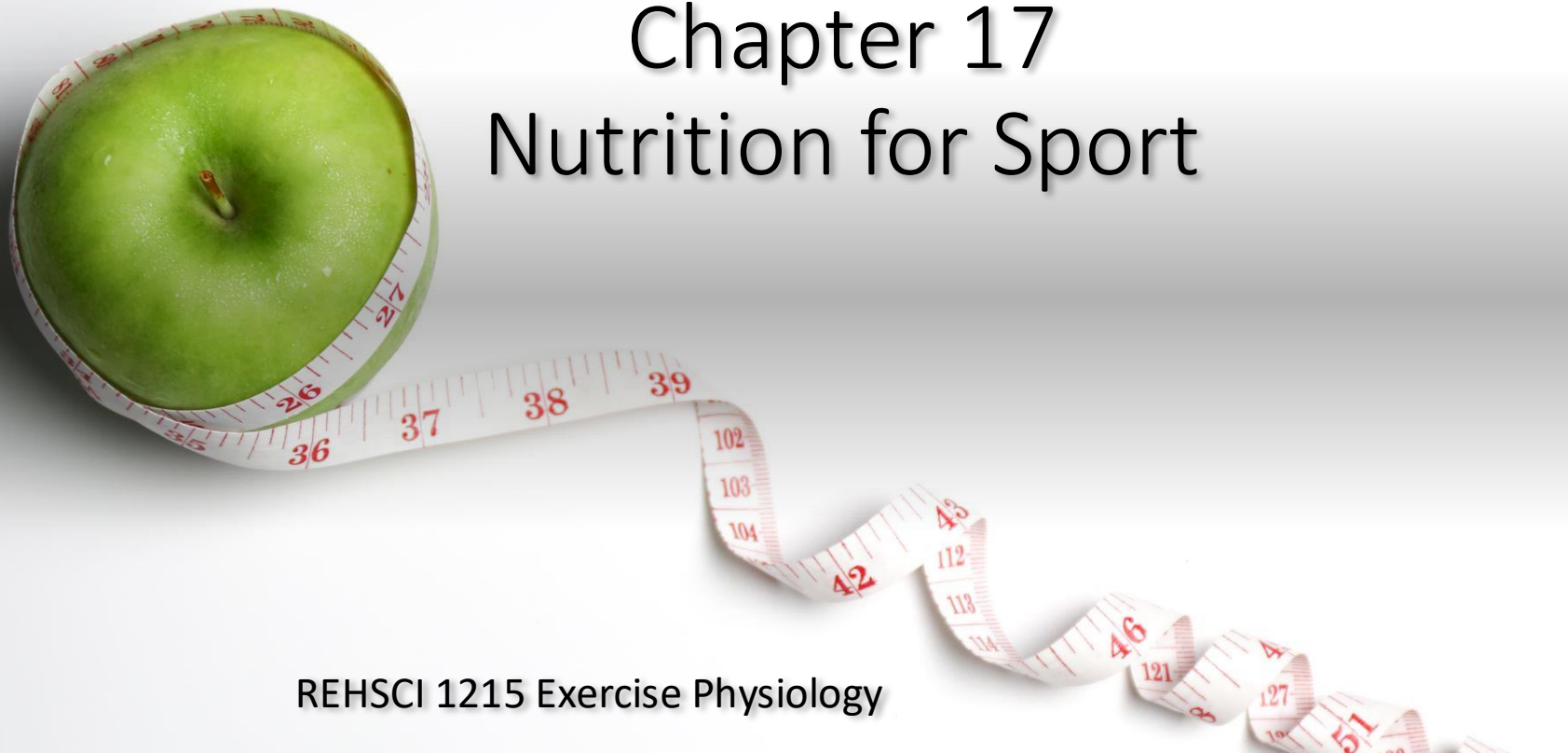


Chapter 17
Nutrition for Sport

REHSCI 1215 Exercise Physiology

Nutrition for Sport - Outline

- Classification of nutrients
- Water and electrolyte balance
- Nutrition and athletic performance

Classification of Nutrients

- Carbohydrate (CHO)
- Fat (lipid)
- Protein
- Vitamins
- Minerals
- Water

Classification of Nutrients

Recommended macronutrient balance

- Carbohydrate: 55-60% of daily kilocalories
- Fat: <35% (<10% saturated)
- Protein: 10-15%**

