SUPERFICIAL MUSCULATURE DURING A SUSPENSION INVERTED ROW AS COMPARED TO AN INVERTED ROW**

R. Brannan1, R. Snarr2, E. Wittle1, C. Janinski1, M. Esco1

1Auburn University at Montgomery, 2Auburn University Montgomery, 3Auburn University Montgomery

*Award Eligible - Outstanding Undergraduate Student Poster Presentation*

Stability, balance and coordination are all important factors when training for specificity or mimicking activities of daily living. Suspension training is a newer form of instability training that can provide a way to perform typical resistance exercises in an unstable environment. Research in stability training has mainly focused on the effects of an unbalanced surface and core musculature activation. Very few studies have focused on the primary and secondary musculature targeted during specific pulling exercises. Therefore, movements such as the inverted row have a need to be examined when an instability device is introduced to this exercise. **PURPOSE:** The purpose of this investigation is to quantify the differences in muscular activation during a suspension inverted row (SIR) and a traditional inverted row (IR) across selected superficial musculature (latissimus dorsi (LD), posterior deltoid (PD), middle trapezius (MT), and biceps brachii (BB)).

**METHODS:** Fifteen men (n = 12) and women (n=3) volunteered to participate in this study. Subjects were asked to perform four repetitions of both the inverted row (IR) and suspension inverted row (SIR). For this study, the order of the exercises was randomized. Mean peak EMG values were recorded for each muscle group during all exercises performed. **RESULTS:** The SIR provided the following values: MT = 2.8496 ± 1.54681, PD = 3.5490 ± 1.61145, LD = 3.9143 ± 2.37325, BB = 3.9482 ± 1.28421. IR values were: MT = 3.0559 ± 1.89448, PD = 3.4137 ± 1.38606, LD = 3.7352 ± 2.14528, BB = 4.4814 ± 1.44295. **CONCLUSION:** This study found no significant differences between MT, LD, and PD activation between the two exercises (p > 0.05). However, IR elicited a significantly greater BB activation compared to SIR (p < 0.05). **PRACTICAL APPLICATIONS:** Practitioners should take note that the suspension and traditional inverted row provide similar activation levels, except for the BB. Therefore, suspension training can provide a substitution for the traditional inverted row when necessary. However, further research is warranted to determine the affects of suspension training on additional exercises with a strong focus on primary and secondary movers.

**Poster 11**

**ELASTIC BANDS AS A COMPONENT OF PERIODIZED RESISTANCE TRAINING**

N. Carpenter1, E. Max1, J. M. Wilson1, R. P. Lowery1, J. M. Joy1, J. E. Dudeck1

1University of Tampa Human Performance Lab

*Award Eligible - Outstanding Undergraduate Student Poster Presentation*

**Purpose:** Variable resistance (VR) training has recently become a more prevalent component of strength and conditioning programs. Prior research has demonstrated increases in power and/or strength using low loads of VR. Typically, researchers have not practically applied VR; wherein, the VR is applied during every session when this may not be the case in a real world setting. However, no study has examined using high loads of VR as a part of a periodized training protocol. Prior research has also compensated traditional load to account for the increased load the VR provides. Therefore, our purpose is to examine VR training within the context of a periodized training program, and to examine a greater load of VR than has been examined in prior research without compensating for the additional load the VR applies. **Methods:** 14 NCAA Division II male basketball players (91.8 ± 15.2 kg, 191.4 ± 12.5 cm) were recruited for this study. Athletes were divided equally into either a VR or control group based upon repetition-maximum (1-RM) strength. Participants underwent identical training protocols; however, the VR group added 30% of their 1-RM as band tension to their prescribed weight on the squat and bench press for one session per week. Thirty percent was calculated with the bands at their longest length, and at the zero-velocity point of the movement, the bands provided little to no tension. Rate of power development (RPD), peak power, and vertical jump height were measured on a force platform. Strength in the squat, bench press, and deadlift were measured as 1RM strength. Body composition was measured via DXA, and vertical jump height was measured a second time with a vertec. Measurements were recorded pre and post treatment. **Results:** No baseline differences were observed between groups for any measurement of strength, power, or body composition. A significant group by time interaction was observed for RPD, in which RPD was greater in VR training group post training than in the control group. Significant time effects were observed for all other variables including squat 1-RM, bench press 1-RM, deadlift 1-RM, vertical jump, and lean mass. While there were no significant group X time interactions, the VR training group’s percent changes and ESs indicate a larger treatment effect in the squat and bench press 1-RM values and the vertical jump performed on the force plate and vertec. **Conclusions:** These results suggest that when using VR as a component of a periodized training program, power and strength can be enhanced. Therefore, athletes whom add VR to one training session per week may enhance their athletic performance. Furthermore, for strength and power oriented athletes or practitioners, it is conceivable that VR training can be applied in order to overcome a stagnation of progress and break plateaus.
EFFECT OF HIP INTERNAL ROTATION TRAINING ON RANGE OF MOTION AND PERFORMANCE VARIABLES IN MALE COLLEGIATE GOLFERS

T. Donahue, D. Szymanski, B. Stover, A. Elumalai, J. Parks
Louisiana Tech University

*Award Eligible - Outstanding Master’s Student Poster Presentation

Previous golf research has reported that increases in the range of motion (ROM) of the shoulders and hips (focused on internal and external rotation) as well as the torso has increased golf club head speed (CHS) and exit-ball velocity (EBV), ultimately increasing carry distance (CD) of the golf ball. PURPOSE: To determine if 8 weeks of hip internal rotation training could improve the golf performance variables of CHS, EBV, and CD. METHODS: Twelve NCAA Division I male golfers competing during the fall season volunteered for this experiment. All subjects signed an informed consent form according to the university’s Institutional Review Board. Subjects had a mean age, height, and body mass of 20.2 ± 1.5 yr, 179.6 ± 7.2 cm, and 77.4 ± 12.0 kg. Subjects underwent a battery of static and passive ROM testing (seated and supine internal and external rotation of the hip, seated internal and external rotation of the shoulder, and right and left torso rotation standing and in the sport-specific stance) in addition to having the golf performance variables of CHS, EBV, and CD measured using the TrackMan (Brighton, MI, USA). TrackMan is a software program that measures both club delivery and the full trajectory of the golf shot. Subjects took 5 swings with their driver and mean values were recorded for CHS, EBV, and CD. Range of motion testing was performed using a Baseline Absolute Axis 360° Digital Goniometer (Fabrication Enterprises, Inc., White Plains, NY, USA) and trunk ROM (standing and sport-specific stance) were measured using a mat with markings placed at intervals of 5°. After pre-testing, subjects were divided into 2 equal groups (treatment = 6 and control = 6). The treatment group used the hip internal rotation devices twice a day, 30 sec per session (3 x 10 sec) for each leg, 5 days a week for 8 weeks (total of 80 sessions) while the control did not. All other training was the same for both groups. After 8 weeks of training, the same tests were completed by both groups. RESULTS: A 2-way analysis of variance (ANOVA) with repeated measures was used to determine any pre- and post-training differences. A statistically significant difference (p < 0.05) was found between groups post-training in the passive supine hip internal rotation on both the left and right leg as well as in the shoulder internal rotation of the left arm for the treatment group. CONCLUSION: Results suggest that using the hip internal rotation device twice per day, 5 times per week for 8 weeks can improve internal rotation of the hips and shoulders; however, there were no improvements in any of the golf performance variables. PRACTICAL APPLICATION: Practitioners that are looking to improve internal rotation of the hips and shoulders can use the hip internal rotation device. Further research is needed with a greater sample size to evaluate the effectiveness of the hip internal rotation device on making improvements in golf performance variables. ACKNOWLEDGEMENTS: We would like to thank CEU Now LLC for partially funding this study.

EFFECT OF RESISTANCE TRAINING ON HYPERTROPHY IN DIFFERENT MUSCLE PORTIONS

M. Drummond, L. Szuchrowski, A. Moi, R. Angelo, B. Couto
Federal University of Minas Gerais, Brazil. FUMEC University, Brazil, Federal University of Minas Gerais, Brazil. Federal University of Minas Gerais

*Award Eligible - Outstanding Doctoral Student Poster Presentation

PURPOSE: The purpose of this study was to investigate the chronic effects of resistance training (RT) on muscle hypertrophy in different portions of the elbow flexors muscles. METHOD: The sample included 10 untrained male volunteers (age 22.1 ± 2.72yr, mass 72.6 ± 11.4kg, stature 1.74±0.07m) who initially underwent a Magnetic Resonance Image (MRI) scan to determine the cross-sectional area (CSA) of the elbow flexors. In the MRI, the CSA of the elbow flexors was obtained using MRI analysis. The proximal CSA muscle portion was defined by the mean of the slices number one, five and six. The medial CSA muscle portion was defined by the mean of the slices 15, 16 and 17 and distal CSA muscle portion by the mean of slices 25, 26, 27 slices. The volunteers subsequently performed RT of the elbow flexors for 12 weeks. The RT protocol included the performance of 4 sets of 8 to 10 repetition maximums of unilateral elbow flexion exercise (right arm) on a Scott-type bench. The rest intervals between sets were 120 seconds, and 3 training sessions were performed each week. After 12 weeks of training a MRI was again performed to determine the proximal, medial and distal CSA of the elbow flexors muscles in right arm. RESULTS: The volunteers exhibited an increase in CSA in all muscle portions examined. The increase in the proximal CSA was 16.2±5.8%, 19.3±4.8% in medial CSA and 17.2±5.3% in distal CSA. There were no significant differences in muscle hypertrophy between all muscle portions examined (p = 0.254, p = 0.190, p = 0.321). CONCLUSION: The muscle hypertrophy due to RT is similar in all portions of the elbow flexors muscles in untrained subjects. PRACTICAL APPLICATION: According to the results, the RT does not determine different hypertrophy between portions of the elbow flexors muscles in untrained subjects. Thus, it is not indicate the RT for such purpose for untrained subjects. ACKNOWLEDGEMENTS: The authors are grateful to “Pró-reitoria de Pesquisa” of Federal University of Minas Gerais, “Fundação de Amparo à Pesquisa do Estado de Minas Gerais – FAPEMIG” and to AXL - Medicina Diagnóstica [Diagnostic Medicine] of Belo Horizonte, Minas Gerais, Brazil.
AMBIENT AIR COOLING FOR EXTERNAL SOFT BODY ARMOR IN A HOT ENVIRONMENT

G. A. Ryan,1 R. L. Herron,2 S. H. Bishop,2 C. Katica,2 B. Elbon,3 A. Bosak,3 P. Bishop3
1The University of Montana - Western, 2The University of Alabama, 3Texas A&M University-Commerce, 4University of Alabama, 5Armstrong Atlantic State University

Previously we have studied the impact of an ambient air induction system on heat storage in concealed soft body armor (SBA) in a hot environment (wet bulb globe temperature [WBGT] = 30 °C) over 60 min of exercise. The Level II SBA is also regularly worn in a non-concealed manner outside the shirt by law enforcement personnel. PURPOSE: The purpose of this study was to investigate the effects of adding an ambient air induction system (-100 L/min) with 1.27 centimeter standoffs to a Level II SBA, worn externally, on heat strain and perceived comfort compared to an unmodified SBA worn externally. METHODS: Nine participants (27 ± 4 years) completed two 60-min work bouts, consisting of cycles of 12-min walking (1.25 L · min⁻¹) and 3-min of arm curls (14.3 kg, 0.6 L · min⁻¹) with a 5-min rest after every other cycle in a counter-balanced manner with control and modified external SBAs. Two-way repeated measures ANOVAs were used to assess the mean differences for physiological measures (core temperature, heart rate, microclimate [temperature and relative humidity]). Post hoc Bonferroni analysis and paired samples t-tests (alpha = 0.01) were conducted on omnibus significant findings. Subjective measures (perceived exertion, thermal comfort) were analyzed using Wilcoxon Signed Ranks Tests. RESULTS: No significant differences in rectal temperature (p = 0.657), heart rate (p = 0.234), ratings of perceived exertion (p = 0.380), or thermal comfort (p = 0.107) were detected between the SBA trial and the SBA modified with the ambient air system following the 60-min work bout. The microclimate under the modified SBA was significantly lower for the variable back temperature at the 30-min (p = 0.002), 45-min (p = 0.001), and 60-min (p = 0.001) time points and back relative humidity at 15-min (p = 0.005), 30-min (p = 0.009), 45-min (p = 0.010), and 60-min (p = 0.010) time points. Overall, a reduction of 1.2 ± 0.2 °C in back temperature and 4.7 ± 1.2 % RH in back relative humidity was noted between the control and modified SBA trials. No difference was noted in microclimate in the front of the vest. CONCLUSIONS: While a small change in back microclimate existed, this change was not associated with reduced physiological (change in rectal temperature, or heart rate) or psychological (ratings of perceived exertion, or thermal comfort) strain in individuals wearing a modified non-concealed Level II SBA in a hot environment. Further improvements to the ambient air system are needed to achieve reductions in physiological and psychological strain. Additional research should be conducted to determine if the shirt fabric (65/35 Cotton/polyester blend) impairs alleviation of heat strain in individuals wearing external Level II SBA. PRACTICAL APPLICATIONS: The data suggest that the introduction of ambient air was ineffective in improving physiological or psychological parameters for individuals wearing an external Level II SBA in a hot environment. However, these findings could be used to suggest the need to change the fabric of both the SBA carrier and uniform worn by law enforcement personnel to better alleviate heat strain associated with wearing SBA in a hot environment.

Repetitions to fatigue (RTF) were performed 2-3 days following 1RM testing. Training was conducted 3X/wk for 12 wk, utilizing a linear periodization model for all groups. Four prediction equations developed for women were applied before and after training. RESULTS: There was no significant pre-training difference in age, height, weight, or 1RM bench press among the intensity groups. 1RM improved significantly (p<0.05) by 22.8 ± 17.7% in the total sample following training, with Gr 1 (16.9 ± 14.3%) increasing significantly less (p<0.01) than Gr 2 (24.9 ± 20.6%) and Gr 3 (26.2 ± 16.9%). Gr 1 (4.7 ± 6.9) significantly increased (p<0.004) the number of RTF more than Gr 3 (1.0 ± 5.1) but not more than Gr 2 (2.6 ± 5.9); Gr 2 was not significantly different (p = 0.17) from Gr 3. Despite these values, only 17 subjects decreased an intensity group and 5 increased an intensity group. At pre-training, the Cummings and Finn equation significantly overestimated (13.5 ± 4.7 kg) 1RM while the Reynolds et al. (0.06 ± 3.0), Mayhew et al. (-0.5 ± 3.0 kg), and Tucker et al. (-0.5 ± 2.9 kg) equations were not significantly different from actual 1RM. At post-training, the Cummings and Finn (17.7 ± 4.7 kg) and Reynolds et al. (1.4 ± 4.3 kg) equations significantly overestimated 1RM while the Mayhew et al. (0.4 ± 3.5 kg) and Tucker et al. (-0.6 ± 3.3 kg) equations were not significantly different from actual 1RM. The Mayhew et al equation had the largest number of subjects within ±10% of actual 1RM at both pre-training (65%) and post-training (71%). The 95% limits of agreement (LOA) for this equation were -5.4 to 5.6 kg. The best RTF range for prediction was 7-10RM at pre-training and 3-6RM at post-training. CONCLUSION: A periodized resistance training program emphasizing strength development can significantly increase upper-body strength in previously untrained young women. Improvements may be similar for low-, medium-, and high-strength women. Certain repetition prediction equations appear to accuracy for estimating 1RM bench press before and after resistance training, with the optimal prediction in the 7-10RM range before training and the 3-6RM after training. PRACTICAL APPLICATION: Periodized resistance training programs are viable methods for enhancing upper-body strength in young women. Repetitions can be used to predict 1RM and appear to be better with some others. Repetitions in the 3-10RM range may be most suitable for prediction accuracy.
Mountain biking is characterized by intermittent bursts of power in an effort to navigate off-road terrain. Mainstays in performance include peak power output and power output at the lactate threshold up to the onset of blood lactate accumulation. Resistance training (RT) has been shown to increase muscular strength, and an increase in strength can increase power output by increasing the velocity and force by which a muscle contracts. While studies have examined the physiological parameters associated with successful riding, little is known about how competitive mountain bikers train to increase performance. PURPOSE: Therefore, the purpose of this study was to identify the prevalence of RT among competitive mountain bikers in their effort to increase performance. METHODS: Forty competitive mountain bikers (mean ± SD, age 25.75 ± 9.12 years) responded to a nationwide online training survey. Participants for this study were recruited by contacting groups whose members are competitive mountain bikers (i.e., NCAA university teams, university sports club teams, sponsored teams, professional teams). The survey assessed several types of training, including RT. Major responses were examined to determine the reliability of the training survey. Cronbach's alpha value for reliability was 0.82. RESULTS: In-Season: Fifty-five percent of respondents reported participating in RT during the in-season. Mean number of workout sessions per week devoted to RT was 3.00(SD=1.19) days per week. Median values of upper body and lower body training sessions were 2 and 3 sessions per week, respectively. Off-Season: Fifty-two and a half percent of respondents reported participating in RT during the off-season. Mean number of workout sessions per week devoted to RT was 2.76(SD=0.9) days per week. Median values of upper body and lower body training sessions per week were 2.5 and 2.0 sessions, respectively. RESULTS: Paired samples t-test revealed no significant difference (t=-0.82, df=15, p=0.42) in the number of workout sessions per week between seasons. Wilcoxon signed rank analyses indicated no significant difference in the number of upper (z=-1.40, p=0.16) and lower body (z=-1.29, p=0.20) workout sessions between both seasons. Further analysis indicated no significant difference in the percentages of riders participating in RT between both seasons (z=0.09, p=0.46). CONCLUSION: Based on the study findings, RT appears to be a popular modality of training to increase performance. In general, it appears that the survey respondents are adhering to the recommended frequency of workouts sessions per week associated with increases in sport performance. Results from the present study also suggest that riders incorporate upper and lower body training sessions into their workout regimen. Overall, not only does the percentage of participation in RT remain consistent throughout the year, results suggest there is a certain amount of consistency among upper and lower body training between both seasons. PRACTICAL APPLICATIONS: The findings are encouraging for RT practitioners. They can help RT practitioners understand the training modalities of competitive mountain bikers. This knowledge can help practitioners design effective training programs for mountain bikers. However, the findings from this study should be interpreted with caution due to the limitations of the study. Future studies with larger sample sizes and different populations are needed to provide a more comprehensive understanding of the training practices of competitive mountain bikers. This information can help practitioners develop effective training programs for mountain bikers. In conclusion, this study provides valuable insights into the training practices of competitive mountain bikers, highlighting the importance of comprehensive training programs for improving performance.
EFFECT OF HIP INTERNAL ROTATION TRAINING ON RANGE OF MOTION AND PERFORMANCE VARIABLES IN COLLEGIATE BASEBALL PITCHERS
B. Stover, D. Szymanski, T. Donahue 1
1Louisiana Tech University

*Award Eligible - Outstanding Master’s Student Poster Presentation

Hips range of motion (ROM) is very important to allow a pitcher to have proper pitching mechanics. During the stride phase, the movement towards the target is started by hip abduction of the dominant leg. As the pitcher continues down the mound, the dominant hip internally rotates as the non-dominant hip externally rotates. Previous research has shown that a limit in hip ROM may have a negative effect in the ability to produce pitched ball velocity. PURPOSE: To evaluate the effect of hip internal rotation training on hip ROM and related sport-specific performance variables in baseball pitching. METHODS: Fourteen healthy NCAA Division I collegiate baseball pitchers (age = 20.36 ± 1.50 years) volunteered for testing. All subjects signed an informed consent form according to the university’s Institutional Review Board. A Baseline Absolute Axis 360° Digital Goniometer (Fabrication Enterprises, Inc., White Plains, NY, USA) was used to measure passive ROM for shoulder internal and external rotation at 90°, seated active hip internal and external rotation, supine passive hip internal and external rotation, and hip abduction and adduction. Deep squat was measured using a yard stick. A Biodex (Biodex Medical Systems, Inc., Shirley, NY, USA) was used to measure internal and external rotation at 90° of the throwing arm at 300°/sec. Flexibility was measured using a sit-and-reach testing box. Sport-specific performance variables were stride length and pitch velocity (PV). Stride length was measured with a measuring tape from the front of the pitching rubber to the back of the pitcher’s lead heel after each pitch. PV was measured using Stalker Pro radar gun (Applied Concepts, Inc., Plano, TX, USA). The velocity of 10 consecutive maximal effort fastballs with 20 seconds of rest between pitches was calculated to represent mean PV for each subject. Participants were divided into 2 groups. Group 1 (n = 7) used the internal hip rotation devices twice a day, 6 days a week for 7 weeks (84 total sessions). They were instructed to stand on 2 hip rotation devices at 1 time. Then they initiated movement by internally rotating 1 leg from the hip for 10 seconds, then the other hip for 10 seconds while isometrically holding the other. They would do this twice and then internally rotate both hips for 10 more seconds for a total of 30 seconds for both hips. Group 2 (n = 7) served as a control and did not do any internal rotation exercises. All other training during the off season was the same for both groups. RESULTS: A two-way ANOVA with repeated measures showed that there were significant differences (p < 0.05) within groups for shoulder internal and external rotation, seated and supine internal and external hip rotation, and hip abduction, but there were no significant differences observed between groups for any variables. CONCLUSIONS: Improvement was seen in both groups in passive and active ROM; however, there were no significant differences in any sport-specific performance variables. PRACTICAL APPLICATIONS: Using a hip internal rotation device twice a day, 6 days per week for 7 weeks did not improve hip and shoulder ROM for 10 seconds any more than the control group after 7 weeks of training for collegiate baseball pitchers. ACKNOWLEDGEMENTS: We would like to thank CEU Now LLC for partially funding this study.

UNILATERAL THIGH MUSCLE CROSS-SECTIONAL AREA AND PEAK ECCENTRIC SQUAT FORCE
J. Travis1, M. S. Stock1, M. Luera1
1Texas Tech University

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

The results from many previous studies indicate that the force a muscle can produce is related to its cross-sectional area (CSA) rather than its volume. However, the majority of these investigations have measured force during single-joint isometric or concentric muscle actions. PURPOSE: The purpose of this study was to use linear regression analyses to determine the relationship between the anthropometric estimation of right thigh muscle CSA and peak eccentric squat force using a novel multiple-joint strength assessment. METHODS: Nineteen resistance-trained men (mean ± SD age = 22 ± 2 years) participated in this investigation. The subjects were engaged in a lower-body strength training program that involved back squats and/or deadlifts. Forty-eight hours following a thorough familiarization session, the subjects visited the laboratory for data collection. Upon arrival, a technique for estimating muscle CSA from anthropometric measurements for the thigh was performed. The measurements included femur length, thigh circumference, and four skinfolds (anterior, posterior, lateral, medial). The subjects then performed three consecutive repetitions of maximal eccentric isovelocity squats. The duration was set to four seconds for each attempt, and an electrogoniometer placed over the right knee joint ensured that each repetition was performed through an 80° range of motion (in accordance with the manufacturer’s guidelines for eccentric strength testing [20°/second]). The repetition with the greatest force values was selected, and the highest peak in the force curve was used for data analysis. Linear regression analyses were used to determine the relationship between the anthropometric estimation of thigh muscle CSA and peak eccentric squat force. RESULTS: The correlation (Pearson r) between these variables was r = 0.01. The regression equation was y = 0.0005 (cm²/N)x + 222.9 cm². Both negative and positive values were included in the 90, 95, and 99% confidence intervals (CIs). The estimation of unilateral thigh muscle CSA from anthropometric measurements explained none of the variance in peak eccentric squat force. We speculate that these results may be related to the different types of training programs used by the subjects (e.g., training primarily for strength and power versus hypertrophy) or the force contributions of the musculature involved in the squat that were not estimated with our anthropometric measurements (e.g., gluteus maximus, erector spinae, gastrocnemius, etc.). PRACTICAL APPLICATIONS: Although previous authors have shown a linear relationship between muscle CSA versus isometric and concentric force, no such association exists for maximal eccentric squats. Our findings are specific to men with previous strength training experience and eccentric strength testing conditions involving a standardized movement pattern and range of motion.
REST INTERVAL LENGTH IN BETWEEN SETS INFLUENCES ACUTE ANABOLIC HORMONAL RESPONSES AND PERFORMANCE DURING 8 WEEKS OF PERIODIZED RESISTANCE TRAINING IN OLDER MEN

M. G. Villanueva1, C. J. Lane1, E. Schroeder1
1University of Southern California

*Award Eligible - Outstanding Doctoral Student Poster Presentation

Purpose: To determine: i) if strength resistance exercise protocols (SRE) with 60-second rest interval lengths (RI) between sets (SS) will elicit significantly greater acute increases in total testosterone (TT) and growth hormone (GH), compared to SRE prescribed with 4-minute RI between sets (SL); and ii) if 8 weeks of periodized, strength resistance training (RT) incorporating 60-second RI in between sets (SS) will induce greater improvements in body composition and muscular performance, compared to the same RT program incorporating 4-minute RI (SLRT).

Methods: 22 men (SSRT: n=11, 65.6±3.4 years; SLRT: n=11, 70.3±4.9 years) were assigned to one of two groups, following 4 weeks of periodized hypertrophic RT (PHRT). From Week 4 to Week 12, SSRT and SLRT followed the same periodized strength RT program, with RI the only difference in RT prescription. 18 of the 22 participants completed 1 acute hypertrophic RE protocol (HRE), prior to the 12-week periodized RT program, and 2 SRE; SRE 1 was completed at Week 4 and SRE 2 upon completion of the RT program (Week 12). Blood was drawn pre-(PRE), immediately post-(POST), 15 minutes post-exercise (15 MIN), and 30 minutes post-exercise (30 MIN), to determine blood concentrations of TT and GH.

Results: Following PHRT, all study participants experienced increases in lean body mass (LBM), maximal upper and lower body strength, stairclimbing power, and dynamic balance (p<0.05). All study subjects experienced significant decreases in percentage body fat, stairclimbing time, and 400-meter walking time (p<0.05). Across the 8-week strength RT phase, compared to SLRT, SSRT experienced significantly greater increases in LBM (p<0.001), upper and lower body maximal strength (p<0.01), and stairclimbing power (p<0.001). HRE (n=18) increased TT, from PRE to POST, 15 MIN, and 30 MIN (p<0.05); for GH, elevations above PRE were also significant at POST, 15 MIN, and 30 MIN (p<0.01). In response to SRE 1 and SRE 2, there was a significant effect for protocol on TT acute change (POST) – (PRE) (p<0.001) and percent change ([POST – PRE]/PRE) (p<0.001; See Figure); the acute elevations in TT in response to SS were significantly greater, compared to SL. There was also a significant effect for protocol on GH percent change (p=0.003); the acute elevations in GH in response to SS were significantly greater, compared to SL. Conclusions: Strength resistance exercise with short rest interval lengths in between sets increases acute TT and GH responses in older men, while long rest interval lengths in between sets blunt the acute TT and GH response to strength resistance exercise. Further, 8 weeks of periodized high-intensity strength RT with short rest interval lengths in between sets induces significantly greater enhancements in body composition, muscular performance, and functional performance, compared to the same RT prescription with long rest interval lengths in between sets. Practical Applications: This study gives insight into a new approach to prescribing strength resistance exercise and periodized strength resistance training for older men, in order to optimize hypertrophic and performance adaptations to short-term strength resistance training and maximally offset the age-related declines in lean body mass, strength, and power.

Acknowledgements: This study received funding through the National Strength and Performance Adaptations to Short-term Strength Resistance Training and Strength Resistance Training for Older Men, in Order to Optimize Hypertrophic Performance. Practical Applications: This study gives insight into a new approach to prescribing strength resistance exercise and periodized strength resistance training for older men, in order to optimize hypertrophic and performance adaptations to short-term strength resistance training and maximally offset the age-related declines in lean body mass, strength, and power.
assess sprinting speed and sprint momentum, each participant performed four 40 m sprints on artificial turf. Timing gates (Brower, Utah) were set on 1m tripods at the 0m, 10m, 20m and 40m marks. Participants began their sprint with their front foot beside a cone 0.75m behind the first gate. The fastest 0-10m and 30-40m sections from the sprints were kept for analysis in order to characterize different sprint qualities. The 0-10m split was used to analyze acceleration ability and the 30-40m section was used to analyze maximum velocity. The times from each section were converted into a velocity by dividing the 10m section by the time taken to complete it. The 0-10m section was considered Initial Sprint Velocity (ISV) and the 30-40m section was considered Maximal Sprint Velocity (MSV). In order to calculate momentum, the velocity scores were multiplied by the body mass of each athlete to calculate Initial Sprint Momen tum (ISM) and Maximal Sprint Momentum (MSM). A 2x2 ANOVA (senior-junior x forward-back) was used to compare body mass, sprinting velocities and sprint momentum scores. If a significant F value was found, post hoc tests (Tukey’s) were conducted to obtain between-group differences. RESULTS: The results indicate significant differences between senior and junior players for ISM and MSM but not for ISV and MSV. Significant differences were also found between senior and junior players for body mass. CONCLUSION: The results seem to indicate that body mass and sprint momentum but not sprinting velocity differentiate between the senior and junior players. Findings from the study suggest that sprint momentum and body mass are key physical qualities to develop in young players transitioning into senior international rugby. Longitudinal studies, however, will be needed to confirm these findings. PRACTICAL APPLICATIONS: When testing sprinting speed in rugby players, strength and conditioning coaches should use 10m splits in order to calculate sprint momentum. In addition to developing sprinting speed, strength and condition coaches working with elite rugby players should focus on developing sprint momentum as it is a key physical quality.

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EFFECTS OF ASSISTED JUMP TRAINING ON VERTICAL JUMP PERFORMANCE IN NCAA DI WOMEN VOLLEYBALL PLAYERS
T. L. Beaudette1, A. M. DuBois1, L. E. Brown2
1California State University, Fullerton, 2Center for Sport Performance, California State University, Fullerton, CA
*Award Eligible - Outstanding Master’s Student Poster Presentation

INTRODUCTION: Vertical jump performance plays an important role in the performance of volleyball players. Assisted jumping research has been shown to acutely increase peak vertical jump, but the adaptations resulting from chronic assisted jump training are currently unknown. PURPOSE: To investigate the effects of assisted plyometric jump training on peak jump height and net relative impulse during bodyweight vertical jumps. METHODS: Eight NCAA Division 1 women’s volleyball players (19.25 ± 0.89 yrs.; 182.84 ± 3.72 cm; 72.2 ± 9.28 kg) performed three maximal baseline countermovement vertical jumps with arm swing followed by four weeks of assisted plyometric jump training. During the first two weeks, subjects performed 2 sets (week 1) and 3 sets (week 2) of 10 jumps at 30% bodyweight reduction (BWR). During the last two weeks, subjects performed 2 sets (week 3) or 3 sets (week 4) of 10 jumps at 40% BWR. Subjects wore a full body harness attached to elastic cords that were stretched from the ceiling by a rope. Using a pulley system, the cords were pulled by the rope adjusting the specified BWR for each trial. After four weeks of training, subjects performed three maximal post vertical jumps with arm swing. All vertical jumps were performed on an AMTI force plate sampling at 1000 Hz. Peak jump height and net relative impulse were calculated during each maximal vertical jump via custom LabVIEW software. RESULTS: Peak jump height significantly (p < 0.05) increased (pre = 33.5286 ± 5.34 cm; post = 35.3541 ± 6.42 cm). However, there was no significant (p > 0.278) change in net relative impulse (pre = 2.64 ± 0.17 N·s·kg⁻¹; post = 2.67 ± 0.21 N·s·kg⁻¹). CONCLUSIONS: Given the increase in peak vertical jump, assisted jump training could be an effective training technique for improving performance in jumping athletes. The increase in peak jump height might be attributed to variables other than net relative impulse, which merits further research of assisted jump training. For future research it might be beneficial to extend the length of the assisted training program beyond 4 weeks and evaluate other variables that might be contributing to increases in vertical jump, such as force, velocity, and power. PRACTICAL APPLICATIONS: Since assisted jump training can be performed with minimal fatigue, implementing assisted training into an ongoing training program might increase an athlete’s vertical jump height without effects of overtraining.

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THE EFFECTS OF WHOLE-BODY VIBRATION ON GROUND REACTION FORCES AND RATE OF FORCE DEVELOPMENT IN COLLEGE AGED FEMALES
N. C. Dabbs1, H. Chander2, C. Allen1, J. Lundahl1, V. L. Cazas2, M. Hilton3, M. Italia4, J. C. Garner5
1The University of Mississippi, 2University of Mississippi
*Award Eligible - Outstanding Doctoral Student Poster Presentation

Varsity and recreationally trained individuals have previously shown to poten tiate vertical jumping performance following exposure to whole-body vibration (WBV). However, determining the optimal rest intervals is still unclear. PURPOSE: The purpose of this study was to evaluate the influence of different rest intervals following WBV on rate of force development (RFD) and relative ground reaction forces (rGRF) in varsity and recreationally trained females. METHODS: Eight varsity (age 20.75 ± 1.16yr, mass 61.35 ± 9.68kg, height 168.19 ± 7.73cm) and eight recreationally (age 22.25 ±1.83yr, mass 64.35 ±4.64kg, height 162.53 ± 2.6cm) trained females completed the study using four visits. Visit one acted as a familiarization visit and visits 2-4 involved two randomized conditions, each with a 10min washout period between conditions. WBV was administered on a Power plate tri-axial platform with a frequency of 30Hz, an amplitude of 2-4mm while performing four bouts of 30s of quarter squats. WBV was followed by 3 countermovement vertical jump (CMJ) with one of five different rest intervals; 0s, 30s, 1min, 2min, 4min. A non-vibration control and collapsed maximum condition were also incorporated. Dependent variables of interest are rate of force development (RFD) and relative ground reaction force (rGRF). RESULTS: Difference in RFD and rGRF were analyzed with a 2x7 (training status by condition) mixed factor ANOVA. There were no significant (>0.05) group differences, therefore groups were collapsed. No significant (>0.05) interaction of training status by condition was found for RFD or rGRF. There was a significant (<0.05) main effect for both RFD and rGRF. This was followed up with a least significant difference (LSD) pairwise comparison demonstrating that collapsed maximum values, regardless of rest interval, were significantly (<0.05) greater than the control condition in both RFD and rGRF. CONCLUSION: This indicates that both varsity and recreationally trained individuals are positively influenced by whole-body vibration exposure. However, improvements are seen following different rest intervals suggesting strong individual differences in optimal rest times. PRACTICAL APPLICATION: Coaches and practitioners should test individuals optimal rest time for optimal performance measures to ensure full jumping performance capabilities.
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Effect of Cluster Sets on Plyometric Jump Performance
S. Moreno1, L. E. Brown1, J. W. Coburn2, D. A. Judelson1
1Center for Sport Performance, California State University, Fullerton, CA

*Award Eligible - Outstanding Master’s Student Poster Presentation

Purpose: Many sport coaches utilize plyometric training to develop the efficiency of an athlete’s stretch-shortening cycle. Knowing the importance of this mechanism, it is imperative that an optimal plyometric program design is administered by coaches. Cluster sets may allow for enhanced power production due to recovery of energy substrates. Therefore, the purpose of this study was to determine the effect of cluster sets vs. traditional sets on plyometric jump power (PW), ground reaction force (GRF), take-off velocity (TOV), and jump height (JH).

