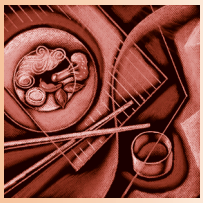

# Shape

## The Waist-to-Height Ratio Is a Good, Simple Screening Tool for Cardiometabolic Risk

**Margaret Ashwell, OBE, PhD, RPHNutr**

**The benefits and limitations of anthropometric measures (weight and shape) to assess the health risks of obesity are discussed. They include the body mass index, the waist-to-hip ratio, the waist circumference (WC), and the waist-to-height ratio (WHtR).**

**The use of WHtR, a proxy for central obesity and shape, could be an important new public health screening tool that can be used for all adults and children older than 5 years, in all ethnic groups. Use of a boundary value of WHtR 0.5 to denote increased risk converts into a simple message: "Keep your waist circumference to less than half your height." Nutr Today. 2011;46(2):85–89**

## Weight for Height and Body Mass Index

The health risks of excess body fat for adults were known for many years to be associated with inappropriate weights for height. Tables of such weights for different frame sizes were originally derived from insurance data. Various indices based on weight and height were then suggested as correlates of total body fat. The body mass index (BMI)—weight in kilograms divided by the square of the height in meters—became the most widely accepted.

Since the early 1980s, the classic BMI chart has been used extensively to assess the health risks of obesity.[1] Healthy weight for height is usually defined as a BMI between 18.5 and 25 kg/m$^2$, overweight as equal to or more than 25 kg/m$^2$ and less than 30 kg/m$^2$, and obesity as a BMI of equal to or more than 30 kg/m$^2$.[2] Body mass index has served us well as a proxy for obesity for many years, but it has always been recognized that it does not differentiate between the overmuscled and the overweight except at very high BMIs. There is another problem with BMI—even in the overweight—it is only a proxy for total fat in the body, and it does not distinguish between individuals with different types of fat distribution.

> *Body mass index does not differentiate between the overmuscled and the overweight unless BMI is very high. Furthermore, it is only a proxy for total fat in the body, and it does not distinguish between individuals with different types of fat distribution.*

## Apples and Pears

Jean Vague[3] first pointed out in the 1940s and 1950s that people with a "central" type of fat distribution (android shape) were at greater health risk than those whose fat was deposited "peripherally" (gynoid shape). However, it has only been in the last 3 decades that there has been general agreement that health risks (predominantly cardiovascular disease [CVD] and diabetes) can be determined more by the relative distribution of the excess fat than by its total amount.[4] The use of imaging techniques such as computed tomography[5] and magnetic resonance imaging[6] has subsequently indicated that the "unhealthy apple shape" (Vague's android shape) is characterized by a preferential deposition of fat in the internal, visceral fat depots rather than in the external, subcutaneous fat depots, which lead to the "healthy pear shape" (Vague's gynoid shape).

*"Unhealthy apple shape" is characterized by a preferential deposition of fat in the internal, visceral fat depots rather than the external, subcutaneous fat depots, which lead to the "healthy pear shape."*

## Waist-to-Hip Ratio

Relative fat distribution can be measured by the waist circumference (WC)–to–hip circumference ratio (WHpR). This was shown to be a good predictor of health risk and was popular for many years.[7] However, although it was useful for risk assessment, WHpR is not helpful in practical risk management because both waist and hip can decrease with weight reduction, and so the ratio of WHpR changes very little as weight is lost. So attention then shifted to the use of WC by itself as a possible replacement for BMI.

## Waist Circumference

Jean-Pierre Després and his colleagues[8] produced exciting results from the Quebec Cardiovascular Study, which showed that WC alone is much better than BMI for predicting not only the traditional metabolic complications of excess fat (eg, hypertension, CVD and type 2 diabetes) but also the newer very important risk factors or "markers" for these complications (high insulin, high apoprotein B, increased concentration of small dense lipoprotein particles; glucose intolerance, high triglycerides, low high-density lipoprotein cholesterol, high ratio of cholesterol to high-density lipoprotein, insulin resistance, and altered haemostatic variables such as fibrinogen). Using his analogy of an iceberg, Després pointed out that measuring BMI allows you to see only the tip of the iceberg when it is too late, but measuring WC can tell you much more and allow you to take preventive measures before it is too late.

