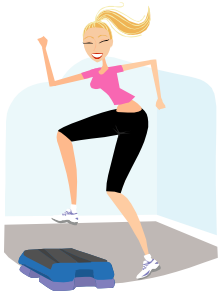
Vitamins and Exercise

Jessica Bailey
And
Kelly Patterson



Vitamin Introduction

- **Vitamins**: essential organic (carbon containing) substances that are needed in small amounts in the diet for the normal function, growth, and maintenance of the body

Two Types of Vitamins

- **Fat-Soluble**
  - A
  - D
  - E
  - K
- **Water-Soluble**
  - Thiamin (B1)
  - Riboflavin (B2)
  - Niacin (B3)
  - Pantothenic acid
  - Biotin
  - Vitamin B6 and B12
  - Folate
  - Vitamin C
  - Choline

Fat Soluble Vitamins

- Require dietary fat in order to be absorbed in the body
- Functions and Sources of Fat-soluble vitamins
  - A: Vision
    - Liver, fish liver oils, fortified milk, eggs, dark green and yellow-orange vegetables, and some fruit

  - D: Affects body's use of calcium and phosphorus
    - Sun exposure, fatty fish (salmon), fortified milk and cereals

Fat-Soluble Vitamins Cont.

- E: Antioxidant
  - Plant oils, wheat germ, asparagus, nuts and seeds
- K: Blood Clotting
  - Liver, green leafy vegetables, broccoli, peas, green beans, vegetable oils



Water-Soluble Vitamins

- Do not require dietary fat for absorption
- Function and sources of water-soluble vitamins
  - Thiamin: the coenzyme thiamin pyrophosphate in metabolism of carbohydrates and some branch-chain amino acids, nerve function
    - Whole grains, green beans, organ meats, peanuts and seeds
  - Riboflavin: Redox reaction functions

    - Milk products, eggs, meats, enriched white breads

Water-Soluble Vitamins

- Niacin: participates in oxidation-reduction actions, especially in the production of ATP
  - Poultry, bread products
- Pantothenic Acid: Part of Coenzyme A
  - Meat, Poultry, many vegetables
- Biotin: coenzyme involved in amino acid metabolism and involved in synthesis of glucose and fatty acids
  - Whole grains, eggs, nuts, legumes

Water-Soluble Vitamins

- B-6: part of over 100 enzymatic reactions; including amino acid synthesis, Heme synthesis, Carbohydrate metabolism, neurotransmitter synthesis, vitamin formation, and immune and lipid metabolism.
  - Meat, poultry, fish, whole grains

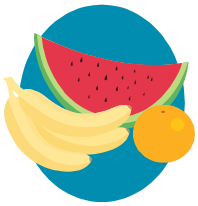
- Folate: Participate in metabolic reactions
  - Liver, fortified breakfast cereals, legumes, dark green leafy vegetables.

Water-Soluble Vitamins

- B-12: essential for DNA synthesis, development of red blood cells, formation of the myelin sheath around nerve fibers
  - Meat, poultry, seafood, eggs
- Choline: precursor for lecithin and acetylcholine, and involved in formation of acetylcholine
  - Milk, liver, eggs, peanuts

Water-Soluble Vitamins

- C: Involved in a variety of different cell functions including collagen synthesis, antioxidant activity, iron absorption, and immune function
  - Citrus fruits, potatoes, green vegetables



Recommended Daily Allowance (RDA) for men ages 19-30 yrs

- IU= international units, RAE=Retinol activity equivalent, ug= micrograms

Vitamin	RDA	Vitamin	RDA
A	900 ug RAE	**Niacin**	16 mg
D	5 ug*	**B6**	1.3 mg
E	15 mg	**Folate**	400 ug
K	120 ug*	**B12**	2.4 ug
Vitamin C	90 mg	**Pantothenic Acid**	5 mg*
Thiamin (B_1)	1.2 mg	**Biotin**	30 ug*
Riboflavin (B_2)	1.3 mg	**Choline**	550mg*

RDA for women ages 19-30 yrs

Vitamin	DRI	Vitamin	DRI
A	700 ug RAE	**Niacin**	14 mg
D	5 ug*	**B6**	1.3 mg
E	15 mg	**Folate**	400 ug
K	90 ug*	**B12**	2.4 ug
C	75 mg	**Pantothenic Acid**	5 mg*
Thiamin (B_1)	1.1 mg	**Biotin**	30 ug*
Riboflavin (B_2)	1.1 mg	**Choline**	425 mg*

Excess and Deficiency

- Water-soluble deficiencies are very rare in developed countries.
- Supplements are usually recommended to those with certain diseases, the elderly, or women who are pregnant.
- Generally, water-soluble vitamins are not toxic in excess, but niacin and B_6 have some side effects.