Methods: Twenty-six recreationally trained men gave University approved informed consent then completed three testing sessions (7 days apart), involving repeated body-weight plyometric jumps with hands on hips for three different plyometric set configurations: traditional (2 sets of 10 with 90 seconds rest), Cluster 1 (4 sets of 5 with 30 seconds rest), and Cluster 2 (10 sets of 2 with 10 seconds rest). All jumps were performed on a force plate sampling at 1000 Hz and analyzed with custom software. Results: GRF results demonstrated no interaction or main effect for condition, but there was a significant (p < .05) main effect for repetition, where repetition 1 was significantly less than repetitions 3-5, 7-10, 12-15, and 17-20. For TOV, PW, and JH, there were significant interactions.

Conclusions: Cluster sets allow for a greater maintenance of PW, TOV, and JH when performing repeated plyometric jumps. The 2x10 condition used a work to rest ratio of 1.9, which allowed for near-complete recovery, unlike the 4x5 and 10x2 conditions. Also, there were substantial decreases in power after the third and fifth repetitions of the 2x10 and 4x5 conditions, respectively. However, the traditional set was the only configuration that showed significantly greater jump heights across repetitions. Practical applications: Therefore, one should execute no more than 5 repetitions to avoid fatigue, but greater than 2 repetitions to elicit the large eccentric loads derived from repetitive jumps. Overall, coaches should have their athletes perform 3-5 jumps with 27 and 45 seconds rest, respectively.

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High Intensity Interval Training Has Positive Effects on Skeletal Muscle Hypertrophy, Power, and On-Ice Performance
1University of Tampa Human Performance Lab, 2Laboratory of Neuromuscular Adaptations to Strength Training, School of Physical Education and Sport, University of Sao Paulo

*Award Eligible - Outstanding Doctoral Student Poster Presentation

Introduction and Objective: Research has shown that high intensity interval training (HIIT) produces greater improvements in anaerobic power, larger increases in aerobic capacity, and higher reductions in body fat despite significant reductions in training volume compared to moderate intensity, continuous endurance exercise (traditional). HIIT has also been demonstrated through research on HIIT, very few studies have looked at the practical applications of interval training on performance in sport. Specifically, no study has ever sought to investigate the effects of HIIT on measures of skeletal muscle hypertrophy, body composition, power, and on-ice performance in hockey players. Therefore, our purpose was to investigate the effects of a 4-week periodized HIIT training program using the Wingate Anaerobic Test (WanT) on measures of skeletal muscle hypertrophy, body composition, power, and on-ice performance in collegiate hockey players.

Methods: Twenty-four hockey players from The University of Tampa men’s club hockey team aged 19.6 ± 1.3 years, 180.0 ± 7.0 cm, 79.9 ± 8.3 kg, and a BMI of 24.7 ± 2.5 with at least three continuous years of hockey experience participated in the study. The participants were randomly assigned to either a traditional or interval group during a four week training program in which they trained twice per week. The traditional group performed continuous moderate intensity cycling for 45-60 minutes per session at an intensity that was 65% of their heart rate reserve. The interval group was involved in a periodized HIIT program in which participants performed 4-10 sets of WanT at an intensity of 7.5-10% of body weight with 2-4 minutes rest in between sets. Participants performed three on-ice measures, which included 6 x 9 m stops, a 33 m sprint test, and a 127 m endurance test. In addition, participants’ quadriceps muscle thickness, lean body mass (LBM), WanT peak power, and WanT average power were all assessed pre- and post-training. A repeated measures ANOVA was used to determine differences between groups, and a Tukey post-hoc analysis was used to locate differences. Results: Groups differed largely in terms of average training volume per week (27.3 min•week-1 vs. 105 min•week-1). There were no significant training effects on LBM and body fat percentage. However, Δ quadriceps muscle thickness significantly increased in the interval group compared to the traditional group (2.1±1.4% vs. -1.9±1.2%, p<0.01). In addition, there were significant group x time effects for both Δ peak power (p < 0.003) and Δ average power (p < 0.02) in which the interval group had greater values compared to traditional. While there were no training effects for the Δ 6 x 9 m stops (p > 0.13), there was a trend for faster Δ endurance test time to completion (p=0.08) and a significantly faster sprint test (p=0.02) time to completion for the interval group. Conclusion: These results indicate that HIIT may be utilized by athletes in order to elicit improvements in skeletal muscle hypertrophy and power. Moreover, these changes in skeletal muscle mass and power can be used in order to improve performance in a sport-specific setting. Therefore, a periodized, HIIT program is a time efficient strategy that can be utilized by coaches and strength and conditioning practitioners in order to improve markers of skeletal muscle hypertrophy, power, and on-ice performance in hockey players.

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Positional Comparison of Reactive Strength Index in High School Baseball Players
1University of Houston, Clear Lake, Department of Clinical, Health and Applied Sciences, Human Performance Laboratory

*Award Eligible - Outstanding Master’s Student Poster Presentation

The ability to generate maximum force in minimal time is a requisite in most sports. Reactive strength index (RSI) is a measure of explosive strength and is computed as the ratio of ground contact time (GCT) and vertical jump height (VJH). Previous research indicates that it may be a predictor of peak force and power capabilities. It may be an efficient method to determine general athletic ability, especially when time and equipment are constrained. Purpose: To quantify vertical jump (VJ) kinetics and RSI from depth box jumps in high school baseball players and determine differences between playing positions. Methods:
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POWER DEVELOPMENT COMPARISONS BETWEEN POWER CLEAN VARIATIONS AT DIFFERENT RELATIVE LOADS

T. J. Suchomel1, G. A. Wright2

1East Tennessee State University, 2University of Wisconsin-La Crosse

Exercise and load selection is vital to strength training programs. When implementing the power clean and its variations, there is no exception. Despite being commonly used exercises, little research has compared the power development between power clean variations. PURPOSE: To compare the peak power (PP) produced by power clean variations at different relative loads.

METHODS: Subjects included 17 athletic men with a minimum of 2 years of training experience with the hang clean (HC) but no previous competitive lifting experience. A one-way ANOVA was used to determine differences between playing positions in VJPP, RPSS, RSIS, and RI46. RESULTS: There were no significant differences (p=0.53) in VJPP between HC (66.17 ± 41.4 W), RPSS (52.5 ± 7.3 W), IF (55.89 ± 7.3 W), and OF (57.99 ± 4.5 W). Likewise, RSIS (p=0.47) values between HC (0.71 ± 0.22 cm.msec^-1) and CAT (0.67 ± 0.21 cm.msec^-1) and IF (0.88 ± 0.20 cm.msec^-1). Finally, RI46 (p=0.62) values also showed no difference between HC (0.74 ± 0.29 cm.msec^-1), CAT (0.69 ± 0.22 cm.msec^-1), OF (0.86 ± 0.21 cm.msec^-1) and IF (0.88 ± 0.20 cm.msec^-1). CONCLUSIONS: General athletic ability as measured using RS1 and VJ kinetics are similar between playing positions in this sample of high school baseball players. This could be attributed to lack of or varied physical and athletic maturity in these young athletes. PRACTICAL APPLICATIONS: RS1 may be a time efficient tool for measuring athletic abilities in sport settings. Research is needed to determine differences amongst elite levels athletes and whether RS1 scores correlate to sport specific skills such as base running speed, agility, and reactive quickness.

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CHANGES IN MEDIAL GASTROCNEMIUS MUSCLE-TENDON INTERACTION WITH AN INCREASE IN MOVEMENT FREQUENCY

J. J. McMahon1, S. J. Pearson1, P. Comfort1

1University of Salford

Tendons account for the majority of muscle-tendon unit (MTU) lengthening and shortening during stretch-shorten cycle (SSC) movements, which allows muscles to operate at more effective velocities for producing large forces. It is unknown, however, how muscle-tendon interaction changes with an increase in SSC movement velocity. PURPOSE: To determine medial gastrocnemius (MG) muscle-tendon interaction across a range of movement velocities in order to inform plyometric training practice. METHODS: Resistance trained males (n=11, 270.7 ± 8.4 years, 180.8 ± 5.8 cm, 86.3 ± 10.2 kg) performed three single-leg hopping trials on an inclined sledge at 2.0, 2.5 and 3.0 Hz in a randomized and balanced order. Three-dimensional motion analysis, ultrasonography of MG and ground reaction forces were collected. For each trial, five consecutive hops performed within ±5% of the prescribed frequencies were analyzed. Sagittal plane joint angles and moments were determined via a combination of motion data, force data and inverse dynamics. Ankle stiffness was calculated as the ratio of peak joint moment (relative to body mass) to peak joint angular displacement. MG muscle-tendon unit (MTU) length was determined as a function of shank segment length and joint angle data. MG muscle length was calculated as MG fascicle length multiplied by the cosine of the pennation angle. MG tendon length was determined by subtracting MG muscle length from MG MTU length. The elongation and shortening phase for each component of the MTU were determined based on the peak MTU elongation during the contact phase. A Repeated Measures ANOVA with Bonferroni post-hoc analysis was used to compare mean differences between frequencies (p=0.05). RESULTS: There were significant (p<0.01) decreases in contact time (279 ± 19 ms vs. 235 ± 19 ms vs. 212 ± 15 ms) and hop height (6.3 ± 1.2 cm vs. 3.5 ± 0.9 cm vs. 1.9 ± 0.4 cm) as frequency increased. In contrast there were significant (p<0.01) increases in ankle stiffness (0.18 ± 0.03 Nm/kg/deg vs. 0.29 ± 0.05 Nm/kg/deg vs. 0.40 ± 0.07 Nm/kg/deg) as frequency increased. The MG muscle lengthened during the landing phase of the hops at 2.0 Hz (3.2 ± 0.8 mm), however, it shortened at 2.5 Hz (-0.6 ± -0.2 mm) and at 3.0 Hz (-1.3 ± -0.4 mm), resulting in a significant (p<0.01) difference between frequencies. The MG muscle shortened significantly (p<0.01) more during the concentric phase of the hops at 2.0 Hz (6.5 ± 1.2 mm) compared to both 2.5 (2.3 ± 0.7 mm) and 3.0 Hz (2.8 ± 0.7 mm) with no significant difference in shortening between the two higher frequencies. Both MG tendon (19.1 ± 2.3 mm vs. 15.1 ± 1.7 mm vs. 11.0 ± 1.9 mm) and MG MTU (22.3 ± 2.6 mm vs. 14.6 ± 2.0 mm vs. 9.8 ± 2.1 mm) lengthening and shortening (MG tendon: 215.3 ± 3.3 mm vs. 170.3 ± 2.4 mm vs. 109.0 ± 3.0 mm; MG MTU: 280.2 ± 3.2 mm vs. 193.2 ± 2.7 mm vs. 137.0 ± 3.0 mm) significantly (p<0.01) decreased as frequency increased. CONCLUSIONS: The MG tendon comprised the majority of MTU lengthening and shortening at the higher movement velocities (i.e. ≥2.5 Hz). PRACTICAL APPLICATIONS: Performing SSC movements at higher velocities mainly trains the series-elastic component, whereas the neuromuscular component is trained more at lower velocities. This study was funded by the NSCA Foundation.
EFFECT OF WEIGHTED IMPLEMENT TRAINING ON BAT VELOCITY OF HIGH SCHOOL BASEBALL PLAYERS: A PILOT STUDY

D. Szymanski1, T. Donahue1, W. Tolbert2, B. Stover3, A. Elumalai1, M. Greenwood2
1Louisiana Tech University, 2Texas A&M University

Success in hitting a baseball is greatly dependent upon augmenting bat velocity (BV). Currently several weighted devices on the market claim to increase BV after training. PURPOSE: To examine the effects of resistance training on BV of Louisiana high school baseball players using a weighted swing implement. METHODS: Twelve high school baseball players (age = 15.8 ± 0.94 yr, ht = 170.7 ± 6.7 cm, wt = 70.0 ± 16.7 kg, %BF = 14.8 ± 8.4%) volunteered for this study. Prior to training, subjects had 3 familiarization sessions with the weighted hitting device, taking 3 x 10 swings per day. On the testing day, participants took 2 x 10 warm-up swings and hit tennis balls off a batting. Then participants took 10 swings (20 seconds rest between swings) with a modified test-bat in their normal batting stance at a baseball resting on a batting tee. BV was measured by a Setpro-SPRITS. After the pre-training testing session, participants were randomly assigned to 1 of 2 training groups. The treatment group (n = 6) took swings at a 2:1 volume ratio of the weighted and standard bat while hitting tennis balls off a batting tee. One-third of their total swings (1020 swings) were taken with a 30.5 in, 48 oz weighted device, another 1/3rd of their swings (1020 swings) were taken with a 30.5 in, 64 oz weighted device, and the final 1/3rd of their swings (1020 swings) were taken with their standard game bat (33 in, 30 oz) 3x/wk for 8 weeks during the off season. The control group (n = 6) swung their standard game bat 3x/wk for 8 weeks for the same total number of swings (3060 swings) as the treatment group while also hitting tennis balls off a batting tee during the off season. To determine differences between or within groups, repeated measures analyses of variance were conducted on BV. Independent samples t-tests were also conducted to compare the 2 groups in terms of percent (%) change (post-BV minus pre-BV divided by post-BV multiplied by 100) of BV (p < 0.05). RESULTS: Repeated measures ANOVA on BV (m/s) indicated that there were statistically significant differences between the groups; however, both groups made significant improvements (treatment p < 0.001 and control p < 0.05) in BV after 8 wk of training. Furthermore, significant differences, t (10) = -2.52, p = 0.04, in % change in BV, pre to post-training, were observed between the 2 groups. CONCLUSIONS: Findings suggest that swinging either a standard baseball bat or a combination of weighted devices and standard baseball bat in a 2:1 weighted to standard bat volume ratio significantly improve BV (5.71 ± 10.42%) after 8 weeks of training for high school baseball players. Furthermore, % change increased significantly more (4.71%) after swinging the weighted devices and standard baseball bat compared to the standard baseball bat alone. PRACTICAL APPLICATIONS: Since both swing protocols produced significant improvements in BV in high school baseball players, high school coaches can choose which device and program to implement. For best results for high school players, it is recommended to use the weighted devices and swing protocol during the off season when players are not competing during the in-season since the volume of total swings were taken only from a batting tee and not during live batting practice which is a very important aspect of being a successful hitter. ACKNOWLEDGEMENTS: Weighted devices were provided by Bats Limited (Hewitt, TX, USA).

PRELIMINARY INVESTIGATION INTO THE SUITABILITY OF AN ALTERNATIVE FORM OF COUNTERMOVEMENT JUMP TEST ANALYSIS FOR ATHLETE TRAINING MONITORING.

R. Gathercole1, B. Sporer2, T. Stellingwerf2, G. Sleivert2
1University of Victoria, BC, Canada/CSI-Pacific, Victoria, BC, Canada/Sport Innovation Centre, Victoria, BC, Canada, 2University of Victoria, BC, Canada/CSI-Pacific, Victoria, BC, Canada

PURPOSE: The countermovement jump (CMJ) test is an athlete monitoring tool used to examine neuromuscular (NM) function and training-effects. There is uncertainty though as to which components of CMJ performance are the most sensitive to training-induced changes in performance. Here we assess the suitability of the CMJ test to detect differences in NM function using an alternative form of CMJ analysis based on jump traces (aCMJ) compared to more typical CMJ-derived measures (tCMJ). METHODS: 5 elite snowboard athletes (2M, 3F) performed 6 CMJ tests prior to and following a structured training block (~4 mo.). CMJ was evaluated using the Ballistic Measurement System (BMS; Fitness Technology, Australia). 20 aCMJ variables, based on time, work and single points during the jump, were analysed using custom-designed software, with raw jump data extracted from the BMS. aCMJ variables (8 reported): Time: eccentric (EccT), concentric (ConT), and total jump duration (TotT), percentage of time spent eccentrically (Ecc%); Work: area under force-velocity trace (FV-AUC), total area under power-time trace (PT-AUC) divided by TotT (PT-AUC/TotT); Single-point: force at zero velocity (Fz0V). aCMJ variables: jump height (JH), peak power (PP), peak velocity (PV), peak and mean force (PF, MF). ‘Outlier’ jumps were removed using standardised procedures. Coefficients of variation (CV) were calculated for each pre and post-variable to examine whether the variability of each variable would permit detection of training-induced changes. RESULTS: Significant differences pre- to post-training (p value) were observed for aCMJ variables for time (EccT: 0.013, 0.017; TotT: 0.033, 0.030; EccT: 5.4%, 0.002), work (FV-AUC: 994N.m², 0.002; PT-AUC/TotT: +4.2watts/kg/s, 0.001) and single-point (Fz0V: +197N, 0.038). The other aCMJ and tCMJ variables were not significantly different. CONCLUSIONS: Compared to the tCMJ variables, the use of aCMJ variables appear better suited to the detection of training-induced NM changes. The results of the aCMJ variables suggest that the effects of training may be expressed as an altered CMJ movement strategy rather than an altered CMJ output (i.e. jump height, peak power). The lack of change in PT-AUC suggests that a similar amount of work was performed during the CMJ. However, the improved speed and time required to perform this work indicates an enhanced performance. PRACTICAL APPLICATIONS: These results indicate that training may affect NM strategy and the movement performed more so than end NM output. Consequently, training-induced NM effects may be more apparent through an analysis of aCMJ variables, rather than more typical CMJ variables (i.e. tCMJ).
Heart rate variability (HRV) is a non-invasive measure of cardiovascular autonomic modulation and is growing in popularity as an important tool to monitor the physiological outcomes associated with exercise training. Researchers have suggested a strong association between body composition and HRV, though the extent of this relationship remains unclear. To date, limited research has examined the link between fat-free mass (FFM) and HRV. PURPOSE: The purpose of this study was to determine the extent of variation in HRV that could be accounted for by FFM and fat-mass (FM). METHODS: Fifty adult men (22 ± 3 yr.) participated in this study. Each subject rested in the supine position while HRV was recorded for a 5-min period. To measure HRV, the frequency domain was used to transform the electrocardiogram into a power spectrum. The normalized area under the curve was used to assess the relationship between HRV (i.e., high-frequency, HF) and body composition (i.e., FM and FFM) parameters. RESULTS: Data are presented as means and SD. HF 40.0 ± 19.2%, FM 9.9 ± 4.8 kg, and FFM 72.6 ± 7.6 kg, respectively. The results indicated that HF significantly correlated with FFM (0.32, P < 0.05), but not with FM (-0.18, P > 0.05). CONCLUSIONS: These data suggest a significant relationship between FFM and HRV. Interestingly, a significant correlation between FM and HRV was not present. PRACTICAL APPLICATIONS: While the results demonstrate a significant relationship between FFM and HRV, more research is needed. However, clinicians should continue to emphasize resistance training as part of a well-balanced program as a means to increase FFM and possibly improve HRV.

Poster: 41
RELATIONSHIPS BETWEEN ATHLETIC PERFORMANCE AND MEASUREMENTS RELATED TO CORE STABILITY IN YOUNG ATHLETES
A. Waldhelm1, L. Li2, D. Heard1
1University of the Incarnate Word, 2Georgia Southern University, 3Athletic Republic, Covington, LA

PURPOSE: Core stability training is a common intervention used to help improve athletic performance. It is hypothesized, a strong and stable core will allow for efficient transfer of power from the ground through the trunk and to the upper extremities which will improve sports performance. Unfortunately, few studies have been performed to investigate the relationship between athletic performance and core stability. Therefore, the purpose of our study was to identify relationships between athletic performance tests and measurements associated with core stability (MCS) amongst young athletes. METHODS: Twenty-one individuals (12 F / 9 M, 13.4 ± 1.2yr) who had not suffered an orthopedic injury in the past year were recruited from a local sports training facility. The participants provided informed consent as approved by the local Institutional Review Board, prior to testing. Nine athletic performance tests included the vertical jump, 20- yd pro shuttle run, DSG 1234, DSG 1432, bilateral single leg long jump (SLLJ), 10 and 20- yd dash, and the Cunningham and Faulkner anaerobic capacity test. The 21 MACS were grouped into five different categories related to strength, muscular endurance, flexibility, motor control and function. One-tailed Pearson correlation coefficient (CC) analyses were performed to estimate the relationship between athletic performance tests and MACS. RESULTS: Overall, the relationships between the athletic performance tests and the MACS ranged from low, r = .002, to high, r = .761 with the strongest relationship observed with right hip abduction strength. CCs ranged from r = .034 to r = .682 between the shuttle run and the MACS, and the highest correlation was with the right single leg side plank. CCs between the DSG 1234 and the MACS ranged from r = .014 to r = .575. Informative correlations are presented between the vertical jump and MACS ranged from r = .047 to r = .559, and the strongest relationship observed with right hip abduction strength. CCs ranged from r = .034 to r = .682 between the shuttle run and the MACS, and the highest correlation was with the right single leg side plank. CCs between the DSG 1234 and the MACS ranged from r = .014 to r = .575. Right SLLJ and MACS had CCs ranging from r = .105 to r = .728 with right hip abduction strength having the strongest relationship. CCs ranged from r = .039 to r = .533 between the left SLLJ and MACS, with right single leg side plank having the strongest relationship. CCs ranging from r = -.006 to r = .659 between the 10- yd dash and the MACS, and the strongest relationship was associated with the left isometric single leg press. The 20- yd dash had only one significant relationship, right hip adduction strength, and CCs ranged from r = .005 to r = -.545. Last, relationships between the Cunningham and Falkner test, which only had 10 participants, and the MACS ranged from r = -.002 to r = .261 with the strongest relationship occurring with trunk extensor endurance. CONCLUSIONS: The overall relationships between the athletic performance tests and the MACS ranged from very low to high correlations and varied between performance tests. PRACTICAL APPLICATIONS: The results indicate different components of core stability may play a role in different athletic performance of young athletes. Therefore, exercises which improve core stability should be included in a sports training program.

Poster: 42
REPEATABILITY OF 3D MARKERLESS MOTION CAPTURE AND HOW IT COULD AFFECT BETWEEN-SESSION TESTING
D. Wassom1, A. C. Fry1, N. Moodie1
1Dynamic Athletics, 2The University of Kansas, Human Performance Laboratory, Lawrence, KS, 3Rockhurst University

PURPOSE: When tracking people using motion capture technology it is important to know that when test you will have repeatable results. It has been shown that maker based motion capture has variability between session testing with a large part of the problem due to marker placement error. Being able to remove that variable potentially could help between-session testing. The purpose of this study was to test the repeatability a 3D markerless motion capture system. METHODS: one subject did 16 controlled squats in the 3D markerless motion capture space while also being videoed. A standardized box was used to control the depth of the squat as well as standardized distances to the box and distance between feet. Collections were done on two separate days and additionally before each take, the subject’s biomechanical skeleton was recreated. The software specifically identified the peak joint angle of the squat as the indicator of when values were measured. The subject paused at the bottom of the squat before rising to allow for proper time for videos to be taken. The left knee angle was calculated at that point. The repeatability of the 3D markerless motion capture system was then compared to an industry accepted video standard. RESULTS: Coefficient of multiple determinations (CMD) was used to statistically evaluate the 3D Markerless motion capture system and video. The 3D markerless motion capture system showed an R2 equal to (.7712), while video had an R2 equal to (.7692). When comparing 3D markerless motion capture to video the R2 value was (.9808). CONCLUSION: 3D Markerless motion capture is statistically repeatable, and is as repeatable as an industry standard. Further research needs to be done to compare 3D markerless motion capture to 3D marker motion capture. PRACTICAL APPLICATION: 3D markerless motion capture has the potential to remove human error from multi-session testing. With the ultimate goal of potentially being able to improve repeatability across multi location data sets.

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INFRASPINATUS STRENGTH ASSESSMENT: CORRELATIONS BETWEEN FORCE PRODUCTION AND EMG ACTIVITY
D. Witt1, N. Talbott1, E. Thompson1, S. Belen1
1University of Cincinnati

Purpose: Assessment of the strength of the infraspinatus is a common component of the examination of athletes with shoulder pain and dysfunction. Important for stabilizing the humeral head during overhead movements and for externally rotating the humerus during shoulder elevation, the infraspinatus is active during multiple motions that are required by athletes during training and competition. One common method for testing and eventually exercising the infraspinatus is resisting external rotation with the arm at the side. For some athletes, the infraspinatus may also be exercised and assessed with the arm elevated to ninety degrees, a position more closely related to the overhead requirements of various sports. Determining the force production and the related electrical activity of the infraspinatus in these two positions will provide information that can assist in the identification of the most appropriate methods for maximizing force in this muscle. The purpose of this study is to determine if the infraspinatus force production and electrical activity significantly change when the shoulder is moved from a neutral position to a position of ninety degrees of elevation in the scapular plane (scaption). Methods: Ten shoulders from five healthy subjects were tested using electromyography (EMG) and dynamometry. Surface electrodes were applied to the infraspinatus two inches inferior to the mid- third of the spine of the scapula. With the subject sitting, the shoulder was placed in a neutral position and resting EMG recorded. Measurements were repeated as the subject performed a maximal isometric external rotation contraction against a stable dynamometer and, after resting, a maximal isometric external rotation contraction against manual resistance applied through a hand held dynamometer. Force was recorded during each contraction and the corresponding EMG activity stored. The
process was repeated with the shoulder in a position of 90 degrees of elevation in the scapular plane. All measurements and images were taken three times. EMG data was filtered and rectified with mean and maximal activity recorded during the mid three seconds of the contraction. **Results:** Force production was significantly greater in the neutral position than in a position of 90 degrees of scapulation. However, EMG activity was not significantly different in the two test positions. During maximal resistance against stable resistance with the arm in a neutral position, mean EMG activity of all subjects averaged .364mV (SD=.14) which was not significantly different from the mean EMG activity of .280mV (SD=.09) recorded in the elevated position. Force was not significantly correlated with EMG activity in either position. **Conclusions:** The application of maximal force significantly changes the EMG activity, but the direction of the change is not significantly related to changes in EMG activity. **Practical Applications:** If maximal force production is a goal, it would be more advantageous to exercise the infraspinatus in a neutral position than in a position of scapulation. Monitoring infraspinatus EMG activity is not supported as a measurement of maximal force production.

**Poster: 44**
**INFLUENCE OF OPPOSITION ON GAME PLAY INTENSITY DURING WOMENS NATIONAL LEAGUE FIELD HOCKEY**
A. White¹, N. MacFarlane¹
¹University of Glasgow

**INTRODUCTION:** Anecdotally, teams are thought to drop the intensity of game play when competing against lower level opposition and vice versa. This study aims to demonstrate whether this is true in national league field hockey. **METHODS:** A mid-placed team in the first division of a national field hockey league was selected for this observational study. 16 female field hockey players (age range 19-35 yrs) were studied (giving seventy-eight player analyses over eight games). Playing activity was recorded using a 5-Hz global positioning system. Markers of distance covered, meterage, player load, efforts in speed zones, percentage time in speed zones and distance covered in speed zones were compared in competitive matches. League position after 8 matches in the current season determined opposition team ranking. **RESULTS:** This study shows Pearson correlation coefficient and regressions analysis results for all parameters. Distance, meterage and player load were all negatively correlated with opposition ranking. **Conclusions:** The outcomes of interest were the rate of perceived exertion, heart rate, grams of carbohydrates and fat burned per minute, and total calories burned per minute. **RESULTS:** Regarding rate of perceived exertion, HRP (16.3 +/- 1.3) was significantly (p<0.05) higher than treadmill (11.4 +/- 1.0), elliptical (15.1 +/- 1.2) and weights (13.1 +/- 2.3). Heart rate was significantly (p<0.05) higher in HRP (156.8 +/- 15.5 bpm) than weights (107.5 +/- 18.3 bpm), but not significantly different compared to treadmill (132.6 +/- 5.1 bpm) or elliptical (132.2 +/- 4.4 bpm). The average grams of carbohydrate burned were significantly (p<0.05) higher in HRP (1.7 +/- 0.4 g/min), compared to treadmill (1.2 +/- 0.3 g/min) and weights (1.0 +/- 0.3 g/min), but not significantly different than elliptical (1.3 +/- 0.3 g/min). The grams of fat burned per minute were significantly (p<0.05) higher in HRP (0.09 +/- 0.03 g/min) than weights (0.2 +/- 0.01 g/min), but were significantly (p<0.05) lower than treadmill (0.3 +/- 0.1 g/min). Total calories burned per minute were significantly (p<0.05) higher in HRP (7.6 +/- 1.4 kcal/min) than treadmill (4.3 +/- 1.2 kcal/min), but not significantly different compared to treadmill (7.5 +/- 0.8 kcal/min) and elliptical (7.9 +/- 0.8 kcal/min). **Conclusions:** Though the rate of perceived exertion was increased using an HRP, heart rate, grams of carbohydrates, grams of fat and total calories were not significantly different compared to running or elliptical training lasting around 30 minutes. **PRACTICAL APPLICATIONS:** An exercise protocol using a hydraulic resistance system may provide cardiovascular benefits similar to a typical cardio workout, as well as the skeletal and muscular benefits of a typical weight training protocol. **ACKNOWLEDGEMENTS:** This investigation was supported by funding from Surge Performance Training Inc.

**Poster: 46**
**LONGITUDINAL TRACKING OF MAXIMUM SQUAT, BENCH PRESS, AND POWER CLEAN PERFORMANCE IN MALE HIGH SCHOOL ATHLETES**
J. A. Bush¹, J. McFarland², R. Herman³, N. A. Ratamess¹, J. Kang¹, S. Klei¹, A. D. Faigenbaum¹
¹The College of New Jersey, ²Hillsborough High School, NJ

A growing number of young athletes are resistance training in school- and community-based programs. While regular participation in age-related resistance training programs can enhance muscular fitness, only limited data are available on longitudinal changes in strength and power in adolescent athletes. Moreover, the use of 1 repetition maximum (RM) testing to assess muscular fitness in young athletes remains contentious. **PURPOSE:** To assess the maximal muscular fitness profile of healthy adolescent athletes who participated in a strength and conditioning program over a 3-yr period. **METHODS:** Subjects participated in a periodized strength and conditioning program about 3 to 4 times/wk for 30 wks/year. The supervised training program focused on enhancing technical proficiency on various weightlifting movements, plyometric drills and resistance training exercises, and the training intensity gradually progressed to 70-95% 1 RM depending on the phase of the training cycle and sport participation. Dependent variables of strength and power over Y1-Y3 were analyzed using a GLM regression with pair-wise comparisons across Y1-Y3. **RESULTS:** Youths were considered of good health. There was a significant (p<0.00) increase (+19%, +13%) in 1 RM bench press from Y1-Y3 & Y2-Y3 respectively with no significant change from Y1-Y2 (p=0.06). There was a significant (p=0.02) increase (+16%, +15%) in 1 RM squat from Y1-Y3 & Y2-Y3, respectively, with no change from Y1-Y2. There was a significant (p<0.01) increase (+7%, +17%, 10%) in 1 RM power clean from Y1-Y2, Y1-Y3, & Y2-Y3, respectively. No injuries resulting from 1RM testing or resistance training were reported. **CONCLUSION:** Regular participation in a long-term strength and conditioning program that includes periodic 1 RM assessments can be a safe and effective activity for adolescent athletes provided the program is characterized by qualified instruction and periodized training. While there was a significant increase in strength and power over the 3-year training period, performance gains were most apparent during the second and third year of training which followed the initial phase of training that focused on developing movement pattern efficiency. **Data from this longitudinal study provide useful information for youth coaches and pediatrics researchers who monitor training-induced changes in muscular fitness and design long-term resistance training programs for young athletes.
**Poster: 47**

CONSTRUCT VALIDITY OF TRADITIONAL AND ALTERNATIVE METHODS OF SCORING PULL-UPS

J. Clemons1, C. Thompson2, J. Guilloy3, E. Roberts1, K. Buteau2

1Department of Kinesiology, University of Louisiana at Lafayette, 2University of Louisiana at Lafayette, 3University of Louisiana at Lafayette

**PURPOSE:** The purpose of this investigation was to examine the construct validity of three different methods of scoring pull-ups (PU): the traditional method of counting only full-range of motion pull-ups (ROM), the modified pull-up with a mouthpiece (PM), and the modified pull-up with a mouthpiece and ROM (ROM, mouthpiece). Pull-up scores used the elbow angle as a reference but without a goniometer, and PU work (NM). **METHODS:** Seventeen college age males (23.5 yrs.±7.91) enrolled in university weight training classes volunteered to participate. The fractional PU method credited participants on the last partial PU by awarding 0.25 points if an estimated elbow angle < 180° but > 95° was reached. A half point (0.5) was given for elbow angles between 95° and 85° of elbow flexion (i.e., 90° ± 5°) and 0.75 points if elbow angles, at the point of failure, were less than 85° but short of lifting the chin above the bar. Four independent testers scored the fractional PU to determine if inter-rater reliability might be achieved. Only one PU test was necessary in that traditional and fractional PU scores were derived simultaneously. Both traditional and fractional work were computed using the formula: PU Work in NM = # pull-ups · vertical distance in m · body mass - 9.81. Pearson correlation was used to compare scores acquired using each method to three commonly accepted criterion measures: absolute strength (i.e., a one repetition maximum [IRM] lat pull down), relative strength (1RM · Body Mass-1) and relative muscle endurance (i.e., repetitions to failure at 75% of the IRM). Inter-rater reliability for the fractional method was examined using four independent testers with data analyzed using Intraclass Correlation (ICC). The alternative hypotheses to the null were two tailed at a Bonferroni adjusted alpha level of 0.0042 based on 12 relationships of interest. The PU, IRM and 75% IRM tests were separated by no less than 4 days and no more than a week. The 1RM attempts were preceded by two unsupervised sets of 50% and 60-80% of a participant estimated IRM. Independent warm-ups were used for the remaining tests. **RESULTS:** Inter-rater reliability for the fractional scoring method was excellent (ICC = 0.999). The strongest relationships were between the 1RM and traditional and fractional scoring methods (r = 0.28, p = 0.27); however, both correlated strongly with relative strength (i.e., IRM · Body Mass-1) and relative muscle endurance (i.e., repetitions to failure at 75% of the IRM). *PRACTICAL APPLICATIONS:* Properly scored and interpreted, PU tests can be valid estimates of either absolute and/or relative strength.