Consequently, the simple measurement of WC has been suggested as a good proxy measure for body fat distribution and subsequent health risk.[9] Unfortunately, several cutoff or boundary values for WC have been proposed, and these have had different values for men and women and also, sometimes, for different age and ethnic groups.[10] Further, a report from Japan[11] showed that metabolic risks differed between people of similar WC with different heights. Another problem is that WC cutoff values for children would have to be sex and age specific. So how can the simple measure of WC be used satisfactorily in a public health context? The solution is to think about WC in relation to height.

## The Waist-to-Height Ratio

The waist-to-height ratio (WHtR) was originally proposed more or less simultaneously in Japan[12] and the United Kingdom[13–15] as a way of assessing shape and monitoring risk reduction. Both proposals suggested that WHtR values greater than 0.5 should indicate increased health risk. We also made a proposal, based on pragmatism, that values greater than 0.6 should indicate substantially increased risk in the prototype shape chart we published in the mid-1990s.[16]

We recently conducted a systematic review of studies that have measured WHtR and BMI or WC and their relationship with metabolic risk factors, diabetes, or CVD in adults or children.[17] Inclusion criteria were human subjects; male, female, or mixed; any age, adults or children; any ethnic group; novel studies, either prospective or cross-sectional design; WHtR; and either BMI or WC measured at least once; studies also had to have a mortality and a cardiometabolic disease end point or cardiometabolic risk outcome measure and present the relationship between obesity and the disease end point or risk outcome.

Prospective and cross-sectional studies (78 in all) showed odds ratios or correlations that were similar for all anthropometric indices, but tended to be higher for WHtR and WC than BMI. Furthermore, WHtR and WC tended to be significant predictors more often than BMI in all prospective analyses, which included 9 studies with diabetes outcomes and 14 studies with CVD outcomes. Thirteen cross-sectional analyses in children supported these predictions.

Analyses to determine the performance of each anthropometric index as a screening tool in adults (ie, assessing and comparing the diagnostic accuracy of different indices for a particular outcome) showed that WHtR was invariably a better tool than WC or BMI. A, yet to be published, meta-analysis has added further support. These specificity and sensitivity analyses were performed in more than 26 studies covering men and women in many ethnic groups including white, Asian, Afro Caribbean, and Hispanic.[17]

These data also confirmed that the cutoff (or boundary) value of WHtR 0.5 for increased risk is appropriate across age, sex, and ethnic populations in adults.

The greater propensity for Asians to develop diabetes at lower BMI than whites has been recognized for some time, leading to different BMI ranges being

suggested for Asians.[10] The use of WHtR circumvents such problems because the adjustment of WC for height means the same boundary value is suitable for both ethnic groups (Figure 1).

In the 1990s, we developed a chart based on WHtR (The Ashwell Shape Chart) that allows health professionals and/or their patients to match their WC against their height—in inches or in centimeters—and to see into which category they fall. These are the 4 regions and what they mean to the patient:

- If your shape is in the "chilli" region (WHtR <0.4), you should "take care."
- If your shape falls in the "pear" region (WHtR between 0.4 and 0.5), you have a "healthy OK" shape.
- If your shape falls in the "pear-apple" region (WHtR between 0.5 and 0.6), you should "consider action."
- If your shape falls in the "apple" region (WHtR >0.6), your health is probably at risk. Why not talk with your health care provider, dietitian, or practice nurse and "take action?"

The data in the chart have recently been converted to plastic disc format—the Ashwell Shape Calculator (Figure 2). This makes it easy for the patients to line up their height (say, 165 cm) with their WC (say, 105 cm) to see that they are recommended to "take action."

The scientific evidence therefore supports the concept that patients should be advised to "keep their waist circumference to less than half their height."

