Controversies in Resistance Training: Solved

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I. Avilla et al. (2010). Effect of moderate intensity resistance training during weight loss on body composition and physical performance in overweight adults. Euro J Appl Phys 109, 517-525.

A. Weight loss in resistance training (RT) programs
   1. 27 male and female subjects (BMI=32kg/m^2): 67 yr
   2. Previously sedentary; medical clearance
   3. 10-week study: randomly assigned to two groups
   4. One group DASH only; 2nd group DASH-RT
   5. Measured weight loss, body composition, muscle
   6. Registered dietician met once a week to explain diet (DASH): all subjects on individualized diet (10% caloric restrict) based on estimated metabolic rate (Harris-Benedict equation)
   7. RT= 40min RT on 3 non-consecutive days; 1 sec concentric; 1sec pause; 2-3 sec eccentric
   8. 6 upper body and lower body exercises; warm-up set followed by 4 sets of 8-12 reps
   9. DASH lost 2% body weight; DASH lost .2% body fat; DASH lost 2.7% muscle
   10. DASH-RD lost 3.6% BW; DASH-RT lost 11.2% BF; DASH-RT gained 1.3% muscle
   11. TAKEAWAY: Findings of study show a decrease in fat mass and improvement in muscle strength with resistance training with dietary intervention.

II. American College of Sports Medicine Position Stand. (2009). Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults.

What is the truth? What is the metabolic rate of muscle tissue?

A. Muscle comprises 40% of the adult human body
B. Influenced by genetics, physical activity, nutrition, hormones, disease
C. 50%-75% of all proteins are in muscle
D. Protein synthesis and catabolism account for 20% of RMR
E. 60% of RMR from liver, kidney, heart and brain (which are 5%-6% of body weight)
F. Liver, kidney, heart and brain metabolic rate 15-40 times to equivalent wt. of muscle
G. RMR effect from resistance training? Approximately 100 kilocalories per day
H. How meaningful is a 100 kcal daily increase? (Hill, J.O. et al. 2003 article reviewed)
I. TAKEAWAY: for optimal caloric deficit do cardiovascular, caloric restriction, and RT

III. Gaesser, G.A. & Brooks, G.A. (1984). Metabolic bases of excess post-exercise oxygen consumption: a review. Medicine and Science in Sports and Exercise, 16(1), 29-43

A. Exercise and E.P.O.C: 'The exercise afterburn'
B. Key Mechanisms of E.P.O.C: lactate removal, CrP replenishment, heart rate recovery, temperature recovery, ventilation recovery, glycogen re-synthesis, hormones recovery (also restoring oxygen to myoglobin; elevated thyroxin, glucocorticoids, fatty acids, calcium ions, epinephrine/norepinephrine)
C. E.P.O.C. is the oxygen consumed to bring several physiological variables to pre-exercise level
D. Most influential factor affecting E.P.O.C. is intensity of exercise
E. Contemporary studies describe E.P.O.C. as a 'homestatic stress' or 'disturbance'
F. Confusion: some studies suggest it lasts no more than 35 min and others report ≥24 hrs
G. Knab et al. (2011). A 45-minute vigorous exercise bout increases metabolic rate for 14 hours. Medicine & Science in Sports & Exercise, 43(9), 1643-1648
H. Effects of 45 min exercise at 70% VO2max on a cycle ergometer; in a metabolic chamber (10 males)
I. All subjects given diet of 55% CHO, 30% Fat, 15% Protein

J. Two trials: Rested (control) vs Exercise: Stayed 24 hrs in metabolic chamber (2min stretching/hr)
K. 45 min workout had an average energy cost of 519 kilocalories
L. E.P.O.C. was significantly elevated for 14 hrs post-exercise
M. TAKEAWAY: E.P.O.C.=190 kilocalories (Enhanced post-workout fat oxidation)
N. New research shows moderate intensity resistance training has similar E.P.O.C to HIIT (Greer et al. {2015}. Research quarterly for Exercise and Sport, 86(2), 190-195.
O. E.P.O.C. with women. Twelve healthy (24-34 yrs) women performed three sets of nine difference resistance-training exercises for a total of 27 sets within 45 min. Volunteers completed 10 repetitions per set at an intensity of 70% 1-RM. The overall 2-hr EPOC corresponded to an 18.6% elevation over the control period…and fuel utilization favors fat oxidation.