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**Poster: 48**

PERFORMANCE MOUTHPIECE IMPROVES X-FACTOR IN YOUNG AND OLD GOLFERS

W. D. Dudgeon1, D. Garner2, E. McDivitt3, B. Hepner1, T. P. Scheett2

1The Citadel, 2College of Charleston

**Introduction:** Jim McLean’s “X-Factor” is a metric used by golfers and instructors to gauge separation of the hips and shoulders at the top of the backswing. It has been shown that a greater X-Factor results in greater club head velocity. Fitness components such as flexibility, stability, and core strength are the major contributing factors in loading certain torso muscles to maximize the torso-pelvic separation. The Armourbute lower mouthpiece (MP) has been shown to positively affect many aspects of human performance, thus it may influence the X-Factor. **Purpose:** The purpose of this study was to examine the effectiveness of an Armourbute MP use on the X-Factor. **Methods:** Ten collegiate male golfers (20.9±0.8 yrs.) and 14 recreational golfers (30.6±7.0 yrs.) performed 10 drives (5 with and 5 without MP) with random treatment order while wearing the iClub Motion Capture System which was integrated to a PC providing results from each swing. **Results:** The collegiate golfers had significant differences in X-factor (p=0.02, 418.6 ±/− 75, MP vs 40.4 ±/− 75, No MP), Max X-Factor (p=0.03, 45.6 ±/− 91, MP vs 43.9 ±/− 8.5, No MP), and Max Hip Speed (p=0.002, 461.0 ±/− 46.7, MP vs 449.9 ±/− 43.3, No MP). Only with Total Hip Rotation (p=0.056, 108.8 ±/− 14.2, MP vs 106.9 ±/− 13.9, No MP) was there a trend for significance with the recreational group. There were no differences in either group individually or combined regarding Total Shoulder Rotation, Hip Rotation at Top, and Max Shoulder Speed. **Conclusion:** Data suggests that the mouthpiece may be helpful to improve parameters of golf performance in collegiate athletes.

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**Poster: 49**

COMPARISON OF A HYDRAULIC RESISTANCE TRAINING SYSTEM AND TYPICAL MUSCULAR STRENGTH AND CARDIOVASCULAR TRAINING PROTOCOLS IN MEN

P. Falcone1, L. Carson1, C. Tail1, M. Kim1, J. Moon1

1MusclePharm Sports Science Center Research Institute

Strength training and cardiovascular training are two essential components of a well-rounded exercise regimen; however, these two types of exercise are traditionally performed separately. Some new technologies have sought to provide a cardiovascular benefit while using resistance training methods. **PURPOSE:** The purpose of this study was to determine the caloric expenditure and anaerobic demand during a 30 minute workout using a hydraulic resistance system (HRS), compared to a standard strength training session and typical cardiovascular training sessions lasting around 30 minutes. **METHODS:** Using a repeated within-subjects design, nine recreationally trained men (25±/−7 years; 181.6±/−7.6 cm; 86.6±/−7.5 kg) completed four exercise sessions lasting around 30 minutes each. Metabolic data were measured with a mobile metabolic system. On the first day of testing, subjects ran on a treadmill at 70% maximum heart rate for 30 minutes. Before and after the running session, subjects performed a moderate warm-up and identical cool-down session on two reaction time devices. Subjects were also tested for their IRM values and waist circumference with the HRS (Surge 560). The next three sessions consisted of the same warm-up and cool-down sessions, as well as these three training sessions for 30 minutes in the following order: bike at 70% maximum heart rate, HRS, and strength training with 3 sets of 6 exercises at 70% IRM. Food intake and exercise were identical 48 hours prior to each testing session. Variables analyzed were heart rate, rate of perceived exertion, calories burned, fat grams, and carbohydrate grams. RESULTS: The HRS significantly (p<0.05) increased calories burned per minute (12.62±/−2.36 kcal/min) compared to treadmill (9.48±/−1.30 kcal/min), bike (9.23±/−1.25 kcal/min), and weights (8.83±/−1.55 kcal/min). Heart rate also significantly increased (p<0.05) on the HRS (156.0±/−9.3 bpm) compared to treadmill (137.2±/−4.6 bpm), bike (138.1±/−5.9 bpm) and weights (137.7±/−15.8 bpm). The rate of perceived exertion was significantly (p<0.05) higher with the HRS (15.8±/−1.9) compared to the treadmill (9.9±/−1.8), bike (10.9±/−1.2) and weights (12.8±/−2.3). The grams of carbohydrate burned per minute were significantly (p<0.05) higher with the HRS (2.98±/−0.59 g/min) compared to the treadmill (1.74±/−0.44 g/min), bike (1.97±/−0.45 g/min) and weights (2.15±/−0.40 g/min). **CONCLUSION:** The HRS significantly increased total calories burned, grams of carbohydrate burned, heart rate and rate of perceived exertion in men, compared to typical cardio workouts (running or cycling) and a weight training lasting around 30 minutes. **PRACTICAL APPLICATIONS:** An exercise protocol using a hydraulic resistance system may provide the cardiovascular benefits of a typical cardio workout as well as the skeletal and muscular benefits of a typical weight training protocol. **ACKNOWLEDGEMENTS:** This investigation was supported by funding from Surge Performance Training Inc.

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VALIDITY AND RELIABILITY OF CRITICAL STROKE RATE DURING UPPER-BODY EROGYMETRY ESTIMATED FROM A THREE-MINUTE ALL-OUT EXERCISE BOUT

D. H. Fukuda1, K. L. Kendall1, A. E. Smith-Ryan1, R. P. Hetrick4, M. E. Wray3, J. R. Stout4

1Creighton University, 2Georgia Southern University, 3University of North Carolina Chapel Hill, 4Fitness One, 5LifeTime Fitness, 6University of Central Florida

A three-minute “all-out” exercise test (3MT) has recently shown to provide values similar to the traditional multi-trial approach when estimating critical power during cycling and running. The purpose of this study was to examine the relationship between the 3MT and the critical power concept, which highlights the work-time relationship, has also been applied to swimming and table tennis to determine critical stroke rate (CSR), or the frequency value at which exercise can be maintained for an extended period of time with minimal fatigue. Limited research exists regarding the work-time relationship during upper body dominant exercise. Furthermore, the determination of CSR has yet to be examined during a 3MT. **PURPOSE:** To examine the validity and reliability of CSR during upper-body ergometry using a within subject, repeated measures design. **METHODS:** Fourteen recreationally active participants (mean±SD; age: 22.1±2.85yrs;
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USING THREE-MINUTE STEP TEST TO PREDICT MAXIMAL OXYGEN CONSUMPTION IN OLDER ADULTS

C. Lee1, H. Huang1, Y. Kuo1, M. Lee1, C. Cheng2
1Center for General Education, National Sun Yat-sen University, 2Department of Physical Education / National Taiwan Normal University

BACKGROUND: Some studies have examined the 6-minute walk test, as a common measure in cardiovascular fitness, but few studies have investigated the 3-minute step test (3MST) and the maximal oxygen consumption (VO2max) of older adults. The purpose of this study was to examine if the 3MST is a useful tool to predict VO2max in older adults. METHODS: Forty healthy older adults (20 males and 20 females, age: 68±6 yrs) without disability, or any cognitive or cardiovascular disease were selected. Participants were instructed to step on the device platform in a step height of 20 cm for 3 min. VO2max was determined by linear regression analysis. RESULTS: The test-retest reliability of a commercially designed device for assessing VO2max was determined by the intraclass correlation coefficient (ICC), standard error of measurement (SEM), and the relative percentage error (RPE). The ICC values were 0.95 (SEM = 0.05), and RPE = 7.5%. CONCLUSION: The 3MST is a useful tool to predict VO2max in older adults. Further research is needed to determine if three minutes is the appropriate duration of all-out exercise to produce steady-state stroke rate values. PRACTICAL APPLICATIONS: The calculation of stroke rate (r = 0.36, p < 0.05), but there was not a significantly correlation between VO2max and fitness index from HR recovery after the 3MST (r = 0.18, p > 0.05). Linear regression analyses identified that 3MST can explain only 1% of the HR recovery with a moderate standard error of estimate (-4.8%); however, the different stages of heart rate during the 3MST can explain 36% and 40% variance for the VO2max with step height 20 cm and 25 cm, respectively. CONCLUSIONS: Predicting the VO2max from HR recovery after the 3MST might be a lower explanation of the variation in older adults (> 65 years), thus indicating the absence of a true physiological cause-effect relationship. PRACTICAL APPLICATIONS: We suggested that 3MST was not a good method for estimating VO2max, and increase in sample would be necessary in the future study. ACKNOWLEDGEMENTS: We would like to thank all participants for their effort in the study. The study was supported by grant of NSC100-2410-H-412-007.

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PERFORMANCE ANALYSIS OF PROFESSIONAL RUGBY UNION USING GLOBAL POSITIONING SYSTEMS AND INTEGRATED ACCELEROMETER

C. McLellan1, S. Coad1, D. Marsh1, M. Lieschke1, B. Gray1
1Bond University, 2Queenslands Reds Rugby Union

Professional Rugby Union (RU) match-play encompassing repeated bouts of high intensity exercise, frequent blunt force trauma associated with high intensity impacts impacted by players during match-play collisions that is separated by periods of low-intensity activity. Quantification of repeated high intensity running that includes rapid acceleration (>2.5 m/s²) and sprinting efforts (> 22 km/h), and repeated high intensity impacts (> 8.0 G), provides insight into the characteristics of competitive performance that can be used to examine the acute and short term post-match fatigue profile of players. Global Positioning Systems (GPS) and integrated tri-axial accelerometer are currently the predominant portable match-play analysis system used in elite Rugby to examine the neuromuscular and physiological demands of competition. PURPOSE: To determine the effect of repeated high intensity impact on high intensity running performance in elite RU match-play. METHODS: Five (5) elite RU players whom competed in the 2012 Super Rugby premiership were monitored for the regular season period of match-play using GPS receivers and integrated accelerometer presenting 55 data sets for analysis (backs n = 34, forwards n = 21). Data was categorised in 1st and 2nd halves of match-play. Correlation analyses were conducted to investigate relationships between frequency of high intensity impacts, high intensity running during each half of match-play. RESULTS: A significant negative correlation was found for high intensity impacts sustained during the 1st half of match-play and the frequency of 2nd half sprinting movements. Specifically zone 6 impacts (>10G) experienced by players during the 1st half had a negative influence on 2nd half total sprint (Zone 6) distance r = -0.42 (p < 0.05), the number of sprints r = -0.31 (p < 0.05), average sprint distance r = -0.45 (p < 0.05), and average velocity after rapid acceleration r = -0.38 (p < 0.05). No significant correlation was found between frequency of 1st half heavy impact collisions and 2nd half acceleration efforts. CONCLUSION: The present study provides insight into the high intensity nature of elite Rugby competition incorporating accelerometer and GPS technology to establish key performance indicators of match-play. The results identify significant negative impacts of repeated high intensity impacts experienced by players during collisions associated with offense and defense match-play characteristics on high intensity running and sprinting profiles during the 2nd half of match-play. PRACTICAL APPLICATIONS: Repeated blunt force trauma associated with high intensity match-play collisions are a fundamental characteristics of elite Rugby match-play. Accordingly, the influence of repeated high intensity collisions experienced by players during the 1st half of competition are likely to influence the high intensity running profile of players during the later stages of completion. Coaches and conditioning staff should therefore consider the inclusion of simulated match-play and training activities that incorporate repeated high intensity collisions to replicate aero and anaerobic energy system demands and simulate the requirements of competition to improve player preparedness and optimise on field performance.

Poster: 53

TEST-RETEST RELIABILITY OF A COMMERCIALLY DESIGNED DEVICE FOR ASSESSING SWAY INDEX DURING THE MODIFIED CLINICAL TEST OF SENSORY INTEGRATION AND BALANCE

T. B. Palmer1, M. J. Hawkey1, R. M. Thiele1, D. B. Smith1, E. C. Conchola1, B. M. Adams1, K. Akehi1, B. J. Thompson1
1Oklahoma State University

There has been a recent interest in the use of commercially designed devices for assessing sway index (SI) during the modified clinical test of sensory integration and balance (m-CTSIB). As a result, it may be of great importance to propose and examine the reliability of SI using these devices in conjunction with the m-CTSIB, so that future studies can determine the minimum sample sizes necessary for observing real differences with adequate statistical power. PURPOSE: To determine the test-retest reliability of a commercially designed device for assessing SI during the m-CTSIB. METHODS: Seventeen NCAA Division I female soccer players (mean±SD, age=19±1yr; mass=65±8kg; and height=165±3cm) participated in this investigation. Participants visited the laboratory three times, separated by 2-5 days at approximately the same time of day (±2hr). During the first visit, participants became familiar with testing procedures. During the second and third visits, participants performed two m-CTSIB assessments, with the average of the two assessments being used for data analyses. For each m-CTSIB assessment, participants removed footwear and positioned their feet on the device platform in...
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AKNOWLEDGEMENTS: Funding for this project was provided by Memorial to identify optimal behavioral interventions to reduce risk for abdominal obesity. The importance of early strength acquisition, as well as the simultaneous need for improved health and fitness in adults. This current study is one of the largest epidemiological investigations to reveal a robust association between strength capacity in adolescents and an aggregated cardiometabolic risk score. RESULTS: In both boys (n=663) and girls (n=746), (percent fat), cardiorespiratory fitness (CRF), and muscular strength capacity (normalized for body mass). RESULTS: In both boys (n=663) and girls (n=746), age, CRF, percent fat, and strength were all individually correlated with multiple risk components, as well as the overall MetScore. However, in the adjusted model it was normalized strength capacity that emerged as the best predictor of MetScore for both boys (B = -4.53; p<0.0001) and girls (B = -3.593; p<0.0001). WC was the strongest loading coefficient within the PCA-derived MetScore outcome. CONCLUSION: These findings reveal that strength-to-body mass ratio is independently associated with lower cardiometabolic risk in adolescent boys and girls. Moreover, WC was associated with all cardiometabolic risk factors and carried the strongest loading coefficient within the MetScore outcome. PRACTICAL APPLICATION: Previous research has demonstrated the value of strength training to improve cardiometabolic risk in adults. This current study is one of the largest epidemiological investigations to reveal a robust association between strength capacity in adolescents and an aggregated cardiometabolic risk profile, even after adjusting for other well-known clinical predictors, i.e., body composition and cardiopulmonary fitness. This finding serves to bolster the importance of early strength acquisition, as well as the simultaneous need to identify optimal behavioral interventions to reduce risk for abdominal obesity. ACKNOWLEDGEMENTS: Funding for this project was provided by Memorial Healthcare Foundation, Owosso, MI.

POSTER: 54
STRENGTH CAPACITY IS INDEPENDENTLY ASSOCIATED WITH LOWER CARDIOMETABOLIC RISK IN ADOLESCENTS.
M. D. Peterson, W. Salterelli, P. S. Visich, P. Gordon
University of Michigan, 2Central Michigan University, 3University of New England

POINTER: Emerging evidence has demonstrated a role for resistance training and strength preservation in the protection against cardiometabolic disease in adults. The purpose of this study was to determine the sex-specific independent association between muscular strength and cardiometabolic risk in a large cohort (n=1409) of 6th grade adolescents. METHODS: Principal component analysis (PCA) was used to determine the pattern of risk clustering and to derive a continuous aggregate score (MetScore) from the following standard cardiometabolic risk components: waist circumference (WC), fasting glucose, blood pressure, plasma triglycerides levels, and HDL-cholesterol. Sex-stratified risk and MetScore were assessed using general linear models for association with age, body composition (percent fat), cardiorespiratory fitness (CRF), and muscular strength capacity (normalized for body mass). RESULTS: In both boys (n=663) and girls (n=746), age, CRF, percent fat, and strength were all individually correlated with multiple risk components, as well as the overall MetScore. However, in the adjusted model it was normalized strength capacity that emerged as the best predictor of MetScore for both boys (B = -4.53; p<0.0001) and girls (B = -3.593; p<0.0001). WC was the strongest loading coefficient within the PCA-derived MetScore outcome. CONCLUSION: These findings reveal that strength-to-body mass ratio is independently associated with lower cardiometabolic risk in adolescent boys and girls. Moreover, WC was associated with all cardiometabolic risk factors and carried the strongest loading coefficient within the MetScore outcome.

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POSTER: 55
COMPARISON PERFORMANCE BASED ON LEVEL IN COMPULSORY FEMALE GYMNASTS
A. R. Russell, H. Williford, G. Schaefer, M. Esco
1Auburn University Montgomery, 2Auburn University at Montgomery

Female artistic gymnasts in the United States (levels 1 through 6) are considered compulsory gymnasts. All gymnasts at the same compulsory level (LV) perform the same predetermined routines. Because LV is based on ability, even though skill difficulty increases with LV, it would be expected that all-around competition scores (AA) would be similar for each LV. However, many in the gymnastics community maintain that AA varies by LV, with level 6 gymnasts scoring lower than gymnasts in other compulsory levels, thus there is currently no scientific research to support this anecdotal hypothesis. PURPOSE: The purpose of this investigation was to determine the difference in AA between level 4, 5, and 6 compulsory female gymnasts. METHODS: Four-hundred and thirty eight level 4 to 6 gymnasts from four states who competed in their compulsory championships were randomly selected for data analysis. The AA score for each gymnast was obtained from www.mymeetscores.com, a public website that publishes meet results from many USA Gymnastics sanctioned events. The AA scores were examined across levels 4 to 6. RESULTS: Mean AA by level was as follows: level 4 (n = 243) 34.73 +/- 2.01; level 5 (n = 130) 34.75 +/- 1.55; and level 6 (n = 64) 34.78 +/- 1.35. There was no significant difference between the AA scores (p > 0.05). CONCLUSIONS: This investigation suggests that AA scores do not differ among compulsory female gymnasts between levels 4, 5, and 6. PRACTICAL APPLICATION: This study indicates that AA is not affected by LV. As LV is determined by ability, drops in AA at a higher LV may be the result of improper LV placement for ability. Practitioners should carefully evaluate their athletes to insure appropriate LV placement.

POSTER: 56
PERCEIVED BELIEFS OF SAFETY PROCEDURE DEVELOPMENT AMONG HIGH SCHOOL ATHLETIC AND CONDITIONING COACHES
G. Schaefer, M. Esco, A. R. Russell, B. Nickerson
1Auburn University at Montgomery, 2Auburn University Montgomery

Of the countless number of injuries occurring in high school athletic and conditioning settings, many can be prevented with adequate safety protocol. The safety culture within an organization, such as a high school sports program, may influence the behavior of employees regarding safety and can contribute to the incidence of injury within the program. PURPOSE: The purpose of this study was to explore the perceived beliefs of safety procedure development among athletic and conditioning coaches within high school sports programs. METHODS: The Recreational Sports Safety Culture Questionnaire, which was a previously developed web-based survey, was distributed to 1425 high school athletic and conditioning coaches via e-mail. A total of 124 surveys were completed (response rate 8.7%). Under the construct proactive safety priority, participants addressed the statement “employees are seldom asked for input when safety procedures are developed.” Of the 114 usable responses, 8.8% strongly agreed, 16.7% agreed, 16.7% somewhat agreed, 14.9% somewhat disagreed, 30.7% disagreed and 12.3% strongly disagreed. Participants also addressed the statement “employees get little recognition for new safety ideas.” Of the 115 usable responses to the question, 9.6% strongly agreed, 15.7% agreed, 13% somewhat agreed, 19.1% somewhat disagreed, 35.7% disagreed and 7% strongly disagreed. CONCLUSIONS: This study showed that athletic and conditioning coaches in high schools have varied beliefs of safety procedure development. Over 38% of the coaches surveyed feel that they get little recognition for new safety ideas. In addition, over 42% of the coaches surveyed believe their input for new safety ideas is not solicited. PRACTICAL APPLICATIONS: Administrators of high school sports programs should be aware of the results of this study when developing safety protocol for their athletic and conditioning programs. Athletic and conditioning coaches should be respected as an integral part of establishing safety procedures. Their knowledge of the dangers involved with physical activity is vital when generating a culture of safety. Further study is needed to investigate why so many athletic and conditioning coaches believe that they have little input or get little recognition for safety procedure development or new safety ideas.
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Coached and Periodized Exercise Training Yields Superior Improvements in Lean Body Mass Compared with Self-Directed Training in Health Club Members

T. Storer1, B. Dolezal1, M. Berenc2, J. Timmons3, C. B. Cooper1
1Division of Pulmonary Medicine/University of California Los Angeles, 2Equinox Fitness Clubs, 3Division of Endocrinology, Diabetes & Hypertension/University of California Los Angeles

BACKGROUND: A variety of exercise training methods are available for improving health- and performance-related fitness. However, it has not been established whether personal trainers (coaches) applying fitness club structured but individualized exercise training to members yield superior results when compared with equivalent amounts of self-directed training. PURPOSE: We tested the hypothesis that subjects randomized to a fitness club personal coaching method (COACHED) would accrue significantly greater lean body mass (LBM) than those randomized to directing their own training (SELF). Additionally, we examined whether COACHED subjects would exhibit significantly greater improvements in other fitness domains and with adherence to the training regimen. METHODS: Males, 30-44 years who were members of a single Southern California fitness club and regularly exercised 5-7 days/month were randomized to COACHED (N=17) or SELF (N=17) for 12-weeks of thrice weekly coaching. COACHED subjects exercised under the direction of coaches who applied the club’s periodized training program; SELF subjects were instructed to exercise 3 days/week on their own. All subjects were informed that the primary objective of training was to increase LBM. Coaches were club employees with BS or MS degrees in exercise science and personal training certifications. The primary outcome variable, LBM, was assessed using dual-energy x-ray absorptiometry, (DXA, Hologic 4500A, Bedford, MA). Secondary outcomes included leg press and chest press muscle strength by 1-RM, leg power using a vertical jump test and electronic timing mat (Just Jump, Probotics, Inc., Huntsville, AL), and aerobic capacity (VO2max) measured with a portable metabolic measurement system (Oxycon Mobile, Care Fusion, Yorba Linda, CA). All measurements were conducted before and after 12-weeks of training. Other than DXA, all assessments were performed by one investigator (BD) in the health club setting; DXA scanning was administered by one of the investigators (JT) at the UCLA Gonda (Goldsmidh) Diabetes Center. Both investigators were blinded to group assignment. RESULTS: COACHED subjects increased LBM by 1.3 (SD, 1.5) kg, while SELF subjects showed 0.0 (SD, 1.6) kg increase (P=0.029 for the difference between groups). Similarly, significantly greater improvements in chest press muscle strength (42% versus 19%), peak leg power (6% versus 0.6%), and VO2max (7% versus -0.3%) were seen in COACHED compared with SELF. Leg press strength improved 38% and 25% in COACHED and SELF, respectively (P=0.14).

CONCLUSIONS: We conclude that significantly greater increases can be accrued in LBM and other measures of fitness when fitness club members are coached by well-trained, certified, and experienced coaches applying a systematic, periodized training program over 12 weeks. PRACTICAL APPLICATIONS: While the results of this study may seem predictable, it demonstrates for the first time in the real-world environment of a health and fitness club setting, that significant improvements in LBM and other important dimensions of health and performance-related fitness are best achieved when periodized exercise training is administered by expert coaches. These data, therefore, lend credence to the personal training profession wherein knowledgeable coaches using proven training methods yield superior results when compared with individuals who self-train with similar objectives.

ACKNOWLEDGMENTS: Funding: Equinox Fitness Clubs, New York, NY.

Antropometric Variables, Aerobic Fitness and Reaction Time in Club Level Rugby Players and Trained Males

C. Tai1, P. Falcone1, L. Carson1, B. Spradley2, K. Crowley2, A. Magner2, E. Esposito1, M. Kim1, E. Serrano1, J. Moon1
1MusclePharm Sports Science Center Research Institute, 2United States Sports Academy, 3University of Mobile

Rugby is played in more than 100 countries, and professional rugby leagues exist all over the world. There are fifteen rugby player positions and they each require different skills and physiological demands. However, reaction time differences among these position-specific athletes, as well as differences in anthropometric and aerobic characteristics, are unclear. PURPOSE: To compare physiological ability, including reaction time, VO2max, and muscular strength among different positions in college level rugby players as well as to compare rugby athletes to recreationally trained men. METHODS: Thirty-six active males ages 18-35 years, including 19 rugby team players (8 rugby forwards and 11 rugby backs) and 17 trained males participated in this study. Body composition and anthropometry measurements included: height, weight, body fat, and lean muscle mass. Aerobic capacity tests were performed on a calibrated treadmill and data were measured via a metabolic cart. Choice reaction time was measured with an audio-visual reaction time testing device. RESULTS: Weight and percent fat were significantly (p<0.05) higher for rugby forwards (102.14 ± 13.63 kg; 26.06 ± 8.65 %) compared to rugby backs (76.67 ± 11.94 kg; 13.45 ± 5.05 %) and trained males (80.58 ± 13.39 kg; 17.42 ± 5.69 %). Absolute VO2max was also significantly (p<0.05) higher in rugby forwards (43.6 ± 0.62 l/min) compared to rugby backs (3.63 ± 0.45 l/min) and trained males (3.69 ± 0.52 l/min). Rugby players had significantly (p<0.05) faster reaction times (0.28 ± 0.02 sec) and 1.01 ± 0.09 kg heart rate compared to trained males (0.31 ± 0.03 to 1.10 ± 0.09 sec). CONCLUSIONS: Higher body fat, body mass and aerobic absolute capacity appear to benefit club level rugby forwards. Club level rugby players demonstrated faster reaction times compared to trained males.

PRACTICAL APPLICATIONS: Rugby players appear to have faster reaction time than trained men. Participating in club level rugby may enhance both aerobic performance and reaction time over typical recreational activities. Furthermore, rugby clubs can use this data to recruit athletes based on size and aerobic performance as well as reaction time. ACKNOWLEDGEMENTS: This investigation was supported by a grant from MusclePharm, Inc.
T/L:

**Poster: 60**

**EFFECTS OF THREE RECOVERY PROTOCOLS ON BASEBALL PITCHERS DURING SIMULATED GAMES**

C. Warren¹, D. Szymanski², M. Landers ³

¹Center for Athletic Performance and Physical Therapy, ²Louisiana Tech University, ³University of Las Vegas

Baseball pitchers have been described as having a very anaerobic energy system with high muscle mass, short stature, and very few natural aerobic abilities. Due to the unique nature of this activity, muscle and muscle fiber composition of the pitcher as well as the number of pitches thrown per inning and per game, there is the possibility of pitchers fatiguing during a game, which could lead to a decrease in pitching performance. PURPOSE: To evaluate the effects of 3 recovery protocols: passive recovery (PR), active recovery (AR), and electrical muscle stimulation (EMS) on range of motion (ROM), heart rate (HR), rating of perceived exertion (RPE), and blood lactate in baseball pitchers after throwing a simulated game. METHODS: Twenty One Division I intercollegiate baseball pitchers (age = 20.4 ± 1.4 y, ht = 185.9 ± 8.4 cm, wt = 86.5 ± 8.9 kg, BF = 11.2 ± 2.6) volunteered to pitch 3 simulated 5-inning games, with a maximum of 70 fastballs thrown per game while wearing a HR monitor. ROM was measured pre, post, and 24 hr post-pitching for shoulder internal and external rotation at 90° and elbow flexion and extension. HR was recorded after each pitch and after every 30 sec of the 6-minute treatment recovery. RPE was recorded after the last pitch of each inning and after completing each 6-minute treatment recovery. Immediately after throwing the last pitch of each inning, post-pitching blood lactate was measured. At the end of the 6-minute treatment recovery, before the next inning started, post-recovery blood lactate was measured. Pitchers were instructed to throw each pitch at or above 95% of their best pitched fastball. This was enforced to ensure that each pitcher was throwing close to maximal effort for all 3 simulated games. All data presented represent group means. RESULTS: The G2 group showed a significant difference in shoulder flexion flexibility among baseline (168.03 ± 6.84), P24 (172.82 ± 4.47) and P48 (173.65 ± 5.36). In the intergroup analyses no significant differences were observed in the four periods evaluated. CONCLUSIONS: These results indicate that the shoulder flexibility was only affected in flexion movement independent of the number of the sets performed. Probably the biomechanical characteristics of the flexion movement induce changes on muscle proprioceptors responses, as well as muscle spindles and golgi tendon organs. PRACTICAL APPLICATIONS: The variability in the number sets (training volume) may be an interesting alternative for coaches and practitioners to improve the shoulder flexibility in an acute manner, especially during movements involving shoulders.

**Poster: 62**

**THE EFFECT OF A SIX-WEEK STRENGTH & CONDITIONING PROGRAM ON DANCE SPECIFIC MEASURES OF FLEXIBILITY AS WELL AS SELF-PERCEIVED ABILITIES**

R. Kudra¹, J. Martin, K. Rose ²

¹DeSales University

Previous research has shown that strength training and metabolic conditioning in dancers can improve strength and reduce fatigue while dancing. Yet many traditionally trained female dancers fear a loss of flexibility or visual aesthetics and therefore avoid most types of strength and conditioning. There is minimal research examining the benefits and detriments of traditional strength and conditioning methods on the unique physical demands of dancers such as hip external rotation, posture, and dance specific flexibility. PURPOSE: The purpose of this study was to examine the effects of a 6-week non-specific strength and conditioning program on dance specific active and passive flexibility. Secondly, this study examines changes in perceived somatic abilities and confidence over the same period of time. METHODS: Fifteen female collegiate dance majors (19.4±1.68yrs of age, 59.3±9.4kg, 12.8±5.8hrs of class and rehearsal per week) were divided into control (CON; n=6) and experimental (EXP; n=9) groups. The EXP group participated in a 6-week strength and conditioning program two times per week for 1 hour in addition to their usual dance classes, rehearsals, and personal practice. The CON group continued with their normal dance and fitness activities only. Functional hip external rotation, height of active and passive developé in second position, and posture in first position, were measured in both groups before and after the 6-week intervention. A questionnaire assessing 5 self-perceived dance specific somatic abilities as well as confidence was also administered at the beginning and end of the study. RESULTS: Separate mixed model ANOVAs were performed for hip external rotation, active and passive developé height, posture, and items of the self-perception questionnaire. There were no differences in functional hip external rotation or active and passive developé height between EXP and CON (group), from pre to post testing (time), nor were there significant interactions (time x group). Among the items of the self-perception questionnaire, perceived strength in dancing (F(1,13)= 10.023, p=0.007) and dance specific confidence (F(1,13)= 4.743, p=0.048) significantly increased over the 6-week period, but no main effect for group or interaction (time x group) was observed. There was a significant interaction effect for perceived ability to achieve and hold dance specific posture (time x group; F(1,13)= 9.274, p=0.009), but no main effects for time or group. The postural assessment of first position showed no differences between groups (EXP vs. CON), time points (pre vs. post), or the interaction (time x group). CONCLUSION: Strength and conditioning training in dancers did not affect hip external rotation or developé height. The EXP group perceived greater ease in achieving and maintaining proper posture in dance following the training intervention, but actual postural assessment did not change. In all other variables the EXP group responded similarly to the CON group. Further research is needed to examine if long-term conditioning in this manner produces any additional changes in flexibility, posture, or other dance specific abilities. PRACTICAL APPLICATION: It appears that short-term strength & conditioning concurrent with dance specific training does not affect active or passive dance specific flexibility but may increase the perceived ease of dance posture.
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ASSISTIVE DEVICE PROVIDES COMPARABLE INCREASES IN HAMSTRING FLEXIBILITY AND STRENGTH IN ELITE TRACK & FIELD ATHLETES COMPARED TO A TRAINED THERAPIST

C. Sutherland1, A. Kanters1, D. Andrews1

1University of Windsor

PURPOSE: Track and field athletes who exhibit a lack of muscle and tendon flexibility are at a higher risk of sustaining a hamstring injury, compared to those athletes with normal flexibility. In order to minimize the athlete’s risk of injury and maximize their performance, all athletes should be implementing a structured stretching regime into their everyday training program. Proprioceptive Neuromuscular Facilitation (PNF) stretching post training is preferred among university track and field athletes because it has been shown to yield greater increases in strength and range of motion compared to static and dynamic stretching. However, conducting PNF stretching on each individual member of a large varsity team following daily training sessions is not always feasible for a team’s therapist due to time constraints and limited resources. Therefore, the purpose of this research study was to determine if athletes who use an assistive device to facilitate PNF stretching will have comparable increases in hamstring flexibility and strength as athletes who receive PNF stretching from the team’s therapist.

