RESULTS: There was a 10.7% reduction in isometric MVC torque (135.1 vs. 120.6 N·m) in the soleus (SOL) and medial gastrocnemius (MG) was measured during the exhaustion. Comparison of the twitch torque amplitude of an interpolated supramaximal twitch (doublet) delivered during the torque plateau of the MVC was performed during the torque plateau of the MVC. The rate of non-contact anterior cruciate ligament (ACL) injuries in females is markedly higher than in males. Strategies for reducing the incidence of injuries focused on neuromuscular training programs. The purpose of this study was to determine the numbers needed to treat (NNT) and relative risk reduction (RRR) associated with neuromuscular training programs in the prevention of non-contact ACL injuries in females. METHODS: A search was conducted using PubMed, MEDLINE, Sport Discus, CINAHL, and Web of Science, from 1966–2005, using the terms knee, injury, anterior cruciate ligament, ACL, prevention, plyometrics, and neuromuscular training. Selected articles were from peer-reviewed journals written in English. Articles compared a neuromuscular training program to a control program to determine the number of non-contact ACL injuries per event exposure or hours of playing time. Five studies met inclusion criteria and were independently rated for quality by three reviewers using the PEDro scale. A consensus PEDro score was given for each article, with scores ranging from 4 to 7. The numbers of subjects, ACL injuries, and exposures in the intervention and control groups were used to calculate NNT and RRR for each study. NNT calculation from all studies were normalized to injuries per average athlete-exposures across one competitive season. RESULTS: In all 5 studies, a prophylactic effect was seen with the neuromuscular training programs. NNT estimates the number of athletes needed to participate in the prophylactic training program in order to prevent one ACL injury over the course of one competitive season and ranged from 28 (95% CI: 15–250) to 193 (95% CI: 1–750). RRR ranged from 48% (95% CI: 7–75%) to 82% (95% CI: 65–91%). CONCLUSIONS: The results of this study indicate that neuromuscular training programs designed to prevent female non-contact ACL injuries are likely to reduce injuries, but evidence examining confidence intervals for numbers needed to treat and relative risk reduction remains inconclusive at this time. There was one high quality randomized control trial and four medium quality prospective cohort studies showing mostly consistent findings. Thus, a SORT level of evidence of 1 with a grade B recommendation may be given to support the use of neuromuscular training programs in the prevention of non-contact ACL injuries in female athletes. PRACTICAL APPLICATIONS: Neuromuscular training programs for injury prevention also contain aspects which have also been shown to improve athletic performance. Due to the minimal time commitment and the multiple benefits which can be achieved through neuromuscular training programs; it would be prudent for sport coaches, strength and conditioning professionals, athletic trainers, and sports physical therapists to implement these dual benefit programs within the current training programs of high-risk athletes.

