PRIMARY METHODS OF DETERMINING BODY FAT

A Brief Review

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### Primary Methods of Determining Body Fat

<table>
<thead>
<tr>
<th>Method</th>
<th>BMI (Body Mass Index)</th>
<th>Hydromethodology (Underwater Weighing)</th>
<th>Anthropometry (Skinfold Measurements)</th>
<th>Near-Infrared Interactance</th>
<th>Dual Energy X-Ray Absorption (DEXA)</th>
<th>BIA (Bioelectrical Impedance Analysis)</th>
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</thead>
<tbody>
<tr>
<td>Procedure</td>
<td>Weight and height are measured then BMI is computed using a simple formula or chart.</td>
<td>Subject is weighed then immersed in a tank of water while fully exhaling. Measurements of immersed weight are repeated as many as 5 times and then averaged.</td>
<td>Skinfold thickness is measured by grasping the skin and underlying tissue, shaking it to exclude any muscle and pinching it with a caliper. Measurements are taken at 1, 3, 5, 7 or 21 locations and entered into a formula. Multiple readings at multiple sites improve accuracy.</td>
<td>A fiber optic probe connected to a digital analyzer indirectly measures tissue types at various body sites to a depth of about 1 cm</td>
<td>NIR data is combined with height, weight, frame size, and athletic level to estimate percent body fat. Multiple readings at multiple sites improve accuracy.</td>
<td>Based on a three-compartment model that divides the body into total body mineral, fat-free soft (lean) mass and fat tissue mass. A whole body scanner reads bone and soft tissue mass simultaneously. Scanner passes over recalling subject once collecting data at 0.5 cm intervals.</td>
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<tr>
<td>Test Time</td>
<td>1-2 minutes</td>
<td>15-60 minutes</td>
<td>10-20 minutes</td>
<td>Under 5 minutes</td>
<td>10-20 minutes</td>
<td>5 to 10 minutes</td>
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<tr>
<td>Subject Comfort</td>
<td>No discomfort.</td>
<td>Difficult for subjects who dislike submersion or have difficulty expelling all the air in their lungs.</td>
<td>Subject must be “pinched” at exposed areas on various parts of their body.</td>
<td>Low discomfort, primarily with single site method.</td>
<td>Safe and non-invasive, requiring only that a subject must lie still throughout the procedure.</td>
<td>Long accepted because of simplicity, low cost, high reproducibility and non-invasiveness.</td>
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<td>Technician Skill</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Subject Cost</td>
<td>Very low</td>
<td>Very low</td>
<td>Very high</td>
<td>Moderate to high</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Equipment Cost</td>
<td>Used in clinical settings as simple indicator of obesity.</td>
<td>Wide use due to low cost of equipment and portability.</td>
<td>Widely used due to low cost of equipment and portability.</td>
<td>Poplar outside the laboratory because it is simple, fast, non-invasive and relatively inexpensive.</td>
<td>Quickly moving from the laboratory setting into clinical studies.</td>
<td>New BIA techniques (phased angle and multi-frequency) are under development for estimating hydration and intra/extra-cellular breakdown. Additional research is needed to refine these method’s accuracy in determining body fat percentage.</td>
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<tr>
<td>Acceptance</td>
<td>National Institutes of Health and World Health Organization have developed basic BMI screening guidelines.</td>
<td>Over 3,500 equations have been validated to account for differences in gender, age and ethnic groups. To save time single readings are often taken providing only a rough estimate of body fat.</td>
<td>Over 3,500 equations have been validated to account for differences in gender, age and ethnic groups. To save time single readings are often taken providing only a rough estimate of body fat.</td>
<td>While single-site measurement at one site is often reported, numerous sources report that more research is needed to substantiate the validity, accuracy and applicability of this method.</td>
<td>Measures fat distribution throughout the entire body in a single scan.</td>
<td>This measurement is entered into a three-compartment model, no need to account for air mass in lungs, and accounts for variations in the distribution of body fat.</td>
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<td>Reliability and Reproducibility</td>
<td>Current guidelines do not differentiate for gender, ethnicity or age. Can be misleading for non-standard body size and shapes, athletes who are overweight but have low body fat, and for sedentary individuals who may have normal BMI but high body fat.</td>
<td>Readings may vary due to changes in hydration and proportion of bone minerals. Requires multiple readings that are then averaged. If remaining air in lungs is estimated, errors can occur.</td>
<td>Precision depends heavily on the skill of the technician. Accuracy is also affected by which sites are measured, the number of sites measured, the taking of duplicate readings, the quality of calipers, and the equation used. Calipers developed for home use (very inexpensive) are unreliable. The more obese a subject, the more difficult it is to grasp the skinfold accurately.</td>
<td>High degree of error has occurred with very lean and obese people. Amount of pressure applied to fiber optic probe, skin color and hydration levels may be sources of error. Low number of readings can increase error. Sold by only one manufacturer. Technician determines fitness level (body type) as in other methods. Measurements should be taken under consistent and controlled conditions to minimize variations.</td>
<td>More reliable than other measures due to three compartment model, no need to account for air mass in lungs, and accounts for variations in the distribution of body fat.</td>
<td>Very high reproducibility and accuracy given proper electrode placement. Measurements should be taken under constant and controlled conditions to minimize variations caused by hydration level. Accuracy is heavily dependent on type of equation used. Most BIA research continues to use underwater weighing as reference.</td>
</tr>
<tr>
<td>Technician</td>
<td></td>
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<td>Very high reproducibility not dependent on technician training. Equations and equipment validated by peer-reviewed research. As with all measurements, analyses should be done under consistent conditions. Uses DEXA as reference method for higher accuracy.</td>
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