Maximize the Caloric Burn and Strategies to Enhance Fat Metabolism

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I. Fat metabolism terms

A. Fat mobilization: use of stored fat when needed
B. Free fatty acids: molecules of triglyceride no longer attached to glycerol backbone
C. Lipolysis: disassembly of triglyceride
D. Metabolism: all reactions in the body
E. Oxidation: loss of electrons: breaking apart of a molecule
F. Triglyceride: storage form of fat in body

II. How much fat and carbohydrate is stored in the body?

A. Carbohydrate: plasma glucose (78 kcal), liver glycogen (388 kcal), muscle glycogen (1550 kcal), Total=2216 kcal
B. Fat: plasma fatty acid (4 kcal), plasma triglyceride (39 kcal), adipose (100,000 kcal), intramuscular fat (2616 kcal), Total=102,659 kcal

III. Principle physiological organs, hormones and enzymes that regulate fat metabolism and lipolysis

A Organs controlling blood lipid levels: liver and kidneys
B. Catecholamines: epinephrine and norepinephrine (fight or flight hormones), major hormones of lipolysis in adipose and intramuscular tissue (at rest and exercise)
C. Site of activation of epinephrine and norepinephrine: (alpha-adrenergic which inhibit lipolysis) and (beta-adrenergic which stimulate lipolysis)
D. Insulin: strongest inhibitor of lipolysis either before or during exercise. During endurance exercise when the need for fat is high, insulin levels are typically lower.
E. Growth hormone: stimulatory effect on lipolysis and fat metabolism during exercise and recovery
F. Thyroid stimulating hormone and thyroxine: increase fat metabolism
G. Lipolytic enzymes: Hormone sensitive lipase (HSL)
    1. Hydrolysis of fat
    2. Catecholamines stimulate HSL
    3. Insulin inhibits HSL
H. Lipolytic enzymes: Lipoprotein lipase (LPL)
    1. Promotes storage of fat
    2. Insulin stimulates LPL

IV. Hormonal regulation of lipolysis during exercise

A. Within seconds of exercise epinephrine and norepinephrine are released, activating HSL for lipolysis
B. Growth hormone and thyroid stimulating hormone follow next
C. Insulin is decreased because epinephrine & norepinephrine inhibit pancreatic insulin release

V. Effect of exercise on lipolysis

A. Mild to moderate exercise (25-65% of VO_2max) increases lipolysis 5 to 10 fold
B. Moderate intensity exercise doubles adipose tissue blood flow with a >10 fold increase in skeletal muscle blood flow
C. During exercise where are we getting the fat we use? 25% to >50% is intramuscular fat with the rest from fatty acids in the blood and then adipose tissue

VI. Effect of exercise on fat metabolism

A. Where is fat completely oxidized in cells: mitochondrion (fat burning furnace of cell)
B. Increase in mitochondrial density (35% bigger and 15% more in actual number) due to mitochondria having their own DNA
C. A proliferation of capillaries in skeletal muscle (5-15% increase)
D. Increase in muscle cell transport proteins of fatty acids (FABP, FAT, FATP)
E. Increase in carnitine transferase
F. Shift in substrate use to more intramuscular fat and less carbohydrate
G. A 2.5 fold increase in oxidative enzymes

VII. Effect of glycemic index (GI) on fat metabolism

A. GI is a function of appearance or disappearance of blood glucose
B. High glycemic carbohydrates pre-workout produce a sharp rise in blood glucose and insulin
C. Ramifications: decrease in plasma fatty acid levels and decrease in fat metabolism (however, the impact on total weight loss has not been scientifically tested)
D. Low GI carbohydrates have much less effect
E. High glycemic foods are much more beneficial immediately post-workout when your body is glycogen depleted
F. GI is measure of rate of digestion and absorption of 50 g of carbohydrate and the effect of blood sugar over a 2-hour period. Baseline is 100
G. Examples of high GI foods (>85) include bagels, carrots, crackers, potatoes, raisins; examples of medium GI foods (60-85) include baked beans, bananas, corn, grapes, rice, spaghetti, pasta; examples of low GI foods (<60) include apples, applesauce, cherries, dates, figs, skim milk, peaches, plums, yogurt

