KINE 648 Lab #6

Clinical and Field Assessment of Body Composition

Equipment needed:

Lange skinfold calipers
Girth measuring tape
Hydrostatic weighing tank
BODYSTAT 1500 electrical impedance body comp analyzer
Handouts
Web page notes

Health Risks Associated with Obesity

- Coronary heart disease and other heart diseases
- Hypertension
- Type II diabetes (“metabolic syndrome”)
- Stroke
- Gallbladder (gallstones) and liver disease
- Osteoarthritis
- Gout
- Sleep Apnea
- Menstrual irregularities and infertility in women
- Cancer
  - Men: colon, rectum, & prostate
  - Women: gallbladder, breast, uterus, cervix, ovaries

Approximately 300,000 deaths / year are associated with obesity
(2001 Surgeon General’s Report)

The Increasing Problem of Obesity

Percentage of population classified as **obese** (CDC stats)

Year	1991	1995	1998	1999	2000
U. S.	12.0	15.3	17.9	18.9	19.8
Texas	12.7	15.0	19.9	21.1	22.7

% of population classified as **overweight:** 35% – 50% (CDC stats)

Classifications based on:

BMI = ([wt in kg] / [ht in meters ^{2}])

CDC defines ***overweight*** as BMI between 25 and 29.9

CDC defines ***obesity*** as a BMI $\geq$ 30

The Problem of Using Body Mass Index

Marshall Faulk:	5’ 10”	211 lbs	BMI = 29.5
Emmit Smith:	5’9”	209 lbs	BMI = 30.9

Other More Useful Measures

Waist size and waist to hip ratio (WHR)

CDC purports u disease risk for men with waists > 40” and women > 35”

CDC purports u disease risk for WHR > 1.0 for both men and women

Body Fat Percentage

Classification	Women (% fat)	Men (% fat)
Essential Fat	10-12%	2-4%
Athletes	14-20%	6-13%
Fitness	21-24%	14-17%
Acceptable	25-31%	18-25%
Obese	32% plus	25% plus

*American Council on Exercise

An Example of Weight Loss Calculation

BW = total body weight
FW = fat weight
LBW = lean body weight (fat free weight or weight of fat free mass)
IBW = ideal body weight
%FAT = body fat percentage
%IF = ideal body fat percentage

1. Calculate fat weight — FW = %FAT x BW
2. Calculate lean body weight — LBW = BW - FW
3. Calculate ideal body weight — LBW = (1 - %IF) x IBW r IBW = LBW / (1 - %IF)
4. Calculate desired weight loss — WL = BW - IBW

EXAMPLE

Sex: M Age: 42 Weight: 210 %FAT: 29 %IF: 17

1. FW = .29 x 210 = 61
2. LBW = 210 - 61 = 149
3. IBW = 149 / (1 - .17) = 180
4. WL = 210 - 180 = 30 lbs

The Measurement of Body Fat Percentage

Methods:

- Hydrostatic
  - accurate when done correctly
- Skinfolds
  - easy to do - embarrassment problems - accuracy problems
- Electrical Impedance
  - accuracy problems
- CT Scan - MRI
  - can assess intraabdominal fat - accurate - expensive - best for research
- Near Infrared sensors
  - based on how much light is reflected vs. absorbed
  - developed from agriculture - accuracy problems (6.3% body fat variation)
- Dual energy X-ray absorptiometry
  - same machine can be used to test bone density
- Air Displacement Plethysmography (the “Bod Pod”)
  - same principle as underwater weighing, but air is displaced rather than water
  - most research suggests accuracy but some (including our lab) do not

Hydrostatic Assessment of Body Fat Percentage

- Based on 2 component model: fat mass and fat free mass
- Density = Mass / Volume
  - Density of fat = .9 grams / ml Density of lean tissue = 1.1 grams / ml
    - it follows that the more dense you are the less adipose tissue you have

Archimedes' Principle: the amount of buoyant force (BF) on an object is equal to the amount of water it displaces: BF = Wt(air) – Wt(underwater) = Wt(water displaced)

$$Db = \frac{Wa}{\frac{(Wa - Ww)}{Dw} - (RV + VG)}$$

Db = **body density**
Wa = **body weight in air (kg) [same as total body weight]**
Ww = **body weight in water (kg) [scale weight - tare weight]**
Dw = **density of the water at the water temperature**
VG = **viceral gas (estimated at .1 Liter)**
RV = **residual volume (Liters)**

ESTIMATES

M [.017(age in yrs) + .06858(ht in ") – 3.477
F [.009(age in yrs) + .08128(ht in ") – 3.9]

Once you determine **Db**, it can be entered in the following estimation equations:

Brozek: **% Fat = (4.57 / Db) – 4.142**

Siri: **% Fat = (4.95 / Db) – 4.5**

Skinfold Assessment of Body Fat Percentage

- Using the thickness of skinfolds to estimate body density r body fat percentage
  - based on 2 component model (fat mass and fat free mass)
  - based on the development of regression equations (given below)
  - are population specific (children, adults, racial differences)
  - accuracy ? - correlation to more accurate methods = .8
  - concerns for use in public schools: encourages anorexia / bulimia ?
  - the more sites utilized, the more accurate the measurement
    - Jackson & Pollack equation for sum of 7 used in this lab
    - computation web site : http://www.exrx.net/Calculators/BodyComp.html