METHODS: Thirty-three university track and field athletes (runners, jumpers and throwers: mean age: 22.2 ± 2.6 years, weight: 71.8 ± 19.8 kg, height: 175.3 ± 9.1 cm) participated in this study and were purposefully assigned to one of three groups: 1) PNF; PNF stretching was performed after each practice by the team’s therapist (n=9), 2) Assistive Device; PNF stretching was performed after each practice by the participant using a newly developed assistive device (n=14), 3) Control; did not perform any PNF stretching (n=10). Four repetitions of the contract-relax PNF stretching technique was used for both the PNF and Assistive Device group. 5 times a week for 10 weeks. Three tests were performed pre, mid and post intervention: 1) sit and reach test for flexibility, 2) active knee extension test for muscle tightness, 3) isokinetic leg curls for concentric and eccentric strength. A 3 (Group: PNF, Device, Control) x 3 (Time: Pre, Mid, Post) repeated measures ANOVA was performed for flexibility, A 3 (Group) x 3 (Time) x 2 (Leg: Right, Left) repeated measures ANOVA was performed for the active knee extension test and the isokinetic leg curls. RESULTS: A significant main effect for time (p<0.05) was found for flexibility, muscle tightness, and concentric and eccentric strength across all 3 groups. All measures improved significantly at mid and post testing compared to pre. A significant main effect for leg (p=0.05) was found for muscle tightness, and concentric and eccentric strength. The right leg showed a lower degree of flexion and was able to generate more force for both the concentric and eccentric leg curls, compared to the left leg. CONCLUSIONS: The assistive device was able to help athletes achieve equivalent improvements in their hamstring flexibility, tightness and strength compared to the PNF group. Although all participants increased in hamstring flexibility, tightness and strength over the duration of the study, there were greater increases in the PNF and Assistive Device groups compared to the Control group. PRACTICAL APPLICATIONS: The assistive device used in this study will enable athletes to gain the benefits of PNF stretching within their personal training sessions without the need to rely on support staff. ACKNOWLEDGEMENTS: Green Shield Sports Therapy Clinic (Dave Stoute and Kathy Harvie), Manufacturing Solutions Ltd. (Paul Mancini), the Downtown Windsor Business Accelerator (Deborah Livneh) and MITACS provided support for this study.

Poster: 64

EFFECT OF SODIUM-SODIUM CITRATE BEVERAGE SUPPLEMENTATION ON SKIN TEMPERATURE & SWEAT RATE IN PREVIOUSLY HYPOHYDRATED SOCCER ATHLETES IN A HOT ENVIRONMENT

K. A. Brooks1, J. G. Carter2, J. Dawes1

1Texas A&M University Corpus Christi, 2Texas A&M University

INTRODUCTION: Research has shown that many athletes are continually in a state of dehydration. This impairs performance, and increases the chance of heat-related illness. Using sodium supplementation to increase fluid absorption and stimulate the thirst mechanism has been a popular practice among athletes. PURPOSE: The purpose of this study was to determine if ingesting a beverage containing 1,780 mg of sodium and 2,953 mg of sodium citrate would impact skin temperature and sweat rate for previously hypohydrated individuals in a heated environment during aerobic exercise. METHODS: Five division one female soccer athletes participated in the study. The subjects had the following descriptive statistics: Age 19 ± 0.7 yr, Height 162.3 ± 4.6 cm, Weight 63.2 ± 8.1 kg, BF% 23.68 ± 9.2%, and VO2max 40.2 ± 5.1 ml·kg⁻¹·min⁻¹. The study required subjects (N=5) to run the experimental protocol twice. Fluid intake was matched for each condition. Prior to running to exhaustion at 70% of their VO2max on a treadmill in a heated chamber, the subjects were passively dehydrated and lost 2.5% of their body mass. The subjects were given 2 hours to rehydrate via either a placebo (10 mmol Na+ + L-1) or the supplement (164 mmol Na+ + L-1). After medical clearance, subjects performed a graded exercise test to determine VO2max. ACSM equations were used to determine running speed at 70% of VO2max. Testing conditions consisted of the subjects running at 70% of their VO2max until exhaustion while in a heated chamber at 90° Fahrenheit. The study employed a double-blind, repeated measure, within subject protocol. The treadmill protocol consisted of a five minute warm-up (3 minutes at 40% of their VO2max, and 2 minutes at 55% of their VO2max), running to exhaustion at 70% of VO2max, and a 10 minute cool down at 30% of VO2max. Every five-minute period on the treadmill, participants were assessed. RESULTS: Results for skin temperature and sweat rate at 70% of maximal VO2 indicated that there were no significant differences between conditions for sweat rate. One participant doubled sweat rate during the TRES trial, although no significant was observed overall. There were no significant differences between conditions for skin temperature until the 25 minute mark. At the 25, 30, 35, and 40 minute marks, there was a significant difference in skin temperature (p<0.05), with the supplement trial reporting lower skin temperatures at each mark. CONCLUSION: Skin temperature was lower when hydrated with the sodium supplemented beverage after sustained aerobic exercise at 70% of VO2max in a hot environment. The ability to maintain a lower body temperature may lead to increased performance through maintenance of blood volume and a decreased effect of cardiovascular drift. Notably, all of the subjects performed better on the first treadmill session regardless of the experimental condition (i.e. placebo or high sodium solution). Absolute conclusions cannot be drawn from this study. PRACTICAL APPLICATION: Dehydration should be a major concern for any athlete, especially for those who are performing in hot, humid environments. Preventative methods such as ingesting a sodium solution, frequent weigh-ins, and continual education for the athlete should all be employed to avoid any form of heat illness to the athlete. Practitioners should be aware of the importance of aerobic conditioning for an athlete while exercising in a hot environment. Knowledge of warning signs and symptoms, and taking proper precautions to prevent complications is of importance. Coaches should be aware that athletes who are less conditioned are at higher risk for heat illnesses; therefore, proper training and steps towards acclimatization must be employed prior to training in the heat.

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EFFECTS OF ANABATINE ON MARKERS OF ECCENTRIC-INDUCED MUSCLE DAMAGE AND DELAYED-ONSET MUSCLE SORENESS

N. D. Jenkins1, D. A. Traylor1, T. J. Houshi1, K. C. Cochrane1, H. C. Bergstrom1, R. W. Lewis, Jr1, R. J. Schmidt1, G. O. Johnson1, J. T. Cramer2

1University of Nebraska-Lincoln

INTRODUCTION: Anatabine is a minor tobacco alkaloid found in Solanaceous plants (e.g., green tomatoes, peppers, and eggplant) and is sold as a dietary supplement for reducing the urge to smoke. Paris et al. (Eur J Pharmacol, 698[1-3145-153, 2013]) suggested that anatabine may also exhibit anti-inflammatory activity, however, the effects of anatabine on markers of exercise-induced muscle damage and delayed-onset muscle soreness (DOMS) are unknown. PURPOSE: To examine the effects of anatabine on selected markers of muscle damage and DOMS after eccentric exercise. METHODS: Using a double-blinded, placebo-controlled, crossover design, 16 men (mean ± SD age = 22 ± 3 years; body mass = 79 ± 16 kg; height = 182 ± 6 cm) participated in two randomly-ordered conditions separated by at least a two-week washout. The anatabine condition consisted of consuming 1-4 lozenges per day for 10 days, and testing took place during days 7-10. The placebo condition was identical except that the lozenges contained no anatabine. Maximal voluntary isometric contraction peak torque (PT) of the forearm flexors, arm circumference, hanging arm elbow joint angle, subjective pain ratings, and serum concentrations of creatine kinase (CK, IU·L-1), myoglobin (Mb, ng·mL-1), lactate dehydrogenase (LDH, IU·L-1), and high sensitivity C-reactive protein (CRP, mg·L-1) were measured before (Test 1), immediately after (Test 2), and 24 (Test 3), 48 (Test 4), and 72 (Test 5) hours after six sets of ten maximal, eccentric isokinetic forearm flexion muscle actions at 30°·s⁻¹. Eight separate two-way repeated measures ANOVAs (condition [anatabine vs. placebo] x time [Test 1, 2, 3, 4, 5, 6 (4 days)] with planned 25-minute periods dependent samples) were conducted to analyze the results with an alpha level of p ≤ 0.05. RESULTS: There was no condition x time (p > 0.05) interactions, there was only one main effect for condition for LDH (anatabine > placebo, p ≤ 0.05), and there were main effects for time (p ≤ 0.05) for all variables (PT, arm circumference, hanging arm elbow joint angle, subjective pain ratings, CK, Mb, LDH, and CRP). For example, PT decreased from Test 1 to Test 2 (70 ± 14 to 41 ± 14 Nm and 72 ± 15 to 40 ± 12 Nm) and then recovered to 77% and 71% of Test 1 by 72
hours after exercise similarly for anatabine and placebo conditions, respectively. CK increased from Test 1 to Test 5 (219 ± 395 to 6,021 ± 9,204 IU·L⁻¹) similarly for anatabine and placebo conditions, respectively. LDH increased from Test 1 to Test 5 (131 ± 28 to 218 ± 170 IU·L⁻¹ and 112 ± 24 to 154 ± 71 IU·L⁻¹) for anatabine and placebo, respectively, but was consistently higher (p ≤ 0.05) during the anatabine condition. CONCLUSIONS: Despite the characteristic decreases in PT and increases in CK that were consistent with previous studies on muscle damage, these data were unable to support the hypothesis that anatabine improves recovery after this model of eccentric-induced muscle damage and DOMS. ACKNOWLEDGEMENTS: This study was supported by a clinical trial grant from Rock Creek Pharmaceuticals.

PRACTICAL APPLICATIONS: While anatabine may be of value as a dietary supplement to reduce the urge to smoke or for other muscle or joint conditions, it did not prove of value for PT, arm circumference, elbow joint angle, pain scale ratings, CK, Mb, LDH, or CRP during a 3-day period following this model of eccentric-induced muscle damage and DOMS. ACKNOWLEDGEMENTS: This study was supported by a clinical trial grant from Rock Creek Pharmaceuticals.

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PRACTICAL BLOOD FLOW RESTRICTION TRAINING INCREASES MUSCLE HYPERTROPHY DURING A PERIODIZED RESISTANCE TRAINING PROGRAM


1University of Tampa Human Performance Lab, 2University of Oklahoma / Neuromuscular Laboratory, Norman, OK, 3Laboratory of Neuromuscular Adaptations to Strength Training, School of Physical Education and Sport, University of São Paulo, 4Laboratory of Human Movement Studies, University Foundation of Itaperuna, Itaperuna, RJ, Brazil

*Award Eligible - Outstanding Undergraduate Student Poster Presentation

Resistance training in combination with practical blood flow restriction (pBFR) is thought to stimulate muscle hypertrophy by increasing muscle activation and muscle swelling. Most previous studies used the KAATSU device; however, little long-term research has been completed using pBFR. OBJECTIVE: To investigate the effects of pBFR on muscle hypertrophy. METHODS: Twenty-four college-aged male participants with a minimum of 1 year of resistance training experience were recruited for this study. Our study consisted of a randomized, crossover protocol consisting of individuals either using pBFR for the elbow flexors during the first 4 weeks (BFR-HI) or the second 4 weeks (HI-BFR) of an 8-week resistance-training program. Direct ultrasound determined biceps muscle thickness was assessed collectively at baseline and at the end of weeks 4 and 8. A repeated measures ANOVA was used to assess any main effects. If a main effect was found a tukey post hoc was employed to locate where differences occurred. RESULTS: There were no differences in muscle thickness between groups at baseline (p=.52). There were time (p<0.01, ES=99) but no condition by time effects (p=0.58, ES=80) for muscle thickness in which the combined values of both groups increased on average from Week 0 (3.66±0.06) to Week 4 (3.95±0.05) to Week 8 (4.1±0.07). However, both the BFR-HI and HI-BFR increased significantly from baseline to Week 4 (6.9% and 6.6%, p<0.01) and from Weeks 4 to Week 8 (4.1%, 4.0%, p<0.01), respectively. CONCLUSION: The results of this study suggest that pBFR can stimulate muscle hypertrophy to the same degree to that of high intensity resistance training. PRACTICAL APPLICATIONS: Athletes and strength practitioners can use LI-pBFR in combination with their training programs in order to elicit muscle hypertrophy without the muscle damage incurred by heavier weight.

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NORMATIVE TRAINING VOLUME AND SLEEP HABITS OF RECREATIONAL ATHLETE WHO SUCCESSFULLY COMPLETED A 160 KM CYCLING EVENT


1University of Connecticut Department of Kinesiology, Human Performance Laboratory

The high level of participation in ultra endurance events by recreational athletes may require large training volumes. Finding the optimal training volume requires sufficient training to cause physiological adaptation without overtraining, which leads to decrements in performance or injury. PURPOSE: To define normal training volume and sleep habits for successful completion of a 160 km cycling event in recreationally active individuals and to determine if training volume affected finish time. METHODS: Fifty three subjects (men, 47; women, 6; age, 43.6±8.7 yr; height, 179.5±71 cm; weight 85.4±13.7 kg; body fat: men, 16±5.0%, women, 24.2±2.9%) completed a survey before a 160 km (100 mi) endurance cycling event in Wichita Falls, Texas in August of 2011. Information included: hours and rides per week, rating of perceived exertion (RPE, 6-20 point scale) for a typical training ride for the previous three months (0-4WK, 5-8WK, 9-12WK); how many months since they experienced a three week break from training; and the hours and quality (poor, 1; good, 5) of sleep on a typical weekday (Wkd) and weekend (Wkend) night. An investigator recorded body mass and three-site skinfold thickness 48-12 hours before the event. The organizer of the event provided finish times and subjects reported RPE at the finish. Subjects were retrospectively assigned to one of three groups (FAST, MED, SLOW) by an analysis of ride time and finish rank order. RESULTS: See table. During the event temperature rose from 25.6° to 41.1° C with humidity of 31.8±15.8% and calm winds (<7.4 kph). MED trained more hours per week than FAST but at a lower RPE for the month leading up to the event (p<0.05). Finish RPE correlated with finish time, but not with measure of training volume. Longer nights of sleep occurred on the weekends (Wkd, 6.7±1.0; Wkend, 7.3±0.9 hr, p<0.001) with similar quality(Wkd, 3.7±0.8; Wkend, 3.8±0.7, p=0.057). Weekday-sleep-length weakly correlated with finish time (r= -0.284, p<0.05). Subjects reported 4.8±8.0 years since the last 3+ week break in physical activity, and 96% of subjects reported training three month consecutively prior to the event. CONCLUSION: Exercise training intensity was higher in the fast group and weekday-sleep-length explained a small portion of the variance in finish times. PRACTICAL APPLICATION: This survey research provided relatively stable normal training volumes across a wide range of abilities. Normal cyclist habits for a 160 km (100 mi) endurance cycling event were in the range (95% confidence interval) of 3-4 rides for a total of 8-11.5 hours per week, at an RPE of 13.5-14.8 for three months prior to the event, with 6.5-7.0 hours of sleep per night. Therefore, general guidelines for training goals for those seeking to complete a 100 mile ride should be to cycle at least 3 times a week for a total of at least 8 hours per week, at an intensity subjectively judged to be between “somewhat hard” and “hard.”
EFFECT OF LADDER CLIMBING ON REGIONAL ANTERIOR PITUTARY IMMUNE RESPONSIVE GROWTH HORMONE RELEASE IN MALE RATS

W. J. Kraemer, S. Flanagan, C. Dunn, Lewis, B. Comstock, D. Hooper, T. Szivak, A. Sterczala, D. Looney, A. Brey, H. Luk

University of Connecticut

PURPOSE: Anterior pituitary gland (AP) somatotroph growth hormone (GH) release is increased in response to resistance exercise. The purpose of this study was to examine the effects of resistance exercise on regional AP FGF-21 (GHRH) and acute GH release in male rats. METHODS: Twelve-month old Sprague-Dawley rats were randomly assigned to one of four groups: 1) No training and no acute exercise (NT-REST), 2) No training and acute exercise (NT-EX), 3) Training and no acute exercise (RT-REST), and 4) Training and acute exercise (RT-EX). The resistance exercise incorporated ten 1-meter long weighted ladder climbs at an 85° angle. RT groups trained three days per week for seven weeks. After rats were euthanized, the AP was removed and divided into four regions (ventral-dorsal and left-right). For each region, unstimulated immunoreactive GH release, % of cells containing GH, forward angle light scatter (FALS) measures of cell size, and perpendicular light scatter (PLS) measures of cell cytoplasmic granularity were taken.

RESULTS: GH release was significantly (p≤0.05) higher in RT-EX compared to RT-REST and NT-REST in ventral regions and compared to NT-REST in the left dorsal region. FALS was significantly lower (p≤0.05) in RT-EX compared to NT-EX in the left ventral region. PLS was significantly lower (p≤0.05) lower in RT-EX compared to RT-REST and in NT-REST compared to RT-REST in the right ventral region. Plasma Gh trunk blood concentrations were: (NT-REST) 8.9±2.4 µg/L; (NT-EX) 15.6±3.4 µg/L; (RT-REST) 9.2±3.5 µg/L, and (RT-EX) 23.4±4.6 µg/L. There were no significant differences between testing values. Acute resistance exercise (RT-EX) was accompanied by significantly higher plasma GH than both resting conditions. Finally, training (RT-EX) resulted in significantly higher GH concentrations than acute resistance exercise alone (NT-EX). CONCLUSIONS: Resistance exercise training appears result in greater unstimulated GH release, smaller somatotroph size, and increased granular content at rest. In addition, the amount of immunoreactive GH secreted in response to training increases. These adaptations are not homogeneous but region specific in nature.

PRACTICAL APPLICATIONS: Understanding the basic underlying mechanisms for GH release from the pituitary provides new insights into the to the 22 kD release from the pituitary using a model not possible in humans.

Saturday, July 13, 2013, 8:30 AM - 8:45 AM
THE RELIABILITY OF ISOSEMIC FORCE-TIME VARIABLES COLLECTED ON A PORTABLE MID-THIGH PULL TESTING DEVICE

G. Haff, S. Nimphius, J. Sheppard

1Centre of Exercise and Sport Science Research, Edith Cowan University, Joondalup, Western Australia, 2Centre for Exercise and Sport Science, Edith Cowan University, 3Edith Cowan University

Mid-thigh pull testing is a popular laboratory technique that has consistently been proven to be a reliable method for assessing key strength indicators related to sports performance. Due to equipment limitations the use of this test is often limited to laboratory-based settings and to date is not often performed in the field because of the limited portability of the testing equipment. PURPOSE: To assess the reliability of a portable mid-thigh pull and force-plate testing apparatus. METHODS: The reliability of a custom made portable mid-thigh pull testing apparatus was tested with 23 Junior Surfers (Age = 16.3±1.2 yrs; Body mass = 58.8±9.0 kg; height = 168.2±7.6 cm; 7% skinfold = 43.5±17.6%) All subject performed the isometric mid-thigh pull after a dynamic warm-up and one familiarization trial. A total of two maximal effort isometric mid-thigh pulls were collected on a custom portable isometric mid-thigh pull system that was coupled with a force platform that sampled at 600 Hz. If the PF values achieved were >250 N from the first trial additional trials were performed. All Force time curves were assessed for several key characteristics including peak force (PF), average force (AF), peak rate of force development (PRFD), and isometric impulse from 0-200ms (200IMP). Reliability was calculated with the use of the coefficient of variance (CV%), intraclass correlation (ICC) and 90% confidence interval (90%CI) for curve variables assessed. Acceptable reliability was determined when a measure met both an ICC > 0.70 and a CV% < 15%. RESULTS: The PF was determined to be highly reliable based upon the high ICC (ICC=0.99, 90%CI=0.98-1.00; CV%=2.2, 90%CI=1.8-3.0). AF was also found to meet the established criteria for reliability (ICC=0.97, 90%CI=0.93-0.98; CV%=2.2, 90%CI=1.8-3.0). 200IMP was also found to meet the criteria for reliability by demonstrating a high ICC (0.87, 90%CI=0.73-0.93) and adequate CV (8.8, 90%CI=7.0-11.9). PRFD met the minimum criteria for the ICC (0.84, 90%CI=0.7-0.92), but failed to achieve a CV% that would be considered reliable (CV%≤0.205, 90%CI=0.16-0.28). CONCLUSION: A portable mid-thigh pull apparatus when employed with a portable force plate can yield reliable PF, AF, and 200IMP values in junior surfers. PRACTICAL APPLICATIONS: Strength and conditioning professionals can reliably collect PF, MF, and 200IMP data in a field-based environment with the use of a portable mid-thigh pull and force plate apparatus. Since PRFD failed to reach reliability standards this assessment should be reserved for laboratory-based assessments.

Saturday, July 13, 2013, 9:00 AM - 9:15 AM
COMPARATIVE GONIOMETRY-DERIVED Q-ANGLES FOR RELAXED VS. CONTRACTED QUADRICEPS FEMORIS MUSCLES

L. Weiss, B. DeForest, S. Nichols, B. Schilling, M. Paquette

1The University of Memphis

A large or small quadriceps angle (Q-angle) is assumed to be indicative of the presence of genu valgum (knock-knee) or genu varum (bow-leg), respectively. Surface goniometry has been used to measure Q-angle, but contractile state of the quadriceps femoris (quad) muscles is not universally controlled. PURPOSE: To determine the respective stability reliability, precision, and comparative difference in Q-angles using surface goniometry when the quad muscles are either relaxed or isometrically contracted. METHODS: Twenty-eight apparently-healthy young, rested men (n=19) and women (n=9), 20-32 years of age (M=23±2.9), who had readily-palpable anterior superior iliac spines (ASIS), were recruited for the investigation. The Q-angle of both knees in relaxed and contracted quad conditions was obtained on two separate occasions either 24 or 48 hours apart. Q-angle was operationally defined as the superior angle formed by intersecting lines running from the ASIS to the center of the patella, and from the center of the tibial tuberosity to the center of the patella on each side of the body. Following landmark identification and foot fixation (i.e., taped together) in a neutral position, an extendable arm goniometer (Lafayette Instruments) was used to measure the Q-angle for both left and right legs with relaxed and maximally-isometrically-contracted quad muscles. Stability reliability was determined by intraclass correlation (ICC2-way random). Precision, or the minimum-detectable real difference, was determined by limits of agreement (LOA95%, 2.77 x standard error of measurement). Comparisons for relaxed vs. contracted conditions were made by dependent t-tests using a Bonferroni procedure with an adjusted α level of 0.0125 (0.05/4), while effect size (ES) was estimated using Cohen’s d for repeated measures. RESULTS: ICCs for Q-angle measurements were as follows: left-leg relaxed = 0.94, right-leg relaxed = 0.94, left-leg contracted = 0.86, right-leg contracted = 0.91. LOA95% for estimating precision was as follows: left-leg relaxed = 2.8”, right-leg relaxed = 3.1”, left-leg contracted = 3.9”, right-leg contracted = 3.6”. During the first session, left-leg relaxed Q-angle (M=12.8±3.95”) was greater than (p<0.001, ES=2.4”) when contracted (10.4±3.88”). Right-leg relaxed Q-angle (14.0±4.30”) was greater than (p<0.001, ES=2.8”) when contracted (10.8±4.32”). During the second session, left-leg relaxed Q-angle (12.4±4.01”) was greater than (p<0.001, ES=3.1”) when contracted (9.3±3.59”). Right-leg relaxed Q-angle (15.6±4.52”) was greater than (p<0.001, ES=3.2”) when contracted (10.5±4.17”). CONCLUSIONS: Q-angle may be reliably obtained with a precision of 4° or better using surface goniometry in young men and women with either relaxed or isometrically contracted quad muscles. Furthermore, Q-angles are greater when the quads are relaxed rather than contracted. PRACTICAL APPLICATION: Although reliable and reasonably precise Q-angle measurements may be obtained using surface goniometry, standardized reporting regarding the contractile condition of the quadriceps femoris muscles is needed in order for meaningful comparisons to be made.

Saturday, July 13, 2013, 9:15 AM - 9:30 AM
RELATIONSHIP BETWEEN RATING OF PERCEIVED EXERTION, RESISTANCE EXERCISE INTENSITY, AND FATIGUE

L. Vasquez, J. Alley, C. Goodman, J. Paul, J. McBride

1Appalachian State University, 2Appalachian State University/Neuromuscular & Biomechanics Laboratory, Department of Health, Leisure & Exercise Science, Boone, NC

To normalize ratings of perceived exertion (RPE) during exercise, multiple scales have been developed which offer a practical method to measure subjective effort. Perceived exertion has been defined as the subjective intensity of effort, strain, discomfort, and/or fatigue experienced during the exercise task. RPE scales have been found to relate to intensity during aerobic exercise, however, the relationship between RPE and resistance exercise intensity and fatigue is unclear. PURPOSE: To...
further examine the relationship between RPE scales to resistance exercise intensity (% of one repetition maximum (1RM)) and fatigue (fatigue index) in male subjects engaged in resistance training. METHODS: Twelve subjects (age = 21.9 ± 1.3 yrs, body mass = 77.8 ± 8.0 kg, height = 177.9 ± 6.4 cm, 1RM = 124.9 ± 32.9 kg) performed sets of a traditional back squat at three different intensities (50%, 70%, and 90% of 1RM) for 3 repetitions and to volitional failure (50-3, 70-3, 90-3, 90-F). RPE using the Borg 6-20 scale was provided by the subjects immediately following each set. All conditions were performed on a force plate in order to provide total work per set and fatigue index was calculated as the number of repetitions completed per set relative to the number of repetitions completed to volitional failure. RESULTS: The number of repetitions (50-F = 36.6 ± 9.4, 70-F = 15.6 ± 5.0, 90-F = 5.9 ± 2.9, p = 0.05) completed and total work (50-F = 31,224.2 ± 8,148.5 J, 70-F = 15,758.3 ± 7,585.8 J, 90-F = 6,003.5 ± 2,180.7 J) were significantly different between 50-F, 70-F, and 90-F although no significant differences were found between RPE (50-F = 16.7 ± 2.2, 70-F = 16.5 ± 1.6, 90-F = 17.4 ± 2.1) and fatigue index. RPE (50-3 = 9.5 ± 1.6, 70-3 = 11.7 ± 1.1, 90-3 = 15.3 ± 1.8) and fatigue index (50-3 = 9.1 ± 1.0, 70-3 = 21.0 ± 7.0, 90-3 = 60.0 ± 23.0) were significantly different between 50-3, 70-3 and 90-3. CONCLUSION: In agreement with previous results this investigation indicates that RPE does increase as intensity increases, but only when performing sets to a predetermined number of repetitions. Our findings also agree with previous investigations that RPE must increase linearly as a function of time (repetitions completed) because the physiological and psychological effect of fatigue (fatigue index) and thus does not differentiate between varying intensities. In the current investigation, when comparing the amount of work performed, the sets completed to a predetermined number of repetitions were similar unlike the RPE values. Alternatively, during the sets to volitional failure all demonstrated similar RPE values, but significantly different amounts of work. This contrast demonstrates that RPE may have little relationship to intensity, repetitions completed, or to work, but does exhibit a strong relationship with fatigue.

PURPOSE: The purpose of this study was to identify the relationship between squat one repetition maximum (1RM) strength and knee position when landing from drop jumps (DJ) of varying heights. Valgus and varus angles are terms to describe frontal-plane knee positions. Valgus is considered a medial deviation of a joint, while varus is a lateral deviation of a joint. Factors such as lack of strength in the gluteal muscles, muscle strength imbalances, or deficiency in general lower body strength relative to body mass may be reasons behind these knee deviations when squatting and landing from jumps. The concern about valgus knee angles during jumping is due to the possible relationship of this phenomenon to anterior cruciate ligament (ACL) injury. Besides the acute injury of an anterior cruciate ligament tear, valgus knee position has also been attributed to more chronic injury such as osteoarthritis. It is postulated that a varus angle is an important component to maintaining knee position with drop jump landings. METHODS: Eleven male subjects completed a 15 minute familiarization session to ensure they were comfortable and aware of proper DJ protocol. DJ heights were randomized at 20 cm, 40 cm and 60 cm and a countermovement jump (CMJ) was performed as well. Reflective markers were placed on the greater trochanter, lateral epicondyle and the lateral malleolus of both the left and right legs to track joint locations and knee angles utilizing three-dimensional videography for two trials of each jump type. Following the jumps a one repetition maximum (1RM) in the squat was completed. RESULTS: The squat 1RM was significantly correlated with the varus/valgus knee angles while landing from jumps at 20 cm (R2 = 0.43), 40 cm (R2 = 0.863), 60 cm (R2 = 0.874) and CMJ (R2 = 0.765). Subjects exhibiting a greater 1RM showed higher levels of knee varus when landing. CONCLUSION: Previous research has identified the relationship between absolute strength of men and women and the tendency for females to land in a more valgus position than their male counterparts. By establishing a significant correlation, this data could now be applied to future research. The varus landing stance of males may be an important factor as to why they experience less ACL injuries every year, as a valgus knee angle has been shown to put the ACL at an increased risk for tearing. If strength is a determining factor for more neutral knee angles at landing, it is possible that by gaining strength and increasing the 1RM of an individual, values will become more normalized, pointing to the need for examination of a training protocol and its effects on knee angles at landing. PRACTICAL APPLICATIONS: By improving the absolute strength of an individual, it is possible that drop-jump landing knee angles will become more favorable, potentially leading to a decrease in injury rates and improved jumping, which could be related to an increase in performance if jumping is a required part of a person’s sport or activity.
THE EFFECT OF INITIATING A STRENGTH PROGRAM ON LOWER BODY SPEED STRENGTH IN ELITE SURFERS
J. M. Sheppard1, S. Nimpfl1, T. Tran2, L. Lundgren3, G. Haff4, A. M. Dunn4
1Surfing Australia & Edith Cowan University, 2Centre for Exercise and Sport Science, Edith Cowan University, 3Centre of Exercise and Sport Science Research, Edith Cowan University, Joondalup, Western Australia, 4Surfing Australia

PURPOSE: Although surfing has been a fully professional, international sport for several decades, the adoption of strength and conditioning methods amongst the sport's elite could be described as being in its infancy. Typically, training approaches for surfing do not acknowledge a considerable strength requirement, instead favoring high volumes of proprioceptive training, flexibility, and endurance. To the authors’ knowledge, there is no data on the effect of strength training methods with a surfing population despite previous investigations finding that speed strength and maximal strength qualities discriminate between higher and lower performers in competitive surfers. The purpose of this study was to evaluate the effect of strength training on lower body power in elite pro-junior (under 20) and professional (World Tour) surfers over a 6 month time period. METHODS: Eleven athletes (19.5±2.2 years, 1.72 m ±0.09 m, 67.3±8.6 kg), including 3 females and 8 males, voluntarily engaged in formal strength training in addition to their in-water surf training and competition. Prior to the study period, each athlete engaged in 3 months of training to develop a minimum level of athletic competence in major movement patterns to prepare for advancement into the strength-training program, as their previous experience in strength training was minimal throughout the group. Depending on each individual’s competitive schedule, athletes completed between 1 and 4 strength-training sessions per week for a 6-month time period, such that they averaged 2 sessions per week over the study duration (48 sessions). Over the training time period, athletes were progressed on an individual basis on the main lifts of bilateral and unilateral squat, snatch, and upper-body push and pulling exercises, as well as accessory exercises. Prior to and to the conclusion of the training period, athletes were assessed for their lower body strength through an unloading jump squat performed on a force platform (500 Hz, Ballistic Measurement System, Adelaide Australia), with the Peak Force (PF), Peak Velocity (PV), and Displacement (DISP) retained as primary dependent variables. Using typical K-S indices for the jump squat (PF: 37 N, PV: 0.01 m/s, DISP: 0.01 m) and a reference value for likelihood of change of 0.2 x group SD, smallest worthwhile change statistics were calculated to reflect the probability that observed results were clinically positive. In addition, paired samples t-tests with an alpha of p<0.05 and effect sizes (Cohen’s d) were calculated. RESULTS: Improvements in PF (172 N, 12%) and PV (0.3 m/s, 11%) were 97% likely to be clinically positive and 3% likely to be clinically trivial, whilst DISP improvements (3.5 cm, 8%) were 89% likely to be clinically positive and 11% likely to be clinically trivial. PF, PV, and DISP changes were all considered statistically significant and to be of moderate to large magnitude of gain (p<0.004, d=0.58; p =0.003, d=0.92; p=0.039, d=0.41, respectively). CONCLUSIONS: Strength training can positively influence speed strength qualities in elite competitive surfers. PRACTICAL APPLICATIONS: Considering that speed strength and maximal strength have been validated as important physical qualities in competitive surfers, strength training methods such as squats and Olympic lifting should be integrated into the overall training of surfers, with a view to increase strength and speed strength qualities.
EFFECT OF WARM-UP DEVICES ON BAT VELOCITY AND PERCEPTION OF HEAVINESS AND SPEED OF SWING OF COLLEGIATE BASEBALL PLAYERS

D. Szymanski1, T. Donahue1, B. Stover1, D. Boyce1, L. Africa1, M. Greenwood1, J. Beam2

1Louisiana Tech University, 2Texas A&M University, 3University of New Mexico

PURPOSE: To examine the effect of various warm-up (WU) devices on bat velocity (BV), and perception of heaviness and speed of swing of collegiate baseball players. METHODS: Twenty Division I college baseball players volunteered for this study and were randomly placed into 1 of 7 groups to swing 7 different WU devices over 7 days. WU devices were: a 33 in, 30 oz standard aluminum baseball bat, 30.5 in, 64 oz flexible weighted implement (FW), 30.5 in, 48 oz flexible weighted implement, 24 oz weighted ceramic cylinder (added to standard bat), 12 oz dynamically weighted plastic cylinder (added to standard bat), 39.5 in, 15 oz end loaded WU device, and 39.5 in, 15 oz dynamic WU device. After a 10 minute active, dynamic WU, players took 2 x10 practice swings with a standard bat, and then sat on a bench in the batting cage area for 5 minutes. A BatMaxx 5500 then recorded WU device velocity for 6 consecutive swings. Immediately after the WU swings, players subjectively rated the heaviness of the WU device to the standard bat. Then, once in the batter’s box, players swung the standard baseball bat 2 times “comfortably” before the experimental trials. A SetPro SPRTSA recorded standard BV from 3 maximal effort swings with 20-seconds of rest between swings while hitting a baseball off a batting tee. Subjects were not allowed to practice swinging between trials. Immediately after each of the 5 swings, players subjectively rated how fast they swung the standard bat. The testing order of different devices was randomly assigned to each group. Each subject was tested on 7 days, using 1 device per day. RESULTS: As expected, there was a significant difference (p < 0.05) between all of the WU device’s swing velocities compared to the standard bat WU swing velocity. There was a significant within-subjects main effect for the WU opinion of “heaviness of bat” data. After comparing each value to the standard bat heaviness rating, all WU devices had significantly different ratings than the standard bat WU heaviness rating. One-way repeated measures ANOVA indicated no significant differences between the mean BV after using any of the 7 WU devices. The only significant within-subjects main effect for the “speed of swing” rating compared to the standard bat was the 64 oz FW. CONCLUSION: Although all of the WU devices swing velocities were different than the standard BV in the on-deck circle and they also subjectively felt different than the standard bat, results indicate that WU devices varying from 15 to 64 oz did not change mean BV of a standard 33 in, 30 oz baseball bat for collegiate baseball players. PRACTICAL APPLICATIONS: Based on BV, players can use any of the 7 WU devices in the on-deck circle and maintain their BV. Therefore, personal preferences as to which WU device to use in the on-deck circle is recommended. The advantage of the WU with a weighted device was thus psychological and not physiological. ACKNOWLEDGMENT: We would like to thank Momentum Sports (Mount Pleasant, IA, USA) and Bats Limited (Hewitt, TX, USA) for partially funding this study.