Neuromuscular Control Training Programs Decrease Non-Contact ACL Injury Rates in Female Athletes: A Numbers Needed to Treat Analysis
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PURPOSE: The rate of non-contact anterior cruciate ligament (ACL) injuries in females is markedly higher than in males. Strategies for reducing the incidence of injuries focused on neuromuscular training programs. The purpose of this study was to determine the numbers needed to treat (NNT) and relative risk reduction (RRR) associated with neuromuscular training programs in the prevention of non-contact ACL injuries in females. METHODS: A search was conducted using PubMed, MEDLINE, Sport Discus, CINAHL, and Web of Science, from 1966–2005, using the terms knee, injury, anterior cruciate ligament, ACL, prevention, plyometrics, and neuromuscular training. Selected articles were from peer-reviewed journals written in English. Articles compared a neuromuscular training program to a control program to determine the number of non-contact ACL injuries per event exposure or hours of playing time. Five studies met inclusion criteria and were independently rated for quality by three reviewers using the PEDro scale. A consensus PEDro score was given for each article, with scores ranging from 4 to 7. The numbers of subjects, ACL injuries, and exposures in the intervention and control groups were used to calculate NNT and RRR for each study. NNT calculation from all studies were normalized to injuries per average athlete-exposures across one competitive season. RESULTS: In all 5 studies, a prophylactic effect was seen with the neuromuscular training programs. NNT estimates the number of athletes needed to participate in the prophylactic training program in order to prevent one ACL injury over the course of one competitive season and ranged from 28 (95% CI: 15–250) to 193 (95% CI: 1–750). RRR ranged from 48% (95% CI: 7–75%) to 82% (95% CI: 65–91%). CONCLUSIONS: The results of this study indicate that neuromuscular training programs designed to prevent female non-contact ACL injuries are likely to reduce injuries, but evidence examining confidence intervals for numbers needed to treat and relative risk reduction remains inconclusive at this time. There was one high quality randomized control trial and four medium quality prospective cohort studies showing mostly consistent findings. Thus, a SORT level of evidence of 1 with a grade B recommendation may be given to support the use of neuromuscular training programs in the prevention of non-contact ACL injuries in female athletes. PRACTICAL APPLICATIONS: Neuromuscular training programs for injury prevention also contain aspects which have also been shown to improve athletic performance. Due to the minimal time commitment and the multiple benefits which can be achieved through neuromuscular training programs; it would be prudent for sport coaches, strength and conditioning professionals, athletic trainers, and sports physical therapists to implement these dual benefit programs within the current training programs of high-risk athletes.

Effects of Fatigue of the Triceps Surae on Peak Torque, Voluntary Activation, and Surface Electromyographic Amplitude in Resistance Trained Men
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PURPOSE: Decreased force production following acute strenuous exercise is thought to be influenced by both peripheral and central factors of muscular fatigue. The purpose of this study was to investigate the effects of muscular fatigue on voluntary activation of the triceps surae in resistance-trained men. METHODS: Subjects for this study included six men (mean ± SD: height: 175.9 ± 7.7 cm; body mass: 78.1 ± 6.2 kg; age: 23.5 ± 1.1 years) with similar histories, and conditioning professionals, athletic trainers, and sports physical therapists to implement these dual benefit programs within the current training programs of high-risk athletes.

Resistance Training for Muscular Hypertrophy: A Meta-Analysis to Determine the Dose-Response
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Recent meta-analytical investigations indicate that there exist distinct strength adaptations and dose-response relationships which correspond to various populations. It has been hypothesized that resistance training for the purpose of muscular hypertrophy development (i.e., lean mass, muscle cross-sectional area, etc.) would similarly exhibit definitive trends. PURPOSE: Identifying optimal doses of the training variables would allow for maximal gains in muscular adaptation to be elicited, per unit of time. The purpose of this meta-analysis was therefore to identify this relationship among moderately experienced resistance trainees. METHODS: A meta-analysis of 40 studies (N = 1,575) was carried out to identify the dose-response relationship for muscular hypertrophy. Effect size data were synthesized for the following training variables over the duration of each controlled resistance training regimen: (1) Mean Intensity of Training, (2) Mean Frequency of Training, and (4) Mean Volume of Training. Each study was also coded for potential moderating variables. RESULTS: Effect size data demonstrate that maximal muscular hypertrophic adaptation is elicited among moderately trained individuals who train at a mean intensity of 80–85% of one repetition maximum (1RM), five days per week, and with a mean volume of 70–80 total sets per week. Furthermore, integrating a rest break of approximately 120 seconds between sets emerged as a significant moderator variable. CONCLUSION AND PRACTICAL APPLICATION: The current data identify a different dose-response relationship for muscular hypertrophy than previous meta-analytical investigations, for strength adaptation. These results demonstrate explicit dose-response trends for maximal improvement in muscular hypertrophy for moderately experienced resistance trainees, and may be directly used to optimize training efficiency and effectiveness. Exercise professionals may apply these data to prescribe systematic, goal-oriented training programs.
The Effectiveness of a Manual Resistance vs. a Weight Resistance Training Program on Body Composition

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Previous research concluded that intense resistance training may improve body composition, by increasing fat-free mass (FFM), decreasing fat mass (FM), and thus decreasing the percentage of body fat (BF). It has been suggested that long-term adherence to resistance training is necessary to achieve significant changes in body composition, while short-term programs typically result in slight increases in FFM. Previous studies examined the effects of traditional weight training, isometric, isokinetic, and plyometric training programs on body composition. The concept of Manual Resistance Training (MRT) is not new, however, no research has been conducted to explore the effectiveness of MRT on body composition. PURPOSE: The purpose of the study was to investigate the effects of a moderate-intensity and high-volume MRT program and an identical weight resistance training (WT) program on body composition.

