WITHINGS

The Science Behind

Body Pro 2

Body Composition

The Importance of Body Composition Measurements within the Medical Community

What is body composition?

When it comes to weight, Body Mass Index (BMI) alone may not tell the whole story. In fact, critical scientific reviews note that it is increasingly clear that BMI is a poor indicator of body fat percentage and also does not account for the mass of fat stored in different parts of the body.[1] BMI's limitations are evident — considered on its own, it oversimplifies health assessments, neglecting crucial factors like muscle mass, bone density, and body composition.

To get a clearer and more accurate view of the body, estimating body composition is key. Body composition refers to the proportion of lean mass and fat mass within the body. Lean mass can be subdivided into muscle mass, water percentage and bone mass.[2]

Body Pro 2 measures body composition: fat mass, muscle mass, water percentage and bone mass.
By measuring it, Withings Body Pro 2 can help care teams get a better picture of their patients overall health.

Why does this matter?

Obesity and body fat distribution are established risk factors of chronic disease.[3] Fat plays an essential role in good health — it allows the body to store energy to support metabolism. However, excessive body fat mass has been linked to certain health risks, including heart disease, breast cancer, and colorectal cancer.[4]

Accumulating excess storage fat, especially around the abdomen, can lead to a higher risk of disease.[5, 6]

Because body composition is constantly changing, it is important to use the same measurement method over time.

What is a healthy body fat level?

Unlike weight, body composition shouldn't be interpreted as a standalone figure, because it must be considered in context with gender, age and metabolism.

By definition, a healthy body composition includes a low proportion of body fat, as well as a higher proportion of non-fat mass.

First of all, a healthy body fat level will be different for men and women. So, body fat percentage results are usually sorted by age and sex according to the following categories:

Body fat ranges for females

Female bodies need more fat to maintain a good hormonal balance, as well as healthy and regular menstrual cycles. Females tend to have 6-11% more body fat than males.

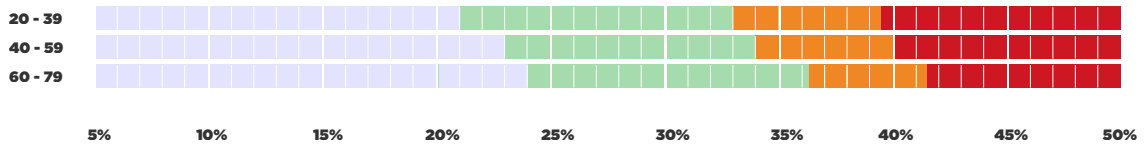


Figure 1: Body fat normality ranges for females

Source: American Council on Exercise

Body fat ranges for males

For males aged 20 to 39, having a body fat percentage that is above 25% is considered obese. This means that no more than a quarter of the total body weight should consist of fat.

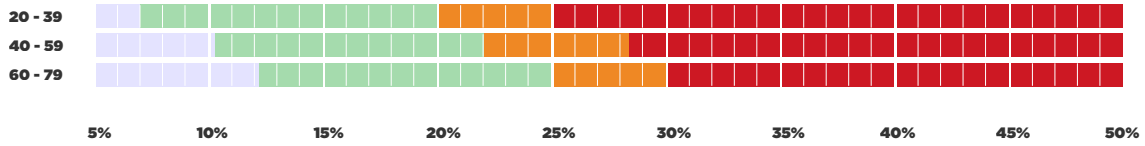


Figure 2: Body fat normality ranges for males

Source: American Council on Exercise

How is body composition usually measured?

There are many ways to determine body fat, muscle mass, water percentage and bone mass. As a patient ages and their lean muscle progressively decreases, it is important to keep body composition in mind.

Different methods exist to measure the body composition:

Method 1 - Bioelectrical Impedance Analysis (BIA)

Bioelectrical impedance analysis is a simple and non-invasive way to measure body fat. With this technique, an undetectable current is sent through the body and by measuring the voltage, we can compute the resistance and then calculate the impedance. The algorithm integrates the impedance measurement with other factors such as age, weight, height, and gender to evaluate an individual's body composition, including water percentage, fat mass, and muscle mass.

Method 2 - Skinfold calipers

By measuring the thickness of a skin fold at key locations on the body, it is possible to estimate the total amount of fat and then deduce the body fat percentage using corresponding charts.

