

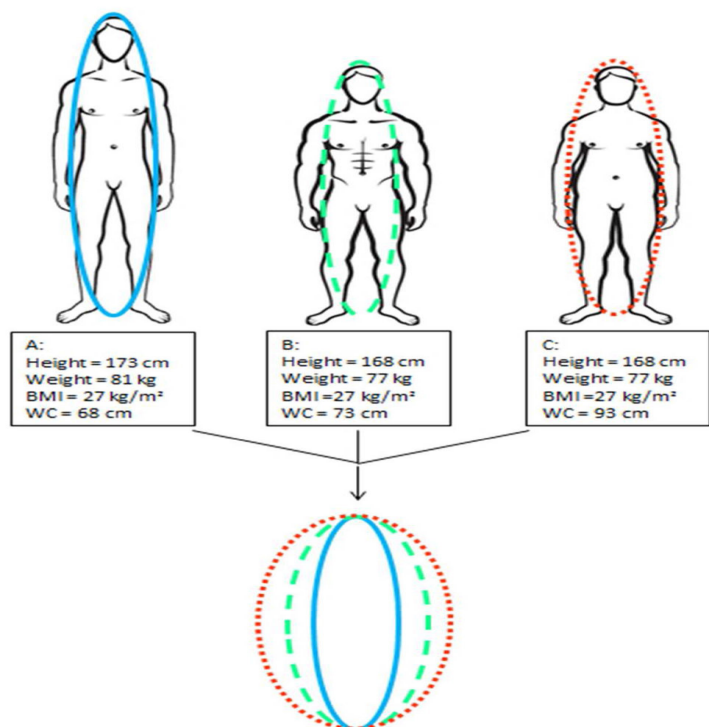
## BODY ROUNDNESS INDEX (BRI)

**i** The Body Roundness Index (BRI) was developed as a new anthropometric index that combines height and waist circumference. BRI reflects both visceral adipose tissue (VAT) and body fat percentage<sup>[1,2]</sup>, which can be used as a tool to evaluate health status.<sup>[1]</sup> The BRI is one of the anthropometric models of obesity that relies on geometry and other statistically generated nonlinear models and thus improves on the predictive accuracy.

The Body Roundness Index ranges between 1 to 20, where 1 represents more narrow body types and 20 represents more round body types. The BRI helps more accurately determine the actual body fat levels of individuals who have the same body mass index (BMI) but different heights and waist circumferences (figure 1). It was first introduced in 1609 by the German astronomer Johannes Kepler to quantify the circularity of planetary orbits, the degree of roundness of an ellipse is characterized by a non-dimensional value referred to as eccentricity.<sup>[5]</sup> In 2013, The Body Roundness Calculator was developed<sup>[1]</sup> and is illustrated below (figure 2). The calculator outputs a graph of body shape with reference to a healthy zone and thus gives the viewer an easy and simple way to visualize their degree of adiposity. By employing a model that incorporates age, gender, height, race, weight and circumferences the BRI calculator also estimates the total percent body fat and total visceral adipose tissue (belly fat). In this BRI calculator, total percent body fat represents the percentage of total body mass that is fat mass. However, total percent body fat does not tell you how personal fat mass is distributed. Fat mass is distributed differently in different individuals. This distribution depends on many factors such as age, height, gender, physical activity levels, and diet. Visceral adipose tissue is located inside the abdominal cavity and surrounds internal organs like the liver and the intestine. Excess fat storage in this depot leads to a high waist circumference and is often referred to as abdominal fat distribution or belly fat. High amounts of visceral adipose tissue (VAT) is closely related to type 2 diabetes, cardiovascular disease (e.g. the risk of heart attack and stroke), and increased mortality.<sup>[3, 4, 6]</sup>

**Figure 1:** BMI vs. BRI results

**FIGURE 1:** BMI as a measure of adiposity fails to distinguish individuals with similar BMI but different degrees of body fat. The three depicted individuals vary in body type but share identical BMI. A: subject is tall and lean, B: subject is muscular, C: subject has highest percent body fat. Although their BMIs are identical, their corresponding BRI values differentiate their body types. After normalizing for height, the three generated ellipses can be visually compared for differences in body roundness, which can be converted into estimates of percent body fat.