IV. Cornelissen, V. & Fagard, R. 2013. Exercise training for blood pressure: A systematic review and meta-analysis. Journal of American Heart Association, 2:e004473

A. Does resistance training reduce arterial compliance (causing artery stiffening)? Controversy over yrs.
B. TAKEAWAY: Most recent evidence shows endurance exercise and dynamic resistance training do lower systolic and diastolic blood pressure.

V. Wilson et al. (2012). Concurrent training: a meta-analysis examining interference of aerobic and resistance exercise. Journal of Strength and Conditioning Research, 26(8), 2293-2307

A. Does aerobic exercise impair strength performance? Concurrent training controversy
B. Concern is more with competitive athletes
C. Referred to as 'interference phenomenon': do endurance signals confuse protein synthesis of RT
D. Hypotheses: Concurrent session may lead to excess fatigue, a greater catabolic state, and alterations in motor unit recruitment patters
E. Hypotheses: Muscle cannot adapt metabolically or morphologically to concurrent training because of the different adaptations that are being demanded
G. Concurrent Training Study Results
H. Power is the most inhibited variable with concurrent training
I. Athletes who concurrently train should select a modality of endurance exercise that closely mimics their sport, to avoid the occurrence of competing adaptations.
J. Concurrently training athletes should only do endurance exercise (20-30 min) $\leq$ 3 days per week
K. TAKEAWAY: the potential deleterious effects of concurrent training apply mostly to athletes

VI. Drummond, M.J., Vehrs, P.R., et al. (2005). Aerobic and resistance exercise sequence affects excess postexercise oxygen consumption. J of Strength and Conditioning Research. 19(2), 332-337.

A. 10 physically active male students (age=26 yr) who had jogged/strength trained for 6 months
B. 1 RM (and exercise order) bench press, leg press, biceps curl, triceps extension, hamstring curl, latissimus dorsi pull-down, knee extension: Max VO_2 treadmill test
C. Protocol
    1. Measurement of RMR
    2. Resistance Only: 3 sets of 10 repetitions at 70%1RM with 105-second rest between sets
    3. Run Only: Subjects ran for 25 minutes at 70% of VO_2max
    4. Combined: 1) Resistance-Run and 2) Run-Resistance {of the above protocols)
    5. Excess Postexerise Oxygen Consumption (EPOC): began 5 minutes after exercise bout and collected for 90 minutes post exercise
E. Result 1: Greatest difference seen in first 10 minutes of EPOC
F. Result 2: Resistance Only (5.8 ml/kg/min); Run-Resistance (5.7 ml/kg/min); Resistance-Run (5.1 ml/kg/min); Run Only (4.7 ml/kg/min): Run-Resistance had greatest EPOC of the two sequences

VII. Kostek et al. (2007). Subcutaneous fat alternations resulting form an upper-body resistance training program. Med Sci Sports Exerc, 39(7), 1177-1185. Spot training vs. target training

A. "The most successful resistance training programs are those that are designed towards target-specific training goals" ACSM 2009 Progression Models in Resistance Training for Health Adults
B. Spot reduction, the exercise-induced localized loss of subcutaneous fat; does it occur in exercise?
C. Compared subcutaneous fat measurements before and after resistance training among 104 subjects (45 min, 59 women)
D. Subjects participated in 12 weeks of supervised resistance training of their non-dominant arm
E. Magnetic resonance imaging and skinfold calipers examined subcutaneous fat in the non-dominant (trained) and dominant (untrained) arms before and after training
F. TAKEAWAY: Results indicate that spot reduction does not occur as a result of resistance training

VIII. Munoz-Martinez et al. (2017). Effectiveness of resistance circuit-based training for maximum oxygen uptake and upper-body one-repetition maximum improvements: A systematic review and meta-analysis. Sports Medicine 47(2), 2553-2568.

A. 14-30 sessions for 6-12 weeks
B. Workouts lasting 20-30 minutes
C. All exercises performed at ~50%-70% of 1RM
D. Each session should be 6-12 exercises (more multi-joint)
E. Perform 12-15 repetitions (or 20-30 seconds per station); very short rest between exercises
F. Must complete at least 2 circuits
G. Improves VO2max up to 10%