Saturday, July 13, 2013, 11:00 AM - 11:15 AM
IS THERE A PACING STRATEGY DURING A 505 CHANGE OF DIRECTION TEST IN ADOLESCENTS?
S. Nimphius1, T. Spiteri1, L. Seitz2, E. Haff3, G. Haff4

1Centre for Exercise and Sport Science, Edith Cowan University, 2Centre for Exercise and Sport Science Research, Edith Cowan University, 3Centre of Exercise and Sport Science Research, Edith Cowan University, Joondalup, Western Australia

One basic fitness component often measured in a testing battery is change of direction (COD) ability. The ability for an adolescent to change direction has had minimal focus in health or sport science research in comparison to other common fitness components. A common test for COD is the 505 COD test which is intended for a high velocity running entry followed by a 180 degree change of direction. This test requires a great deal of eccentric strength especially when entering at a high velocity. PURPOSE: To examine if adolescents use a pacing strategy to handle the difficult change of direction during the 505 COD test. METHODS: Twenty male and 19 female adolescents (age: 13.4 ± 0.4 years; height: 161.8 ± 6.7 cm; body mass: 59.9 ± 11.1 kg) volunteered to participate in this study. Maximal acceleration ability was assessed using the 10 m split from a 30 m sprint. The traditional 505 test was used to assess COD ability. Reliability of 10 m sprint times and COD performance were assessed by intraclass correlation coefficient (ICC) and coefficient of variation (CV). The presence of a pacing strategy was assessed by comparing the 10 m sprint split time to the 10 m split prior to the “505” change of direction by a paired T-test and magnitude of effect (ES). Further, the relationship between COD deficit (505 time minus 10 m split time) relative to COD performance was examined using Pearson’s product moment correlations with 90% confidence intervals (90%CI) using log-transformed data. RESULTS: There was a high level of reliability of 10 m sprint time, 10 m split in the 505 and 505 times in these adolescents (ICC: 0.82-0.91; CV: 2.1-3.5%). The 10 m split during a 505 entry was significantly slower than the 10 m split of a 30 m sprint (p < 0.001, ES = 0.55) with adolescents reducing their time by 4.05% ± 3.77% in anticipation of entering the 505 portion of the COD test. In addition, there was a very strong relationship (r = 0.78, 90%CI:0.65 to 0.87) between COD deficit and 505 performance. CONCLUSION: The results demonstrate that some adolescents slow their entry running velocity even before entering the “505” portion of the test where performance time is derived in the traditional 505 test. Further, the assessment of the “COD deficit” is an indicator of actual COD ability by inherently controlling for sprint ability. Although COD deficit explains approximately 60% of the variance in 505 time it seems to be a more specific measure of isolating COD ability with respect to, instead of despite their individual speed capabilities. PRACTICAL APPLICATIONS: Some adolescents may use a pacing strategy when faced with a difficult COD task and their ability to change direction can be assessed independent of their speed by expressing it as a COD deficit.

Saturday, July 13, 2013, 11:15 AM - 11:30 AM
THE COMBINED EFFECTS OF EXERCISE, DIET, AND A MULTI-INGREDIENT DIETARY SUPPLEMENT ON BODY COMPOSITION AND ADIPOKINE CHANGES IN OVERWEIGHT ADULTS
S. M. Arent1, P. Dolan1, J. Pellegrino1, H. Lopez1, T. Ziegenfuss2, A. Walker1, S. Woeller3

1Rutgers University, Human Performance Laboratory, 2Center for Applied Health Sciences

While many supplements are promoted for weight and fat loss benefits, very few of them undergo finished-product research to examine efficacy. PURPOSE: To determine the effect of a dietary supplement containing raspberry ketone, capsaicin, caffeine, garlic, and Citrus aurantium on body composition, hip and waist girth, and adipokines in conjunction with an 8-week exercise training program. METHODS: Overweight males and females (N=50; Mage = 38.2 ± 10.3 yr, Mweight = 88.12 ± 16.0 kg, M%BF = 38.3 ± 7.6%) completed this randomized, placebo-controlled, double-blind study. Subjects consumed 4 capsules per day of the supplement (EXP; n = 15) or placebo (PLA; n = 15). Following baseline testing, both groups underwent 8 weeks of daily supplementation, a calorie restricted diet (500 kcal < RMR x 1.4), and three session per week of supervised progressive exercise training. Training consisted of 3 sets of 5-7 resistance training exercises at an intensity of 90-100% 1RM followed by 30 min of aerobic exercise at an intensity of 70-85% HRR. Body composition (via BOD POD), hip and waist girth, as well as select adipokines (adiponectin, resistin, leptin, IL-6) were assessed at baseline, week 4, and post-intervention (T1, T2, & T3). RESULTS: Significant decreases in weight (-2.3 ± 3.5 kg, P<.001), fat mass (-3.5 ± 2.4 kg; P<.001), and %BF (-3.4 ± 2.2%, P<.001), and a significant increase in LBM (1.6 ± 2.0 kg; P<.001) were seen from T1 to T3. Waist (-8.7 ± 5.8 cm, P<.001) and hip (-6.2 ± 6.3 cm, P<.001) girth were also reduced. There were no significant Group differences (P>.53) for the body composition or girth measurements, though the Time x Group interaction approached significance for waist girth (P=.10). Significant decreases in IL-6 (P=.018), leptin (P<.005), and resistin (P<.01) were seen from T1 to T3 across groups. There was also a significant Time x Group interaction for adiponectin (P=.038), with EXP displaying a 46% increase in adiponectin from T1 to T3 while PLA remained stable. There were no other significant Group effects (P>.30). Changes in leptin were positively correlated with changes in weight (r=.46, P=.015) and waist girth (r=.39, P=.04), and approached significance for correlations with changes in LBM (r=.35, P=.068), FM (r=.36, P=.058), and hip girth (r=.37, P=.07). PRACTICAL APPLICATIONS: The exercise and diet program resulted in significant improvements in body composition, FM, LBM, and girth. With the exception of waist girth, these changes were not enhanced by supplementation with EXP. It is possible that intensity of the program and degree of caloric restriction mitigated potential supplement effects. The significant improvements in adipokines support the utility of exercise, diet, and fat loss for impacting inflammatory biomarkers. Reductions in leptin were associated with changes in weight loss variables and waist girth, whereas increases in adiponectin and reductions in adipokines suggest potential beneficial effects of EXP. The results from this study suggest that EXP could have important health implications. ACKNOWLEDGEMENTS: Funding provided by Ultimate Wellness Systems, Inc.
INTRODUCTION: Research has shown that many athletes are chronically in a state of dehydration. This impairs performance, and increases the chance of heat-related illness. Using sodium supplementation to increase fluid absorption and stimulate the thirst mechanism has proven effective in rehydration. PURPOSE: The purpose of this study was to determine if ingesting a beverage containing 1,780 mg of sodium and 2,953 mg of sodium citrate would increase fluid absorption and stimulate the thirst mechanism. However, it has yet to be evaluated in this study and is another potential question to evaluate. Cyclists change the results of this study remains to be evaluated. Time to fatigue was not evaluated in this study and is another potential question to evaluate. Wilcoxon Sign Ranks Tests revealed no significant differences in performance, making the potential of the proprietary blend of VAAM interesting but needing more conclusive research. PURPOSE: The purpose of this study was to examine the effect of an acute intake of VAAM on 30 minutes of submaximal cycle ergometer exercise at an intensity just under the ventilatory threshold (VT). METHODS: A double-blinded, randomized, placebo controlled, counterbalanced design was used. The placebo was similar to the VAAM in color, smell, taste, consistency and caloric quantity. Both placebo and VAAM were mixed in 8 ounces of water. Sixteen physically active college-age individuals (5 female, 11 male, mean age = 210.6 ± 13.4 years) volunteered. All participants completed 4 cycle ergometer exercise sessions including a maximal exercise test (to determine ventilatory threshold and submaximal workload), a familiarization session (to allow adaptation to equipment and submaximal workload), and two 30 minute cycling sessions (one taking a placebo and one taking a VAAM supplement). RESULTS: Two way repeated measures ANOVA revealed no significant differences when comparing the VAAM and placebo groups on the following physiological variables: VO2 (33.34 ± 4.18 vs. 35.77 ± 4.23 ml kg⁻¹ min⁻¹, p = 0.238), respiratory exchange ratio (0.95 ± 0.04 vs. 0.94 ± 0.05, p = 0.737), blood lactate (3.37 ± 2.29 vs. 3.57 ± 2.31 mmol L⁻¹, p = 0.725), exercise heart rate (164.5 ± 163.7 beats min⁻¹, p = 0.444) and total caloric expenditure (255.60 ± 111.5 vs. 255.77 ± 117.2 kilocalories, p = 0.918). Wilcoxon Sign Ranks Tests revealed no significant differences in median Borg Scale ratings of perceived exertion at 10 minutes (12.5 ± 13, p = 0.124), 20 minutes (15 ± 15, p = 0.174) and 30 minutes (15.5 ± 15.5, p = 0.942) of exercise. CONCLUSIONS: The acute intake of the VAAM did not significantly affect physiological responses during cycling exercise performance at intensities just below the VT. PRACTICAL APPLICATIONS: An acute dose of this VAAM supplement was not shown to be an effective ergogenic aid for the enhancement of submaximal performance during 30 minutes of cycling. Whether an increase in dosage based on body weight or a loading regimen over several weeks would change the results of this study remains to be evaluated. Time to fatigue was not evaluated in this study and is another potential question to evaluate. Cyclists interested in a product that will assist with cardiovascular endurance performance should consider studies such as this one prior to making ergogenic aid decisions.
This investigation was supported by FSI Nutrition, Inc. Omaha, Nebraska.

In a time-efficient manner comparable to traditional endurance training, it may that completed HIIT, where the workload during an exercise bout was not great regardless of training or supplementation status. The lack of change could be group (\(=0.79\)). Conclusions: The present study indicated no changes in EMGFT (\(=0.40\)), nor was there a main effect for treatment vs. mid vs. post) \(x\) treatment (BA vs. PL vs. CON) was used to analyze EMGFT. The y-intercept defined as the EMGFT. A two-way mixed factorial ANOVA \([\text{time (pre, after 3 weeks, after 6 weeks)} \times \text{treatment (BA vs. PL vs. CON)}\] was used to compare the effects of \(75-250\) W) were completed starting at each participant's power cycle ergometer test to determine their EMGFT. Four, two-minute work bouts (ranging from 75-250 W) were completed starting at each participant’s power output at VT and increasing 25 W each consecutive work bout. A bipolar surface electrode arrangement, placed over the right vastus lateralis was used to record EMG amplitude, averaged over 10 s epochs during each cycling bout. The four power outputs were plotted as a function of four EMG slope coefficients, with the y-intercept defined as the EMGFT. A two-way mixed factorial ANOVA (time [pre vs. mid vs. post] \(\times\) treatment [BA vs. PL vs. CON]) was used to analyze EMGFT. Results: The results of the ANOVA indicated there was no significant interaction \((p=0.31)\), main effect for time \((p=0.40)\), nor was there a main effect for treatment group \((p=0.79)\). Conclusions: The present study indicated no changes in EMGFT regardless of training or supplementation status. The lack of change could be attributed to the lower relative intensities used during the EMGFT in the groups that completed HIIT, where the workload during an exercise bout was not great enough to elicit a positive slope across the four, two minute bouts. Practical Applications: Although HIIT has been reported to improve cardiovascular fitness in a time-efficient manner comparable to traditional endurance training, it may not be effective in improving the onset of the EMGFT. ACKNOWLEDGEMENTS: This investigation was supported by FSI Nutrition, Inc. Omaha, Nebraska.

**EFFECTS OF CAFFEINE ON THE RELIABILITY OF EMG AMPLITUDE AND FREQUENCY FOR THE BICEPS BRACHII**

M. Trevino 1, J. W. Coburn 2, L. E. Brown 2, D. A. Judelson 2, M. H. Malek 3

1Exercise Physiology Lab, California State University, Fullerton, CA, 2Center for Sport Performance, California State University, Fullerton, CA, 3Wayne State University

Purpose: The purpose of this study was to determine the influence of caffeine on the reliability of electromyographic (EMG) amplitude and frequency of the biceps brachii. Methods: Fourteen men (22 ± 2 y, 173 ± 7 cm, 85 ± 12 kg) came to the laboratory four times. Visit one served as a familiarization visit. During visits two, three, and four, subjects ingested their assigned drink (0, 5, or 10 mg of caffeine per kg of body mass in a randomized, repeated measures design), rested for 60 min, and performed three maximal isometric muscle actions of the elbow flexors for each visit. RESULTS: No group differences in age, height, weight, and % body fat were present at baseline or after the intervention. Significant time effects indicating decreased body fat (baseline, 44.7 ± 0.1 %; post, 44.5 ± 0.1 %), increased lean body mass (baseline, 52.0 ± 0.1 kg; post, 56.2 ± 0.1 kg), increase in 1-RM (baseline, 111.4 ± 16 kg; post, 127.6 ± 1.7 kg), increased satiety (baseline, 31.5 ± 2.3; post, 38.6 ± 2.54) and decreased adiponectin concentrations (baseline, 6126.8 ± 162.2 ng/mL; post, 5610.2 ± 162.2 ng/mL) were measured. No changes were observed in any other blood variables regardless of group. CONCLUSION: Exercise training for four weeks increases lean body mass, strength, and satiety in sedentary, overweight and obese adults. Most importantly, macronutrient choice and caloric intake (-150 kcal) in close proximity to nocturnal sleep over four weeks does not negatively impact body weight and body composition, despite common perception, when coupled with an exercise regimen. PRACTICAL APPLICATION: Trainers and coaches may be able to advocate small macronutrient meals prior to sleep in overweight and obese clients, however, much more research is needed to elucidate all possible benefits to nighttime eating and in different populations. ACKNOWLEDGEMENTS: Our participants, Gold's Gym, Jim Burdolt and Zach Muller. This study was supported by the FSU CRC grant and the NSCA Young Investigator Award to MJQ.

**EFFECTS OF A PERSONAL OXYGEN SUPPLEMENT ON PERFORMANCE DURING REPEAT WINGATE ASSESSMENTS**

M. Sartori 1, D. Bellar 1, L. Judge 2

1University of Louisiana at Lafayette, 2Ball State University, Muncie, IN

In many sports the ability to intermittently work at high intensities without degradation in performance is important for success. It is therefore important to study supplements that might benefit repeated high intensity activity. PURPOSE: Peak and mean power from the Wingate test were compared to determine if a personal oxygen supplement can enhance performance during repeat Wingate tests. METHODS: Ten college aged students participated in this investigation (n=10), Two Wingate tests separated by thirty seconds were performed twice in a counterbalanced fashion. Half of the participants received the oxygen treatment during the first Wingate test, and the other half received the oxygen treatment during the second Wingate test. Adequate recovery time was provided between bouts of repeated Wingates. Participants who performed the Wingate with the supplemental canister of Oxygen (95% Oxygen, 4L) were dosed liberally between Wingates. The participants in the control group remained seated on the cycle until the thirty seconds had elapsed. RESULTS: Analysis of the mean power produced during Wingate testing resulted in significant main effects for treatment \((F=6.283, p=0.041, p=0.033)\). The peak power generated during the Wingate testing did not result in a main effect for treatment \((F=2.34, p=0.207, p=0.160)\). No significant interaction effects for treatment*time were found for either mean or peak power \((p>0.05)\). CONCLUSION: The control treatment resulted in a higher mean relative power outputs were plotted as a function of four EMG slope coefficients, with the y-intercept defined as the EMGFT. A two-way mixed factorial ANOVA (time [pre vs. mid vs. post] \(\times\) treatment [BA vs. PL vs. CON]) was used to analyze EMGFT. Results: The results of the ANOVA indicated there was no significant interaction \((p=0.31)\), main effect for time \((p=0.40)\), nor was there a main effect for treatment group \((p=0.79)\). Conclusions: The present study indicated no changes in EMGFT regardless of training or supplementation status. The lack of change could be attributed to the lower relative intensities used during the EMGFT in the groups that completed HIIT, where the workload during an exercise bout was not great enough to elicit a positive slope across the four, two minute bouts. Practical Applications: Although HIIT has been reported to improve cardiovascular fitness in a time-efficient manner comparable to traditional endurance training, it may not be effective in improving the onset of the EMGFT. ACKNOWLEDGEMENTS: This investigation was supported by FSI Nutrition, Inc. Omaha, Nebraska.

**EVENING PROTEIN CONSUMPTION AND EXERCISE: HEALTH AND PERFORMANCE OUTCOMES**

M. J. Ormsbee 1, A. W. Kinsey 1, W. R. Eddy 1, T. A. Madzima 1, L. B. Pantone 1, J. Kim 1

1Florida State University

Common perception is to limit caloric intake in close proximity to nocturnal sleep as it may promote adverse effects on cardiometabolic health and body composition. However, a paucity of data exist that investigate nighttime macronutrient intake and health and performance outcomes. PURPOSE: To compare the effects of carbohydrate (PLA), whey protein (WP), or casein protein (CP) when consumed prior to nocturnal sleep and combined with exercise training on metabolism, body composition, cardiovascular health, appetite, and strength. METHODS: Forty-seven sedentary, overweight and obese adults (BMI ≥25 kg/m2) participated in this double blind, placebo-controlled study. Participants were stratified by gender and % body fat into one of three groups: PLA \((n=14);\) men, 4; age, 281 ± 7.9 yrs, mean ± SD, WP \((n=16);\) men, 3; age, 30.3 ± 6.2 yrs). CP \((n=17);\) men, 3; age, 30.1 ± 6.4 yrs). For four weeks, participants consumed their respective supplements (PLA, 150 kcal/serving; WP, 150 kcal/serving; CP, 140 kcal/serving) as the last caloric beverage at least two hours after dinner and no more than 30 minutes prior to sleep. Participants also completed supervised exercise (3x/week; two days of resistance exercise and one day of high-intensity cardio-based exercise). Pre and post training measurements of anthropometrics, body composition (dual energy X-ray absorptiometry), resting metabolic rate (indirect calorimetry), appetite (visual analogue scales for hunger, desire to eat, and satiety), fasting lipids and glucose (Cholestech LDX), hormonal responses (leptin, C-reactive protein, insulin, insulin-like growth factor-1, cortisol, adiponectin), and one-repetition maximum (1-RM) strength for upper and lower body were completed. A one-way ANOVA was performed to examine group differences at baseline. A 3 X 2 repeated measures ANOVA was used to evaluate changes in dependent variables. When appropriate, Tukey’s post hoc comparisons were performed to locate differences. Values are means ± SE. RESULTS: No group differences in age, height, weight, and % body fat were present at baseline or after the intervention. Significant time effects indicating decreased body fat (baseline, 44.7 ± 0.1 %; post, 44.5 ± 0.1 %), increased lean body mass (baseline, 52.0 ± 0.1 kg; post, 56.2 ± 0.1 kg), increase in 1-RM (baseline, 111.4 ± 16 kg; post, 127.6 ± 1.7 kg), increased satiety (baseline, 31.5 ± 2.3; post, 38.6 ± 2.54) and decreased adiponectin concentrations (baseline, 6126.8 ± 162.2 ng/mL; post, 5610.2 ± 162.2 ng/mL) were measured. No changes were observed in any other blood variables regardless of group. CONCLUSION: Exercise training for four weeks increases lean body mass, strength, and satiety in sedentary, overweight and obese adults. Most importantly, macronutrient choice and caloric intake (-150 kcal) in close proximity to nocturnal sleep over four weeks does not negatively impact body weight and body composition, despite common perception, when coupled with an exercise regimen. PRACTICAL APPLICATION: Trainers and coaches may be able to advocate small macronutrient meals prior to sleep in overweight and obese clients, however, much more research is needed to elucidate all possible benefits to nighttime eating and in different populations. ACKNOWLEDGEMENTS: Our participants, Gold’s Gym, Jim Burdolt and Zach Muller. This study was supported by the FSU CRC grant and the NSCA Young Investigator Award to MJQ.
the determination of EMG amplitude and frequency. Results: The results indicated high intraclass reliability coefficients for each of the three EMG amplitudes (R = 0.936, 0.965, and 0.961) and EMG frequency conditions (R = 0.917, 0.888, and 0.839) for the 0, 5, and 10 mg·kg⁻¹ of body mass caffeine conditions, respectively. Conclusion: It’s concluded that EMG amplitude and frequency may be reliably determined from the biceps brachii following ingestion of either 0, 5, or 10 mg·kg⁻¹ of body mass of caffeine. Practical Application: Researchers and practitioners interested in measuring neuromuscular responses to caffeine can do so reliably using EMG.

Poster: 8
BINGE DRINKING FOLLOWING HEAVY ECCENTRIC RESISTANCE EXERCISE: EFFECT ON MUSCLE POWER
J. L. Vingren¹, N. Idemudia¹, C. Cregar¹, A. A. Duplanty¹, R. G. Budnar¹, D. W. Hill²
University of North Texas
Purpose: To investigate the effect of alcohol on explosive performance measures during recovery from heavy eccentric resistance exercise. Methods: Twenty-one healthy men (Mean ± SD: 24 ± 2 years, 180 ± 6 cm, 86 ± 13 kg) completed 3 identical acute heavy resistance exercise tests (AHRET) separated by 1 week. The AHRET consisted of 4 sets of 10 repetitions of eccentric smith machine squats at 110% of 1-repetition maximum (1-RM) with 4 min of rest between sets. The first AHRET session was used as preconditioning and no performance measures were obtained. The second and third AHRET sessions were used for the experimental protocol. On these 2 visits participants consumed a drink containing either alcohol (EtOH; 1.086 g of alcohol per kg lean mass; 82-122 ml total) or Placebo (no alcohol) from 10-30 minutes post-AHRET. The participants were blinded to conditions and the order of conditions was counter-balanced. Blood alcohol concentration (BAC) was measured using a breathalyzer. Before the AHRET (PRE), and 24 and 48 hours post AHRET, participants performed 3 consecutive vertical jumps on a forceplate, 20 yard shuttle runs, and 20 yard sprints, all at maximal effort. Muscle soreness was measured using analog scales at PRE and 24 and 48 hours. Results: BAC peaked 60-90 min-post exercise in all participants (0.1±0.02 g/dl) on alcohol ingestion days. No effect (p>0.05) of alcohol was found for vertical jump peak power (EtOH, PRE: 55 ± 11 W·kg⁻¹, 24h: 51 ± 6 W·kg⁻¹, 48h: 51 ± 7 W·kg⁻¹; Placebo, PRE: 49 ± 15 W·kg⁻¹, 24h: 51 ± 6 W·kg⁻¹, 48h: 53 ± 6 W·kg⁻¹), vertical jump height, shuttle run time or 20 yard sprint time. Leg soreness increased moderately from PRE (EtOH: 0.7 ± 0.9; Placebo: 1.0 ± 1.2) to 24 hours (EtOH: 2.4 ± 0.7; Placebo: 2.1 ± 0.6) with no difference between conditions. Conclusion: A moderate-high BAC does not appear to affect explosive lower body power capability 24 and 48 hours following a heavy eccentric squat session that induces moderate muscle damage. Practical Application: Moderate alcohol consumption post exercise may not influence lower body soreness or power performance in the short term recovery period.

Poster: 9
SUPPLEMENTAL CITRULLINE MALATE ENHANCES RESISTANCE TRAINING PERFORMANCE IN TRAINED MALES
B. Wai³, K. Luckett¹, J. Miller¹, A. Thippenen¹, H. E. Webb¹, A. N. Kavazis¹, J. Townsend¹
³Mississippi State University
Ergogenics intended to improve muscular endurance and performance have been utilized as early as 500-400 B.C. In this regard, an amino acid combination consisting of L-citrulline and malate are being promoted as providing an ergogenic effect on muscular endurance during athletic performances. PURPOSE: The aim of the study was to investigate the ergogenic properties of citrulline malate (CM) during a resistance training protocol. Based on CM chemical composition and prior study, we hypothesized that CM supplementation will improve muscular endurance. METHODS: To test our hypotheses, fifteen trained males (age = 23.73 ± 2.28 yr, mass = 86.91 ± 9.37 kg, height = 178 ± 6.73 cm) participated in a randomized, counterbalanced, double blind study. Subjects were randomly assigned to placebo CM (8.0g) or (PL) and performed three sets of chin-ups, reverse chin-ups, and push-ups to failure. One week later, participants ingested the other supplement (CM or PL) and performed the identical exercise protocol. Blood lactacid and heart rate were determined pre- and immediately post-exercise. RESULTS: CM supplementation increased repetitions in chin-ups (CM = 32.93 ± 6.04; PL = 29.26 ± 7.65, p < 0.05), reverse chin-ups (CM = 32.8 ± 7.40; PL = 26.93 ± 5.56, p < 0.05), push-ups (CM = 100.73 ± 36.73; PL = 91.2 ± 36.98, p < 0.05), and total trial repetitions (CM = 166.46 ± 43.99; PL = 147.4 ± 47.67, p < 0.05). Blood lactate was significantly increased (p < 0.05) post-exercise compare to pre-exercise, but were not significantly different between CM and placebo. Self-reports measures of RPE did not reveal any significant interaction effects, and revealed only a main effect for time with RPE increasing equally across time in both conditions. Further, a significant interaction effect was revealed for systolic blood pressure, a significant condition effect for diastolic blood pressure, and a significant time effect for HR. Post-hoc analysis revealed that SBP responses were more elevated in the placebo condition during recovery. CONCLUSION: Collectively, these novel findings suggest that CM increases muscular endurance during upper body resistance exercise. PRACTICAL IMPLICATIONS: Our data suggest that acute CM ingestion prior to resistance exercise may provide an ergogenic effect by increasing muscular endurance and mitigating demands on the cardiovascular system, yet further research is warranted.

Poster: 10
SELECTING A RESISTANCE ASSESSMENT METHOD AND AN OPTIMAL LOAD USING REGRESSION MODELS
J. Anning¹, C. Lefever¹, B. Jensen¹
¹Slippery Rock University
Purpose: The purpose of this study was to develop an objective approach for professionals to select the most appropriate resistance assessment method along with an optimal training load based on resistance training background. METHODS: Following IRB guidelines, seventy college resistance training students (19 men and 51 women; 20 untrained, inexperienced group; 29 untrained, experienced group; 21 trained, experienced group) completed the flat bench press using three resistance assessment methods: (a) Body Weight (Baechle and Groves, Weight Training: Steps to Success, 2nd Edition), (b) 10RM, and (c) IRM. Students also completed questionnaires seeking their descriptive and resistance training background information. Stepwise regression analyses used sex, body weight, and resistance training characteristics (status [TS], frequency [TF], intensity [TI], experience [EX]) as independent variables and bench press (BPE) to develop models for resistance assessment method selection and optimal load predictions. RESULTS: The stepwise regression analysis developed the following resistance assessment method selection model (scale of 1-3): -1.262 + 0.49 (Sex) -0.072 (TS) +0.185 (TI) + 0.534 (TE) + 0.993 (BPE) -0.002 (BW) (r2 = 0.941). The models predict optimal loads in pounds for each assessment method included following the following: (a) Body Weight Method = 158.156 - 77.889 (Sex) +6.953 (TS) +21.41 (BW) (r2 = 0.891), (b) 10RM Method = 162.521 - 103.319 (Sex) +0.355 (BW) +10.426 (TS) +17.597 (TF) +17.188 (BPE) -10.463 (TI) (r2 = 0.92), (c) IRM Method = 173.107 -103.357 (Sex) +4.933 (BW) +11.207 (TS) +19.954 (TF) +10.500 (TI) (r2 = 0.905). CONCLUSION: These stepwise regression models appear to be useful in identifying the appropriate resistance assessment method prior to estimating an optimal load based on resistance training status and experience. PRACTICAL APPLICATION: Referring to the important variables identified through stepwise regression analyses, professionals will know what questions are necessary to determine resistance training status and experience. This information can then be used to select an appropriate assessment method and load prior to designing a resistance training program.

Poster: 12
COMPARISON OF ONE REPETITION MAXIMUM BACK SQUAT UNDER BAREFOOT AND SHOD CONDITIONS
B. Busketta¹, E. Bayer¹
¹Manhattan College
Debate exists over the merit of barefoot training in general; even less clear are the potential advantages of barefoot resistance training. PURPOSE: The purpose of this investigation was, therefore, to compare one repetition maximum IRM back squat strength under barefoot and shod conditions. METHODS: Subjects included 16 Division I athletes (8 male, 8 female, 20+1.2 yrs). None of the subjects had significant barefoot training experience. Over the same two-week period, each reported to the weight room on two separate occasions for two counterbalanced IRM back squat assessments. On one occasion, subjects were tested barefoot; on the other, each wore standard running shoes S (sequence counterbalanced). An identical warm-up and IRM assessment protocol were used throughout all testing. A paired samples t test (SPSS software) was used to compare IRM means across conditions. RESULTS: No significant differences in IRM were revealed (B 233.1+75.2, S 235.6+79.4, p>0.05). No adverse events were reported. CONCLUSION: It can be concluded that, in college age subjects, naive to B training, no advantage in terms of force production through the lower body can be discerned. Future research will be required to evaluate other potential benefits/risks (proprioception, kinematics, injury risk). PRACTICAL APPLICATION: Strength coaches, personal trainers, athletic trainers and physical therapists are advised that no clear benefit, in terms of lower body force production, seems to be derived from B training. As no deleterious effects were noted here, the judgment of the professional may determine the appropriateness of B training in a given setting.
THE ACUTE EFFECTS OF CONCURRENT TRAINING ON PERCEIVED EXERTION AND STRESS DURING STRENGTH TRAINING SESSIONS

G. Deakin1, K. Doma2
1Institute of Sport and Exercise Science, James Cook University, Cairns, Australia. 2Institute of Sport and Exercise Science, James Cook University, Cairns, Australia.

PURPOSE: Concurrent training has been shown to impair strength training adaptation. The “acute adaptation hypothesis” contends that residual fatigue generated from previous endurance training sessions may impair muscular contractility during subsequent strength training sessions. Whilst studies have examined this acute effect on individual strength training sessions on the same or following day, there have been limited investigations of the quality of multiple strength training sessions during a typical concurrent training week. METHODS: Sixteen male and eight female moderately trained runners who were familiarized with strength training were evenly separated into concurrent training (CON) and strength training (ST) groups. The CON group undertook six running sessions on consecutive days and three strength training sessions on alternating days (St1, St2 and St3, respectively). On days when strength training and running sessions were combined, a nine hour recovery period was provided. For the ST group, the participants undertook strength training sessions on alternating days only. The running sessions consisted of three incremental stages (i.e. 70-, 90- and 110% of their ventilatory threshold) on the treadmill with two minutes of recovery in-between each stage. The first stages were 10 minutes in duration whilst the third consisted of three intervals (i.e. 1:1 work to rest ratio) followed by a run to exhaustion. The strength training session consisted of incline leg press, leg extension and leg curls with each exercise performed at six repetition maximum. There were three minutes rest in-between each set and exercise. Rating of muscle soreness (RMS) and muscle fatigue (RFE) were measured prior to each strength training session. Rating of perceived exertion (RPE) was measured at the completion of each of the three first sets during the incline leg press exercise then reported as an average value. Blood lactate was collected immediately following each strength training session. A two-way (group x session) repeated measures ANOVA was used to examine differences. RESULTS: A group x session interaction effect was found for RMS and RMF (P < 0.05) and a main effect for session found for blood lactate and RPE (P < 0.05). Specifically, RMS and RMF were significantly greater for the CON than the ST group and that these parameters during St1 and St3 were significantly greater than St1 for the CON group (P < 0.05). For the CON group, RPE and blood lactate were significantly greater during St2 and St3 than St1 (P < 0.05). However, blood lactate was significantly less during St2 and St3 compared to St1 for the ST group (P < 0.05). CONCLUSION: Concurrent training increases the physiological stress and perception of effort in subsequent strength training sessions despite a nine hour recovery period, a scenario that is not found when performing strength training sessions alone. PRACTICAL APPLICATIONS: Due to the accumulative effects of fatigue with moderate to high intensity concurrent training sessions, strength and endurance training sessions with similar intensity and volume to the current study should be performed on alternating days to allow sufficient recovery and optimize the quality of each training session. In addition, ratings of perceived exertion, soreness and fatigue can be used to monitor the level of recovery during a concurrent training program.