## Practical Example of WHtR as a Better Screening Tool Than BMI

We recently had the opportunity to test WHtR against BMI in British survey data on nearly 2000 men and women.[19]

Data from the nationally representative National Diet and Nutrition Survey, collected in 2000/2001, allowed us to investigate how the BMI and WHtR are associated with CVD risk factors.

Screening CVD health risk by BMI alone would "miss" 35% of men and 14% of women who are within

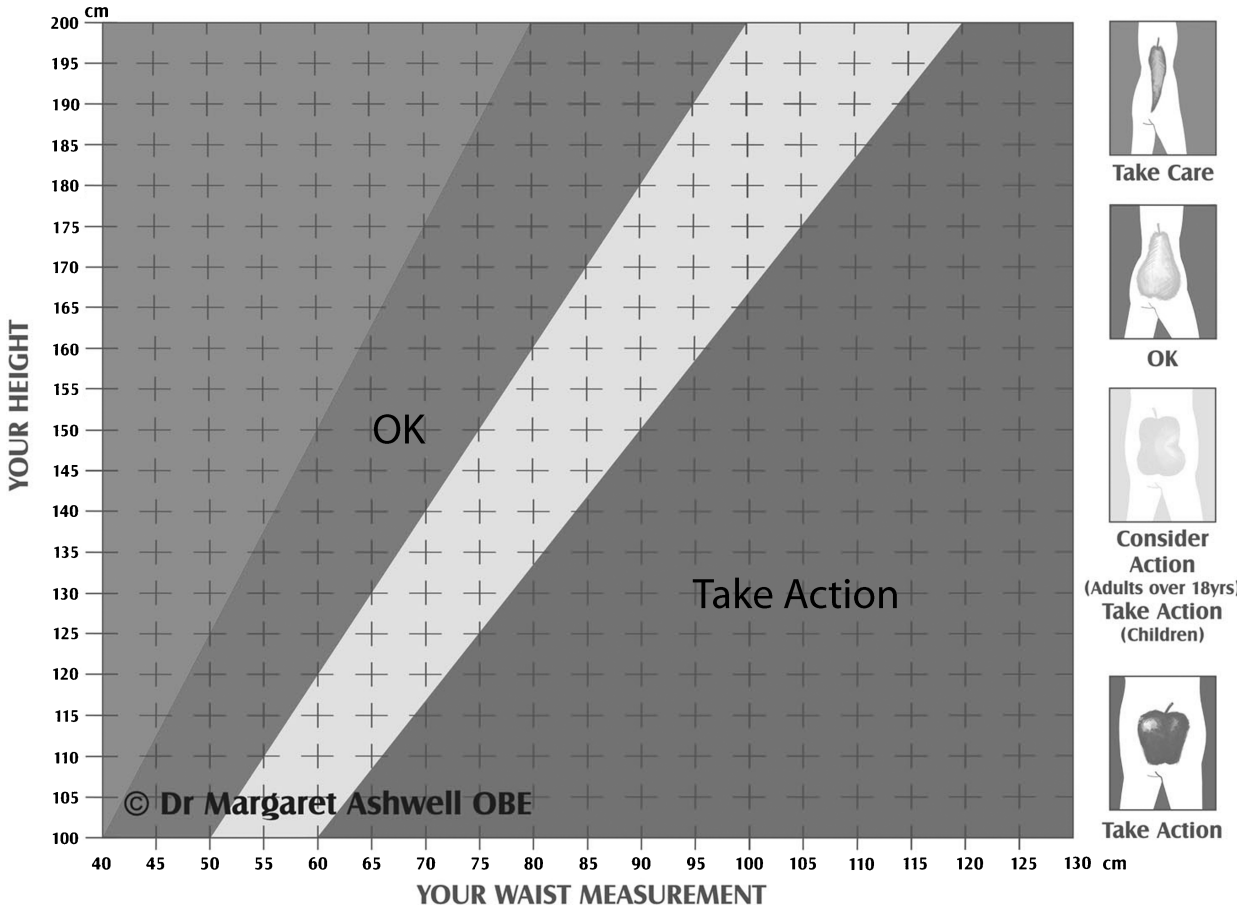


Figure 1. The Ashwell Shape Chart is a chart of waist circumference against height. It uses the boundary values of WHtR 0.5 and 0.6 to indicate 2 levels of increased risk.