Vitamins and Exercise

- Previous research said that supplementation helped athletes more in their training by reducing oxidative stress, but more recent research is showing almost no correlation.
- Supplementation is more of a popular concept than a necessary one.
- There are also differences in trained athletes versus recreational athletes, and in ages as well.
- Proper amounts of vitamins can be received in a well balanced diet.

Antioxidant supplementation prevents exercise-induced lipid peroxidation, but not inflammation, in ultramarathon runners.

- Mastaloudis, A., Morrow, J.D., Hopkins, D.W., Devaraj, S., & Traber, M.G. (2004) *Radical Biology and Medicine*, 36, 1329-1341.

Hypothesis:

- Determine if 6 weeks of supplementation with Vitamin E and Vitamin C will improve exercise-induced lipid peroxidation and inflammation

Methods:

- 22 runners (recreationally trained)
  - 11 male, 11 female
- 18-60 yrs of age
- V02 max of 58 ± 1 ml/kg/min
  - Classified as excellent fitness
- Non smokers

Methods

- Exclusion Criteria:
  - Current use of antioxidants
  - Abnormal Cholesterol levels
  - Other supplement use
  - Vegetarian or any other restrictive diet
  - Pregnancy
  - History of chronic respiratory infection

Methods

- Double Blind placebo controlled study
- 2 Groups:
  - Placebo Group (PL)
    - 300 mg soybean
    - 500mg citric acid 2x daily
  - Antioxidant group (AO)
    - 300 mg Vitamin E
    - 500 mg Vitamin C 2x daily

Methods

- Blood samples
  - Baseline (B)
  - After 3 weeks of supplementation
  - 1 hour prior to run
  - Mid race
  - Post-race
  - 2 hrs post race
  - Daily for 6 days post race

Results

- Plasma antioxidants after 6 weeks of supplementation
  - α-tocopherol (Vitamin E)
    - Increase in AO group
    - No change in PL group
  - Ascorbic Acid (Vitamin C)
    - Increase in AO group
    - No change in PL group

Results

- Plasma antioxidants in response to ultramarathon
- Vitamin C
  - Increased in AO group at all time points
  - Increased alike between AO and PL
  - All runners returned to pre-race levels 2hrs post race
  - No significant difference between men and women

Results

- α-tocopherol
  - Increased in AO group at all time points
  - Increased differently during race
    - Increased at mid-race
    - Returned to pre-race level at end of race
    - Dropped below pre-race levels for remainder of study

Results

- Lipid Peroxidation (oxidative stress)
  - Measured by F_2-Isoprostanes (F_2-IsoP) concentrations
  - No significant difference between gender or AO/PL groups at B, 3, or 6 week supplementation
  - F_2-IsoP increased at post-race only in PL group
  - No significant differences between genders

Results

- Inflammatory response
  - Run provoked increases in almost every inflammatory marker
  - No significant differences noticed between AO and PL groups

Discussion

- Supplementation with Vitamins E and C prevented lipid peroxidation
- Supplementation with Vitamins E and C had no effect on inflammation
- This suggests that lipid peroxidation and the inflammatory response work separately in our bodies

Evaluation

+	-
• 75 references used • Measured inflammatory response and lipid peroxidation • Men and Women	• Only used recreationally trained subjects

Relationship of vitamin **E** metabolism and oxidation in exercising human subjects

- Traber, M. *(2006), British Journal of Nutrition, 96, S34-S37.*

Hypothesis

- Prior supplementation with antioxidants (vitamins E and C) would decrease oxidative stress during distance running and, therefore, decrease lipid peroxidation and inflammation, muscle damage and/ or improve recovery.