VIII. Effective exercise intensities for fat loss: The 'pitfalls' of too HIGH of an exercise intensity

A. Limitations in fat utilization during high-intensity exercise
B. Decline in circulating fatty acids due to:
    1. Decrease in fatty acid release from adipose tissue
    2. Decrease blood flow to adipose tissue
    3. High increase in glycogen metabolism
C. Impaired fatty acid transport into mitochondria
D. Limitations occur at exercise intensities >85% VO_2max

IX. Len's exercise physiology lab experiment results!

A. Into the lab to answer some real-life questions on fat burning!

Intensity	%VO2 Max	Total Kcals	Fat Kcals	CHO Kcals
Somewhat Hard	66%	219	35	184
Hard	74%	249	30	219
Very Hard	83%	275	22	253

B. Conclusion: To burn more fat, burn more calories at a comfortable but challenging intensity

C. What if my client can't train high intensity?

D. Increase the frequency or duration (or both)

E. Question: I've heard if I do cardio 1st thing in the morning I will burn more fat. Is this true?

F. 70% glycogen depletion from night's rest; % fat utilized will be higher, but low levels of pyruvate will impair oxaloacetate production in the TCA (inhibiting fat oxidation); impairs endurance performance (and total fat loss) by 20% to 25%; encourage client to have a low-glycemic index snack before exercise in the morning

X. Strategies to enhance fat metabolism with exercise

A. Incorporate low to moderate-intensity metabolic base training workouts

1. Rationale: increase mitochondrial density

B. Incorporate some high-intensity, short-duration workouts (interval & fast continuous)

1. Rationale: increase total caloric expenditure and fat loss

C. Incorporate multi-mode training

1. Rationale: increase total caloric expenditure and fat loss

D. Avoid high glycemic foods up to 2 hours prior to the cardiovascular workout

1. Rationale: less insulin to impair fat metabolism

E. Calculating caloric expenditure: caloriesperhour.com; calculating E.P.O.C. (Exercise Afterburn); Multiply workout calories by 0.15; For example; Let's say the Client's workout is estimated to be 300 calories; then 300 calories times 0.15 = 45 calories (this is the E.P.O.C or exercise afterburn); Total calories = 300 + 45 = 345 calories

Tempo Training: Continuous aerobic exercise at 70-85% VO2 max (14-17 RPE) for 30 to 60 minutes; this is Called a Maximal Steady State Training bout

Metabolic Base Training: Continuous aerobic exercise at a moderate intensity [40% to 70%] (11-14 RPE) for 60 to 80 minutes.

Split Training: 2 to 4 high-intensity exercise bouts about 15 to 20 minutes each at 70-85% of VO2 max (14-17 RPE). Separated by 5 minutes ACTIVE rest. Complete on multiple modes

Interval Training: Alternate 3 minute bouts of low (30-40% VO2 max) {10-11 RPE} with 3 minute bouts of high intensity (80-90% VO2 max) {16-18 RPE} for 30 to 60 minutes.

Supramaximal Interval Training: 15-20 supramaximal exercise bouts (105-110% VO2 max) {all out sprints} for 1 minute. Two to 5 minutes of ACTIVE rest between bouts.

NEW Circuit Training: 11 college males who had completed an 11-week resistance training program: leg press, bench press, lat pull, arm curl, seated press, triceps push-down, upright row, leg extension, seated row; 40 repetitions/min cadence (one second out and one second in tempo); 2-5 sec rest between sets; All exercise at 40% of 1 RM; 10 reps per exercise; 5 circuits!

Fartlek PLUS Training: Swedish word for speed play; Spontaneous variations in slow, medium and fast training over a variety of distances on various modes of exercise; No set structure for 30-60 min

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