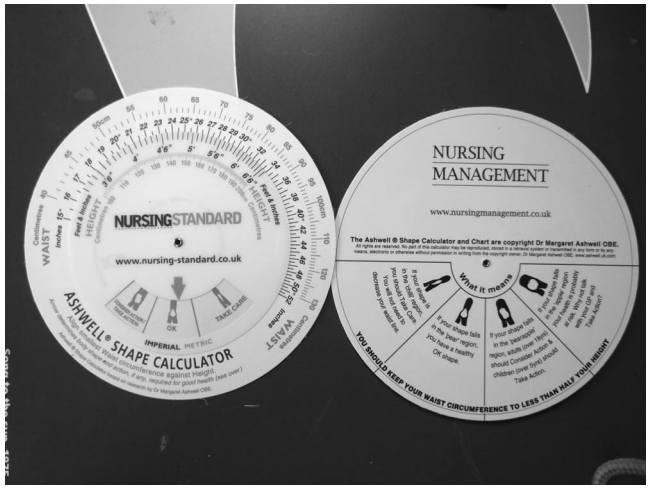


Figure 2. The data in the Ashwell Shape Chart have recently been converted to plastic disc format—the Ashwell Shape Calculator. The calculators above have been produced for the Royal College of Nursing in United Kingdom to distribute in their journals.[18]

the normal BMI range (18.5–25kg/m$^2$) but have central fat distribution, defined by a boundary value of WHtR greater than 0.5. In the total population, this equates to 11% of all men and 6% of all women who would be inadequately screened by BMI alone.

Furthermore, in a combined analysis of men and women, exhibiting central fat distribution with a normal BMI, was associated with higher levels of CVD risk factors than being overweight without central fat distribution. In other words, the use of the WHtR focuses attention and resources on men and women who are "apple shaped." It would also make it clear that women who are "pear shaped" have less health risks than those who are "apple shaped."

For the following reasons, we believe that WHtR can be a very useful screening tool:

- The techniques for measuring height and WC are easy to carry out with minimal personal intrusion.
- The calculation is easy and can be done using imperial or metric values.
- The boundary value of 0.5 for increased risk is easy to remember.

*It is easy to promote the simple message of "keep your waist circumference to less than half your height" to everyone, whatever their sex, age, or ethnic group.*

## Measuring WC

There is no definitive site for the measurement of WC that is universally accepted. It can be measured at 4 different sites in children and adults.[20] The World Health Organization[2] recommends measurement to be taken at the "natural waist," which is at the midpoint between the 10th rib (lowest rib margin) and the iliac crest. Another method takes the measurement at the level of the umbilicus. Sometimes, instructions are given to measure WC at the narrowest point (as is done on the chart). If the waist is difficult to find in an individual who is obese, then measuring at the umbilicus level is the preferred method because the landmark is fixed, even if it is not ideal. Measurements are taken on the skin, using a flexible, but not stretchable, measuring tape. The most important point is that the method should be reproducible[20] so that the patient can be motivated by witnessing a reduction in their WC measurement with their weight reduction efforts.

Standardization of the measurement of WC will become even more important, and several studies have already addressed this issue.[21] It is particularly important that this standardization includes population groups such as the elderly and very obese.

## Conclusion

The use of WHtR, a proxy for central obesity, could be an important new public health tool that has global applicability for all adults and, maybe, even for children.[22] Further validation of the boundary values for higher risk in adults and for children is now required. A new comprehensive systematic review[17] supports the use of WHtR of 0.5 as a simple screening tool, as used in the Ashwell Shape Chart, and provides a simple message: "Keep your waist circumference to less than half your height."