Method 3 - Body circumference measurement

In this method, a tape measurement is placed around the waist, neck, and hips. According to the Centers for Disease Control and Prevention (CDC), body circumference can serve as a preliminary screening tool but should not be solely relied upon for assessing an individual's body fat level or overall health. It is advisable for a qualified healthcare professional to conduct comprehensive health assessments to accurately evaluate an individual's health status and potential risks.[7]

Method 4 - Dual-energy X-ray Absorptiometry (DEXA)

DEXA scans are performed in clinical environments and use spectral imaging (X-ray) to measure bone mineral density. DEXA provides detailed information about tissue composition, and can distinguish lean tissue mass from fat tissue mass with proven accuracy.[8]

A Dual X-ray Absorptiometry (DEXA) scan, often considered as the gold standard for measuring fat mass, has some disadvantages when compared to BIA. DEXA can only be performed in a supervised clinical setting and is too costly, time-consuming, and inconvenient for efficient daily monitoring of body fat levels. While BIA will not yield as accurate a result as DEXA in terms of exact value, it will accurately display variations in body fat when comparing two measurements taken under similar conditions.[9] This technique can be very useful when measuring changes in body fat, and it can help provide a more complete picture of overall health.

Body Pro 2 is equipped with multifrequency bioelectrical impedance analysis to provide accurate and reproducible body composition measurements.

Body Composition in Body Pro 2

How does Body Pro 2 measure a patient's body composition?

Use of BIA

Bioelectrical impedance analysis (BIA), or bio-impedance, is the measurement of the resistance of biological tissues to the flow of a low-voltage current.

The human body is composed of different types of tissues, which have different levels of electrical conductivity. Currents will pass mainly through the most conductive tissues, such as water or muscle.

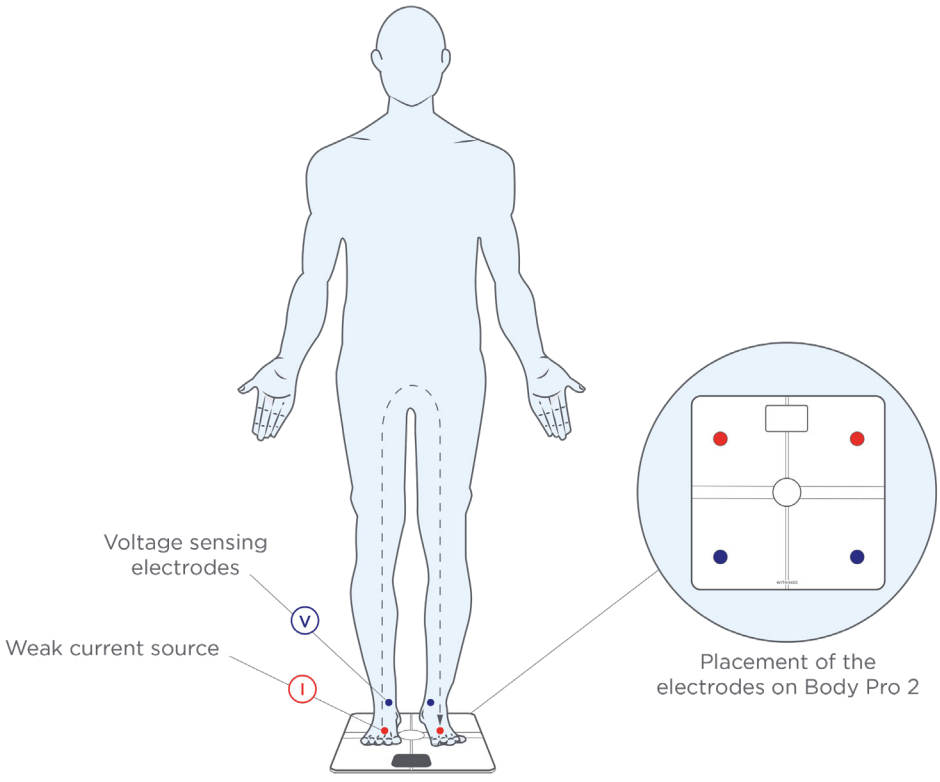
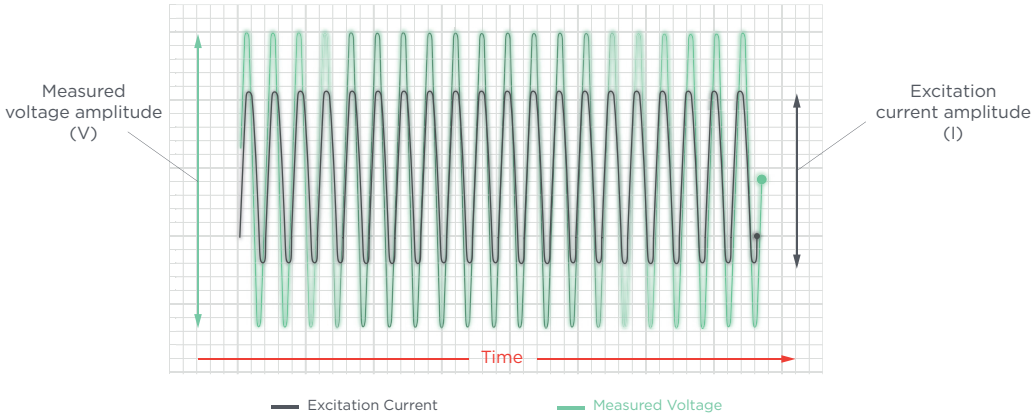