Methods

- Randomized, double-blind study in runners (11 females and 11 males) who were participants in an annual ultra marathon race.
- Subjects were randomly assigned to consume either antioxidants, 300 mg vitamin E and 1000mg vitamin C, 500mg twice ,or 2 matching placebos.

Methods

- The subjects were ultra marathon runners who compete in 31 mile races.
- The study was done 6 weeks pre-race and 1 week post-race.
- Blood samples and following 3 weeks supplementation were obtained prior to supplementation.
- Subjects were approximately 40 years old and were recreationally trained endurance runners.

Results

- Men compared with women are subjected to continued higher oxidative stress especially in the days after the endurance event.
- In response to endurance exercise, ROS are generated causing oxidative damage
- Vitamins E and C only prevent increases in lipid peroxidation but had no effect on inflammation, or muscle damage. These results suggest that the mechanism of oxidative damage is operating independently of the inflammatory and muscle damage responses.

Results

- Vitamin C and E are necessary in exercise and each subject received adequate nutrition.
- Antioxidant supplementation proved to prevent the damaging increase in lipid peroxidation without influencing inflammation. This is important since prevention of exercise induced inflammation could inhibit muscular adaptation to physical activity
- The supplemented group showed no improved endurance performance compared to the placebo group.

Antioxidants prevent health-promoting effects of physical exercise in humans

- Ristow, M., Zarse, K., Oberbach, A., Kloting, N., & Birringer, M., Kiehntopf, M., Stumvoll, M., Kahn, C.R., Bluher, M. (2009). *Proceedings of the National Academy of Sciences of the United States of America*, 106, 8665-8670.

Hypothesis:

- Commonly used antioxidants like Vitamin E and Vitamin C may eliminate the health promoting effects of physical exercise and oxidative stress in humans

Methods

- Subjects
  - 40 healthy males
    - No history (hx) of acute chronic inflammatory disease
    - No hx of metabolic disease
    - No hx of hypertension
    - No hx of cardiovascular or peripheral artery disease
    - No alcohol, nicotine or drug abuse
  - Ages 25-35 yrs
  - BMI below 27 kg/m^2

Study part 1

- Purpose: Are health promoting effects of exercise because of production of reactive oxygen species (ROS)?
- Methods:
  - 16 subjects
  - 3 days of exercise
  - Muscle biopsies before and after
    - Vastus lateralis
- Measures Thiobarbituric acid-reactive substances (TBARS)
  - Marker for overall oxidative stress

Study Part 1

- Results
  - More than a 2x increase in oxidative stress following exercise in PL group
  - No significant increase in AO group
- Discussion
  - short-term exercise causes ROS production
  - Antioxidant supplementation inhibits this formation
    - At least during the first 3 days

Methods

- 2 Groups
  - 20 trained (TR)
    - More than 6 hours of exercise per week
  - 20 untrained (UT)
    - Less than 2 hours of exercise per week
- Sub-groups
  - 10 antioxidant subjects
    - 500 mg Vit C 2x daily, and 1000 IU Vit E daily
  - 10 placebo subjects

Methods

- Subjects participated in supervised physical activity for 4 weeks
  - 5 days/week
  - 85 minute sessions
  - Subjects exercised at their personal submaximal heart rate (HR)
    - V02 max was obtained
    - Used HR monitors during exercise

Methods

- Measures taken
  - Blood samples
    - Plasma glucose concentrations
    - Plasma insulin concentrations
    - Plasma adiponectin concentrations
  - Skeletal muscle biopsies
    - Right vastus lateralis muscle
- Taken at:
  - Baseline
  - After 4 week intervention

Results

- **Glucose Infusion Rates (GIR)**
  - Measures insulin sensitivity
  - Used a Hyperinsulinemic Euglycemic Clamp

- PL group showed significant increase in TR and UT
- AO group showed no significant difference in TR and UT
- Within both groups there were no difference between the TR and UT subjects

Results

- Adiponectin
  - Secretory protein derived from adipocyte
  - In previous studies shown to positively correlate with insulin sensitivity
- PL group showed significant increase in TR and UT
- AO group showed no significant difference in TR and UT
- Within both groups there were no difference between the TR and UT subjects

