Body Composition

Chapters 18 and 23
**Somatotype (Body Type)**

- **Soft roundness?**
  - endomorphy
- **High muscle mass?**
  - mesomorphy
- **Linearity and fragility?**
  - ectomorphy
Body Composition Methods

- Height Weight Tables e.g. Metropolitan Life Insurance
- Body Mass Index
- Percent Body Fat
## Height / Weight for Women & Men

### Height / Weight for Women

<table>
<thead>
<tr>
<th>Height Feet Inches</th>
<th>Small Frame</th>
<th>Medium Frame</th>
<th>Large Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>4' 10&quot;</td>
<td>102-111</td>
<td>109-121</td>
<td>118-131</td>
</tr>
<tr>
<td>4' 11&quot;</td>
<td>103-113</td>
<td>111-123</td>
<td>120-134</td>
</tr>
<tr>
<td>5' 0&quot;</td>
<td>104-115</td>
<td>113-126</td>
<td>122-137</td>
</tr>
<tr>
<td>5' 1&quot;</td>
<td>106-118</td>
<td>115-129</td>
<td>125-140</td>
</tr>
<tr>
<td>5' 2&quot;</td>
<td>108-121</td>
<td>118-132</td>
<td>128-143</td>
</tr>
<tr>
<td>5' 3&quot;</td>
<td>111-124</td>
<td>121-135</td>
<td>131-147</td>
</tr>
<tr>
<td>5' 4&quot;</td>
<td>114-127</td>
<td>124-138</td>
<td>134-151</td>
</tr>
<tr>
<td>5' 5&quot;</td>
<td>117-130</td>
<td>127-141</td>
<td>137-155</td>
</tr>
<tr>
<td>5' 6&quot;</td>
<td>120-133</td>
<td>130-144</td>
<td>140-159</td>
</tr>
<tr>
<td>5' 7&quot;</td>
<td>123-136</td>
<td>133-147</td>
<td>143-163</td>
</tr>
<tr>
<td>5' 8&quot;</td>
<td>126-139</td>
<td>136-150</td>
<td>146-167</td>
</tr>
<tr>
<td>5' 9&quot;</td>
<td>129-142</td>
<td>139-153</td>
<td>149-170</td>
</tr>
<tr>
<td>5' 10&quot;</td>
<td>132-145</td>
<td>142-156</td>
<td>152-173</td>
</tr>
<tr>
<td>5' 11&quot;</td>
<td>135-148</td>
<td>145-159</td>
<td>155-176</td>
</tr>
<tr>
<td>6' 0&quot;</td>
<td>138-151</td>
<td>148-162</td>
<td>158-179</td>
</tr>
</tbody>
</table>

### Height / Weight for Men

<table>
<thead>
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<th>Large Frame</th>
</tr>
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<tr>
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<td>138-150</td>
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<tr>
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<td>140-153</td>
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<td>132-138</td>
<td>135-145</td>
<td>142-156</td>
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<tr>
<td>5' 3&quot;</td>
<td>134-140</td>
<td>137-148</td>
<td>144-160</td>
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<td>152-172</td>
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<td>5' 9&quot;</td>
<td>146-157</td>
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<td>161-184</td>
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<td>5' 10&quot;</td>
<td>149-160</td>
<td>157-170</td>
<td>164-188</td>
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<td>6' 0&quot;</td>
<td>152-164</td>
<td>160-174</td>
<td>168-192</td>
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<tr>
<td>6' 1&quot;</td>
<td>155-168</td>
<td>164-178</td>
<td>172-197</td>
</tr>
<tr>
<td>6' 2&quot;</td>
<td>158-172</td>
<td>167-182</td>
<td>176-202</td>
</tr>
<tr>
<td>6' 3&quot;</td>
<td>162-176</td>
<td>171-187</td>
<td>181-207</td>
</tr>
</tbody>
</table>

Weights at ages 25-59 based on lowest mortality. Weight in pounds according to frame (in indoor clothing weighing 3 lbs.; shoes with 1" heels)
Body mass index

\[ \text{BMI} = \frac{\text{Wt (kg)}}{\text{Ht (m}^2)} \]

- **Underweight**: < 18.5
- **Normal**: 18.5 - 24.9
- **Overweight**: 25.0 - 29.9
- **Obesity I**: 30.0 - 34.9
- **Obesity II**: 35.0 - 39.9
- **Obesity III**: > 40.0