METHODS: Physically active college males (n = 45) and females (n = 34) were randomly assigned to either the MRT or the WT group. Both groups completed three training sessions per week for 14 weeks. The MRT and WT programs were identical in the number of exercises, sets, reps, and rest intervals. A single training session was comprised of the same six to nine exercises with two to four sets of eight to twelve repetitions. Body composition was assessed pre- and post-training by underwater weighing with residual volume measurement. Pre- and post-test data were analyzed using an ANOVA with repeated measures. At baseline, there was no significant difference between the MRT and WT groups (p > 0.59). However, a significant effect of gender (p < 0.001) was observed for pre- and post-test values of BF for males. A marginally significant improvement (p = 0.08) for BF, FFM, or FM, or for each of the MRT group (20.7 ± 6.4% to 20.7 ± 6.4%, 64.9 ± 8.6 kg to 65.4 ± 8.3 kg, and 17.8 ± 8.3 kg to 17.4 ± 8.4 kg, respectively) or the WT group (21.5 ± 7.9% to 20.8 ± 7.2%, 65.6 ± 7.9 kg to 66.8 ± 8.0 kg, and 19.8 ± 9.8 kg to 20.0 ± 10.9 kg, respectively) for the MRT females (p = 0.001) was a significant improvement in BF (29.7 ± 8.6% to 27.5 ± 8.5%), FFM (44.9 ± 6.0 kg to 46.8 ± 5.8 kg), and FM (19.8 ± 8.0 kg to 18.4 ± 7.6 kg) following training. A similar improvement was observed in the WT females for FFM (43.6 ± 4.5 kg to 44.9 ± 4.5 kg (p = 0.002)), although, no significant (p > 0.45) change was observed for the WT females for BF (29.5 ± 8.5% to 29.7 ± 8.5%) or FM (29.7 ± 8.4 kg to 20.2 ± 8.4 kg). CONCLUSION: For these data, a moderate-intensity and high-volume resistance training program did not result in improvements in BF, FFM, or FM for males. However, a short-term resistance training program facilitated an improvement in FFM for females. Additionally, the MRT program produced positive improvements in BF, FFM, and FM for females.

PRACTICAL APPLICATION: A moderate-intensity and high-volume MRT program may provide a cost effective alternative training method for improving the body composition of females. For males, however, a short-term resistance training program may not provide sufficient stimulus to elicit alterations in the body composition. A longer-term adherence to either WT or MRT programs may be necessary to achieve improvements in body composition in males.

Effect of Personal Trainers on Motivation and Physical Activity in College Aged Females

