Epidemiology and Research Design

I. Epidemiology: What is it?

A. Epidemiology is the study of the causes and distribution of disease (or other agents of mortality or decreased health) in populations

B. Physical activity epidemiology focuses on the (potential) relationships between activity habits and disease (or other agent of mortality or decreased health)

C. Some examples

1. 1849 - English physician John Snow - London cholera (water borne disease) epidemic – Broad Street pump

2. 1940's, 50's and beyond: Smoking and lung disease, heart disease, cancer, osteoporosis

- Increased risk of osteoporosis, hip fracture
- Increased risk of injury from exercise/sport
- Increased time for fracture to heal

3. 1970's- 90's Car accidents, seat belts, and air bags

4. 1980's: Reports of a severe immune deficiency – the agent was identified as HIV

5. 1990's: Erin Brockovich – PG&E and Chromium 6

6. 2000's: Equine fetal loss syndrome

II. Epidemiology: Background

A. Human epidemiology uses human subjects in "real life" (as opposed to laboratory) settings

B. Epidemiologists must deal with 100's of potential variables such as:

Age, gender
Nationality, race
Socioeconomic status, education
Genetics, family history
Diet, nutritional status
Smoking, alcohol consumption
Environmental conditions (geographic etc.)
Many, many other aspects of life – including amount of physical activity

C. Foundation

1. Epidemiologists deal with these many uncontrollable, independent variables by using advanced statistical techniques and carefully designed experiments

2. People who major in epidemiology will need to take biology classes such as physiology, as well as calculus and linear algebra (and maybe more math) and many classes in statistics and experimental design

III. Physical Activity Epidemiology

A. Exercise and vascular disease

1. People who exercise regularly are at a lower risk for stroke, claudication

2. Physiology experiments are aimed at understanding the MECHANISMS of the protective effect of exercise

- Capillary growth
- Lower resting blood pressure

B. Exercise and heart disease

1. People who exercise regularly are at a lower risk for congestive heart failure and ischemic heart disease
2. People who have had a heart attack have improved health if they exercise
3. Experiments in physiology investigate the MECHANISM of the protective effect of exercise
    - Changes in cholesterol levels
    - Lower blood pressure

C. Exercise and type II diabetes (Non Insulin Dependent Diabetes Mellitus)

1. People who exercise regularly are at a lower risk for developing NIDDM
2. Exercise can improve the prognosis and lower the insulin dosage of a person who has NIDDM
3. Mechanisms: Non-insulin dependent glucose entry into cells, increased insulin sensitivity, capillary growth, etc.

D. Exercise and Cancer, e.g., Breast Cancer

1. 2001 study: Vigorous physical activity (> 5X resting) was associated with a lower risk of developing breast cancer in both Hispanic and non-Hispanic post-menopausal women
2. Not all studies have found an association between exercise and breast cancer

E. Exercise and osteoporosis

1. Resistance and impact exercise increase bone mineral density
    - Jumping off a box – Dr. Winters
2. Higher BMD is associated with a lower risk of fracture
3. Too much exercise may increase osteoporosis risk (such as in women who develop low estrogen levels)
4. Dr. Winters has several exercise and bone health studies on-going

IV. Study Designs

A. Variables

1. Dependent variable – the outcome variable
    - Examples (in epidemiology): Risk of developing a disease, severity of disease, index associated with disease such as BMD
2. Independent variables – the variables you manipulate, measure, and/or record
    - Examples: Age, gender, % body fat, amount of physical activity
3. Extraneous variables – variables not measured or controlled, assumed to have no relation to the outcome variable or to be accounted for by randomization
    - Example: Eye color, number of siblings

B. Correlation versus Causality

1. A correlation is a greater than nothing relationship between two variables

2. Correlation does NOT necessitate causality
   - Cows lie down before it rains
   - In the 20th Century, the murder rate rose and the sheep farming rate fell
   - Smoking causes lung cancer, or is it factor X?
3. Correlation is measured using "r" or "R^2"
   - r ranges from –1 to 1
   - R^2 ranges from 0 to 1

C. Experimental Design

1. Experimental studies involve the manipulation of one or more independent variables
   - Example: A clinical trial for a treatment – drug, ergogenic aid, or exercise e.g.
   - Example: Dietary manipulation such as low fat or low CHO, hot or cold environment, % oxygen in air
2. More than two categories of an independent variable are called "levels" - e.g., high intensity, moderate intensity, low intensity, or no exercise
3. Experimental studies are intended to establish mechanisms - causality

D. Experimental and Control Groups

1. Experimental studies randomly assign subjects to either an experimental or a control group
2. The experimental group(s) receive(s) the intervention – the IV of interest – a special diet, a drug, or an exercise program
3. The control group is as identical as possible to the experimental group in every facet EXCEPT the independent variable of interest – no special diet, no drug, no exercise program
4. Potential confounders (variables that could affect the DV) are hopefully balanced between the two (or more) groups

E. Bias control

1. Experimental studies are susceptible to both subject and experimental bias
   - A subject who thinks that an ergogenic aid (such as creatine or boron) will make him (or her) stronger may unconsciously try harder during testing after supplementation than before
   - An experimenter who expects a drug to improve symptoms may unconsciously rate symptoms as more severe without the drug than with the drug
2. To control for these effects, experiments can be
   a. Blind – the subject does not know which group he or she is in – the experimental or control group
   b. Double-blind – neither the subject nor the experimenter knows which group the subject is in

F. Observational Study Designs

1. Observational studies do not involve direct manipulation of a variable,

although subjects may be grouped according to the level of a variable, e.g.,has disease or does not, age group, high/medium/low physical activity level)

- • Cross-sectional
- • Retrospective (case-control)
- • Prospective (longitudinal)

2. Cross-Sectional

   - Individuals are selected at random from a population and both the IV's and the DV's are measured in all subjects at one time
   - This study design allows correlations to be made between potential risk factors (such as inactivity) and disease
   - For example, is "maleness" related to a higher incidence of creatine supplementation among athletes?
   - This study design does not allow causality to be established

3. Retrospective

   - Also called case-control design
   - Subjects are divided according to an outcome variable (has disease/does not have disease) and the IV's are measured retrospectively – according to medical records, etc.
   - Recall is susceptible to error and bias
   - Again, allows correlations to be established, but not causality

4. Longitudinal

   - Also called prospective design
   - Initially healthy individuals are tested and retested, for both IV's and DV's over time
   - E.G: Muscle strength in people who do and do not engage in resistance exercise measured at age 40, 50, and 60
   - Difficult to retain all subjects due to changing interests & availability, moving, mortality etc.
   - Looks for IV's with power to predict the DV, e.g., smoking predicts more than 80% of lung cancer cases
   - Study can establish correlation but not causality