Males

$$Db = 1.112 - .00043499(S7) + .00000055(S7)^2 - .00028826(age)$$

Females

$$Db = 1.0970 - .00046971(S7) + .00000056(S7)^2 - .00012828(age)$$

Body Fat Percentage Using Electrical Impedance

- Uses 2 compartment model
- Lean body weight (LBW) is compose of about 73% electrolytic water
- Fat weight (FW) is composed of about 5% - 10% electrolytic water
- LBW yields a low resistance (Ohms) to the flow of an electric current
- A single impedance measurement is reflective of total body water (W_{TB}) & LBW
  - W_{TB} (kg) = [.593 X (ht in cm ^{2} / resistance)] + .[065 X body wt in kg]
- LBW and thus % fat is estimated from a population specific regression equation
  - example women 18 - 29:
  - LBW in kg = [.4764 X (ht in cm ^{2} / R in ohms)] + [.295 X body wt in kg] + 5.49
  - FW = body wt - LBW
  - % FAT = FW / body wt

Data Collection Overveiw for Lab #6

For each of the modalities for assessing anthropometric body composition, (waist and hip girth, hydrostatic weighing, skinfolds, and electrical impedance) complete the following:

1. Work in groups of 2 and record all data for each type of assessment.
2. Compute the hydrostatic assessment of body composition using the RV's you obtained in the pulmonary function lab and the estimation equations found on a previous slide of this presentation.
2. Make copies of your final assessments of 1. waist / hip ratio measurements and 2. body fat by each of the hydro methods (the hydrostatic assessment using both measured and equation estimated RV) 3. Skinfolds, and 4. Electrical impedance, and share them with your classmates (each student should have a copy of the results for all students).

Lab Assignment for Data Collection #6
Assessment of Waist and Hip Girth

1. With a tape measure, comfortably measure the distance around the smallest area below the rib cage and above the belly button. Record the measurement on a data sheet

2. With a tape measure, comfortably measure the distance around the largest extension of the buttocks. Record the measurement on a data sheet

Lab Assignment for Data Collection #6 - Hydrostatic Weighing

1. Fill the tank to the 4th step as directed by the instructor. Have the subject enter the tank and sit comfortably in the chair. The water level should be about shoulder depth when seated.

2. Record the water temperature just prior to each test. Note and record the water density at this temperature (see chart near the east side of tank). Also, record the tare weight (weight of the empty chair with the tank full). on your data sheet.

3. Instructions to subject

   a. Submerge and shake hair free of all bubbles - bathing suit as well.

   b. Attach nose clamp and hyperventilate for 4 to 5 breaths.

   c. Bend forward and submerge slowly and completely while expiring remaining air from lungs.

   d. When totally submerged, force ALL the air from your lungs and wait for signal to surface.

   e. The technician will record your underwater weight when satisfied that you have expired as much air as possible (no more air bubbles appear around your mouth).

   note: If at any time, for any reason, you feel you need to surface, do not hesitate to do so. You will repeat this procedure a minimum of seven to ten times.

Key Points for Evaluator

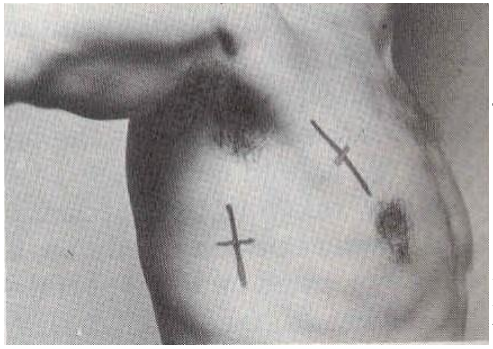
1. Be sure the subject is completely submerged and expels air completely. Carefully record the underwater weight of the subject from the scale.

2. Instruct the subject to submerge and surface slowly so as to minimize water turbulence and scale oscillation.

3. Take a minimum of 5 weights and record the mean of the highest three weights as the actual underwater weight to enter into the estimation equation.

Lab Assignment for Data Collection #6 - Skinfolds

Assess the thickness of 7 sights on each subject in the class. Pick up the subject's skinfold between your index finger and thumb of your left hand. Be sure that you have two layers skin and the underlying fat only. Allow the skinfold to follow the natural stress lines of the body. If you doubt that you have a correct skinfold, have the subject contract the underlying muscle; if you have a correct skinfold you will, in most cases, be able to easily retain the fold your grasp. The fold should be held using the tips of the thumb and forefinger while the measurement is being made. Apply the calipers to the fold about 1/2 inch from the fingers where the fold is parallel. The pressure on the fold must be exerted by the calipers only. Wait 2 seconds then measure the skinfold (to the nearest 0.5 mm). Take the mean of two most accurate measures. To be recorded as accurate consecutive measurements must be within 1mm of one another.