![Figure 4. Relationship of body mass index to disease risks.](image)
Body Composition

Two-component system

- Fat-free mass
- Fat mass
  - different densities
# Underwater Weighing

<table>
<thead>
<tr>
<th>Variable</th>
<th>Jack</th>
<th>Dave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>188 cm (74 in.)</td>
<td>188 cm (74 in.)</td>
</tr>
<tr>
<td>Weight</td>
<td>93 kg (205 lb)</td>
<td>63 kg (205 lb)</td>
</tr>
<tr>
<td>Underwater weight</td>
<td>6.5 kg</td>
<td>5.0 kg</td>
</tr>
<tr>
<td>Volume</td>
<td>86.5 L</td>
<td>88.0 L</td>
</tr>
<tr>
<td>Density</td>
<td>1.075 g/ml</td>
<td>1.057 g/ml</td>
</tr>
<tr>
<td>Relative fat</td>
<td>10.5%</td>
<td>18.4%</td>
</tr>
<tr>
<td>Fat weight</td>
<td>9.7 kg (21.4 lb)</td>
<td>17.1 kg (37.7 lb)</td>
</tr>
<tr>
<td>Fat-free weight</td>
<td>83.3 kg (183.6 lb)</td>
<td>75.9 kg (167.3 lb)</td>
</tr>
<tr>
<td>Goal weight at</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10% fat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight loss to</td>
<td>0.4 kg (0.8 lb)</td>
<td>8.7 kg (19.1 lb)</td>
</tr>
<tr>
<td>achieve goal weight</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: volume = weight – underwater weight  
density = weight + volume*
Hydrostatic (Underwater) Weighing

Density = Mass ÷ Volume

How is mass measured?

How is volume measured?

Percent body fat = \(\frac{495}{\text{Density}} - 450\)
Underwater Weighing

Accuracy ± 2.0% at best

Lung volume
Air Plethysmography (Bod Pod)
Air Plethysmography (Bod Pod)

- **Measures** volume from the amount of air displaced

  - **Density** = Mass ÷ Volume

  - **Percent body fat** = \((495 ÷ \text{Density}) - 450\)

- **Accuracy** ± 2-3%
Dual Energy X-Ray Absorptiometry (DEXA)

Accuracy ± 1-3%
Bioelectrical Impedance Analysis

- Measures body water
- Fat-free mass is higher in water
- Accuracy ± 2 or more%
Bioelectrical Impedance Analysis

Greater error
Bioelectrical Impedance Analysis
Skinfold Thickness
Females:

\[
\text{Density} = 1.0994921 - (0.0009929 \times \text{sum of 3 SKFs}) + (0.0000023 \times \left[\text{sum of 3 SKFs}\right]^2) - (0.0001392 \times \text{age}).
\]

Males:

\[
\text{Density} = 1.0938 - (0.0008267 \times \text{sum of 3 SKFs}^*) + (0.0000016 \times \left[\text{sum of 3 SKFs}\right]^2) - (0.0002574 \times \text{age}).
\]

\[
\text{Percent body fat} = \left(\frac{495}{\text{Density}}\right) - 450
\]

Accuracy 3.7% or more
Body Fat Values

- **Men**
  - Recommended for health = 10-20%
  - Obese > 25%
  - Recommended for performance = ?
  - Essential fat = 3-5%

- **Females**
  - Recommended for health = 15-25%
  - Obese > 30%
  - Recommended for performance = ?
  - Essential fat = 12-15%
Obesity and Weight Control

F.Y.I.

- BMI of ≥30 classification of obesity
- Prevalence of obesity in U.S. adults increased
  - 15% in 1976-80
  - 23.3% in 1988-94
  - 30.9% in 1999-2000
- Include those classified as overweight (BMI 25-29)
- Prevalence of overweight & obesity is 64.5%
Obesity and Weight Control

Prevalence of Overweight and Obesity in the United States, 1999-2004

Cynthia L. Ogden, PhD; Margaret D. Carroll, MSPH; Lester R. Curtin, PhD; Margaret A. McDowell, MPH, RD; Carolyn J. Tabak, MD, MPH; Katherine M. Flegal, PhD

Waist to Hip Ratio

- Not all obesity levels are the same.
- **Upper body**
  - ratio > 0.95 for men
  - ratio > 0.80 for women
F.Y.I. Waist-Circumference