Intake based on g/kg body weight to support training & goals

- CHO: 3-12 g/kg of body weight
- Protein: 1.2-1.7 g/kg of body weight**

**studies suggest higher

Classification of Nutrients

- Recommended Daily Allowance (RDA)
  - Outdated—not bad, just insufficient
  - Estimated safe, adequate dietary intakes & minimum vitamin/mineral requirements

- Daily Recommended Intake (DRI)
  - Current standard
  - Intakes grouped by nutrient function, classification

Carbohydrates

Molecular composition	Functions in body	Consumption and storage
• Monosaccharide • Disaccharide • Polysaccharide	• Energy source • Regulation of fat & protein metabolism	• Excess CHO stored as glycogen • Glycogen stores determined by dietary CHO intake

Carbohydrates

- Determinants of glycogen replacement
  - CHO intake
  - Exercise type
    - eccentric → ↓ glycogen synthesis

- Glycogen maintenance
  - CHO: 3 - 12 g/kg body weight/day to maintain glycogen stores
  - Athletes: hunger often insufficient drive for CHO consumption
  - Insufficient CHO intake → heavy, tired feeling

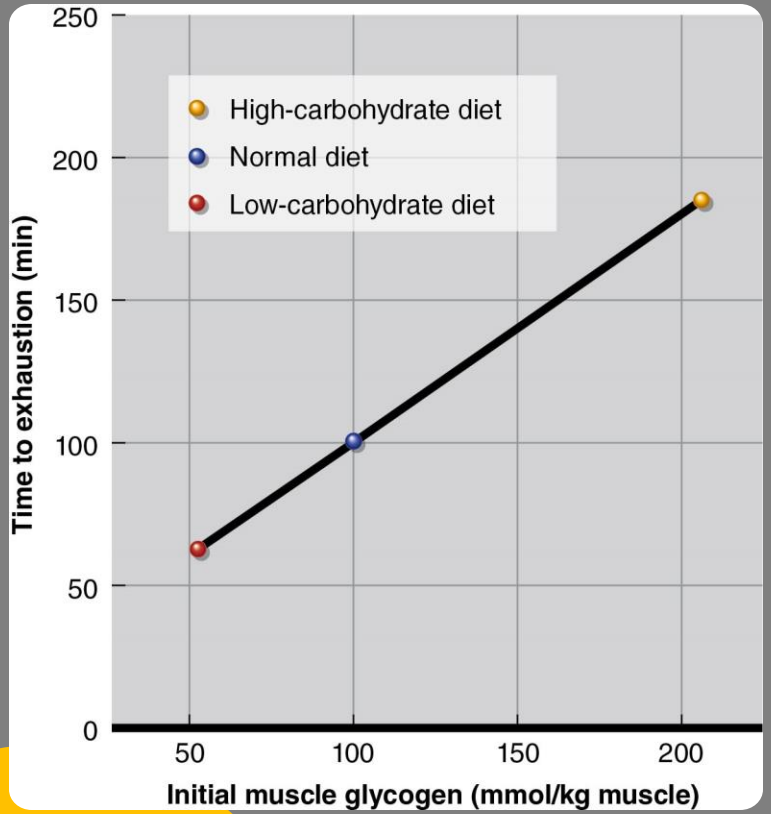


Fig. 17.2. Relationship between pre-exercise muscle glycogen content and exercise time to exhaustion

Glycemic Index (GI):

- Food categorized by glycemic (blood sugar) response
- High GI (GI >70): sport drinks, jellybeans, baked/fried potatoes, corn flakes, pretzels
- Moderate GI (GI 56-70): pastry, pita bread, white rice, bananas, soda, ice cream
- Low GI (GI ≤55): spaghetti, legumes, milk, apples, pears, peanuts, peanut M&M's, yogurt
- Fat + high GI = lower GI

Carbohydrate

- CHO factors that ↑ exercise time to fatigue
  - CHO loading: 1-3 days prior
  - Normoglycemia, low-GI pre-exercise snack
  - CHO feedings during exercise

- CHO factors that ↓ exercise time to fatigue
  - No CHO loading- lower glycogen stores*
  - Hypoglycemia, high-GI pre-exercise snack
  - No CHO feeding during exercise

**fat adaptation*

Carbohydrates & Exercise

- CHO during exercise
  - Does not trigger hypoglycemia
  - Improved muscle permeability to glucose?
  - Insulin-binding sites altered during exercise?