Figure 3: Principle of bioelectrical impedance analysis

Withings Body Pro 2 has four electrodes that are attached to the surface of the glass plate. 6.25 kHz and a 50 kHz high-frequency sinusoidal voltages are sent between two electrodes, located near the tops of the feet. A safe, undetectable current of less than 300 µArms is sent through the lower half of the body (Fig. 3) and will not be felt by the user. By measuring the voltage drop between the other two electrodes, located near the heels of the feet, the scale can measure the impedance, which can then be used to calculate an estimate of non-fat body mass. Then, by subtracting the difference with body weight, fat mass is calculated as well. Other independent regressions are used to calculate total body water and bone mass. Finally, muscle mass is deduced by subtracting body fat and bone mass from total weight.

By measuring the voltage drop between the electrodes, BIA determines the resistance level of these tissues to the excitation current. The scale then displays the body composition measurements, including fat mass, water percentage, muscle mass, and bone mass, based on scientifically validated equations. The measurements are calculated using several parameters such as lower body impedance, weight, height, age, gender, and athletic profile.



Impedance (Z) = measured voltage amplitude (V) / excitation current amplitude (I)

Figure 4: Biolectrical impedance signal obtained by Body Pro 2

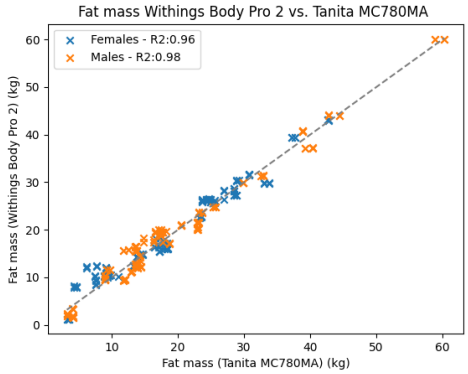
BIA provides a reliable estimate of total body water, which is a useful technique to assess body composition in both healthy individuals and people affected by a chronic condition.[10]

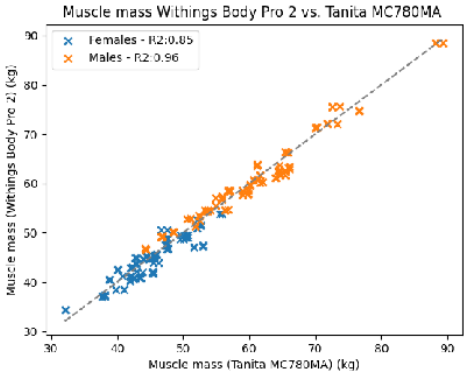
Scientific validation of Body Pro 2

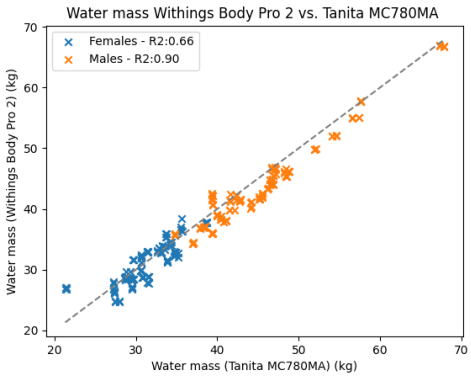
An accurate measurement of body composition.