- Men < 40 inches
- Women < 35 inches
Obesity

- Prevalence of overweight in children and adolescents (ages 6-19)
  - 5-7% in late 1970
  - 11% in 1988-94
  - 15% in 2000
Obesity

- Normal weight = 25 billion
  - Obese = 60-80 billion
- Less severe obesity
  - Fat cell **hypertrophy**
- Severe obesity (fat mass >30 kg)
  - Fat cell **hyperplasia**
- Weight loss
  - Fat cell atrophy only
  - Hyperplasia = more difficult weight loss/maintenance
Obesity

- Genetic factors
  - 25% of the transmissible variance for fat mass and percent body fat
- Cultural factors (30%)
- Individual choices (45%)
Weight Loss

- Caloric balance or imbalance
  - Energy In > Energy Out = Weight Gain
  - Energy In < Energy Out = Weight Loss

- Caloric expenditure
  - RMR = 60-75%
  - Thermic effect of food = 10%
  - Physical activity = 15-30% of daily caloric expenditure
Weight Loss

- Weight loss greater than 1-2 pounds per week.
- Where is the weight loss coming from?
  - Fat
  - Water
  - Muscle
Energy And Nutrient Balance

- Calories of “Energy In” and “Energy Out” are not constant.

- Nutrient balance
  - Excess carbohydrate and protein intake are not “converted” to fat.
  - Rather, it causes less fat to be oxidized and therefore more fat to be stored.
Weight Loss

- Recommendations:
  - 1-2 lbs of weight loss per week
  - 500-1000 fewer calories per day
  - 3,500-7,000 per week
Diet and Weight Loss

• Common to reduce energy intake by 1,000-1,500 kcals/day

• Very-low calorie diets (< 800 kcal/day)
  • temporary results at best
  • medical supervision
Caloric Intake and Resting Metabolic Rate
Metabolic Rate

• Resting metabolic rate = 1 kcal/kg/hour

• For a 183 pound person, RMR = 2000 kcals.

• 60-75% of daily caloric expenditure
Metabolic Rate

- Caloric intake
- Muscle mass
- Hormones
- etc.
Diet Composition

- Diet composition on weight loss is uncertain
- Why might a high protein diet be helpful with weight loss?
- Increase thermogenesis and satiety
Physical Activity and Body Fat

![Graph showing the relationship between nonbasal expenditure and percent body fat for males and females.](image)

- **Percent body fat** is plotted on the y-axis, ranging from 0 to 70.
- **Nonbasal expenditure** is plotted on the x-axis, ranging from 0.00 to 0.20 MJ/kg/day.
- Points are differentiated by color: red for males and blue for females.

The graph illustrates the correlation between physical activity (nonbasal expenditure) and body fat percentage, with males generally having higher expenditure at lower fat percentages compared to females.
Exercise and Weight Loss
Exercise and Weight Loss

- Exercise alone
  - less effective than diet alone
- Duration:
  - 150 min/wk up to 300 min/wk
  - > 2000 calories/wk
- Caloric expenditure
  - 0.77 kcal / kg / mile for walking
  - 1.53 kcal / kg / mile for running

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>BODY WEIGHT (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td>Swimming, 25 yds/min</td>
<td>220</td>
</tr>
<tr>
<td>Walking, 3 mph</td>
<td>256</td>
</tr>
<tr>
<td>Tennis, singles</td>
<td>320</td>
</tr>
<tr>
<td>Bicycling, 12 mph</td>
<td>328</td>
</tr>
<tr>
<td>Cross-country skiing</td>
<td>560</td>
</tr>
<tr>
<td>Jogging, 5.5 mph</td>
<td>592</td>
</tr>
<tr>
<td>Running, 10 mph</td>
<td>1,024</td>
</tr>
</tbody>
</table>
Exercise and Weight Loss

- Exercise may be most critical to help maintain weight loss
- Exercise helps to maintain muscle mass and metabolic rate
Exercise and Weight Loss

- Aerobic exercise vs Resistance exercise
- Resting metabolic rate
- Duration vs Intensity
Fat Burning Zone?
Exercise and Fat Metabolism

Would you rather have 10% of person A’s money or 90% of person B’s money?
Exercise and Fat Metabolism

- Is low-intensity exercise best for burning fat? [A Closer Look 4.3]
Weight Loss

• Successful weight loss
  • diet and exercise
  • **Diet: limited caloric intake** (source of calories is unimportant)
  • **Exercise: expended ~400 kcal/day**