**Margaret Ashwell, OBE, PhD, RPHNutr,** is an independent scientific consultant, who has worked previously as a research scientist for the Medical Research Council, as principal of the Good Housekeeping Institute, and as science director of the British Nutrition Foundation. She is a visiting research fellow at Oxford Brookes University, Oxford, United Kingdom.
There are no sources of support for this study.
Corresponding author: Margaret Ashwell, OBE, PhD, RPHNutr, Ashwell Associates (Europe) Ltd, Ashwell St, Ashwell, Hertfordshire SG7 5PZ, UK (margaret@ashwell.uk.com; www.ashwell.uk.com).
DOI: 10.1097/NT.0b013e3182118779

## REFERENCES

1. Garrow JS. *Treat Obesity Seriously—A Clinical Manual*. Edinburgh, Scotland: Churchill Livingstone; 1981.
2. World Health Organization. *Obesity. Preventing and Managing the Global Epidemic. Report of a WHO Consultation*

*on Obesity, Geneva, June 3–5, 1997*. Vol series 894. Geneva, Switzerland: World Health Organization; 2000. WHO Technical Report Series.
3. Vague J. The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout and uric calculous disease. *Am J Clin Nutr*. 1956;4:20–34.
4. Bjorntorp P. How should obesity be defined? *J Intern Med*. 1990;227:147–149.
5. Ashwell MA, Cole TJ, Dixon AK. Obesity: new insight into anthropometric classification of fat distribution shown by computed tomography. *Br Med J*. 1985;290: 1692–1694.
6. Seidell JC, Cigolini M, Charzewska J, Ellsinger BM, di Biase G. Fat distribution in European women: a comparison of anthropometric measurements in relation to cardiovascular risk factors. *Int J Epidemiol*. 1990;19:303–308.
7. Bjorntorp P. The associations between obesity, adipose tissue distribution and disease. *Acta Med Scand*. 1988;723:121–134.
8. Després JP, Lemieux I, Prud'homme D. Treatment of obesity: need to focus on high risk abdominally obese patients. *Br Med J*. 2001;322:716–720.
9. Han TS, van Leer EM, Seidell JC, Lean MEJ. Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. *Br Med J*. 1995;311:1401–1405.
10. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009;120:1640–1645.
11. Hsieh S, Yoshinaga H. Do people with similar waist circumference share similar health risks irrespective of height? *Tohoku J Exp Med*. 1999;188:55–60.
12. Hsieh SD, Yoshinaga H. Abdominal fat distribution and coronary heart disease risk factors in men-waist/height ratio as a simple and useful predictor. *Int J Obes Relat Metab Disord*. 1995;19:585–589.
13. Ashwell M. A new shape chart for assessing the risks of obesity. *Proc Nutr Soc*. 1995;54:86A.
14. Ashwell M, Cole TJ, Dixon AK. Ratio of waist circumference to height is strong predictor of intra-abdominal fat [see comment]. *BMJ*. 1996;313:559–560.
15. Cox BD, Whichelow M. Ratio of waist circumference to height is better predictor of death than body mass index. *BMJ*. 1996;313:1487.
16. Ashwell M. The Ashwell Shape Chart—a new millennium approach to communicate the metabolic risks of obesity. *Obes Res*. 1997;5:45S.
17. Browning L, Hsieh S, Ashwell M. A systematic review of waist-to-height ratio as screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutr Res Rev*. 2010;23:247–269.
18. Ashwell M. Obesity risk: importance of the waist-to-height ratio. *Nurs Stand*. 2009;23:49–54.
19. Ashwell M, Gibson S. Waist-to-height ratio is a simple and effective obesity screening tool for cardiovascular risk factors: analysis of data from the British National Diet and Nutrition Survey of adults aged 19 to 64 years. *Obes Facts*. 2009;2:97–103.
20. Wang J, Thornton JC, Bari S, et al. Comparisons of waist circumferences measured at 4 sites. *Am J Clin Nutr*. 2003;77:379–384.
21. Kagawa M, Byrne NM, Hills AP. Comparison of body fat estimation using waist:height ratio using different 'waist' measurements in Australian adults. *Br J Nutr*. 2008; 100:1135–1141.
22. Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *Int J Food Sci Nutr*. 2005;56:303–307.