- CHO intake after exercise essential
  - Glycogen resynthesis high <2 h after exercise
  - Protein + CHO intake enhances glycogen stores
  - Stimulates muscle tissue repair

Fat

Fat is essential for body function

Total fat <35% of total daily kilocalories (0 trans fat)

Saturated fat <10% total daily kilocalories

Cholesterol <300 mg/day

Protein

- Essential for body function
  - Cell structure, growth, repair, maintenance
- 20 amino acids: essential & nonessential
  - Necessary for human growth & metabolism
  - Complete vs incomplete proteins
- Protein consumption
  - 15% of total daily kilocalories
  - ~0.8 g/kg body weight/day is the RDA

Protein Requirements for Athletes

- Endurance & Strength Athletes: 1.4 – 1.8g/kg body weight
- Endurance training: protein possible fuel substrate
- Strength training: protein needed for building/repairing muscle

Protein Intake & Resistance Training

To increase muscle mass = rate of protein synthesis > rate of protein degradation

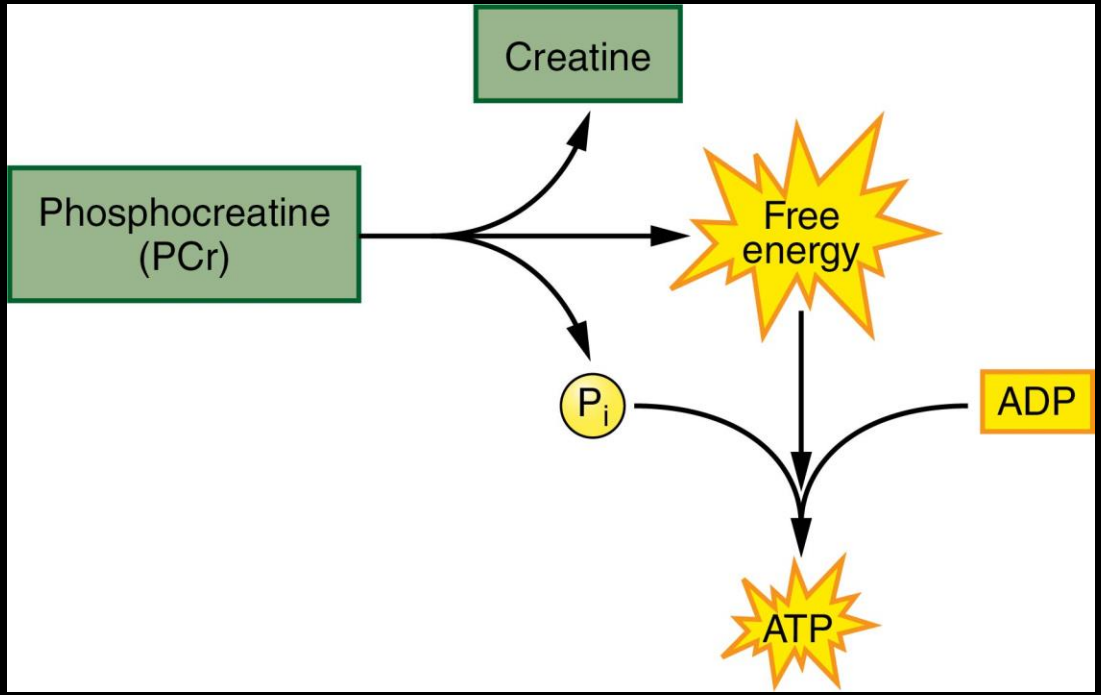
Resistance training & protein consumption can independently promote protein synthesis

- Peak muscle protein synthesis correlates w/ peak leucine concentration
  - Trigger for stimulating protein synthesis
  - High-quality dairy protein contains all essential aa & high in leucine

Protein consumption 1-2 hours post-ex is important

Phosphocreatine

- Phosphocreatine (PCr) is an essential substrate within ATP-PCr energy metabolism
- 98% of Phosphocreatine stored in muscles
- Remember that the ATP-PCr system is mainly utilized for short-duration, high-intensity exercise (Approx. 6-30 sec)
- Can increase our muscles PCr stores with supplementation!