COMPARISON OF ON-CAMPUS AND OFF-CAMPUS SUMMER TRAINING ON STRENGTH PERFORMANCE OF COLLEGE FOOTBALL PLAYERS

M. Heinecke1, J. L. Mayhew2
1Winston-Salem State University, 2Truman State University

Anecdotal evidence suggest that football players have better results in their summer training if they remain on-campus under the supervision of a strength and conditioning specialist in preparation for the fall season. The supposition is that those who are not under the guidance of a strength and conditioning specialist may not reach the same intensity in their training and thus will not achieve the same strength gains as those who stay on-campus. PURPOSE: To assess the changes in 1RM strength performance during summer training in college football players for those who remain on-campus and those who do not. METHODS: 88 NCAA Division II college football players (height = 185.0 ± 7.4 cm, weight = 102.2 ± 22.8 kg) self-selected into groups that stayed on-campus for 90% of the summer (ES, n = 16), 50% of the summer (PS, n = 25), and 0% of the summer (NS, n = 47). 1RMs for bench press and squat were performed at the beginning of summer and again prior to Fall training camp. Each player performed individually prescribed resistance training programs throughout the summer based on pre-summer maximal strength measurements. RESULTS: Height (p = 0.43) and weight (p = 0.89) were not significantly different among the 3 groups. Although initial BP was not significantly different among the 3 groups (p = 0.25), SQ was significantly higher (p < 0.01) in ES (228.6 ± 53.5 kg) than in PS (189.6 ± 22.1 kg) and NS (181.9 ± 29.0 kg). Due to the differences at pre-training, ANCOVA was used to determine differences in BP and SQ values, holding pre-training scores constant. The ES (BP = 9.9 ± 6.0 kg, SQ = 29.7 ± 18.2 kg) and PS group (BP = 8.2 ± 5.9 kg, SQ = 23.2 ± 15.7 kg) made significantly greater improvements (p < 0.001) than the NS group (BP = 1.6 ± 6.0 kg, SQ = 4.3 ± 15.8 kg). Two-way ANOVA indicated that the ES group and PS group made significantly greater percent improvement in SQ (15.7 ± 8.0% and 11.9 ± 7.7%, respectively) than in BP (6.9 ± 4.3% and 6.2 ± 4.1%, respectively). Both ES and PS groups made significantly greater percent improvements than NS (BP = 0.8 ± 4.1% and SQ = 0.9 ± 7.6%). CONCLUSION: Whether it is due to a better routine of training or greater motivation, resistance training under the supervision of a strength and conditioning specialist on-campus, even for part of the summer, appears to have a greater impact of strength development than when players leave campus. PRACTICAL APPLICATION: Strength improvements made by college football players over the summer appear to be substantially greater when part or all of the training time is spent on-campus under the direction of a strength and conditioning specialist.

ASSESSMENT OF BODY COMPOSITION AND PERFORMANCE MEASURES DURING A COMPETITIVE VOLLEYBALL SEASON IN COLLEGIATE FEMALE ATHLETES

S. Hayward1, J. Outlaw1, J. Holt1, K. Ralph1, B. Burks2, S. W. Urbina3, C. Wilborn3, L. W. Taylor2
1Univ of Mary Hardin-Baylor, 2Univ of Mary Hardin-Baylor-Human Performance Laboratory

PURPOSE: Throughout the course of an athletic competitive season, an athlete pushes their body to perform at their peak. The general goal of in-season conditioning is to maintain as much lean muscle mass as possible thus preserving the performance associated with the lean mass. Thus the purpose of this study was to observe the physiological changes that occur over the course of a season utilizing collegiate female anaerobic athletes to assess if their current in-season training is maintaining performance and body composition. METHODS: Ten Division III female volleyball players (18.8 ± 1.03 yrs, 65.36 ± 11.6 kg, 170.4 ± 8.6 cm, 21.39 ± 5.1 %BF) participated in a pre-season and post-season assessments. Subjects were tested prior to the season (PRE) consisting ofDEXA, a standing vertical jump (VJ), and a 3-step approach VJ (3-SVJ) to mimic an approach for hitting during competition. In-season training consisted of resistance training (2 days/week) and sport-specific workouts, practices, and competitions designed by the coaching staff. Subjects repeated all testing at the completion of the season (POST). Statistical analyses utilized a paired t-test to compare all dependent variables from PRE to POST (p < 0.05). RESULTS: A significant decrease from PRE to POST (p = 0.03) was observed for change in lean body mass (PRE: 45.01 ± 7.0 kg vs. POST: 44.15 ± 6.47 kg) which contributed to the observed significant (p = 0.03) increase in body composition (%BF). POST body composition measured as percent body fat via DEXA increased to 22.33 ± 4.74 from PRE 21.39 ± 5.11. A slight statistical trend (p = 0.08) was observed for increases in fat mass (PRE: 13.11 ± 5.3 kg vs. POST: 13.56 ± 5.24 kg) over the course of the season. No significant differences were observed between dependent variables body mass (PRE: 65.4 ± 11.6 kg vs. POST: 65.3 ± 11.4 kg), VJ (PRE: 21.45 ± 1.83 inches vs. POST: 21.94 ± 1.45 inches), or 3-SVJ (PRE: 23.1 ± 2.28 inches vs. POST: 23.39 ± 1.96 inches). CONCLUSION: The primary findings of this study suggest despite the high volume of activity and training that is present during a competitive collegiate volleyball season, significant decrements in body composition are observed as indicated by increases in %BF and decreases in lean muscle mass with no change in body mass. With no observed decreases in both VJ and 3-SVJ, it could be suggested that the volleyball related activities and conditioning can prevent performance decrements in lower body power. PRACTICAL APPLICATION: The results of this study can be translated to help know that a higher intensity resistance training program may be beneficial to implement to help negate the decrease in muscle mass over the course of a season. Also dietary protein and nutritional considerations could also help abate the decreases in muscle mass, although these factors were not assessed here. The practical application is the additional knowledge for strength and conditioning specialists when prescribing proper in-season training to programs specific to collegiate level women’s volleyball.
USE OF A LOW INTENSITY OCCULSION SET TO ENHANCE POST ACTIVATION POTENTIATION IN A STRENGTH TASK: A PILOT STUDY

G. W. Kerby1, T. J. Pujol1, A. L. Howard1

1Southeast Missouri State University

PURPOSE: Post activation potentiation has been a common means of positively augmenting power and strength prior to athletic competition. Conditions encountered during occluded weight lifting provide a favorable intramuscular environment to facilitate augmentation of strength and may be able to serve as a potentiating activity. The intent of this study is to compare the effectiveness of a low intensity occluded set as a means of post activation potentiation to traditional potentiation methods. METHODS: Eleven (20±1y) normal weight women volunteered to participate in this study. The women performed rep sets with 30% 1RM to volitional fatigue. Repetition maximum was then conducted 8-10 minutes post potentiation. Traditional potentiation involved two potentiating sets at 80% 1RM for 5 repetitions. Repetition maximum was then conducted 8-10 minutes post potentiation. A statistical analysis was conducted using SPSS v19.0 statistical software package. Statistical significance was set at p<0.05. RESULTS: A repeated measures statistical analysis indicated a significant difference in mean work performed between PIRM and TPAP (1122.7± vs. 1883.183) (p<0.001). A significant difference was found comparing mean work performed between PIRM and OPAP (1122.7± vs. 1755.0±) (p<0.001). No significant difference was found when comparing mean work performed between OPAP to TPAP. CONCLUSION: Occluded potentiation yields similar results to traditional potentiation utilizing only a fraction of the load and volume. PRACTICAL APPLICATIONS: When utilizing an occluded set as a means of potentiation substantially reduced loads (20-30%) appear to be as effective in augmenting strength in subsequent tasks. Consequently the volume and strain placed on the muscle is reduced, thereby potentially lowering the risk of muscular strain, fatigue and injury during the potentiating activity. This may be useful for athletes returning to competition post injury as they can achieve their desired outcome for a strength task while reducing the strain placed on the muscle.

A COMPARISON OF STRENGTH AND POWER MEASURES BETWEEN MALE ARMY RESERVE OFFICER TRAINING CORPS CADETS AND DIVISION ONE MALE AND FEMALE SPORT TEAMS

K. A. Leiting1, J. Reed2

1East Tennessee State University

PURPOSE: The purpose of this research is to identify differences and similarities between male Army reserve officer training corps (ROTC) cadets and athletes of various division one sports. METHODOLOGY: 98 athletes (men's soccer, women's soccer, men's tennis, women's tennis, baseball, women's volleyball, and men's golf) and 23 male cadets performed a series of static jumps (SJ) or countermovement jumps (CMJ) unloaded, (pvc pipe) or loaded (20kg barbell) across their shoulders. Participants also performed an isometric mid-thigh pull on a force plate to assess maximal strength and rate of force development (RFD). A one-way ANOVA with post-hoc Bonferroni adjustment was used to determine statistically significant differences. RESULTS: Baseball players were statistically significantly stronger and had a higher jump height in all conditions compared to male ROTC cadets. Men's soccer players were statistically significantly stronger maximally and alometrically scaled and had a higher jump height in 0kg SJ and 20kg CMJ. Blackwelder, (1982) suggested that an alpha greater than 0.50 indicates that two groups are considered similar. Women's soccer players are considered statistically similar to male ROTC cadets in measures of alometrically scaled IPF and rate of force development (RFD). Men's golf players are considered statistically similar to male ROTC cadets on all performance measures except 20kg SJ and CMJ as men's golf did not perform that jump condition. Women's volleyball and men's tennis players are considered statistically similar to male ROTC cadets on all performance measures. DISCUSSION: Most military tasks have been identified as strength dependent and Army training is based on “warrior tasks and battle drills” although, most ROTC and active duty training is based on aerobic capacity and muscular endurance. ROTC cadets and soldiers are a product of their physical fitness training. This data suggests disconnect between Army physical fitness training and tasks soldiers are expected to perform. It is commonly accepted that females are typically weaker than male counterparts due to less body mass and specifically muscle mass. This data suggests male ROTC cadet’s lack strength and power when compared to athletes from other sports. APPLICATIONS: Physical fitness training for Army ROTC cadets and active duty soldiers should increase emphasis on strength training activities similar to athlete training programs.

EFFECTS OF DIFFERENT REST INTERVAL BETWEEN ANTAGONIST PAIRED SETS ON REPETITION PERFORMANCE AND MUSCLE ACTIVATION

M. D. Maia1, G. A. Paz2, E. Bezerra2, R. Simão1, H. Miranda1

1Federal University of Rio de Janeiro, School of Physical Education and Sports, Rio de Janeiro, RJ, 2Federal University of Amazonas, School of Physical Education, Manaus, AM., 3Federal University of Rio de Janeiro

PURPOSE: The purpose of this study was to investigate the effects of different rest intervals between antagonists paired set training (APST) in the number of repetitions completed and muscle activation. METHODS: Fifteen recreationally trained men (22.5 ± 1.9 years, 174 ± 10.1 cm and 24.3 ± 2.1 kg) with previous resistance training (RT) experience (3 ± 0.8 years) participated as subjects in this study. In the first and second test session was applied the 10 repetition maximum (RM) test and retest for lying curl (LC) and seated leg extension (LE) resistance exercises (48h apart). In six non-consecutive days were applied the six experimental protocols: 1) Traditional protocol (TP) - one set of repetition to failure on LE; 2) One set of LC followed by a set of LE without rest interval (PWR); 3) Thirty seconds rest interval between LC and LE (P3.0); 4) One-minute rest interval between paired sets (P1); 5) Three-minutes rest interval between paired sets (P3); and 6) Five-minutes rest interval between paired sets (P5). The number of repetitions and electromyographic (EMG) activity of vastus lateralis (VL), vastus medialis (VM) and rectus femoris (RF) muscles were recorded during the LE set during each protocol. The root mean square was computed during each set and normalized through by the percentage of maximal voluntary isometric contraction (% MVC). The current study was carried out following the Declaration of Helsinki and the US Department of Health and Human Services Policy for the Protection of Human Research Subjects (US Code, Title 45, Part 46 Protection of Human Subjects). A one-way ANOVA with repeated-measures followed by LSD post hoc test was used to evaluate differences in repetition performance and muscle activation (p < 0.05). RESULTS: Significant increase in repetitions performance were observed for PWR (14 ± 1.3), P3 (13 ± 1.2) and P1 (13 ± 1.7) compared to TP (10 ± 0.4). The P3.0, P5 (11 ± 1.6) and PS (11 ± 2.3) also showed significant difference for PWR. Similar results were observed between P3 and P5 compared to P3.0, as well as, among P3 and P5 for PI. The RF activation showed a significantly increasing during PWR (75.9 ± 9.8%) when compared to TP (70.1 ± 10.9%), P3 (74.2 ± 12.1%) and P5 (69.2 ± 13.9%), and also for P3 compared to TP, P5 and P5. No differences were observed among TP, P3 and P5. Similar results were observed for VM during PWR (90.2 ± 12.1%) compared to TP (86 ± 10.1%), P3.0 (82.3 ± 11.1%), PI (84.2 ± 10.3%), P3 (81.2 ± 10.3%) and PS (80 ± 12.1%). Additionally, no significant differences were found for VL. CONCLUSIONS: Significantly greater muscle activation was evident for the agonist muscles (e.g. VM and RF) following the antagonist manipulating (e.g. LC) protocol versus the TP. The number of repetitions completed without rest interval and with 1 minute to 30s-rest intervals during APST was significantly higher when compared to 3 and 5-minutes rest intervals. PRACTICAL APPLICATIONS: Therefore, there is justification for practitioners to experiment shorter rest intervals between APST which may be associated to agonist enhancement on repetition performance and muscle activation.
within one week of each other. RESULTS: IRM bench press increased from pre-training (147.5 ± 20.6 kg) to post-training (151.7 ± 22.0 kg) for the composite sample, although there was considerable variability in the change scores ranging from a decrease of 24 kg (18%) to an increase of 31 kg (25%). The effect size was considered trivial (ES = 0.20). 66% of players increased their IRM by 5.3 ± 4.5%, 6% remained the same, and 18% decreased by 5.9 ± 4.6%. The change in strength was not significantly related to initial IRM (r = -0.05), initial body mass (r = -0.11), or change in body mass (r = 0.07). In the 46 players (22%) who gained 10 kg or more in IRM, the improvement was also not significantly related to initial IRM (r = -0.19), initial body mass (r = 0.02), or change in body mass (r = 0.03). However, in the 15 players (7%) who decreased by 10 kg or more in IRM, the change was significantly related to initial body mass (r = 0.57), indicating that the greater the decrease in body mass, the greater the decrease in IRM following training. NFL-225 repetitions increased from pre-training (14.2 ± 6.5) to post-training (15.2 ± 6.7) for the composite sample, ranging from -6 to 8 repetitions. The effect size was considered trivial (ES = 0.15). 60% of players increased NFL-225 repetitions by 2.3 ± 1.6 repetitions, 17% remained the same, and 23% decreased by 1.9 ± 1.3 repetitions. NFL-225 prediction equations had higher correlations with IRM before training (ICC=0.97) than after training (ICC=0.85). CONCLUSION: Short-term resistance training in major college football players is capable of minor improvement in strength and muscle endurance in college football players. The change in strength may be negatively related to the change in muscle endurance. PRACTICAL APPLICATION: Heavy resistance training may alter the association between muscular strength and muscular endurance in college football players and render the NFL-225 test less effective in predicting the change in IRM bench press strength following training.

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INFLUENCE OF BODY BUILD AND INITIAL STRENGTH LEVEL ON STRENGTH GAIN FOLLOWING RESISTANCE TRAINING IN COLLEGE MEN

J. L. Mayhew1, A. Smith-Ryan2, W. Kemmler1, D. Lauber2, A. Wassermann4
1Truman State University, 2University of North Carolina, 3University of Erlangen, Erlangen, Germany, 4University of Bayreuth, Bayreuth, Germany

Previous investigation has suggested that genetic predisposition of body build may influence the gains in lean tissue and muscle strength resulting from resistance training. PURPOSE: To determine the effect of body build on the increase in upper-body strength and fat-free mass (FFM) resulting from periodized resistance training in college men. METHODS: 207 college men were assessed for IRM free weight bench press and 3-sitkneelord percentage body fat (%fat) prior to and following 12 weeks of periodized resistance training. Fat mass (FM) and fat-free mass (FFM) were calculated from %fat values. Body build distribution was divided in thirds (slender = SL, average = AV, and solid = SO) based on the regression of FFM/Ht2 on FM/Ht2 as reported by Van Etten, Verstappen and Westerterp (Med Sci Sports Exerc, 26:515-521, 1994). Strength level was divided in thirds (low = LS, average = AS, and high = HS) based on percentile distribution of IRM bench press. RESULTS: At pre-training, body build groups were significantly different (p<0.001) on all variables (FM, FFM, %fat, HT, WT) except age (p = 0.19). SL (51.1 ± 10.8 kg) and AV groups (63.5 ± 13.8 kg) were not significantly different in absolute strength (p=0.08), but were significantly lower than the SO group (69.6 ± 16.4 kg). Relative strength for SL (0.93 ± 0.17 kg/kg) and AV (0.90 ± 0.18 kg/kg) were not significantly different (p=0.83), but were significantly higher than the SO (0.79 ± 0.16 kg/kg). Strength groups were significantly different only in body mass (p<0.002) and FFM (p=0.001). LS (51.2 ± 5.1 kg) and AS groups (64.2 ± 5.5 kg) were not significantly different in absolute strength but were significantly lower than the HS group (84.7 ± 12.7 kg). LS group (0.77 ± 0.12 kg/kg) was significantly lower in relative strength than AS (0.86 ± 0.36 kg/kg) which was significantly lower than the HS group (1.06 ± 0.16 kg/kg). Following training, there were no significant differences among the body build groups for the gain in absolute strengths (SL = 7.0 ± 5.6, AV = 7.6 ± 6.9, SO = 8.3 ± 6.0 kg) or relative strength (SL = 0.09 ± 0.09, AV = 0.10 ± 0.09, SO = 0.09 ± 0.007 kg/kg). There was no significant difference among the strength groups in absolute strength gain (LS = 8.1 ± 6.6, AS = 8.1 ± 5.6, HS = 6.4 ± 6.5 kg), but the HS group made significantly less gain in relative strength (0.06 ± 0.08 kg/kg) compared to LS (0.11 ± 0.09 kg/kg) and AS (0.10 ± 0.08 kg/kg). CONCLUSION: Neither body build nor initial strength level appear to influence upper-body strength gains resulting from a short-term periodized resistance training program in young men. PRACTICAL APPLICATION: Although training specificity is of known importance to sport-specific strength gains, results from the current study suggest that all body types will respond in a similar fashion to resistance training.

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THE RESISTANCE CHARACTERISTICS OF SUSPENSION TRAINING SYSTEMS AT DIFFERENT ANGLES AND DISTANCES FROM THE HANGING POINT

D. Melrose1, J. Dawes2
1Texas A&M University- Corpus Christi, 2Texas A&M University Corpus Christi

The resistance or load utilized during resistance exercise is the cornerstone for appropriate exercise prescription. Suspension training systems (STS) are generally constructed out of adjustable straps hanging from a central point, a foot sling and/ or hand grip. The resistance or load experienced by the use depends on the manipulation of gravitational pull. These manipulations are achieved by modifying strap length, angles, and body positions. To date, load characteristics of STS have not been investigated. PURPOSE: The purpose of this project was to investigate the effect of body angle and distance from the STS hanging point on the percentage of body mass resistance experienced by users. METHODS: Thirty-two college-aged participants (14 females, 18 males) were used as subjects (age 24.06 ± 6.69 yrs, HT 172.53 ± 6.36 cm, WT 79.0 ± 17.55 kg, BMI 26.59 ± 5.27 kg/m², BF% 15.09 ± 9.84%). The STS was connected to an analog dynamometer hung from a standard power rack cross-bar. A proprietary frame was installed on the floor between the power-rack uprights. The frame was sectioned into 30.48 cm increments to allow measurement of resistance beyond the hanging point of the STS. A proprietary goniometer (183 cm in length) was used to achieve specific body angles during the data collection. Testing began with subjects placing their feet on the floor frame directly below the hanging point of the STS. Holding onto the STS handles, the subjects were instructed to lean back to 60° as confirmed by the goniometer aligned between the ankles and shoulders. Resistance readings were taken from the scale dynamometer connected to the STS. Resistance measurements were also taken at 45°, 30°, and 15°. The subject would then move back to each 30.48 cm increment from the hanging point and measure resistance at each angle until maximum STS lengths had been attained. At 60°, six increment measurements were made. At 45°, five increment measurements were made. At 30°, four increment measurements were made, and 15° allowed only three increment measurements. RESULTS: Across all increments, the resistance at 60° was 28.55 ± 0.85 kg (36.13 ± 1.07%) of the subjects’ body mass. The prediction equation for this angle is: y = 0.3639x + 2.2697. At 45°, the resistance was 40.05 ± 0.51 kg (50.69 ± 1.30%) of the subjects’ body mass. The prediction equation for this angle is: y = 0.5086x + 1.9822. At 30°, the resistance was 51.54 ± 1.46 kg (65.24 ± 1.85%) of the subjects’ body mass. The prediction equation for this angle is: y = 0.6306x + 2.8325. At 15°, the resistance was 59.76 ± 1.54 kg (79.68 ± 2.06%) of the subjects’ body mass. The prediction equation for this angle is: y = 0.7154x + 4.569. Resistance measurements varied inversely (±1.82%) between the extremes of each increment from the hanging point of the STS. CONCLUSIONS: As the degree of angle changes from 60° to 15°, the amount of resistance (percentage of body mass) encountered by the user is increased. Changes in distance away from the hanging point do not affect the percentage of body mass the individual must resist. PRACTICAL APPLICATION: With known averages of body mass resistance at different angles, resistance can be more accurately predicted and prescribed to STS users based on situational needs.
by LSD post hoc was applied to evaluate the differences among protocols and variables (p < 0.05). The current study was carried out following the Declaration of Helsinki and the US Department of Health and Human Services Policy for the Protection of Human Research Subjects (US Code, Title 45, Part 46 Protection of Human Subjects). RESULTS: The number of maximum repetitions performed during BP in the AP protocol was 9.9 ± 0.4 repetitions. Significant differences in repetition performance were observed between the AP condition versus the TP (p = 0.0001) and PNFA (p = 0.0001) protocols. No significant differences in repetition performance were observed between the PNFA and TP protocols. During the SR exercise, LD muscle activation was significantly higher for the AP versus the TP (p = 0.0001) and PNFA (p = 0.0001) protocols; significantly higher activation was also demonstrated for the AS versus the TP (p = 0.036) and PNFA (p = 0.004) protocols. Similarly, BB muscle activation was significantly higher for the AP versus the TP (p = 0.0001) and PNFA (p = 0.0001) protocols; significantly higher activation was also found for AS versus the TP (p = 0.001) and PNFA (p = 0.007) protocols. However, for the antagonist musculature, no significant differences were observed in muscle activation for PM and TL muscles between protocols during the SR exercise. CONCLUSIONS: These results suggest that either pre-loading (AP) or pre-stretching (AS) of the antagonist musculature might facilitate an increase in repetition performance for the agonist musculature versus traditional resistance exercise done without preparatory antagonist manipulation. PRACTICAL APPLICATIONS: The results of the current study can be applied using conventional RT machines, often used for the majority of athletes and the general population. Exercise models performed using a reciprocal antagonist/agonist protocol, as in the current study, may also be less time-consuming and could be useful in clinical practice as well as sports performance training.

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NO EFFECT OF GRADUATED COMPRESSION SLEEVES ON MUSCLE POWER
M. C. Pereira1, M. Saulo1, R. Valdinari1, M. Andre1, J. Carmo1, L. E. Brown2, M. Bottaro1
1University of Brasilia, 2Center for Sport Performance, California State University, Fullerton, CA
INTRODUCTION: Investigations have demonstrated that lower-body compression garments can enhance jump power and running economy. Thus, athletes of many different sports wear graduated compression sleeves during games and training to enhance performance. Recently, the use of upper-body compression garments has become popular in sports that require muscular strength, endurance, and power. However, studies on the effects of these compression sleeves on muscular performance still need to be performed. PURPOSE: Thus, the aim of this study was to investigate the effects of graduated compression sleeves on elbow flexor power. METHODS: Twenty-two resistance-trained males (age: 23.9 ± 5.2 years; body mass: 79.2 ± 9.9 kg; height: 176.1 ± 6.3 cm) were randomly assigned to one of two groups: 1) graduated compression sleeves (CS, n= 9) or placebo sleeves (PS, n= 13). Arm circumference was used for the correct size of graduated compression sleeve. The placebo sleeve was visually similar to the compression sleeve but without the capacity for compression. Subjects performed 4 sets of 10 unilateral maximal elbow flexion concentric/ecstatic reciprocal actions with their dominant arm. They were seated in a chair with their arms draped over a “preacher curl bench.” All exercise was performed on a Biodex System 3 isokinetic dynamometer at 120°s-1 with one minute rest between sets. Data were sampled at 100 Hz and were analyzed via Biodex software. Average power (W) was calculated for each set of concentric and eccentric actions. A 2 x 4 (group x set) mixed factor repeated-measures ANOVA was used to compare groups across sets (CS vs. PS). RESULTS: There was no significant interaction but there were significant (p<0.05) main effects for set for both concentric and eccentric actions. For concentric actions, power significantly decreased across sets for both PS (p= 0.045 ±16.6 W > set 2: 43.5 ±9.3 W > set 3: 40.9 ±11.3 W > set 4: 36.1 ±9.2 W) and CS (p= 1.5 ±18.9 W > set 2: 36.9 ±5.3 W > set 3: 31.9 ±6.2 W > set 4: 29.3 ±8.7 W). Similarly, power significantly decreased across sets for eccentric actions, PS (p= 0.04) = 92.4 ±22.0 W > set 2: 71.7 ±14.9 W > set 3: 55.6 ±13.5 W > set 4: 463.1 ±13.8 W) and CS (p= 0.077 ±12.4 W > set 2: 74.1 ±12.4 W > set 3: 53.9 ±9.3 W > set 4: 48.4 ±12.1 W). CONCLUSION: Our findings suggest that the use of graduated compression sleeves during elbow flexion exercise has no effect on muscle power output for either concentric or eccentric actions. These results indicate that graduated compression sleeves commonly worn by athletes and fitness enthusiasts during training and competition do not contribute to improved muscle power of resistance trained men during elbow flexor exercise. PRACTICAL APPLICATIONS: Although graduated compression sleeves did not enhance power, they also did not hinder power. Therefore, coaches and athletes may use graduated compression sleeves at their preference for other purposes.

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THE RELATIONSHIP BETWEEN THE NUMBER OF WEEKLY PRACTICE HOURS AND COMPETITION PERFORMANCE OF COMPULSORY FEMALE GYMNASTS
A. R. Russell1, W. Williford2, G. Schaefer3, M. Esco1
1Auburn University Montgomery, 2Auburn University at Montgomery
Female artistic gymnasts in the United States (levels 1 through 6) are considered compulsory gymnasts. All gymnasts at the same compulsory level perform the same predetermined routines. While the skills and routines for each level are clearly outlined, there are no regulations or instructions regarding the appropriate number of training hours per week for gymnasts at a particular level. Thus, the number of hours gymnasts train each week is determined by individual gymnastics clubs, and varies widely from gym to gym. PURPOSE: The purpose of this investigation was two-fold: first, to determine if there is a correlation between number of weekly practice hours (WPH) and all-around competition scores (AA) of compulsory female gymnasts, and second, to determine if there was a significant difference in WPH between gymnasts grouped by quintiles based on AA. METHODS: The 2012 State Championships all-around scores (AA) from 438 level 4 to 6 gymnasts from four states who competed in their compulsory championships were randomly selected for data analysis. All scores were obtained from www.mymeetscores.com, a public website that publishes meet results from many USA Gymnastics sanctioned events. The number of weekly practice hours (WPH) for each gymnast was obtained from practice schedules posted on public websites of the gyms that the gymnasts represented at their respective state championships. Pearson product correlation was used to determine the relationship between WPH and AA. In addition, the sample was grouped into quintiles based on competition scores as follows: Q1 (AA = 32.0 +/- .12); Q2 (33.9 +/- .03); Q3 (35.0 +/- .03); Q4 (35.8 +/- .02); and Q5 (36.9 +/- .05). One-way analysis of variance with follow-up procedures was used to evaluate differences in WPH between the groups. RESULTS: There was a small significant correlation between WPH and AA (r = 0.12; p < 0.05). The mean (+/- SD) WPH for each group were as follows: 81.8 +/- 2.6 (Q1); 85.4 +/- 2.7 (Q2); 94.4 +/- 3.4 (Q3); 95.5 +/- 3.4 (Q4); and 89.5 +/- 3.5 (Q5). There was a significant main effect for WPH between the groups (p < 0.05, Cohen's d = 0.19). Follow up procedures showed no significant difference between Q1 and Q3 (p < 0.05) There was no significant difference in WPH between Q3 and Q1, and no significant difference in WPH between Q2, Q4, and Q5. WPH for Q2, Q4, and Q5 was significantly greater than WPH for Q3 and Q1. CONCLUSIONS: This study found a significant correlation between WPH and AA in compulsory female gymnasts. Furthermore, there was a significant difference based on AA. Results indicated an overall small effect size. PRACTICAL APPLICATIONS: Practitioners should be aware of the results of this study when determining weekly practice time for compulsory female gymnasts. The association between WPH and AA is small. Further study is needed to investigate the relationship between the number of practice hours and performance outcomes of compulsory female gymnasts.

Poster: 25
EFFECTS OF THREE WEEK PRESEASON STRENGTH AND CONDITIONING PROGRAM ON A PROFESSIONAL SOCCER TEAM
M. Silva1, L. Arelano Acero1
1Claremont Graduate University, 2Club America
Participation in professional soccer requires an optimal fitness level because the physical demands of the sport. Therefore preseason conditioning programs play an important role in the athletic success of participants. Because the nature of the game, many professional soccer teams during preseason conditioning program put special emphasis on cardiovascular endurance, speed, strength and power aiming to improve athletic performance during competition. Purpose: to investigate the effects in physical performance before and after three week preseason strength and condition program for an under-20 professional soccer team competing in the Mexican soccer league. Methods: a total of 18 males (mean ± SD: age 19.4 ± 0.7 years) served as subjects for this study. Participants underwent to a condition program with major emphasis on cardiovascular endurance, speed muscular strength, and power. The first week of the conditioning program consisted of two practice sessions per day for six days and one day of rest, and on the second and third week, the frequency decreased to one practice session per day and one day of rest after six practice sessions. Before and after the conditioning program, a battery of field tests was administered to each of the participants to measure cardiovascular endurance, muscular strength, and power. The field tests utilized were vertical jump (VJ), 30 meters run, 1 repetition maximum (IRM) bench press, IRM squat, and 1 kilometer run. The subjects participated in two days of testing before and after preseason. On day one participants performed the vertical jump and the 30 meters run, and on the second day IRM bench press, IRM squat and 1 kilometer run. A paired-samples t-test was used to determine
A COMPARISON OF RAPID FORCE PRODUCTION AND TIME-TORQUE CHARACTERISTICS IN ADOLESCENT MALES VS YOUNG ADULT MALES


1Oklahoma State University, 2Oklahoma State University, Applied Musculoskeletal and Human Physiology Lab, Stillwater, OK

The ability to produce force or torque is related to human performance and the ability to produce force or torque rapidly may be even more related to human performance. Rapid force and time torque characteristics can be measured during the completion of a maximal isometric muscle action. During the IRM isometric muscle action we can obtain peak torque (PT) and rate of torque development (RTD) across specific time periods while the muscle is contracted. PURPOSE: The purpose of this study is to compare maximal and rapid muscle force characteristics of adolescent males vs young adult males. The study is designed to examine the effects of maturation on strength and rapid force development. METHODS: Twelve adolescent males (mean±SD, age=11.6±0.9yr; mass=52.5±18.9kg; and height=152.3±10.2cm) and 26 young adult males (mean±SD, age=24.9±3.0yr; mass=118.6±11.3kg; and height=178.3±7.0cm) reported to the laboratory one time for testing. The testing session lasted approximately 45 minutes. During the testing session the subjects completed a 5 minute warm-up on a cycle ergometer. Maximal isometric strength testing was performed on the dominant leg using a Biodex System 4 isokinetic dynamometer. The participants were seated with stabilizing straps placed over the trunk, hip, and thigh and the axis of rotation of the lever arm was aligned with the axis of rotation of the knee joint. For leg extension testing the lever arm was positioned at 60° below the horizontal plane and for the leg flexion testing the lever arm was positioned at 30° below the horizontal plane. Each participant performed 2-3 isometric voluntary contractions (MVCs) lasting 3-4 seconds with the legs extended for flexors with a one minute rest period between muscle actions and three minutes of rest between muscle groups. Testing order was randomized to control for any effects of fatigue. PT and RTD at specific time periods (PeakRTD, RTD50ms, RTD100-200ms, RTDI/6MVC, RTD/2MVC) were collected for each subject and comparisons were made between the two groups (adolescents vs young adults). RESULTS: A one-way ANOVA was used to compare the collected performance variables between the two groups. For leg extension there was a significant (p<0.05) difference between the two groups for every variable tested with the young adults having greater PT, and higher PeakRTD, RTD50, RTD100 and RTD100-200. When normalized to strength the two groups were also significantly (p<0.05) different at RTDI/6MVC and RTD/2MVC. For the leg flexors, similar results were found across all variables except for there was no significant (p>0.05) difference between the two groups at RTD/2MVC. CONCLUSIONS: The ANOVA results indicated that the young adult males appear to be able to develop force more rapidly than adolescent males. The young adult males performed better for all variables for the leg extenders, and all of the variables with the exception of the relative RDF at 1/2MVC for the leg flexors. PRACTICAL APPLICATIONS: These findings indicate that there are differences between adolescent and young adult males in the ability to rapidly produce torque which are primarily related to strength differences between the two groups. This appears to be related to developmental changes in muscle size and possibly neural factors associated with strength increases that occur with maturation which could affect functional performance.