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Efforts to promote physical activity have focused on designing interventions that might effectively promote regular physical activity, such as the use of a personal trainer. PURPOSE: The purpose of this study was to determine the effect of using a personal trainer on motivation, behavior, and physical activity in college-aged females. METHODS: Sixty-seven college aged females, aged 20.5 ± 1.9, were randomly placed in one of three groups: control group (C), weight room group (FREE), and personal training group (PT). Of those recruited, 47 participated completed an 8 week intervention which included either free access to the strength center (FREE) or free access to the strength center and the assignment of a student personal trainer (PT). All trainers were students in the undergraduate ERP strength and conditioning concentration. Groups were assessed twice, pre-intervention (PRE) and post-intervention (POST) in the following: amount of physical activity (PA), percent body fat (BF), motivation for physical activity (MOT), and stages of the Transtheoretical Model of Behavior Change (STM). PA was assessed using the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1986). Body composition was estimated using a dual energy X-ray absorptiometry (DEXA). MOT was assessed with the Self-Motivation Inventory (SMI) (Dishman, 1978). RESULTS: Descriptive statistics were performed and a mixed design repeated measures ANOVA (p < 0.05) with Wilk’s lambda as the test statistic was used to evaluate differences between subjects (PT, FREE, C) and within subjects (PRE versus POST). Comparisons were made with a Bonferroni adjusted alpha level to determine which components contributed to the significant differences. MOT and STM were not significantly different between the groups, however BF significantly decreased (p = 0.00) over time (PRE: PT = 30.3 ± 8.7%, FREE = 35.0 ± 9.9%, C = 32.0 ± 7.6%; POST: PT = 28.9 ± 8.1%, FREE = 34.3 ± 9.6%, C = 30.9 ± 8.1%). CONCLUSIONS: Although there were no significant differences in PA, there was an increase in the number of times participants in the PT and C group reported performing strenuous and mild activity over a 7 day period. In other words, the physical activity changed, however not significantly from PRE to POST, which suggests that the quality of the activity was altered by the intervention. While there were significant differences detected in BF over time, they were close to being within-measurable error (±2%) for estimating body composition using DEXA. Participants were primarily in stage 3 of the STM prior to and during the intervention, which may have accounted for the lack of differences between groups in MOT. However, the average MOT for each group was close to the suggested level for being dropout prone (<24). PRACTICAL APPLICATION: These observations suggest a longer intervention may be necessary to detect changes in motivation and participation in physical activity, and in turn, improvements in physical fitness. In addition, further analysis into the nature of the activities (e.g., structured resistance training programs compared to unstructured recreational type activities) may be warranted. However, it may be suggested that those in the higher stages of change are still at risk for dropping out of physical activity programs regardless of access to facilities.

The Heart Rate Response in Elite Walking Golfers to Variable Ambient Temperatures

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Although golfers do not engage in a physically demanding sport, they often play in extreme ambient temperatures for extended durations, and may go long periods of time without consuming enough fluids. Intuitively, changes that occur will transpire much more subtly than may be experienced for more metabolically demanding activities. However, the slightest alteration in functionality may prove to be detrimental golf performance, compounded over the course of a round or tournament. As core body temperature rises, there is a concomitant increase in cardiovascular strain, as evidenced by reduced stroke volume. With a limited ability to effectively dissipate heat, along with increased taxation of the cardiovascular system, fatigue will heighten, exponentially.

PURPOSE: The purpose of this investigation was twofold: (1) To analyze the heart rate response of walking golf in moderate ambient temperature (i.e., mean: 29.3 degrees Celsius) versus high ambient temperature (mean: 40.5 degrees Celsius); and (2) To quantify the total volume of activity during each trial round. METHODS: Study subjects were thirteen male volunteers (mean age: 24.1 years) of elite-level golfing ability (i.e., < 7 handicap). In order to fulfill the requirements of inclusion criteria, subjects had to complete two rounds of walking golf on separate occasions. One round was played during an early summer morning in Arizona, whereas the second round was played within the same week, but during the afternoon. Both rounds of golf were played on the same course, and with a matched number of golfers in the successive outings. Polar 5610i Wireless Heart Rate Monitors, Yamax pedometer step counters, and Global Positioning System (GPS) bluetooth loggers were worn by all participants in this study to monitor heart rate reactivity, total activity volume, and total distance walked throughout the round, respectively. Descriptive statistics were analyzed as means and standard deviations. RESULTS: Relative intensities were calculated for each golfer and stratified based on intuitive heart rate zones. During the moderate temperature golf round, the group spent 6.3, 36.4, 54.2, 7.2, and 0.4% of total time at the following heart rate zones, respectively: (1) 70–90 bpm, (2) 91–110 bpm, (3) 111–130 bpm, (4) 131–150 bpm, and (5) >150 bpm. Comparing the high ambient temperature golfing, time spent in each heart rate zone was significantly different (p = 0.05), as represented by 1.8, 23.8, 37.3, 30, and 7% of total time. No significant differences were found for volume of activity, as presented as step counts (Low Temp: 11,930 ± 851 versus High Temp: 11,581 ± 964). PRACTICAL APPLICATION: Additional research is needed to examine alterations in core body temperature and hydration status to explicate these findings. Lastly, these data also demonstrate the superiority of walking golf as a means of cardiovascular exercise.
The Effectiveness of a Manual Resistance vs. a Weight Resistance Training Program on Aerobic Power