Creatine Supplementation

- Benefits:
  - Increase Maximal Strength
  - Increase Power
  - Increase in Lean Body Mass

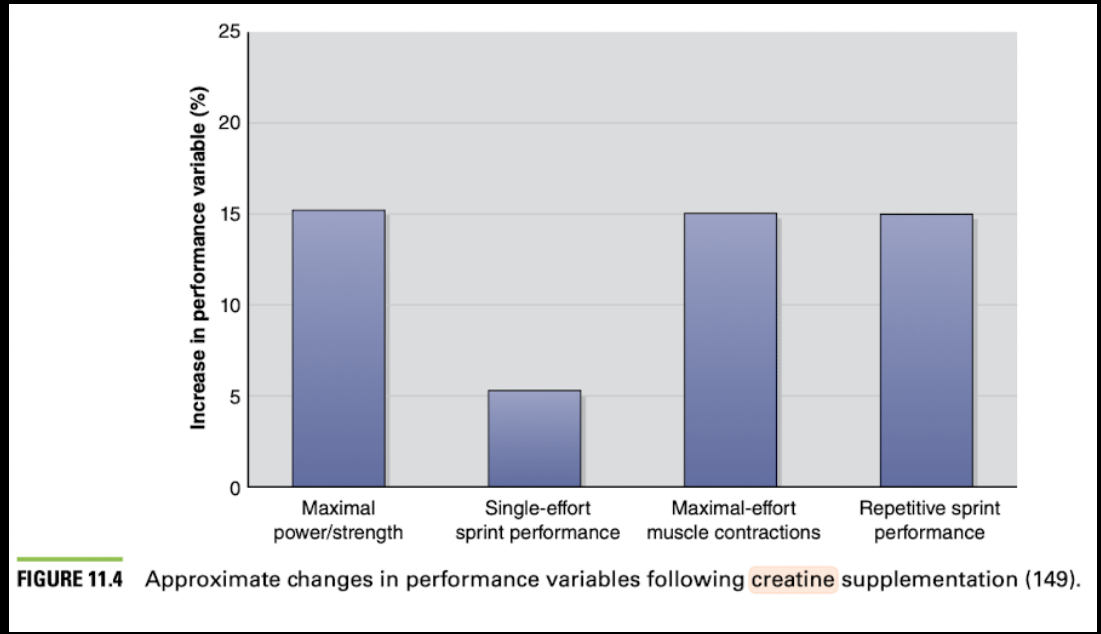


FIGURE 11.4 Approximate changes in performance variables following creatine supplementation (149).

Creatine Supplementation Regime

- Loading Phase :
  - 20-25 g daily for 5 days OR 2g daily for 30 days
- Maintenance Phase :
  - 2g daily
- IMPORTANT NOTE: Cap out saturation of 150-160mmol/kg of BW

Vitamins

Small, essential organic molecules

- Enable use of other ingested nutrients
- Act as catalysts in chemical reactions

Fat soluble vs water soluble

- Fat soluble stored, possible toxic accumulations (A,D,E,K)
- Water soluble excreted, toxicity difficult to reach

Vitamins

- B-complex vitamins (12+ total)
  - Essential for cellular metabolism, ATP production
- Vitamin C
  - Important for collagen maintenance, antioxidant
  - Adrenal hormone synthesis, iron absorption
- Vitamin E
  - Stored in muscle and fat
  - Potent antioxidant

Minerals

Inorganic substances needed for cellular function

Calcium- 40% of mineral content of body
- Bone density, nerve & muscle function
- Disease: osteopenia, osteoporosis

Phosphorus- 22% of mineral content of body
- Bound to calcium in bones
- Provides strength & rigidity
- Important for metabolism, cell membranes, buffers

Minerals

Iron- micromineral

- Critical for hemoglobin, myoglobin (O_2 transport)
- Deficiency → anemia

Sodium, Potassium, Chloride, Magnesium- electrolytes

- Na^+, Cl^- found primarily in interstitial fluid & plasma
- K^+ in intracellular fluid
- Need for nerve impulses, cardiac rhythm, fluid & pH balance

Water & Electrolyte Balance

- 50% - 60% of total body weight is water weight
  - Fat-free mass 73% water, fat mass 10% water
  - 2/3 of body water intracellular, 1/3 extracellular
  - 1-6% body-weight loss in sweat common for athletes
  - 9-12% loss possibly fatal
- Medium for transportation, diffusion
- Temperature regulation
- Blood pressure maintenance