A COMPARISON OF THE MODIFIED SINGLE-LEG SQUAT AND THE BACK SQUAT IN NCAA DIVISION I BASEBALL ATHLETES

F. Spaniol1, R. Burnett1, J. Dawes2, B. McQueen1

1Texas A&M University-Corpus Christi, 2Texas A&M University Corpus Christi

PURPOSE: The purpose of this study was to compare the effects of performing the Modified Single-Leg Squat (MSLS) versus the Back Squat (BS) on rotational power, lower-body strength, and leg-power in NCAA Division I Baseball Athletes. METHODS: Thirty-five Baseball contestant-athletes completed an 8-week resistance training protocol consisting of either the MSLS or the BS. The Rotary Power Test was used to determine rotary power (RP). Bilateral strength (BLS) was measured using a BS 3 repetition-max (RM) test; unilateral strength (ULS) was measured using a MSLS 3 RM test. Bilateral (BLP) and unilateral leg power (ULP) were assessed via vertical jump testing on a HYTEK force plate. Subjects were randomly divided into two groups, which were further sub-categorized based on position (pitchers and position players). Both groups were required to perform the same resistance-training program; however, one group was assigned the MSLS as the primary lower-body strengthening exercise whereas the other group was assigned the BS. The 8-week off-season training program consisted of a four/day/ week upper and lower body split-routine. Both the MSLS and BS exercises were progressed in a linear fashion, beginning with 50% of each subject’s IRM for 10 repetitions per set (R/S) for 4 sets in weeks 1-7, and ultimately progressing to 90% of each subject’s IRM for 3 (R/S) for 5 sets in week eight. Load assignments per set and desired repetitions ranges were similar for each group. RESULTS: Paired t-tests were used to determine statistical differences between pre and post-testing for each variable in both groups. Independent T-tests were also used to analyze any mean differences between the groups’ post-test scores; significance was determined at the p < 0.05 level. The MSLS group improved significantly from pre-testing in RP (p = 0.03), ULP with the right leg (p = 0.04), ULS (p < 0.001) and BLS (p < 0.01). There were no significant differences between groups on any of the performance variables. CONCLUSIONS: These results suggest that both the MSLS and BS exercises are effective in increasing lower-body strength. However, only the MSLS group revealed a statistically significant difference in RP and ULP from pre to post test. Thus, it appears the MSLS exercise may be a more appropriate exercise for increasing baseball athletic performance. PRACTICAL APPLICATIONS: Results indicate that both unilateral and bilateral closed-kinetic chain, lower body strength training exercises may be viable options for increasing bilateral and unilateral leg strength. Only the unilateral strength exercises increased rotational power and unilateral power of the right leg in this study. The additional hip and knee stability requirements, in addition to the strengthening of hip and knee extensors, make the MSLS a valuable exercise for comprehensive lower-body development.

A COMPARISON OF THE EFFECTS OF PLYOMETRIC AND RESISTANCE TRAINING ON LOWER BODY MUSCULAR PERFORMANCE IN RECREATIONALLY TRAINED MALES

M. T. Whitehead1, T. P. Scheett2, M. R. McGuig3, A. V. Martin4

1Stephen F. Austin State University, 2College of Charleston, 3Sports Performance Research Institute New Zealand, 4Louisiana State University Shreveport

PURPOSE: The purpose of this study was to compare the effects of eight weeks of separate plyometric and resistance training programs on lower body muscular performance. METHODS: A convenience sample of thirty recreationally active, apparently healthy, low-risk males aged 21.3 ± 1.8 years, height 177.3 ± 9.4 cm, mass 80.0 ± 2.5 kg, body fat 16.1 ± 2 % volunteered and participated in this investigation. Participants were grouped and participated in progressive plyometric or resistance training twice per week for eight consecutive weeks or a control group that did not participate in any training. Performance tests were administered prior to and following the training period and included measures of vertical jump, one-repetition maximal back squat, 20-meter sprint, and agility. RESULTS: Analysis of variance followed by post hoc analyses was performed in order to determine significant differences between the groups. Data were converted to pre-post change in order to account for initial between group differences, and statistical significance set at p £ 0.05 for all analyses. Significant differences between the groups following the eight-week training period were indicated for vertical jump, and one-repetition maximal back squat with no between group differences found for 20-meter sprint or the agility run. Post hoc analyses indicated that the plyometric training program resulted in greater improvement in vertical jump 17.15 ± 10.60 vs. 5.87 ± 4.82 vs. 0.71 ± 1.62 % for the plyometric, resistance training, and placebo groups, respectively. No
Non-traditional strength training typically involves exercises such as heavy tractor tire flips, pushing and pulling heavy sleds or cars, lifting sandbags, and other heavy objects. Biomechanical analysis of many of these types of non-traditional exercises has been performed to describe the kinematics and kinetics involved. However, while many strength and conditioning coaches use this type of training for their athletes, no previous study has investigated how using these types of training tactics may affect the changes in strength, speed, and power normally produced during an off season. PURPOSE: The purpose of this investigation is to determine the efficacy of supplementing non-traditional (NT) strength training with traditional (T) strength training performed by college football players. Our intention is to determine if the use of NT training may replace one T training sessions per week. METHODS: Forty-six Division III college football players were recruited for the study. All subjects played at least one season and participated in traditional strength training under the direction of the Strength and Conditioning Staff. Subjects were assigned to a NT group (n=23) made up of offense and defensive linemen, tight ends, linebackers or a T group (n=23) made up of offensive (running backs, wide receivers, quarterbacks) and defensive (defensive back) skill positions. All subjects participated in a 12 week off-season training program consisting of block periodization. Speed, agility, energy system development (ESD) and strength training made up the program with 1 day per week (d/wk) speed, 1 d/wk agility, 1 d/wk ESD and 4 d/wk strength training (2 upper, 2 lower body). The only difference between the 2 training groups was that the NT group substituted “Strongman” type exercises for the second lower body training with traditional (T) strength training performed by college football players. Our intention is to determine if the use of NT training may replace one T training sessions per week. METHODS: Forty-six Division III college football players were recruited for the study. All subjects played at least one season and participated in traditional strength training under the direction of the Strength and Conditioning Staff. Subjects were assigned to a NT group (n=23) made up of offense and defensive linemen, tight ends, linebackers or a T group (n=23) made up of offensive (running backs, wide receivers, quarterbacks) and defensive (defensive back) skill positions. All subjects participated in a 12 week off-season training program consisting of block periodization. Speed, agility, energy system development (ESD) and strength training made up the program with 1 day per week (d/wk) speed, 1 d/wk agility, 1 d/wk ESD and 4 d/wk strength training (2 upper, 2 lower body). The only difference between the 2 training groups was that the NT group substituted “Strongman” type exercises for the second lower body strength workout. Exercises used for the NT training included various sandbag lifts, heavy sled pulls and pushes, heavy ropes, weighted carries, and flipping of a weighted implement. These exercises were periodized similar to the rest of the training for each block (high volume vs. high load). Pre and post testing included football specific tests of strength, speed and power: 10 meter weighted simulated sled drive (45 kgs) for time, standing vertical jump, push press throw peak power (60 kg), and repeat Pro Agility test (10 x Pro Agility; 1 every 30 sec). RESULTS: Improvement was observed in both groups for all tests. Independent t-tests indicated there were no significant differences observed between groups between pre and post testing (% change) for the 10 meter sled drive (T = -0.7% ±7.9%, NT = -2.2% ± 7.7%; p=0.29), push press throw power (T = 11.0% 9.4%, NT = 11.8±12.4%; p=0.81), Pro Agility Total Time (T = 2.3±5.3%; NT = 2.0±5.2%; p=0.84), Pro Agility Best Time (T = -2.2± 2.9%, NT = -1.6 ± 3.9%; p=0.57), and vertical jump (T = 6.4±4.4%; NT= 5.3±5.8%; p=0.11). CONCLUSIONS: The substitution of a non-traditional strength training session at the expense of one less weight room session per week does not decrease the amount of strength, speed, and power improvement during an off-season football training program. PRACTICAL APPLICATIONS The results of this study indicate that NT training does not need to be an additional training session during a microcycle. This type of training activates most muscle groups trained for football, therefore could replace one training session per week during either a split routine or total body training sessions.
PHV (-0.2 ± 0.4 y; n=11) and Post PHV (1.0 ± 0.4 y; n=12). Training consisted of four exercises (3 x 10-12 repetitions) that aimed at developing both bilateral and unilateral horizontal and vertical force production. Exercise progression was based on increasing load but also movement complexity. At baseline, post training and detraining, the participants completed a 30-m sprint, horizontal jump, and ballistic concentric squats on a supine squat machine at five different loads relative to body mass in a randomised order: 80%, 100%, 120%, 140% and 160%. From the ballistic protocol, one-repetition maximum (IRM) and force-velocity-power profiles were determined using the load-velocity, force-velocity and load-power relationships. Standardized differences within and between groups were assessed via magnitude-based inference statistics, with clear effects defined by acceptable 90% confidence intervals. Relative VO2 of all subjects. The decay in Izard in and power was trivial to moderate across the groups (-0.5% to -6.5%), the detraining effect smaller for Mid and Post PHV compared to Pre PHV subjects. Decay in sprint performance was only meaningful in Post PHV (0.6 to 0.9%). Conclusion: The strength-training program was beneficial in improving vertical strength, vertical and horizontal power, acceleration and maximal speed across different maturity groups but the magnitude of the training and detraining effects were maturity dependent. The maturity-specific adaptations to strength training and detraining have important implications for optimal training emphasis periods during growth and maturation. Practical Applications: Strength training was more beneficial at enhancing vertical power and 10-m time in Mid and Post PHV compared to Pre PHV. Rather than strength training, activities providing a velocity stimulus may be more valuable for athletes prior to PHV to develop power and speed. Regardless, practitioners should include bilateral and unilateral vertical and horizontal force production exercises to optimally enhance all aspects of explosive performance and maintenance programs should be planned to reduce rate of decay, especially in Pre and Post PHV subjects. Acknowledgements: The investigators would like to thank Will G. Hopkins for his advice on the statistical analysis of this project.

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METABOLIC DEMAND DURING MULTI-MODAL UPPER EXTREMITY EXERCISE IN PEOPLE WITH SPINAL CORD INJURY

G. Duran-Monge1, B. Clift1, N. Evans1
Beyond Therapy, Shepherd Center

PURPOSE: Spinal cord injury (SCI) often results in immediate and permanent disability. Individuals who suffer a SCI often become less physically active due to reduced ambulatory capacity, decreased activation of skeletal muscle, and limited access to adaptive exercise activities. As a result, those with SCI are more likely to become sedentary, expend fewer daily calories, and develop secondary health complications such as obesity, Type II diabetes, and cardiovascular disease. In order to counteract the deleterious effects of reduced physical activity, it is imperative that individuals with chronic SCI continue to be physically active and exercise professionals have a full understanding of the physiologic and metabolic demands of specific exercise activities in order to optimize training outcomes for those with SCI. The purpose of this project was to quantify the metabolic demands associated with three specific exercise activities performed by subjects with SCI. METHODS: Data was obtained from five, male subjects aged 29 to 58 years with paraplegia resulting from SCI. All subjects completed three, 30 minute exercise sessions including: (1) rope training, (2) hand cycle ergometry, and (3) boxing. One exercise session was performed for recovery between sessions. Metabolic testing was performed to determine exercise energy expenditure (EE) and relative VO2 during each session. Due to the intense nature of the exercise, we hypothesized that 30 minutes of rope training would elicit the highest exercise EE and relative VO2 compared to boxing and hand cycle ergometry. RESULTS: Mean EE for each 30 minute exercise activity was 145.7±47.3 kilocalories (rope), 139.0±26.9 kilocalories (boxing), and 144.3±44.1 kilocalories (hand cycle ergometry). A between group analysis revealed no significant difference (p = 0.96) in EE between exercise modalities. In addition, there were no significant differences (p = 0.39) observed in relative peak VO2 between exercise modalities, however, for all but one subject, the rope training exercise elicited the highest relative peak VO2, compared to boxing and hand cycle ergometry. CONCLUSIONS: Based on preliminary results, it appears that the average caloric expenditure for 30 minutes of either rope training, boxing, or hand cycle ergometry is relatively similar between exercises among this small sample of subjects with SCI. Therefore, it would seem that each of these activities would be equally valuable in facilitating a modest daily caloric expenditure and could be used in conjunction with other exercise modalities to promote lifelong physical health. However, the rope training protocol in this study may provide additional cardiovascular benefit above and beyond that of boxing and hand cycle ergometry based on the intense nature of the activity and the fact that the highest peak VO2 values among all but one subject were observed during the rope training sessions. Additional research with a much larger sample size is needed to elucidate whether a real and meaningful difference in metabolic demand truly exists between these exercise modalities. Practical Applications: Data obtained from this study can be used to help individuals with disabilities and exercise professionals identify those exercises that may elicit the greatest cardiovascular benefit and greatest overall EE to facilitate caloric balance and reduction of secondary health complications following chronic SCI. ACKNOWLEDGEMENTS: Thanks to the Shepherd Center and the Beyond Therapy Department for their support and continued commitment to improve the quality of care for individuals with disabilities.

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THE PREVALENCE OF LOW BACK PAIN IN THE RECREATIONAL WEIGHT TRAINING POPULATION

W. J. Hanney1, M. J. Kolber2, P. Pabian1
1University of Central Florida, 2Nova Southeastern University

Purpose: An estimated 45 million Americans participate in some form of weight training (WT) on a regular basis. Data from the National Health Interview Survey conducted by the Centers for Disease Control found that nearly 20% of adults ages 18 to 65 participate in some form of WT two or more times a week. Although the benefits of resistance training have been well documented, participation is not without risk. A significant number of injuries associated with WT have been reported in the literature with approximately 25% of those being severe enough to seek medical attention. Previous reports indicate that WT participants sustain, on average, 2.6 injuries per 1000 hours of activity. Low back pain (LBP) and or injury has been reported at a rate of 0.43 per 100 hours of participation and appears to be one of the more common sites of injury among WT participants. Previously reported injury rates among WT participants have generally been inclusive of a competitive population and there is little information with regards to LBP in the recreational WT population. Therefore, the purpose of this study was to identify the point and period prevalence rates of LBP in the recreational WT population. Methods: Individuals between the ages 18 to 59 were recruited to participate. Subjects participated in weight training 2 times per week for at least 1 year. Information was collected via in person surveys and included age, height, body mass, and gender. Participants were asked if they are currently experiencing LBP (point prevalence) or have had an episode in the past 6 months or 1 year. Results: Point prevalence of LBP in the recreational weight training population was approximately 10.5% while the six-month prevalence was 28% and 1-year prevalence was 41.5%. Conclusions: Point prevalence of LBP in recreational weight trainers in this study was lower than the general population, which has been estimated to be as high as 28%. Also approximately 28% of the subjects in our study had a 6-month period prevalence of LBP where it has been reported to be has high as 48.9% in the general population. Finally, the one-year recurrence rate of LBP has been reported to be as high as 80% while our study demonstrates reports to be 41.5%. Our findings suggest that recreational WT participants have lower reports of LBP than the general population. Practical Applications: While LBP prevalence rates have been reported to be a significant problem in the competitive WT population the results of our study show that the point prevalence, 6 month and 1 year period prevalence of LBP among recreational WT is below the general population. It seems the one-year prevalence rates are much lower than the general population. Perhaps participation in a recreational weight-training program is protective for episodes of LBP evident by the lower rates. Prospective based studies are needed to determine if indeed recreational WT mitigates risk for LBP.

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ACCURACY OF THE BODY ADIPOSIETY INDEX FOR ESTIMATING BODY FAT IN INDIVIDUALS WITH DOWNS SYNDROME

B. Nickerson1, A. R. Russell1, S. Bicard1, A. Mahurin2, M. Esco1
1Auburn University Montgomery, 2Baptist Family Residency Program

The Body Adiposity Index (BAI) was recently developed as a method to predict body fat percentage (BF%) by using only the variables of hip circumference and height. The simplistic, non-invasive nature of BAI makes it an attractive option for estimating adiposity in individuals with Down’s syndrome (DS), who may feel threatened by more elaborate equipment. However, the BAI was previously validated within groups from the general population. The accuracy of the BAI for
individuals with DS remains questionable since body fat is distributed differently in this special population compared to individuals without DS. PURPOSE: The purpose of this study was to cross-validate the BAI in individuals with DS using dual-energy x-ray absorptiometry (DXA) as the criterion measure. METHODS: Twelve adults and five adolescents with DS (n=17) participated in the study. Height was measured with a wall-mounted stadiometer and hip circumference was measured horizontally at the maximal extension of the gluteus maximus. The BAI method was used to predict BF% with the following equation: BAI BF% = [([hip circumference/height]+5.5) – 18]. Criterion BF% was determined via DXA. RESULTS: The mean BF% obtained from the DXA was 35.7 ± 13.4 and predicted from the BAI was 39.4 ± 11.2 (p = 0.06, Cohen’s d = 0.30). The BAI significantly correlated with the DXA (r = 0.85; p < 0.05) and had a high power of estimate (SEE) of 7.8%. The method of Bland-Altman revealed that the 95% limits of agreement ranged from 11.2% below to 18.6% above the constant error (CE) of 3.7%. CONCLUSIONS: The findings of this study suggest that BAI overestimated BF% by 3.7% compared to the criterion. Though the mean difference between the two BF% measures was not quite significant, the effect size was moderate. In addition, the BAI resulted in a high SEE of 7.8% and the limits of agreement were large. PRACTICAL APPLICATIONS: The BAI has the potential to become widely used in clinical and fitness settings. Practitioners who design healthy lifestyle strategies for individuals with DS should consider the results of this investigation before using the BAI for predicting BF%. It appears to provide overestimated values and may result in a large range of individual error. Therefore, the BAI should be used with extreme caution when predicting BF% in individuals with DS.

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MEASUREMENTS OF REACTION TIME DOES NOT DIFFER BETWEEN FUNCTIONAL FITNESS GROUPS IN OLDER ADULTS
S. Paulson1; M. Gray2
1Shippensburg University, 2University of Arkansas
Research suggests reaction time (RT) slows as one ages. Conversely, some individuals display a resistance to age-related declines in RT due to maintenance of physical fitness. PURPOSE: The purpose of this study was to assess differences in RT measurements between low and high functionally fit older adults. METHODS: Nineteen older adults volunteered to complete a computer-based RT assessment and a power stair climb test (PSCT) to measure functional fitness. Relative power from the PSCT was used to create the two functional fitness groups: low (n = 8, age: 73 ± 10 yrs; ht: 1.64 ± 0.16 m; mass: 76 ± 15 kg; body fat: 36 ± 10%) and high (n = 11, age: 70 ± 5 yrs; ht: 1.64 ± 0.14 m; mass: 72 ± 16 kg; body fat: 33 ± 12%). All subjects passed the Mini Mental State Examination and were free from uncontrolled cardiovascular, metabolic, and pulmonary disease. Anthropometric measurements and a dual energy x-ray absorptiometry were completed prior to testing. A 10-min computerized task was used to measure simple reaction time (SRT), choice reaction time (CRT), sequential reaction time 1 (SEQ1), and sequential reaction time 2 (SEQ2). For the PSCT, each subject was instructed to ascend a set of nine steps as quickly and as safely as possible for three trials. The subjects began at the bottom of the first step and a stopwatch was started on the command “Go”. Time ended when both of the subjects’ feet touched the landing. The best time was used for analysis. Data were analyzed using a one-way ANOVA. RESULTS: There was no statistically significant difference between the functional fitness groups on SRT, CRT, SEQ1, or SEQ2 (p > .05). CONCLUSION: The results of this study should not be a difference between those of functional fitness on various measurements of RT in older adults. PRACTICAL APPLICATION: While functional fitness as it is an important aspect of quality of life of older adults, it appears not to influence RT. The best time was used for analysis. Data were analyzed using a one-way ANOVA. Conclusion: The findings of this study suggest that BAI overestimated BF% by 3.7% compared to the criterion. Though the mean difference between the two BF% measures was not quite significant, the effect size was moderate.

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THE INFLUENCE OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON MAXIMAL FORCE PRODUCTION IN PARKINSONS DISEASE
B. Poston1; E. Heisler2; R. Walsh3; J. Alberts3
1Cleveland Clinic-Las Vegas, Lou Ruvo Center for Brain Health, 2Cleveland Clinic
Transcranial direct current stimulation (TDCS) is a non-invasive brain stimulation method that has recently been used as a modality to acutely increase maximum force production in healthy young adults and stroke patients. Previous studies have also shown that TDCS may improve some aspects of motor function in Parkinson’s disease (PD) such as the rate of motor skill acquisition and the speed of gait. PURPOSE: To determine the influence of acute application of TDCS on the maximum force production capacity of hand muscles in PD. METHODS: The study was a sham-controlled, cross-over experimental design and 6 subjects diagnosed with idiopathic PD participated in the study. Each subject completed 2 experimental sessions each separated by a washout period of 7 days. Subjects received either real TDCS or SHAM stimulation on a given day with the order of presentation of the conditions counterbalanced. Subjects performed 3 maximal voluntary contractions (MVCs) in an index finger abduction task and a pinch grip task before (Pre-tests) and after (Post-tests) application of both real TDS and SHAM stimulation. Real TDCS was applied continuously to the area of the scalp overlying the hand area of the contralateral motor cortex of the primarily affected hemisphere for a 20-min period. SHAM stimulation was applied in the same experimental settings for 20 minutes and conducted according to a well-established protocol that elicits the same sensations on the surface of the scalp as real TDCS application. Thus, subjects could not distinguish between real TDCS and SHAM stimulation. MVC force was measured before and after application of TDCS in both the index finger abduction and pinch grip tasks. MVC force was quantified as the average maximum force produced during the 3 MVC trials for each task. RESULTS: The increase in MVC force between the Pre- and Post-tests was greater (~ 10.0%) following application of real TDCS compared to SHAM stimulation (~ 0.3% force increase) in the index finger abduction task. In the pinch grip task, MVC force was increased (~ 5.5%) between the Pre- and Post-tests in the real TDCS condition, but decreased (~ 2.0%) in the SHAM condition. CONCLUSIONS: Collectively, these findings suggest that a single application of TDCS can acutely increase the maximum force production capacity of hand muscles in PD. PRACTICAL APPLICATIONS: TDCS may represent a new adjunct intervention strategy to acutely increase force production in healthy adults and in patients with movement disorders. Furthermore, TDCS devices are relatively inexpensive, easy to operate, portable, and extremely safe. However, further research is needed to determine the optimal parameters of TDCS to improve force production and to examine the extent to which chronic TDCS application (weeks or months) may improve force production in healthy adults, well-trained athletes, and in patients with movement disorders. ACKNOWLEDGEMENTS: The Lincy Foundation.

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MICROCLIMATE UNDER SOFT BODY ARMOR DURING MODERATE PHYSICAL EXERTION
1The University of Montana - Western, 2The University of Alabama, 3Texas A&M University-Commerce, 4University of Alabama, 5Armstrong Atlantic State University
Better understanding of the heat strain that law enforcement personnel face while wearing concealed soft body armor (SBA) can be used to help improve comfort and safety and benefit both the officer and the public. PURPOSE: The purpose of this study was to characterize the microclimate (micro-WBGT) under a concealed Level II SBA during 60-min of moderately intense work at two separate macro-WBGTs (26 °C and 30 °C), and to establish WBGT corrections to allow prediction of heat strain in an individual wearing a concealed Level II SBA. METHODS: Nine volunteers (27 ± 4 yr) outfitted with a standard law enforcement uniform and a traditional concealed Level II SBA, worked in a moderately warm environment (WBGT = 26 °C). Each participant performed cycles of 12-min of walking (1.25 L · min⁻¹) and 3-min of arm curls (14.3 kg, 0.6 L · min⁻¹) with a 5-min rest after every other cycle, for a total of 60-min. This trial was compared to a previously completed 60-min work bout at WBGT of 30 °C. A two-way ANOVA with repeated measures was used to evaluate the difference between the two trials. A one-way ANOVA was used to test the difference within each trial. For each trial, micro-WBGTs were calculated from 20-min blocks of walking and 10-min blocks of arm curls. RESULTS: Data were analyzed using a one-way ANOVA. RESULTS: Significant differences were found between the two trials. The maximum heat strain (Δ Tskin) for the 26 °C condition was reduced (~ 2.0%) compared to the 30 °C condition (~ 2.0%). CONCLUSIONS: The results of this study suggest that a single application of TDCS can acutely increase the maximum force production capacity of hand muscles in PD. PRACTICAL APPLICATIONS: TDCS may represent a new adjunct intervention strategy to acutely increase force production in healthy adults and in patients with movement disorders. ACKNOWLEDGEMENTS: The Lincy Foundation.
yet to be tested. Future research should focus on various macro-environments and intensities of work to further improve the accuracy of the WBGT corrections and to start to establish a prediction model. **PRACTICAL APPLICATIONS:** This research is the first step in attempting to quantify the effect of macro-WBGT on individuals wearing concealed SBA. The findings from this research can begin to be applied to law enforcement personnel and other individuals, including athletes, who are required to wear non-permeable, concealed, protective equipment in hot environments.

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**PREDICTION OF MILITARY RELEVANT OCCUPATIONAL TASKS IN WOMEN FROM PHYSICAL PERFORMANCE COMPONENTS**

T. Szivák¹, B. Nindl², J. Maladouangtok¹, C. Dunn-Lewis¹, B. Comstock¹, D. Hooper¹, S. Flanagan¹, D. Looney¹, W. DuPont¹, D. Dombrowski¹, W. J. Kraemer¹

¹University of Connecticut, ²Army Institute of Public Health

**PURPOSE:** This study sought to determine through multiple regression analysis which variables were most predictive for a repetitive box lifting task (RBLT) and for a load bearing task (LBT) (i.e. 2 mile, 341 kg rucksack carry) in 13 women (23±4 yrs, 165±7 cm, 64±10 kg). **METHODS:** The RBLT consisted of the maximum number of boxes (20.45 kg) that could be lifted from the floor to a height of 1.32m within a 10 min period (subjects were required to move between two boxes 2.4 m apart between lifts). The LBT consisted of the minimum time to traverse 2 miles while carrying a 34.1 kg military style rucksack. Independent variables (IVs) included body mass, height, magnetic resonance imaging assessed leg cross-sectional area, muscular strength (squat, bench press, high pull, boxlift), lower body explosive power (mechanical power assessed via jump tests), muscular endurance (# of pushups in 2 min and # of squat repetitions at a controlled rate with a 45 kg load (squat endurance test)) and aerobic capacity assessed from a 2 mile run (2MR in secs). **RESULTS:** The means±SD (range) for the RBLT (# of repetitions) was 86±23 (20-159) and for the LBT (in seconds) was 2054±540 (1307-3447). The following equations were generated (p<0.05): RBLT (# of repetitions) = 57.4 ± 0.2 (peak jump power) + 0.4( # of pushups in 2 min) + 0.15( # of repetitions during the squat endurance test) + 1.39(IRM boxlift in kg) − 0.04(2MR in seconds) [R = 0.81; SEE = 14]; LBT (in seconds) = 1831 − 4.28 (# of repetitions during the squat endurance test) + 0.95(2MR in seconds) − 13.4( body mass) [R = 0.73; SEE = 232]. **CONCLUSIONS:** The fact that the 2MR and squat endurance test entered into both equations illustrates their utility as potential predictors for successful military occupational performance. **PRACTICAL APPLICATIONS:** These data suggest that women can augment their performance in physically demanding occupations by participating in conditioning programs targeting both muscular strength and endurance.

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**INFLUENCE OF REST INTERVALS FOLLOWING ASSISTED JUMPING ON PEAK VELOCITY, RATE OF VELOCITY DEVELOPMENT & RATE OF FORCE DEVELOPMENT**

V. L. Cazas¹, L. E. Brown², J. W. Coburn³, A. J. Galpin¹, J. J. Tufano¹, J. C. Garner¹, N. C. Dabbs¹, H. Chander¹

¹University of Mississippi, ²Center for Sport Performance, California State University, Fullerton, CA, ³Edith Cowan University.

**The University of Mississippi

The outcome of an athlete's vertical jump is crucial in sports. If an athlete can increase their peak velocity, rate of velocity development or rate of force development during this explosive movement, vertical jump height may increase. Assisted jumping, an over-speed concept, is a relatively new method to optimize vertical jump performance. Research is needed to investigate how to optimally manipulate programing variables to achieve the best training effect. **PURPOSE:** To determine the effect of rest intervals on peak velocity (Vp), rate of velocity development (RVD) and rate of force development (RFD) following assisted jumping. **METHODS:** Twenty healthy recreationally trained males (age: 22.85 ± 1.84 yr, height: 179.44 ± 5.99 cm, mass: 81.75 ± 9.51 kg) attended five sessions. For all sessions, subjects performed the same dynamic warm up then executed one set of five consecutive assisted jumps at 30% body weight reduction. Assisted jumping was performed with subjects standing on a force plate sampling at 1000 Hz. They wore a full body harness attached to elastic bands which were attached to a rope passed through pulleys on the ceiling. They then rested for 30 seconds (C0.5), one (C1), two (C2), or four (C4) minutes, followed by three body weight jumps with no assistance. Baseline jump (CB) height was measured without preceding assisted jumps. **RESULTS:** All force plate data was collected and analyzed via custom software. ANOVA revealed that Vp, RVD and RFD demonstrated no significant difference in any of the conditions. (Vp, CB: 3.73 ± 0.29 m/s, C0.5-4 Collapsed x 3.77 ± 0.30 m/s, RVD, CB: 14.78 ± 2.84 m/s, C0.5-4 Collapsed x 15.30 ± 5.25 m/s, RFD, CB: 66.313 ± 2920.20 N/s, C0.5-4 Collapsed x 6989.93 ± 2667.29 N/s) **CONCLUSION:** It appears there is no difference between CB and all other conditions. These rest intervals may not acutely enhance Vp, RVD or RFD. **PRACTICAL APPLICATION:** However, despite not enhancing Vp, RVD or RFD athletes who are exploring various warm-up methods could utilize the five-assisted vertical jumps, as it did not hinder performance.

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**THE EFFECT OF LOW LOAD GLUTEAL ACTIVATION EXERCISES ON SPRING PERFORMANCE IN ELITE SKELETON ATHLETES**

D. W. Chapman¹, T. Cannon², L. Earles³, E. Bernotas⁴

¹Olympic Winter Institute of Australia, ²Australian Catholic University, ³Australian Olympic Team

**PURPOSE:** To determine whether the addition of low load gluteal activation exercises to the current warm-up protocol of an elite skeleton athlete cohort would improve the computerized sprint and spring specific bout-over sprint performance. **METHODS:** 30 m sprint times using an electronic timing system were recorded while athletes either sprinted in an upright ‘normal’ position or in a bent-over position pushing a simulated skeleton sled during morning and afternoon testing sessions using the control (no gluteal activation) or experimental intervention (gluteal activation). The series of low load gluteal exercises were performed in sequence with one set of 10 repetitions performed for each exercise. During the exercises each athlete was instructed to maintain a neutral spine and verbal cues were used to help achieve activation of the gluteal muscles. Subjects were consistently instructed to engage the gluteal muscle group throughout the exercise movements. The gluteal exercise program was performed under supervision of the team Physiotherapist taking approximately 10 minutes to complete. The seven low load gluteal exercises were double leg bridge, side lying hip abduction, quadraped lower extremity lift, side lying gluteal clam in 60°, prone single leg hip extension, body weight squats, hip abduction in quadraped (‘fire hydrant’), RESULTS: Morning 30 m sprint times in the control intervention were significantly (P<0.01, ES=0.53) faster than in the experimental intervention (4.041 ± 0.1269 s for control vs 4.159 ± 0.1300 s for experimental). Afternoon 30 m sprint times in the experimental intervention were significantly (P<0.001, ES=0.24) faster than in the control intervention (4.152 ± 0.1361 s for control vs 4.048 ± 0.1367 s for experimental). Afternoon bent-over 30 m sprint times showed no statistical difference (P=0.07, ES=0.29) between control or experimental interventions (4.905 ± 0.1903 s for control vs 4.743 ± 0.2173 s for experimental). Comparison of control and experimental interventions over time highlighted that upright 30 m sprint time was significantly (P<0.01) improved in the morning and afternoon sessions respectively (4.041 ± 0.1269 s for control AM vs 4.152 ± 0.1361 s for control PM; 4.159 ± 0.1300 s for experimental AM vs 4.048 ± 0.1367 s for experimental PM). Bent-over 30 m sprint performance showed a 19.5% decrement when compared to upright sprint times (4.908 ± 0.1065 s for bent-over vs 4.100 ± 0.0621 s for upright). **CONCLUSION:** The results indicate that the addition of low load gluteal activation exercises in this athlete population can improve bent-over 30 m sprint performance, regardless of the influence of diurnal fluctuations. **PRACTICAL APPLICATION:** The ease of implementation with minimal risk of injury to the athlete suggest that low load gluteal activation exercises should be incorporated as the standard pre-competition warm-up protocol for skeleton athletes.

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**DETERMINING PERFORMANCE DECREMENTS DURING SQUAT JUMPS PERFORMED WITH VARIOUS LOADS**

P. Comfort¹, C. Gray¹, J. Rogers¹, M. Thomasson¹

¹University of Salford

The optimal power load for squat jumps (with no countermovement) has been shown to be lower than the loads usually recommended for power training using Olympic lifts. Lower relative loads during squat jumps may permit the performance of additional repetitions prior to the onset of fatigue compared to heavier loads. **PURPOSE:** To identify the occurrence of decrements in performance, defined as a statistical significant decrease in peak power or jump height, during squat jumps with various loads. **METHODS:** Male collegiate athletes (n=16; 22.5 ± 1.5 years, 178.5 ± 7.2 cm, 72.85 ± 8.59 kg, one repetition maximum (1-RM) back squat = 129.6 ± 9.75 kg). Participants performed sets of ten repetitions of squat jumps, using five loading conditions as determined by their best 1-RM performance (0, 10, 20, 30, 40% 1-RM back squat). The loading conditions were allocated in a randomized and balanced order, with 5-6 min rest permitted between sets. Squat jump
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THE RELATIVE IMPORTANCE OF OPEN- AND CLOSED-SKILL AGILITY PERFORMANCE FOR SELECTION AS A STARTER IN ADULT MALE BASKETBALL PLAYERS

V. Dalbo, A. Scanlan, P. Tucker

'Central Queensland University

Purpose: Open-skill agility qualities have yet to be described in adult male basketball players. Further, the importance of open- and closed-skill agility for team selection remains unknown. Thus, this study aimed to: (1) describe the open- and closed-skill agility of adult male basketball players and (2) compare these properties between starting and non-starting players. Methods: A cross-sectional study was conducted in a gymnasium on four adult male basketball players (184.7 ± 7.4 cm; 84.4 ± 17.9 kg; 50.6 ± 3.9 mL·kg\(^{-1}·\text{min}^{-1}\)) state-level basketball players. Each player completed multiple trials for the Change of Direction Speed Test (CODST) and Reactive Agility Test (RAT). Results: No statistically significant between-group differences were evident for CODST movement time (starters: 1.652 ± 0.047 s; non-starters: 1.626 ± 0.040 s, p = 0.68; effect size = 0.24) or RAT decision-making time (starters: 110.7 ± 11.0 ms; non-starters: 147.3 ± 14.2 ms, p = 0.08; effect size = 1.18). Starters possessed significantly faster RAT movement times than non-starters (2.001 ± 0.051 vs. 2.182 ± 0.040 s; p = 0.02; effect size = 1.61). Conclusions: Our findings suggest that closed-skill agility properties are similarly developed in starting and non-starting players. In contrast, facets of open-skill agility performance such as anticipation, visual scanning, pattern recognition, and situational knowledge, might be central distinguishing qualities for team selection in basketball. Practical Applications: The development of perceptual and cognitive components of agility performance might be important in distinguishing starting from non-starting players in basketball. Basketball coaching and conditioning staff should incorporate sport-specific reactive training drills for all players during the annual conditioning plan.