Results

- Fasting Plasma Insulin

- Significant decrease in plasma insulin in PL group
- No significant difference in AO group
- Within both PL and AO groups there was no significant difference between TR and UT

Discussion

- This study suggests that antioxidant supplementation of Vitamins E and C cancels out the health promoting benefits that physical exercise has on insulin metabolism in the body

Evaluation

+	-
• Used multiple measures to obtain results • Specific inclusion criteria • 35 references • Consistent exercise sessions	• Only men subjects • Current diets high in Vitamin E or C were not examined

Oral administration of vitamin C decreases muscle mitochondrial biogenesis and hampers training-induced adaptations in endurance performance

- Gomez-Cabrera, M., Domenech, E., Romagnoli, M., Borras, C., Pallardo, F. (2008) *The American Journal of Clinical Nutrition, 87, 142-149.*

Objective

- Determine if vitamin C administration in training-induced men shows increases in VO_2 max and endurance capacity and on the skeletal muscle mitochondrial biogenesis.

Methods

- The study was double-blind and randomized.
- Fourteen men (27-36 year old) were trained for 8 weeks.
- The men were supplemented daily with an oral dose of 1 g vitamin C.
- They continued a normal diet and were asked to avoid alcohol.

Methods

- VO_2 = The maximal capacity to take up, transport and utilize oxygen during exercise.
- Endurance is defined as the time limit of a person's ability to maintain a specific power level during a running protocol.
- Fourteen healthy men volunteered for this study their $VO_2 < 43$.

Methods

- The tests were performed on a stationary bike.
- Values of oxygen uptake were obtained for all men after a 5 minute rest.
- The men next performed a 3 minute warm-up at a low intensity.
- At exhaustion they continued pedaling against resistance for 3 more minutes.
- These tests were done 3 times a week or an 8 week period.

Results

- Vitamin C significantly hinders endurance capacity and does not improve VO_2 max associated with training.
- Training increased endurance and VO_2 max in the unsupplemented group.
- The vitamin C supplemented group shows a much lower increase in endurance, thus, coming to the conclusion that vitamin C hinders endurance performance.

Discussion

- Vitamin C supplementation not only did not improve endurance but actually made it worse compared to those who did not intake the vitamin C.
- Validity – Small sample size and they only tested men.
- Both groups experienced an increased in mitochondrial biogenesis and VO_2 max but much more significantly in the group without the vitamin C.

Human Ecological Model

- Vitamins are necessary in every person's lives not only athletes.
- The body can only use so many vitamins and excess is excreted out of the body.
- Vitamins can be efficiently consumed through a well-balanced diet.
- **Balance, Moderation, and Variety**

References

- Dunford, M. (2006). *Sports nutrition a practice manual for professionals (4th edition)*. Chicago, Il: American Dietetic Association.
- Gomez-Cabrera, M., Domenech, E., Romagnoli, M., Borras, C., Pallardo, F. (2008). *Oral administration of vitamin C decreases muscle mitochondrial biogenesis and hampers training-induced adaptations in endurance performance. The American Journal of Clinical Nutrition, 87, 142-149.*
- Mastaloudis, A., Morrow, J.D., Hopkins, D.W., Devaraj, S., & Traber, M.G. (2004). *Antioxidant supplementation prevents exercise-induced lipid peroxidation, but not inflammation in unltramarathon runners. Free Radical Biology and Medicine*, 36, 1329-1341.
- Ristow, M., Zarse, K., Oberbach, A., Kloting, N., & Birringer, M., Kiehntopf, M., Stumvoll, M., Kahn, C.R., Bluher, M. (2009). *Antioxidants prevent health-promoting effects of physical exercise in humans. Proceedings of the National Academy of Sciences of the United States of America*, 106, 8665-8670.
- Traber, M. *(2006). Relationship of vitamin **E** metabolism and oxidation in exercising human subjects. British Journal of Nutrition, 96, S34-S37.*
- Wardlaw, G.M., Hampl, J.S., & DiSilvestro, R.A. (2004). *Perspectives in nutrition (6th edition)*. New York, NY: McGraw-Hill.
- Williams, M.H. (2005). *Nutrition for health, fitness, and sport*. New York, NY: McGraw-Hill.