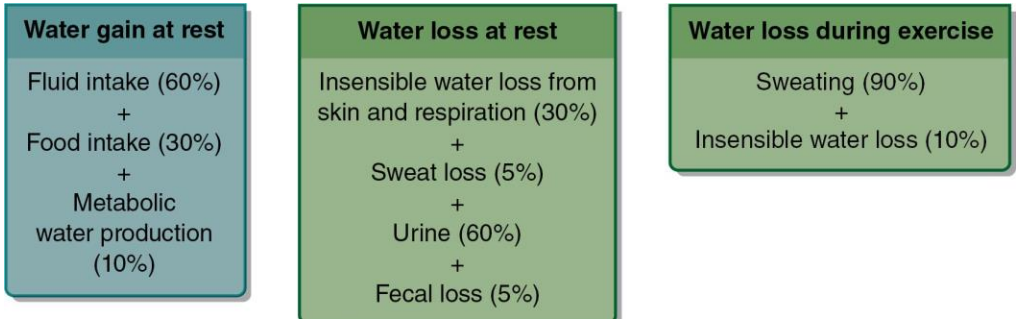


Fig. 17.6. Sources of body water gains & losses at rest & during exercise

Volume of sweat produced during exercise is determined by:

- Environmental temperature
- Humidity
- Air velocity
- Body size
- Metabolic rate

Dehydration Impairs Exercise Performance

↑ temperature → ↑ sweat loss → ↓ performance

↓ plasma volume → ↓ cardiovascular function

↓ plasma volume → ↓ thermoregulatory function

Water and Electrolyte Balance

- Electrolyte loss in sweat
  - Elevated rates of sweating contain large amounts of NA^{+} & Cl^{-}

- Electrolyte loss in urine

  Kidneys regulate electrolyte excretion

  ↓ urine production = ↓ electrolyte excretion

Water and Electrolyte Balance

- Thirst
  - Regulated by osmoreceptors in hypothalamus (high blood osmolality)
  - Thirst not well calibrated to hydration levels
  - 24-48 h to completely rehydrate

- Benefits of fluids during exercise
  - Minimize dehydration & water loss
  - Maintain performance & cardiovascular function

Water and Electrolyte Balance

- Hyponatremia
  - Serum Na^+ <135 mmol/L
  - Excessive Na^+ loss + excessive rehydration
  - Relatively rare (e.g., ultramarathoners)

- Symptoms
  - Mild: bloating/puffiness, nausea/vomiting, headache
  - More severe: cerebral edema, cognitive or central nervous system dysfunction, seizures, pulmonary edema, coma, death

Fluid Replacement Guidelines

- Before (2 hrs): 400-600 ml (14-22 oz) of fluid
- During: intake to stay within 2% of pre-exercise body weight
- After: replacement of all fluid losses; salty snack
- Exercise > 1hr: drinks with CHO (4-8%) & Na^+ (0.5-0.7 g/L)

The Endurance Athlete's Diet

- Maximal glycogen stores → ↑ performance

- Carbohydrate (glycogen) loading
  - Training tapered during week before event
  - Days 6-4 before event: normal CHO diet
  - Days 3-1 before event: high CHO diet
  - Muscle glycogen stores doubled

The Endurance Athlete's Diet

Pre-competition meal 2 h before competition

- 200-500 kcal
- Mostly CHOs:
  - Cereal, milk, juice, toast

Post-competition meal within 2 hours

- 2:1 CHO:Protein

Sport Drinks

Composition of sport drinks

Water + energy (CHO) + electrolytes

CHO concentration: energy delivery

↑ CHO content slows gastric emptying

Most drinks have 6-8 g CHO/100 ml fluid

- Glucose and glucose polymers
- 30-60 g CHO per hour of competition

Sport Drinks

- Na^+ concentration aids rehydration
  - Na^+ → ↑ thirst and palatability
  - Na^+ retention promotes water retention

- Palatability
  - Light flavor, no strong aftertaste

Summary

- CHO: primary fuel source for most athletes
- Fat < 35% of total calories
- Protein 1.2 - 2.0 g/kg BW
- Dehydration impairs exercise performance by altering variety of physiological functions
- Sport drinks can reduce dehydration & provide energy