**Measuring Body Composition**

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There are various methods for measuring body composition in humans, each providing their own strengths and weaknesses. A single technique is therefore unlikely to suit every situation and it is preferable to refer to multiple measures to get the most accurate results. Common measures of body composition have been outlined in the table below.

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| **Method** | **Pros** | **Cons** |
| Cadaver Analysis | The most accurate method to measure fat and fat-free mass | Can only be applied to deceased individuals |
| Body Mass Index (BMI) | Simple, inexpensive application  Strongly correlated with body fatness, morbidity, and mortality in adults  Universally applicable with extensive reference data to compare against | Fails to differentiate between fat and fat-free mass  Less accurate measure for children and the elderly |
| Basic Anthropometry (height or weight) | Easiest measures to take  Indicates changes over time (useful in children to chart growth) | Fails to differentiate between fat and fat-free mass  Inaccurate measures of body adiposity |
| Abdominal Circumference | Easy, inexpensive application  Measures intra-abdominal and subcutaneous fat concentration around the abdomen, which is correlated with an increased risk of metabolic disorders, cardiovascular disease, some cancers and mortality  Strongly correlated with total body fat in adults | Imperfect indicator of intra-abdominal fat alone  Heterogeneity in application (some clinicians measure waist circumference, belly button circumference or circumference from the widest point)  Difficult to measure and less accurate in individuals with a BMI > 35 |
| Waist-to-Hip Ratio (WHR) | Easy, inexpensive application  Measures intra-abdominal and subcutaneous fat concentration around the abdomen, which is correlated with an increased risk of metabolic disorders, cardiovascular disease, some cancers and mortality  Strongly correlated with total body fat in adults | More prone to measurement error due to the use of two variables  Complicated to interpret (increased WHR could be caused by increased abdominal fat or decreased lean muscle mass around the hips)  Difficult to measure and less accurate in individuals with a BMI > 35 |
| Waist-to-Height Ratio | Easy, inexpensive application  Strong predictor of total body fat, visceral fat and metabolic syndrome (more powerful than BMI and abdominal circumference) | More prone to measurement error due to the use of two variables  Difficult to measure and less accurate in individuals with a BMI > 35 |
| Skinfold Thickness | Easy, inexpensive application  Portable and convenient  Safe and accurate method to measure children | Not as accurate as BMI  Not as reproducible as other methods  Very difficult to measure in individuals with a BMI > 35 |
| Bioelectrical Impedance | Easy, inexpensive application  Portable and convenient | Hard to calibrate  Not as accurate as other methods  Less accurate in individuals with a BMI > 35 |
| Underwater Weighing (Densitometry) | Accurate | Time consuming  Requires individuals to be submerged underwater |
| Air-Displacement Plethysmography | Accurate  Safe, quick and comfortable | Expensive |
| Dilution Method (Hydrometry) | Accurate  Low cost  Suitable for individuals with a BMI > 35 as well as children and pregnant women | The ratio of body water to fat-free mass may change during illness |
| Dual Energy X-ray Absorptiometry (DEXA) | Accurate | Expensive  Cannot distinguish between subcutaneous and visceral fat  Exposes individuals to a low dose of radiation |
| CT and MRI Scans | The most accurate method to measure fat and fat-free mass | Expensive  CT scanners administer ionising radiation |

*Adapted from Duren et. al. (2), Wells & Fewtrell (3), Harvard Medical School (4), NHS (5), Harvard T.H. Chan School of Public Health (6), Van Dijk et. al. (7), Swainson et. al. (8)*

BMI is an effective tool for population-based screening due to its straightforward interpretation, ease of application and its proven correlation with higher all-cause mortality, highlighted by a meta-analysis of 239 prospective studies across four continents (1). However, BMI is limited as it fails to account for different body fat distributions, such as visceral adiposity, which is associated with an increased mortality risk.

A meta-analysis investigating the correlation between BMI, waist circumference, waist-to-hip ratio, waist-to-height ratio, body fat percentage and cardiovascular disease risk factors found that waist circumference had the strongest correlation (7).

In addition, a study of 81 adults compared BMI, waist circumference, waist-to-hip ratio, waist-to-height ratio and waist/height0.5 against body fat percentage and visceral fat obtained from dual energy X-ray absorptiometry (8). Waist-to-height ratio was found to be the best predictor of both body fat percentage and visceral fat. Waist-to-height ratio was also found to be the best predictor of metabolic syndrome, when compared against BMI and waist circumference in a Chinese population.

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