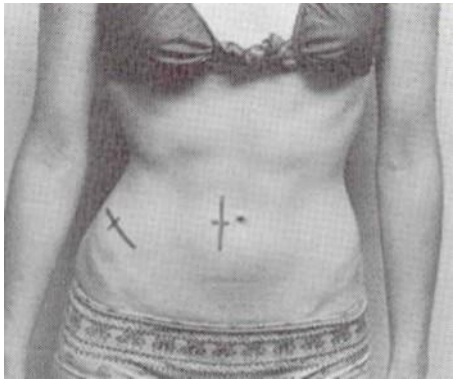


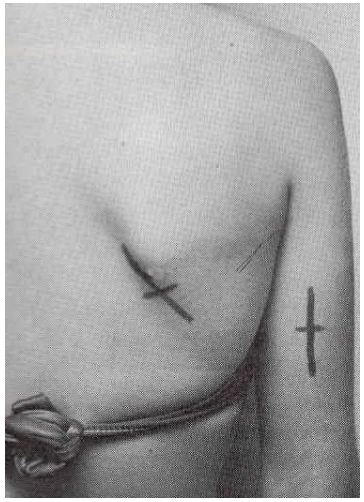
Chest: diagonal fold 1/2 (for men) or 1/3 (for women) of the way between the anterior axillary line and the nipple.

Axillary: Mid axillary line at xiphoid process level

Suprailiac: diagonal fold at the top of the ilium at the anterior axillary line

Abdominal: vertical fold 2 cm from and adjacent to the belly button

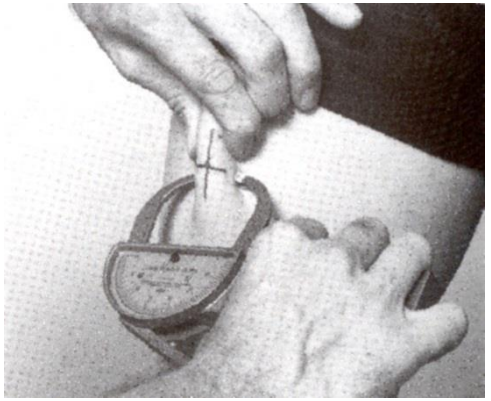




Subscapular: diagonal fold 1 cm from the inferior angle of the medial border of the scapula

Triceps: vertical fold rear midline of upper arm halfway between top of shoulder and elbow

Thigh (note technique): vertical fold on the midline of the thigh halfway between the hip and knee joints



Lab Assignment for Data Collection #6

(Using the *BODYSTAT 1500* body comp analyzer)

1. Turn on machine (switch on left side) If LCD does not show SUBJECT NUMBER = , battery is dead

2. Attach red electrode to back of hand behind middle finger and black electrode on top of wrist next to the ulnar head

3. Attach red electrode behind the 2nd toe next to the big toe and black electrode to the front of the foot between ankle bones

4. Press ↵ and use the u and d arrow keys to enter data that is asked for

5. Press ↵ to go to the next data entry display

6. After all data is entered press ↵, the screen will read "MEASURING" and body fat % will be displayed

7. Continue to press ↵ to obtain:

   - Fat weight
   - Lean body weight
   - Total body weight
   - Fluid level as % of total body weight
   - Total body water volume
   - Basal metabolic rate estimate
   - An estimate of calories needed to maintain current body weight
   - Body mass Index
   - The actual impedance to the flow of the electric current

Press ↵ again to begin another test

Lab Work-up for Assignment #6

1. Use the actual equations to calculate the estimate of body fat percentage for the hydrostatic and skinfold methods. **(note: for this calculation, use the estimate of residual volume as yielded by the equations on slide 7 of this presentation)**. Also calculate the amount of weight, if any, your subject should loose to put them in the "Athletes" category as listed on the American Council on Exercise table on slide 4 of this presentation. Show your calculations in detailed form in and in logical concise order.

2. Look up a published resource **(not an internet publication)** that lists norms for body composition, BMI, and waist to hip ratios. Using the average of the 3 different body fat % estimates as the actual body fat % of your subject, determine the **percentile rank** where your subject fits. Do the same for BMI and waist to hip ratio. Be sure to cite your resources for the norms.

3. Using the data for all class members and the Analysis of Variance tool in EXCEL, determine if there is a significant difference among the means for the three different methods of obtaining body fat percentage (hydrostatic, skinfold, impedance). Be sure to include a copy of the EXCEL output in your write-up.

4. Using the data for all class members and the graphing and analysis tools in EXCEL, construct a scatter plot of the hydrostatic versus skinfold values, then determine the correlation between the two methods.

5. Using the data for all class members and the t-test procedure in the analysis tools in EXCEL, determine if there is a significant difference between the hydrostatic assessment of body composition as calculated with measured RV (Lab 5) and RV as estimated by equation.

6. Discuss the potential sources of error for each of the three methods of body fat % assessment.