Previous research indicated that high intensity and low volume resistance training programs are minimally effective for improving aerobic power. Conversely, with programs of low to moderate intensity and of increased volume, small improvements in aerobic power have been observed; however, with circuit weight training protocols. Previous studies examined the effects of traditional weight training, isometric, isokinetic, and plyometric training programs on aerobic power. The concept of Manual Resistance Training (MRT) is not new; however, no scientific research has been conducted to explore the effectiveness of MRT on aerobic power. PURPOSE: The purpose of the study was to investigate the effects of a moderate-intensity and high-volume MRT program and an identical weight resistance training (WT) program on aerobic power.

Twenty-eight subjects were randomly assigned to two study groups: 1) a moderate-intensity (30% of 1RM) and high-volume (12.76 ± 0.96 second) resistance training group, and 2) an identical weight resistance training group. The weight training group had a pretest mean (16.19 ± 0.91 second) and posttest mean (16.59 ± 1.6 second) compared to the control (16.5 ± 1.61 second), respectively. The results of this study show that plyometric training can be an effective training technique to improve an athlete’s reaction times and test scores on agility. PRACTICAL APPLICATION: Sports, such as volleyball, basketball, and soccer, require athletes to execute both quick reaction times and explosiveness. For the lower extremities, this combination can be achieved by training in a plyometric training program lasting only 6 weeks.

Recovery From Resistance Exercise in College- and Middle-Aged Men

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PURPOSE: The purpose of this investigation was to examine recovery from resistance exercise in college- and middle-aged men. METHODS: Fifteen healthy college-aged and middle-aged men who had resistance training experience completed three sets of eight repetitions in the bench press and leg press at a resistance of 70% of their 1RM. The exercise status, as indicated by the ability to repeat pre-test repetitions-to-fatigue, was evaluated at 48, 72, and 96 hours, in a counterbalanced fashion, after the exercise session. RESULTS: A repeated-measures ANOVA revealed a significant difference in recovery across hours in both exercises in both subject groups (p < 0.001). Bonferroni follow-up procedure showed no significant difference in number of repetitions completed between 0 and 72, and 0 and 96 recovery hours for the college-aged men. All other combinations demonstrate a significant difference in number of repetitions completed. A significant main effect was observed for recovery hours for middle-aged men. Number of repetitions completed was found to be significantly different for all combinations of all four recovery intervals. In addition, it took 72 hours for the majority of college-aged (93.3%) and middle-aged (53.3%) men to recover in the bench press. Also, it took 96 hours for the majority of both college-aged (66.7%) and middle-aged (80%) to recover in the leg press. CONCLUSIONS: These results suggest that it may take longer for strength to recover from strenuous resist- tion exercise durations than the often-recommended 48 hours especially for the leg press. In addition, it may take longer for middle-aged subjects to recover. PRACTICAL APPLICATION: Longer recovery times indicated in this investigation suggests practitioners may need to allow longer recovery to prevent overtraining, especially in middle-aged populations.

The Effects of Combined Ballistic and Heavy Resistance Training on Maximal Lower- and Upper-Body Strength in Recreationally-Train Men