IX. Robergs, R.A. & Kravitz, L. (2005). Role of cortisol in concurrent training. IDEA Fitness Journal, 2(9), 20-23.

A. Cortisol: very complex hormone with multiple functions in body: Article function focus: increases amino acid supply to liver, increasing protein catabolism
B. Cortisol, like most steroid hormones is released 24 hrs a day: release most of cortisol during sleep
C. Cortisol is released in resistance exercise and aerobic exercise: intensity dependent
D. More cortisol is released during resistance exercise than aerobic exercise
E. In prolonged exercise, cortisol clearly functions to preserve carbohydrate reserves
F. During prolonged aerobic exercise, the muscle catabolic effects of cortisol can be diminished simply by maintaining blood glucose, which in turn is best done through the ingestion of carbohydrate. Alternatively, when aerobic exercise is performed for durations short enough to not critically lower muscle or liver glycogen (e.g. < 45 min), then exercise-induced cortisol release will most likely be irrelevant to muscle protein balance.
G. TAKEAWAY: Nutrition factor of hypertrophy: insufficient carbohydrate due to higher protein diets

X. Robergs, R.A., Ghiasvand, F., & Parker, D. (2004). Biochemsitry of exercise-induced metabolic acidosis. American J of Physiology: Regulatory, Integrative and Comparative Physiology. 287: R502-R516.

A. Lactate not the cause of the burn.
    1. Hydrogen ions that are released from splitting of ATP are cause of burn
    2. Lactate is really a buffer trying to neutralize the acidosis
    3. Training Applications (5 min cardio sprints 2-3 times a week to train acidosis buffering)

XI. Schoenfeld, B. (2011). The use of specialized training techniques to maximize muscle hypertrophy. Strength and Conditioning, 33(4), 60-65.

A. Muscle hypertrophy theories: greater intensity (greater motor unit recruitment); longer time under tension (greater motor unit recruitment for a longer period of time)
B. Metabolic stress: resistance training elicits anaerobic glycolysis, which increases inorganic phosphate, hydrogen ions, lactate, anabolic hormones and ischemia; this activates hypertrophy cellular pathways

XII. Proske, U. & Allen, T.J. (2005). Damage to skeletal muscle from eccentric exercise. Exercise and Sport Science Reviews. 33(2), 98-105.

A. What is the BEST way to reduce DOMS?
    1. General warm-up always best for increase in muscle temperature
    2. Concentric exercise (low-intensity) prior to high-intensity (eccentric)
    3. Repeated Bout Approach: progressive eccentric exercise in previous workouts

XIII. How does an eccentric action develop more force than a concentric or isometric action? Herzog, W. et al. (2016). Residual force enhancement following contractions: A new mechanism involving titin. Journal of Applied Physiology, 31(4), 300-312. Video explanation of new theory how eccentric actions develop 40% more force than concentric and isometric actions. Introduction to Supramaximal eccentric training.

XIV. New theory on muscle cramps. Giuriato, G. 2018). Muscle cramps: A comparison of two-leading hypothesis. Journal of Electromyography and Kinesiolgy, 41, 89-95.

A. 1st documentation of cramps: 1908
B. 50-60% of people experience cramps
C. No gender difference in cramps
D. Occur more commonly in endurance athletes and elderly
E. Three types: Nocturnal, pathological (related to type 2 diabetes and nerve dysfunction), exercise-associated
F. Exercise-associated muscle cramp risks: poor stretching habits, muscle fatigue
G. OLD, exercise-associated muscle cramp theories: electrolyte imbalance of sodium, potassium, chloride, calcium and phosphate(2 studies have not supported); dehydration theory (not supported by recent research); environmental theory from exercising in a hot, humid environment (no supportive evidence)
H. Newest exercise associated muscle cramp theory: Neuromuscular theory. From fatigue, there is an imbalance of stiumuli from muscle spindle and golgi tendon organ

XV: Short Research Takeaways

A. How much protein is needed for optimal muscle growth? 1.6-1.7 g/kg/day
B. What are the two most common causes of overtraining in resistance exercise? Intensity & Volume
C. How much rest is needed between multiple sets? Fit Females-1-2 min, Males 2-3 min (interestingly, estrogen enhance blood flow into and out of muscle, thus speeding up recover between sets)
D. How safe are these extreme conditioning programs? Concern is with exertional rhabdomyolysis. Breakdown of striated muscle tissue. Elevated proteins in blood (notably myoglobin) can lead to acute renal (kidney) failure, blood clotting, and heart arrhythmias. Response to excessive, prolonged or repetitive exercise in persons with low fitness level and/or too early introduction to the demands of the exercise program can be quite deleterious. Ensure suitable rest periods between sets and workouts; vary workouts so all are not to exhaustive fatigue; discourage clients from using caffeine and other stimulants (energy drinks) which mask fatigue; be cautious of training at high intensities in hot environments

Thank you for coming to this session!