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IMPACT OF 3% DEHYDRATION ON INTERMITTENT SPRINT PERFORMANCE

J. Davis, K. Allen, M. Laurent, M. Green, N. Stolworthy, T. Welch, M. Nevett

'University of Montevallo, ^2Bowling Green State University, ^3University of North Alabama, ^4University of South Florida

PURPOSE: Hyponhydration of 2% has been shown to impact aerobic exercise but the critical level in which anaerobic performance is affected has been suggested to occur at a higher level of dehydration. This study examined the effects of 3% dehydration on intermittent sprint performance and perceptual measures. METHODS: Eight collegiate baseball players completed the intermittent sprints either dehydrated (DY) of 3% body mass or euhydration (EU). All participants body mass was reduced by 3% via exercise in the heat with controlled fluid intake occurring 1day prior to the trial. Participants completed 24 x 30meter sprints, divided into 3 bouts of 8 sprints with 45sec rest between each sprint and 3min each bout. Perceived Recovery Status Scale (PRS) was recorded prior to the start of each trial. Heart rate (HR), RPE (0-10 Omni scale), and Perceived Readiness Scale (PRS) was recorded after every sprint and session RPE (S-RPE) was recorded 20min after completing the entire bout. RESULTS: Results from a 2 (condition) x 3 (bouts of sprints) repeated measures ANOVA revealed a significant main effect of condition on average sprint time (p=0.03), HR (p<0.01), RPE (p<0.01), and PR (p=0.02). Post-hoc follow-ups show significantly faster average sprint times during the EU vs DY trial during the second (4.87±0.29 vs 5.03±0.33s; p = 0.01) and third bout of sprints (4.91±0.29 vs 5.12±0.44s; p=0.02). HR was also found to be significantly lower for EU during the second bout (158 vs 168 bpm; p = 0.05) and third bout (161 vs. 171 bpm; p = 0.01). Post-hoc measures also show significantly decreased (p<0.05) training recovery (PRS) prior to exercise and increased (p<0.05) perceptual strain before each bout (PR) during the second and third bouts of repeated sprint work (i.e., RPE and PR) and following the total session (S-RPE) in the DY condition. CONCLUSION: Dehydration impaired sprint performance, decreased perception of recovery status prior to exercise, increased perceived exertion, and elevated heart rate. Results highlight the importance of adequate hydration during intermittent sprint performance.

PRACTICAL APPLICATION: Deleterious effects of dehydration are not limited to endurance-based sports. Athletes in intermittent sports are encouraged to pay special attention to hydration during practices without ignoring potential day to day fluid deficits. ACKNOWLEDGEMENTS: No sources of funding were used to assist in the preparation of this abstract. The authors have no conflicts of interest that are directly relevant to the content in this abstract.
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ELECTROMYOGRAPHY ACTIVITY OF THE GLUTEUS MEDII AND GLUTEUS MAXIMUM MUSCLES USING A GOLF SPECIFIC POWER HIP TRAINER IN COLLEGIATE GOLFERS

J. Ghiigiarelli1, K. Sell1, J. Ng1, A. Rothstein1
1Hofstra University

Low handicap golfers are reported to have increased pelvic rotational speed as well as increased gluteus medius and maximus strength compared to high handicap golfers. This study investigated the effects of a sport-specific strength training program in male collegiate golfers. METHODS: Twelve male collegiate golfers participated in an 8-week supervised training program utilizing a golf-specific power hip trainer and high-intensity resistance exercises. The golf-specific power hip trainer (GSPHT) involved 2 sets of 15 repetitions of the medicine ball throw, resisted elastic band tubing, GSPHT closed, and GSPHT open exercises. At the beginning of each training session, maximum voluntary isometric contraction (MVIC) manual muscle testing for the gluteus medius and gluteus maximus muscles were performed to record maximum electromyography (EMG) activity. The EMG amplitude of each muscle response was analyzed to assess the level of muscle activity simulating the downswing phase movement of each exercise. RESULTS: The medicine ball and hip trainer closed position produced the most overall muscle activation of 41.2% and 34.2%, respectively, with emphasis on the right gluteus medius and gluteus maximus. The greatest relative % peak EMG was observed in the right gluteus medius (56.6%) for hip trainer closed and right gluteus maximus (53.5%) for medicine ball throws. CONCLUSIONS: The GSPHT does effectively isolate the gluteus medius muscles specifically when twisting in the closed position against a spring loaded resistance. The medicine ball rotational throws recruits more overall hip muscle activation which is due to the heavier loading that can be provided by the resistance of the ball and the athlete is able to engage more muscle activity due to the nature of the exercise. PRACTICAL APPLICATIONS: The GSPHT can be an effective tool to increase gluteus medius strength which will allow more rotational velocity during the downswing phase of the golf swing. Subsequently this may lead to increased club head velocity and increased driving distance.

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REPEATED MEASURES OF PEAK POWER, VERTICAL JUMP, AND MOOD STATE IN NCAA-DI WOMEN, BASKETBALL PLAYERS DURING PREPARATORY AND COMPETITIVE TRAINING PERIODS

M. T. Jones1, G. L. Coleman1, T. Rusbasan1, S. Walls1
1George Mason University

Purpose: Previous research has studied changes in power output or mood during competitive seasons. The current study was designed to investigate whether or not changes occur in peak power, vertical jump, or mood state over the course of 9-week (wk) preparatory and 11-wk competitive training periods in collegiate basketball (BB) athletes. Methods: Demographic data (M + SD) were obtained from 14 NCAA-Di women athletes age: 20.5±11 yr; height: 175.9±6.6 cm; weight: 70.7±9.9 kg; BMI: 22.8±2.3 kg·m^-2; and %fat: 19.6±6.3%. Countermovement vertical jump height (CMVJ), peak power (PP), and mood state were measured each wk at the same time and day for the 6-wk off-season (OS) training and 3-wk pre-season (PS) periods. In BB season (IS), measures were limited to wk 11-16, 18, and 20. Subjects were divided into starters (S, n=7) and non-starters (NS, n=7) based upon total minutes played during the BB season (>57% vs NS <45% total game minutes). A force plate (AMTI, Inc.) and Vertec® (Sports Imports) were used concurrently to measure PP and CMVJ, respectively. Athletes were skilled jumpers who were instructed to jump as high and quickly as possible with knees and ankles extended. Power was calculated from ground reaction force (Fz) and the center of mass vertical acceleration (COMvel). Athletes were given 3 CMVJ attempts separated by 1 min each. To assess mood state changes athletes completed the Brief Assessment of Mood (BAM), which measures 6 affective states: (1) tension (TE), (2) depression (DP), (3) anger (ANG), (4) vigor (VIG), (5) fatigue (FAT), and (6) confusion (CON), and is a commonly used method for assessing mood. Data were analyzed as percent change from OS-wk 1 measures. Two-way repeated measures ANOVAs were used to analyze PP, CMVJ, and the 6 BAM affective states between groups. Alpha level was set at p<0.05 for ANOVAs, and p<0.01 for Bonferroni tests due to the high number of pairwise comparisons required for the 20-wk period. Results: PP increased 6.2% (p=0.001) from OS-wk 1 to OS-wk 6 (3860±523 vs 4097±553.4 watt) for all athletes. No changes occurred between S and NS groups for PP and CMVJ over the OS, PS, or IS periods. Of the 6 BAM affective states, significant changes between groups were found for TEN (NS>S, p=0.001), VIG (NS>S, p=0.009), and FAT (S>NS, p=0.001) while DEP, ANG, and CON remained unchanged. Bonferroni’s post-hoc test showed significant changes of FAT for NS were lower in wk 7 (p=0.051), wk 11 (p=0.064), wk 16 (p=0.034), and wk 18 (p=0.072) compared to S. Conclusions: Mood state has been shown to be sensitive to changes in training load and, therefore, can be indicative of how well an athlete adapts to changes in training programming. In the current study, all athletes improved PP over the 6-wk OS training period with no further increase found in the PS and IS periods. During PS and IS, the S group exhibited greater change in the negative descriptor of FAT. The NS displayed higher values in the positive descriptor of VIG. This may be a result of S having more negative feelings in their response to the increased training load as PS progressed into the IS period. Practical Application: The administration of the BAM to team members might give prior indication of actual team performance. These results support the usefulness of monitoring psychological and physical markers for preparatory and competitive training periods. Training load can then be adjusted and adequate recovery methods provided as necessary.

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THE IMPACT OF THE 1RM POWER CLEAN ON POST ACTIVATION POTENTIATION OF USING OVERWEIGHT IMPLEMENTS IN THE OVERHEAD BACK SHOT PUT THROW

L. W. Judge1, D. Bellar2, B. Craig3, E. Gilereath4, S. Cappos5, E. Wanless5, C. Ethredge6
1Ball State University/School of PE, Sport, and Exercise Science, Muncie, IN, 2University of Louisiana at Lafayette, 3Ball State University/Human Performance Laboratory, Muncie, IN, 4Indiana State University/Department of Athletics, Terre Haute, IN, 5University of Iowa, 6University of Louisiana at Lafayette, Lafayette, La

Although the value of strength to shot putting appears undisputable, several authors have recommended that explosive power is actually a more important physical characteristic. Debate about the effectiveness of post activation potentiation (PAP) is mostly attributed to the characteristics of the conditioning activity (CA) and the training status of the subjects. PURPOSE: To examine the relationship between IRM in the power clean to the acute effects of heavy and light implements on subsequent OHB shot put performance. METHODS: The participants included 41 athletes (20.9±1.18yrs) from two NCAA Division I schools (n=23 male, n=18 female). Participants reported to the field on four separate occasions. On the first visit, participants became familiar with the technique of the OHB throw. On the second through forth visits, participants warmed up (~15 min of dynamic stretching) and then completed three, maximal effort, OHB throws with a competition shot put. Each attempt was preceded by one of three randomly assigned treatments. The treatments included three OHB throws with a shot 1kg heavier or 1kg below the standard weight, or the competition weight (7.26kg men, or 4kg women). Mean distance for OHB throw and fatigue was examined post treatment (control, light shot put warm up, heavy shot put warm up) via Repeated Measures ANOVA with Bonferroni corrected post hoc analysis. The relationship of strength to the treatments was examined via Pearson’s Bivariate Correlations. RESULTS: Statistical analysis by Pearson’s bivariate correlations revealed that the change in average performance between the heavy warm-up and the control condition was related to the 1 RM power clean for the athlete that was reported by the coach (r= 0.338, p=0.045) and the squats (r= 0.302, p=0.068) or the bench press (r= 0.271, p=0.10). Change between the light warm-up and control was not related to any IRM numbers reported by the coach of the athlete (r< 0.155, p=0.359). Results of the repeated measures ANOVA demonstrated a significant main effect for treatment in regard to average distance (F=6.276, p=0.003). The heavy shot put warm-up resulted in the greatest mean performance (14.39m±1.82) followed by the light shot put warm up (14.18m±1.68) and the control (14.15m±1.70). Post hoc testing suggested that the heavy shot put warm-up resulted in significantly better mean OHB performance than either the light shot put warm up (t=2.983, p=0.0048, ES=0.472, Power=0.930) or the control shot put warm-up (t=3.349, p=0.0018, ES=0.513, Power=0.893). CONCLUSION: In moderately trained collegiate athletes, the use of heavy shot puts as part of the pre-activity warm-up does enhance OHB performance. The change in average performance between the heavy warm-up and the control condition was related to the 1 RM power clean. PRACTICAL APPLICATIONS: Athletes with a resistance training background can utilize the concept of PAP in training and competition to improve performance in throwing events.

NSCA National Conference & Exhibition Abstracts
ASSESSMENT OF UPPER BODY ANAEROBIC POWER AND CAPACITY IN COMPETITIVE MALE CURLERS

D. M. Kivi1, D. W. Smith1, A. D. Blando1

1Lakehead University

Sweeping is one of the most physically demanding skills in the sport of curling, requiring balance, coordination, strength, and endurance. The purpose of sweeping is to increase the distance the stone will travel down the ice, and to reduce the amount of time in between shots. Curlers are responsible for sweeping the stone, which is performed by sliding a broom along the ice. The sweeping motion is an upper body anaerobic activity, with a sweeping force and speed of 570 W/kg, and an endurance of 150 s. The purpose of this study was to examine upper body anaerobic power and capacity in competitive male curlers. METHODS: Twelve male curlers (age: 18.2 ± 1.2 yrs, height: 179.0 ± 7.5 cm, mass: 73.7 ± 10.0 kg) were recruited to participate. All had previously participated in regional, provincial, or national curling events, and players from each of the four positions on the team (lead, second, third, and skip) were included. The participants first completed a standardized warm-up, which involved 5 minutes of pedalling at a self-selected pace with 5-second maximal effort sprints at 2, 3, and 4 minutes against a resistance of 3% body mass. Starting from a cadence of 60 revolutions per minute, the participants performed the 30-second upper body Wingate anaerobic test at a maximal effort. Testing was completed using a cycle ergometer which had been modified for the upper body, with the resistance set at 40% of body weight. Relative peak power, average power, and fatigue index were measured, along with the amount of time that a power output greater than 90%, 80%, and 70% of peak power was sustained. RESULTS: The mean relative peak power and average power for all participants were found to be 5.37 ± 0.72 W/kg and 4.48 ± 0.65 W/kg, respectively. The mean fatigue index was 37.27 ± 7.79 %. Over the duration of the test, the participants were able to sustain power outputs greater than 90% of peak power for an average of 12.4 ± 2.6 sec, greater than 80% for 18.9 ± 3.2 sec, and greater than 70% for 24.1 ± 3.4 sec. CONCLUSIONS: This research provides insight into the upper body anaerobic performance of competitive male curlers. The results suggest that curlers are capable of working at greater than 90% of their peak power for approximately half the time that the stone is travelling down the ice, and greater than 70% of their peak power while sweeping over full length of the ice. PRACTICAL APPLICATION: Because curlers may be required to sweep at maximal efforts for prolonged periods of time, an understanding of upper body anaerobic power and capacity can assist with the development of curling-specific training programs. Athletes and coaches may also use this information to help develop strategies to optimize sweeping performance during competitive play by knowing the amount of time that near maximal power outputs can be sustained. ACKNOWLEDGEMENTS: This study was funded by the Northern Ontario Curling Association.
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SELECTED PREDICTORS OF VOLLEYBALL PLAYING ABILITY IN FEMALE COLLEGIATE VOLLEYBALL PLAYERS

J. Miller*, B. J. AlSarraf*

*Oklahoma City University, *Department of Physical Education and Sport, College of Basic Education in Kuwait

PURPOSE: Selecting valid assessments to evaluate the effectiveness of a training program on actual on court volleyball playing performance is a challenge for the strength and conditioning professional. Additionally, assessment selection for the purpose of talent identification for volleyball playing ability is equally important and challenging for the volleyball coach. The purpose of this study is to examine the strength of the relationship between the assessments: single response squat (SJ), vertical (VJ) and approach jump (AJ), and passive ankle dorsiflexion (PAD) with a quantified coach’s rating (CR) of volleyball playing ability. METHODS: Eight female collegiate volleyball players (age=19.5±1.3yrs; height = 68.5±m; weight = 158±15lbs) volunteered for the study. All testing took place within a week of the last volleyball match of the season. Upon arriving for testing athletes performed a 5 min general warm up on the cycle ergometer. Following the general warm up participants performed multiple sets of low intensity jumps including two sets of the SJ and VJ. Following the warm up period the order of assessment was SJ, VJ, AJ and right (RDF) and left (LDF) PAD. For the SJ, hands were placed on the hips and the participants achieved/held a parallel squat for 4 second before jumping. There was no hold time with the VJ and participants were permitted to use a countermovement and arm swing. The AJ was performed by the participants utilizing the 3-step volleyball specific approach before jumping. Athletes performed as many jumps as necessary until two successive jumps were no longer higher than the best recorded score. A 30sec rest was observed between all jump assessments/Attempts. All jump assessments were conducted on a contact mat (Just Jump, Probotics, Huntsville, AL). PAD was assessed after jump assessments utilizing a tape measure placed on the floor perpendicular to a wall. With shoes removed, athletes placed the knee of the selected leg against the wall while sliding the heel away from the wall. The distance from the posterior side of the heel to the wall was measured and recorded for both legs, PAD scores were normalized to the athletes’ height. The difference between PAD scores for the right and left leg was calculated to assess asymmetry. CR of the athletes’ volleyball playing ability was provided by the athlete’s volleyball coach in response to a standardized question which quantified volleyball playing ability using a 10pt scale (10=superior, 1=inferior). All jump scores were analyzed as absolute and relative values (relative to bodyweight and body mass index). SJ, VJ, AJ and PAD scores were correlated with the CR using a Spearman’s rank correlation (ρ). RESULTS: Moderate strong correlations existed between CR and the AJ (ρ = 0.51) and AJ/BMI (ρ = 0.32), and right (ρ = -0.34) and left (ρ = -0.55). PREDICTIONS: The AJ appears to be the best predictor of general volleyball playing ability when playing ability is quantified by a volleyball coach. Additionally, some passive ankle stiffness may be important in jumping ability and also contribute to a reduction in contact time with the ground during changes of direction yielding improved general performance in the sport of volleyball as assessed by a volleyball coach. PRACTICAL APPLICATION: The sport-specific AJ is the best predictor of general volleyball playing ability as determined by a volleyball coach and therefore may be an important assessment when evaluating potential collegiate volleyball players. The AJ may also serve as a measure that can effectively mediate the degree of transfer from a strength and conditioning training program to actual volleyball playing ability.
was only a small relationship between IMP and PV. Conclusion: Although, just a correlation, these results demonstrated a very strong relationship exists between IMP and PP, and PV for older adolescent surfers. However, the only small relationship between IMP and PV for young adolescent surfers may imply that younger adolescent surfers may have a jump technique that is not conducive to using an LPT to measure PV. A false PV for inexperienced or younger adolescents may occur due to excessive forward trunk bend during the jump. Therefore, the PV value for these younger adolescents could be indicative of the velocity their trunk not the system mass velocity. This might explain the lack of relationship between IMP and PV in the younger adolescent surfers. Practical Application: Strength coaches and sports scientists should consider the implication of jump technique when using an LPT. Specifically, the amount of trunk flexion should be observed if an LPT is in use.

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**COMPARISON OF MUSCLE RECRUITMENT DURING BENCH PRESS EXERCISE WITH ELASTIC BANDS VS. A FIXED-BARTRAJECTORY**

C. Capps¹, J. Calatayud¹, S. Borreani¹, J. Colado¹, D. Moya², F. Martin²

¹Appalachian State University, ²University of Valencia

The push-up and bench press are traditional exercises normally used to strengthen the trunk and upper extremities. Resistance training is commonly performed with expensive and specific equipment whereas elastic bands may allow a feasible alternative to performing resistance training at home. However, there is a lack of evidence regarding muscle recruitment during push-ups with additional elastic load and their possible comparison with the bench press. PURPOSE: The aim of the study was to compare muscle activation of the pectoralis major and anterior deltoid while performing 6RM push-ups with elastic bands and a 6RM bench press in a Smith machine. METHODS: Physically fit and healthy male and female subjects took part in a randomized, within-subject design study. Loads were adjusted during push-ups with the addition of elastic bands, and during the bench press with additional weight so that subjects could perform only 6 maximal repetitions (6RM). Different colors (gold, silver and/or blue) and length of the elastic bands were adjusted to reach maximal effort. Each subject used a standardized grip width (biacromial+50%), range and speed of movement. Correct body position was confirmed with a laser goniometer. The respective 6RM loads (bands or weights) were determined on a different day, prior to the main testing sessions involving the electromyography. The order of the elastic bands and bench press conditions were counter-balanced. The best of two maximum voluntary isometric contractions (MVIC) for each muscle was evaluated for normalization purposes. Pectoralis major (PEC) and Anterior deltoid (Delt) muscular activities were recorded and the mean and peak root mean square values were calculated. Surface electromyography activity was analyzed during the entire 6 repetitions. All values, expressed as the mean and peak %MVIC of both muscles were compared using a paired samples t-test. Significance level was set at p<0.05. RESULTS: No significant differences were found between both conditions for PEC (mean: t(33)=0.093, p=0.927; peak: t(33)=0.040, p=0.968) and Delt (mean: t(36)=1.85, p=0.224; peak: t(36)=0.34, p=0.73). Results are reported in this study. CONCLUSIONS: Performing a 6RM set of push-ups with elastic bands resulted in similar muscle activation to performing a 6RM set of bench press in a Smith machine. PRACTICAL APPLICATIONS: Push-ups with elastic bands are a feasible and cost-effective alternative to traditional bench press exercise, especially in relatively untrained individuals. In the early stages of a training program, subjects can benefit from this training modality and may prefer the convenience to traditional equipment. Another application may be in the elderly, and in either case, until strength levels increase to the point where traditional exercises are warranted.

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**MUSCULAR ACTIVATION DURING PUSH-UPS PERFORMED ON SUSPENSION TRAINING DEVICES WITH DIFFERENT TYPES OF ANCHORING**

T. Haines¹, F. Martin², S. Borreani¹, J. Calatayud¹, D. Moya², J. Colado²

¹Appalachian State University/Neuromuscular & Biomechanics Laboratory, Department of Health, Leisure & Exercise Science, Boone, NC, ²University of Valencia

Suspension devices for physical conditioning have increased the available tools for training. Suspension devices can anchor from a single point or from two points, and the effect on the body may differ. PURPOSE: To compare agonist and lumbo-pelvic muscular activation during push-ups performed on suspension training devices with different anchoring points. METHODS: 29 physically fit and healthy subjects took part in the investigation. Muscular activation was evaluated in Triceps Brachi, Upper Trapezius, Anterior Deltoid, Clavicular Pectoralis, Rectus Abdominis, Rectus Femoris, Lumbar Erector Spinae and Gluteus Maximus during execution of 3 repetitions of the push-up exercise at low height, using two different suspension devices. Surface electromyography was recorded and the average root mean square values were calculated for each condition and muscle group. The conditions were counter-balanced. The maximum isometric voluntary contraction (MVIC) was evaluated for the normalization of the electromyographic signal. All values, expressed as %MVIC, were compared using a Student's paired T-test analysis. Significance level was set at p<0.05. RESULTS: Differences between each condition are shown in this study. CONCLUSION: Push-ups performed with a suspension device with one anchoring point induce significantly greater activation in the Triceps Brachi and Upper Trapezius; however, push-ups performed with a suspension device with two anchoring points induce significantly greater activation in the Anterior Deltoid and Clavicular Pectoralis. PRACTICAL APPLICATIONS: The dual anchoring point configuration appears to mimic the bench press better while the single anchoring point configuration appears to necessitate more use of the upper back musculature, which may be counterproductive to the training goals. These results could help to determine which type of suspension device should be used depending on the primary training purpose.

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**THE USE OF ASYMMETRIES IN UNILATERAL LEG POWER FOR MOVEMENT SCREENING IN FEMALE TEAM SPORT ATHLETES**

R. G. Lockie¹, A. B. Schultz¹, T. M. Luzzo², S. P. Berry³, M. D. Jeffriess, S. J. Callaghan¹, C. A. Jordan¹

¹University of Newcastle/Exercise and Sport Science, ²California State University Monterey Bay/Department of Kinesiology

Movement screens are commonly used to assess movement deficiencies in athletes. The Functional Movement Screen (FMS) is comprised of 7 actions: deep squat (DS), hurdle step (HS), in-line lunge (ILL), shoulder mobility, active straight-leg raise (ASLR), trunk stability push-up (TSPU), and rotary stability. However, without the requisite experience, the FMS is hard to administer. Multidirectional (vertical, horizontal, lateral movement planes) unilateral jumps, and between-leg jump asymmetries, are also used for screening. The relationship between an established screening protocol such as the FMS, and unilateral jump asymmetries, has not been investigated. PURPOSE: To determine the relationship between FMS scores and leg power asymmetries as measured by unilateral vertical, standing broad and lateral jump performance. METHODS: 14 female team sport athletes were tested over 2 sessions. Subjects were assessed in the FMS by 2 exercise scientists in the first session. The vertical, standing broad and lateral jump tests were completed in the second session. Percentage between-leg asymmetries for each jump condition were also calculated (powerful leg - weaker leg/powerful leg x 100). Subjects were also split into 2 groups (lesser and greater asymmetry) depending on the jump asymmetry that had the strongest relationship to the FMS. RESULTS: Spearman’s correlation (r) analysis (p<0.05) found significant relationships between the FMS scores and jump asymmetries. A 1-way analysis of variance (p<0.05) determined between-group differences, and effect sizes (ES) were calculated. Unilateral vertical jump asymmetry was correlated with the right-leg ILL (r=-0.536), TSPU (r=-0.615), and overall score (r=-0.551). Subjects were split into lesser (n=9) and greater (n=5) vertical jump asymmetry groups. The TSPU had a significant between-group difference (lesser=2.44±0.73; greater=1.40±0.89; ES=1.28). There were large, non-significant, effects for the DS (lesser=1.78±0.83; greater=1.02±0.00; ES=1.33), and right-leg ILL (lesser=2.44±0.51; greater=2.00±0.00; ES=1.22). CONCLUSION: The between-leg asymmetry in unilateral vertical jump performance had the strongest relationships to selected scores within the FMS; the TSPU, right-leg ILL, and overall score. When subjects were split into groups of lesser or greater vertical jump asymmetries, a significant difference was only observed in the TSPU. This result indicates the need for understanding the moderate-to-large effects for the differences in DS, right-leg ILL, and overall score, with the group lesser performing better each time. The relatively small sample for this study may have contributed to only 1 significant between-group difference being found. Nonetheless, as shown by relationships to the TSPU and ILL, and the between-group differences, athletes with lesser asymmetries possess a more stable trunk, mobile hip, knee, and ankle joints, and appropriate muscle activity throughout the entire body. PRACTICAL APPLICATIONS: This research provides further support for the use of unilateral vertical jump performance for screening, particularly when considering between-leg asymmetries. By comparing unilateral vertical jump asymmetries to the FMS, coaches now have an indication of the mechanical characteristics present in female team sport athletes with lesser between-leg power asymmetries as measured by unilateral vertical jump performance. To reduce leg power asymmetries, female team sport athletes require a stable core, and must ensure balanced mobility and strength for both legs.
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THE RELATIONSHIP BETWEEN IRM SQUAT, BODY FAT, AND POWER IN NCAA DIVISION I FOOTBALL LINEMEN
B. H. Jacobson1
1Oklahoma State University
Training for lower body strength and power consists of squats and power cleans and is assessed by IRMs and vertical jump distance (VJ). Studies involving soccer have found notable correlations between max half squats and sprint performance and VJ suggesting that squats may enhance lower body power. While power and strength has received noteworthy attention, no studies have focused on DL linemen.

METHODS: The purpose of this study was to determine the association between IRM squat (SQ), (%F), and the VJ in offensive (OL) and defensive (DL) football linemen. METHODS: Following IRB approval, data spanning a four-year period was collected and analyzed. A total of 160 observations inclusive of body mass, height, %F, IRM squat, and VJ were compared. Descriptive means for OL and DL included: mass 131.7 kg (290.3 lbs.), height 191.1 cm (75.25 in.), 22.6% fat, 63.5 cm (25.0 in. VJ), and 232.1 kg (511.8 lbs.). RESULTS: Based on correlational analysis, a weak relationship existed between VJ and IRM squat (r=0.10) and a negative relationship was found between VJ and %F (r=-0.37). Additionally a significant relationship between body mass and %F was found. Results yielded a stronger correlation between VJ and SQ (r=0.55) following control for %F CONCLUSION: On the larger scale athlete, %F is a compromising factor in power output as demonstrated by the VJ. Large athletes with less fat tended to parallel results in the association between IRM SQ and VJ found in soccer players. PRACTICAL APPLICATIONS: The implication that %F hinders power production and that lean muscle mass promotes power production in extremely large athletes serve as further evidence that fat reduction should be prioritized in the conditioning of OL and DL.

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EFFECT OF CAFFEINE ON POWER-DURATION RELATIONSHIP DURING 3-MIN ALL-OUT EXERCISE
C. Cheng1, W. Hsu1, M. Shih1, T. Chen1, C. Lee2
1Department of Athletic Performance, National Taiwan Normal University, 2Graduate Institute of Sports Training, Taipei Physical Education College

PURPOSE: The ergogenic effects of oral caffeine on aerobic and anaerobic performance, which both are important elements for team sport athletes, remain controversial. Caffeine may enhance excitation-contraction coupling stems by decreasing plasma potassium (K+) concentration during prolonged exercise, but not during high-intensity exercise. The 3-min all-out exercise test (3MT) has been developed to simultaneously estimate critical power (CP) and the curvature constant for severe exercise (W). Therefore, this study examines the effects of acute caffeine ingestion on the 3MT performance and plasma ion concentrations in basketball players. METHODS: Fifteen male Division I collegiate basketball players (age, 20 ± 2 years; height, 188 ± 6 cm; weight, 84 ± 12 kg; VO2max, 52 ± 6 ml·kg-1·min-1) were recruited and completed 2 trials separated by at least 1 week: caffeine (CAF, 6 mg·kg-1 of caffeine) and placebo (PL, identical number of capsules containing cellulose) conditions. Visit one served as familiarization. During visit two, subjects performed an incremental cycling test to determine the resistance of 3MT. During the following visits, subjects performed CAF or PL trial in a randomized crossover design. One hour after ingesting capsules, subjects performed the 3MT on a cycling ergometer to estimate the CP and W. Blood samples for sodium (Na+), K+, pH, and lactate (La) concentrations were drawn at pre-test, 1 hour after ingesting capsules, and 5-min after the 3MT. The oxygen uptake (VO2) and heart rate (HR) were continuously measured during the 3MT. Pair-samples t-tests and repeated measures two-way analysis of variance (ANOVA) with Bonferroni post-hoc tests were used to compare all variables between trials. RESULTS: The W in CAF (13.4 ± 3.0 kJ) was significantly higher than that in PL (12.1 ± 2.7 kJ, p < 0.05). There were no significant differences were found in CP (CAF vs. PL, 242 ± 37 vs. 244 ± 42 W), VO2max, and %F between two trials. Significant trial × time interaction was observed for the La. The La concentration after 3MT in CAF (13.4 ± 2.6 mmol·L-1) was significantly higher than that in PL (9.8 ± 1.8 mmol·L-1, p < 0.05). There was no significant interaction effect for [Na+]. The [K+] at 1-h after ingesting caffeine was significantly lower than that in PL (CAF vs. PL, 3.87 ± 0.22 vs. 3.99 ± 0.30 mmol·L-1, p < 0.05). CONCLUSIONS: These results indicate that caffeine ingestion might not enhance CP; however, it could prevent a rise in resting plasma [K+] and improve the work capacity when power output exceeds the CP. The increases in the accumulation of La and elevation of HR resulted from caffeine should also be considered during intense exercise. PRACTICAL APPLICATIONS: Caffeine may affect the physiology of excitation-contraction coupling. Thus, training trials benefiting subsequent performance during severe intensity exercise, although it does not appear to improve aerobic capacity.

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DIFFERENCES IN LOADED-SLED SPRINT TIMES BETWEEN FEMALE VOLLEYBALL AND SOFTBALL PLAYERS

INTRODUCTION: The purpose of the study was to investigate if differences existed between two female power sports in regards to loaded-sled sprint times. Resisted sprints have been studied using taping devices (e.g., parachute) but there is a paucity of information related to the effects of sled pushing on athletic performance. The current study examined if any difference may exist between two female power sports to determine if future studies would need to establish specific muscular force-time characteristics criteria for participant selection to minimize heterogeneity. METHODS Participants were Division II female power athletes (Volleyball (VB) n = 9; Softball (SB) n = 5. Body-mass = 70.71 ± 5.39 kg, Height = 170.28 ± 6.41 cm, Body-fat % = 17.47 ± 3.62) who were tested during their off-season training phase. Participants were tested each week on the same day and time for 7 consecutive weeks and allowed to miss 2 consecutive testing sessions before being removed as a participant. Body mass was measured using a digital scale, while body-fat % was measured using skinfold calipers. Participants had previously used the push-sled during their strength and conditioning program so no familiarization session was used. Seven sprint conditions were used, with each condition having a distance of 18.8 m, with 35 seconds recovery between 6 sprinting bouts. Participants performed sprints (control), sprints pushing sled-only (29.48 kg), and sprints pushing the sled with an additional 10 kg, 15 kg, 20 kg, 35 kg, & 50 kg. Timing was completed by the same researcher using a hand-held stop watch, which was started on the participant's first movement and stopped upon covering the specified distance. All testing was conducted in an indoor field house on an rubberized flooring. RESULTS No statistically significant differences were seen between the two sports peak sprint times. Cronbach's alpha demonstrated reliability (α = 0.82). DISCUSSION No statistical differences were seen between female VB and SB athletes, although the SB athletes demonstrated practically faster sprint times with sprinting conditions ≥ 20 kg loads. These observable differences may be indicative of the SB athletes incorporating sprints of greater than 10 m in their strength and conditioning program. The results suggest that future sled-pushing studies may utilize both groups in assessing the effects of sled pushing on sprint performance. PRACTICAL APPLICATION Sled-pushing loads during strength and conditioning programs do not need to be adjusted for the respective sports between female volleyball or softball players.