PURPOSE: to investigate the additive effects of ballistic training to a traditional heavy resistance training program on body maximum strength. METHODS: Seventeen resistance-trained men were randomly assigned to one of two groups: 1) a combined ballistic and heavy resistance training group (COM, N = 8; age = 21.4 ± 1.7 years, body mass = 82.7 ± 15.1 kg), or 2) a heavy resistance training group (HR; N = 9; age = 20.1 ± 1.2 years, body mass = 81.0 ± 9.2 kg) and subsequently participated in an 8-week resistance training program. Each subject trained 4 days per week performing 6–8 exercises per workout (6–8 traditional exercises for HR; 4–6 traditional + 2 ballistic exercises in COM using an upper/lower body split routine) for 3–8 repetitions with 2–4 minute rest intervals between sets. Maximal strength (one-repetition maximum [1RM] bench press and squat) and power (jump squat and plyometric push-up performed on a portable force plate) of the lower and upper body were measured before and after their experimental periods. RESULTS: A significant increase in 1RM squat was shown in both groups (COM = 15.2%; HR = 17.3%) with no difference observed between groups. However, 1RM bench press increased to a significantly greater extent (p < 0.04) in COM than HR (11.6% versus 7.1% respectively). For peak power attained during the jump squat, an interaction (p = 0.04) was observed where the 5.4% increase in COM and −3.2% reduction in HR were statistically significant. Non-significant increases were observed in peak plyometric push-up power. CONCLUSIONS: Lean body mass and fat significantly increased in both groups with no between-group differences observed (2.9 and 3.2% respectively for COM and HR). PRACTICAL APPLICATIONS: The results of this study support the inclusion of ballistic exercises into a heavy resistance training program for increasing 1RM bench press and enhancing power.

The Effects of a 6-Week Plyometric Training Program on Agility

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Plyometrics is a training technique used by athletes in all types of sports to increase strength and explosiveness. Agility is the ability to rapidly change directions without loss of speed, balance, and body control. Improved performances in tests of agility can be one goal of a plyometric program, since plyometrics are aimed at reducing the amount of time spent on the ground in preparation for movement. However, there is minimal research on plyometric training and the effects on agility. PURPOSE: To determine if 6 weeks of plyometric training can improve an athlete’s agility. METHODS: Subjects were divided into 2 groups, a plyometric training and control group. The plyometric training group participated in a 6-week plyometric training program, progressively increasing the foot contacts ranging between 90–140 repetitions. The control group did not perform any plyometric training techniques and were told to continue with their usual training program. Twenty-eight subjects were randomly assigned to 2 groups, a plyometric training group (n = 14, age = 22.29 ± 3.06 year, height = 69.07 ± 3.37 in, and weight = 176.57 ± 32.90 lb) and a control group (n = 14, age = 24.21 ± 4.77 year, height = 68.93 ± 3.94 in, and weight = 179.07 ± 46.49 lb). Subjects were at least 18 years of age, free of lower extremity injuries, and were not included in any type of plyometric training. All subjects participated in 3 agility tests: T-test; Illinois Agility Test, and ground reaction time on a Force Plate both pre- and post-test. Repeated measures ANOVAs were conducted to analyze the independent variables of group (training or control) and time (pre- test and post-test) as the between-subjects factors on the dependent variables of agility (T-test, Illinois agility test, force plate). Significant main effect was set at p < 0.05. RESULTS: The repeated measures ANOVA revealed a significant effect by test interaction F1,25 = 46.12, p = 0.0000, R = 0.9999 for the T-test agility measure. The plyometric training group had a pretest mean (12.76 ± 0.96 second) and posttest mean (12.13 ± 1.11 second) compared to the control (12.61 ± 1.07 and 12.61 ± 1.08 second). A significant group by test interaction F1,25 = 16.19, p = 0.0000, R = 0.971 was found for the Force Plate test. The plyometric training group had a pretest mean (256.89 ± 28.21 second) and posttest mean (230.53 ± 37.17 second) compared to the control (229.83 ± 32.87 and 352.63 ± 39.5 second). A significant group by test interaction was found in the Illinois agility test, F1,25 = 44.23, p = 0.0000, R = 0.999 was found. The plyometric training group had a pretest mean (17.09 ± 1.69 second) and posttest mean (16.59 ± 1.6 second) compared to the control (16.5 ± 1.61 and 16.51 ± 1.91 second), respectively. The results of this study show that plyometric training can be an effective training technique to improve an athlete’s reaction times and test scores on agility.