An internal study was conducted on a diverse group of 61 patients composed of 52% male and 48% female, non-athletes, caucasian adults. The purpose of this study was to compare the performance of Withings Body Pro 2 and the Tanita MC780. The MC780 scale uses segmental measurements. It uses 3 frequencies to measure body composition and is a medical device of class IIa, approved by the FDA.

Participants performed 3 measurements on each device. The results of this study are shown below.







The results demonstrate a high degree of agreement between the Body Pro 2 and Tanita scales, underscoring the superior quality of our impedance measurements and numerical models.

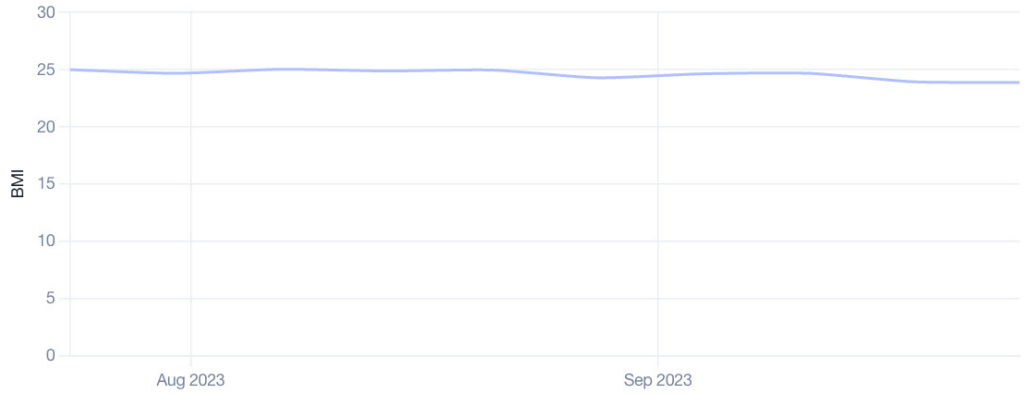
Even though Withings Body Pro 2 measures only impedance in the lower half of the body, as opposed to all segments, the correlation with the Tanita MC780 was found to be very strong, with minimal errors. This conclusion is evident in the graph, which illustrates a strong correlation between the two devices.

Furthermore, the mean absolute error on fat percentage was found to be below 2.5% for both sexes, indicating a high level of accuracy. The R2 coefficient, a statistical measure indicating the extent to which an independent variable explains the variance in a dependent variable, was found to be 0.9. This high R2 value also signifies a strong correlation, further validating the reliability and accuracy of the Withings Body Pro 2 scale.

In conclusion, Withings Body Pro 2 has demonstrated excellent performance and accuracy in this study, reinforcing its position as a reliable tool for health measurements.

A repeatable measurement of body composition

Monitoring body composition over time is crucial. Trends in body composition can provide valuable insights into a patient's health status, often more so than individual measurements. For instance, during a weight-loss journey a person may experience a plateau and lose their motivation if they feel that their efforts are not working anymore. However, by tracking their body composition they will be able to understand the shift in their fat mass and muscle mass as illustrated below. Therefore, the ability to accurately and consistently measure body composition over time is of utmost importance.



Withings scale user (39 years old woman)

In this context, Withings has conducted rigorous internal tests on Body Pro 2, designed to provide highly accurate and repeatable measurements. The tests involved a production jig that mimics the behavior of human limbs, using a combination of resistors and capacitors in parallel. The jig made contact with the scale through conductive pads on the top of the glass, under a weight of 70 kg.

The results of 30 consecutive measurements with 6.25 kHz and 50 kHz frequencies were highly consistent, demonstrating the superior repeatability of Withings Body Pro 2. The mean relative error was 0.13% with a standard deviation of 1.33 ohm at 6.25 kHz, and an even lower mean relative error of 0.07% with a standard deviation of 0.45 ohm at 50 kHz. These results underscore the reliability of Withings Body Pro 2 in providing consistent body composition measurements over time, thereby facilitating the tracking of health trends with high precision and confidence. This makes it an invaluable tool for monitoring patients.

Body Pro 2 utilizes multifrequency BIA technology for the evaluation of patient body composition to offer accurate and repeatable measurements to care teams. This enables healthcare providers to receive daily measurements from their patients, facilitating the long-term tracking of their progress and thus allowing for in-depth follow up with personalized advice.

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