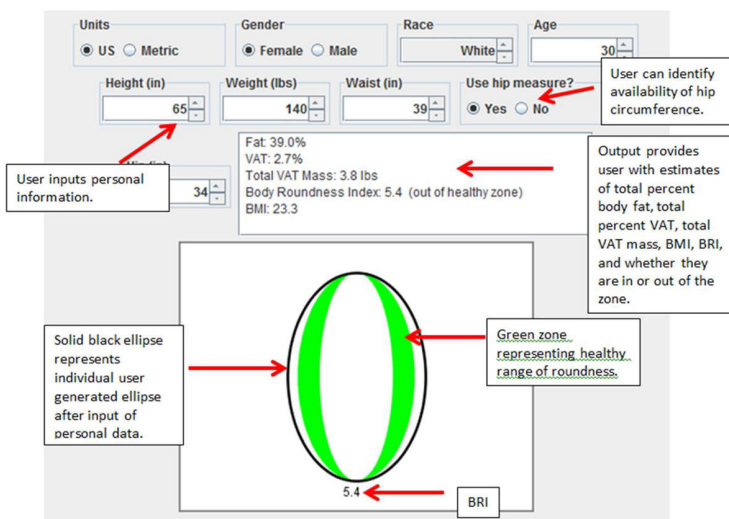


## BODY ROUNDNESS INDEX (BRI)

**i** The BRI was found to correlate well with measurements taken by Bioelectrical Impedance Analysis (BIA) - a widely used method to reliably estimate percentage of body fat as a whole and in specific parts of the body. The BRI has been found to improve predictions of percent body fat and percent visceral adipose tissue compared to more traditional measurements of body mass such as body mass index, waist circumference and hip circumference.<sup>[1,2]</sup> The BRI is able to determine the presence of cardiovascular disease (CVD) and diabetes mellitus (DM); however, the capacity of the BRI as a novel body index to identify CVD or DM was not superior compared to established anthropometric indices like BMI, waist circumference<sup>[8]</sup> or waist-to-height ratio.<sup>[8,10,11]</sup> On the other hand, the Body Roundness Index was found to be superior to the BMI and is an alternative index for assessing diabetes in Han Chinese people in Northeast China.<sup>[9]</sup> BRI was also found to predict coronary heart disease (CHD) risk in Chinese males and females.<sup>[7]</sup>

As a stand-alone prediction index, the BRI outperforms traditionally applied indices such as BMI, waist circumference, and hip circumference.<sup>[1]</sup> The BRI also improves its accuracy of prediction by including the effects of age, height, race, gender, and weight. In addition, the geometrical measurements (height, waist circumference, and hip circumference) were applied to output the BRI, and the generation of an elliptical graph depicts healthy body roundness index (in green) were determined from published healthy body fat cutoffs.<sup>[2]</sup>

**Figure 2:** Body Roundness Calculator Screen Shot



**FIGURE 2:** Screen shot of Body Roundness Calculator. After the user enters personal information for age, height, weight, sex, race, waist and hip circumferences, the program outputs total percent body fat, the body roundness index, and whether the individual is within the determined healthy range of body roundness. A graph depicting the resulting individual ellipse (African American curve) and healthy range (green shaded area) provide the user a visual representation of their body roundness relative to the healthy range.



### Frequently Asked Questions

- Q** How does the calculator determine how round I am?
- A** We use your height and waist circumference to produce an oval (also known as an ellipse) to approximate your body shape. Then we calculate how close the oval is to being a circle using a number called eccentricity. There is more detailed information about eccentricity on the tab titled "About this model".
- Q** How was the healthy zone in the diagram computed?
- A** We used equations that relate roundness to percent fat and determined the green ranges by substituting in the healthy age-dependent body fat ranges published in [2]

# BODY ROUNDNESS INDEX (BRI)



## Frequently Asked Questions

**Q** What is being estimated in total percent body fat?

**A** Total percent body fat represents the percentage of your total body mass that is fat mass. Note, that this number does not tell you how your personal fat mass is distributed. Fat mass is distributed differently in different individuals. This distribution depends on many factors such as age, height, gender, physical activity levels, and diet.

**Q** What is visceral adipose tissue?

**A** Visceral adipose tissue is located inside the abdominal cavity and surrounds internal organs like the liver and the intestine. Excess fat storage in this depot leads to a high waist circumference and is often referred to as abdominal fat distribution or belly fat. High amounts of visceral adipose tissue is closely related to type 2 diabetes, cardiovascular disease (e.g. the risk of heart attack and stroke), and increased mortality. [3,4]

**Q** Is waist circumference a sufficient input in the calculator to get a good prediction?

**A** Waist circumference predicts total percent body fat fairly well (over 88% of the variance is explained by including waist circumference) and percent visceral adipose tissue (70% of the variance is explained), however, including hip circumference raises the accuracy of the prediction. We highly recommend entering both if possible. We recognize that a completed experiment may not have access to hip circumference and may still want to analyze data using the calculator, which is why we have this option.

**Q** Why do I need to include my race?

**A** We found that race is a factor for predicting body fat and visceral fat. Including your race will allow for the most accurate prediction of your percent body fat and percent visceral adipose tissue without directly measuring you using clinical methods. None of the inputted information is recorded, tracked, or saved.

**Q** I am out of the zone. What can I do?

**A** You should bring this information to your doctor or health care provider to find out what the best strategies may be to improve your health.



## References

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