Obesity risk: importance of the waist-to-height ratio

**Summary**

This article reviews the benefits and limitations of some of the different anthropometric measures to assess the health risks of obesity. Those covered are the body mass index, the waist-to-hip ratio, waist circumference and the waist-to-height ratio. The latter has the potential to be globally applicable to different ethnic populations and to children and adults. The suggested boundary values of 0.5 and 0.6 are used in a shape chart and shape calculator, described here, to indicate different levels of health risk in adults and children. A simple message from this work is ‘keep your waist circumference to less than half your height’.

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**Aims and intended learning outcomes**

The aim of this article is to outline the benefits of the waist-to-height ratio (WHtR) and its graphical representation in the Ashwell® Shape Chart and Ashwell® Shape Calculator for assessing the health risks of obesity. The article demonstrates that the same boundary value of WHtR has the potential to be used in adults and children and in all ethnic groups. The aim is to show that a simple, universal measure such as this has enormous potential for health promotion. After reading this article you should be able to:

- Understand the importance of measuring central obesity rather than total obesity.
- Appreciate the emerging work on the value of the WHtR as a good proxy for central obesity.
- Identify the increased health risk in patients who are ‘apple’ shaped compared with those who are ‘pear’ shaped and the importance of prioritising resources for these patients.
- Perform simple waist circumference and height measurements to calculate and record WHtR to assess health risks in patients.

**Introduction**

The health risks of excess body fat for adults were for many years 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, but the body mass index (BMI) – weight in kilogrammes divided by the square of the height in metres – became the most widely accepted.

Since the early 1980s, John Garrow’s (1981) classic chart based on BMI has been used extensively to assess the health risks of obesity. Healthy weight for height was defined in UK as a BMI between 20 and 25, overweight as more than 25 and less than 30, and obesity as 30 and over. The United States (US) eventually adopted the same BMI categories much later than many other countries. BMI has served health professionals well as a proxy for obesity for many years, but it has always been recognised that it does not
Differentiate between the over-muscled and the overweight (Garrow 1981). There is another problem with BMI: even in the overweight, it is only a proxy for total fat in the body and does not distinguish between individuals with different types of fat distribution.

Vague (1956) 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 past two decades that there has been a consensus that health risks (predominantly cardiovascular disease (CVD) and diabetes) can be determined as much by the relative distribution of the excess fat as by its total amount (Björntorp 1988). Also, only recently has there been media interest in the ‘unhealthy apple shape’ and the ‘healthy pear shape’. The use of imaging techniques, such as computed tomography (CT) (Ashwell et al 1985) and magnetic resonance imaging (MRI) (Seidell et al 1990) have indicated that the unhealthy apple shape is associated with a preferential deposition of fat in the internal, visceral fat depots rather than the external, subcutaneous fat depots. The healthy pear shape has proportionately more fat in the external fat depots.

Relative fat distribution can be measured by the waist-to-hip ratio (WHpR). This was shown to be a good predictor of health risk and was popular for many years (Björntorp 1988). Although useful for risk assessment, WHpR is not helpful in practical risk management because the waist and hip can decrease with weight reduction, so the ratio of WHpR changes very little. As a result of this, attention shifted to the use of waist circumference itself as a possible replacement for BMI.

Jean-Pierre Després and his colleagues (Després et al 1990, Després et al 2001) produced exciting results from the Quebec Cardiovascular Study, which showed that waist circumference alone is much better than BMI for predicting not only the traditional metabolic complications of excess fat (for example, hypertension, CVD and type 2 diabetes), but also the newer important risk factors or ‘markers’ for these complications, for example high insulin, high apoprotein B, increased concentration of small dense lipoprotein particles, glucose intolerance, high triglycerides, low high density lipoprotein (HDL) cholesterol, high cholesterol-to-HDL ratio, insulin resistance and altered haemostatic variables. Using Després’ (2001) analogy of an iceberg, measuring BMI only allows you to see the tip of the iceberg when it is too late, but measuring waist circumference can identify risk factors much earlier and enable preventive medicine measures.

The simple measurement of waist circumference has been suggested as a good proxy measure for body fat distribution and subsequent health risk (Han et al 1995). However, several cut-off or boundary values for waist circumference have been proposed that have had different values for men and women and, sometimes, caused confusion for different age groups (Zhu et al 2005). More importantly, Hsieh and Yoshinaga (1999) showed that metabolic risks differed between people of similar waist circumference with different heights. Another problem is that waist circumference boundary values for children would have to be sex and age specific because of different growth patterns.

**Waist circumference-to-height ratio in use**

The WHtR ratio was originally proposed more or less simultaneously in Japan (Hsieh and Yoshinaga 1995a, 1995b) and the UK (Ashwell 1995, Ashwell et al 1996, Cox and Whichelow 1996) as a way of assessing body shape and monitoring risk reduction. It was suggested that WHtR values above 0.5 should indicate increased risk (Ashwell 1995, Hsieh and Yoshinaga 1995b, Ashwell et al 1996, Cox and Whichelow 1996). It was also suggested that values above 0.6 indicate substantially increased risk (Cox et al 1997).

Prospective studies have also shown that waist circumference and WHtR are better than BMI at predicting deaths from coronary heart disease and all-cause mortality (Cox and Whichelow 1996, Hadaegh et al 2006, Lu et al 2006, Chei et al 2008). WHtR is a slightly better predictor than waist circumference alone. This is probably because there is a positive association between waist and height in global populations of mixed ethnicity that include a wide range of heights.

An advantage of using WHtR over waist circumference in a public health context is that boundary values can be set that are the same for men and women. The suggested boundary value of 0.5 proposes that individuals should ‘keep waist circumference to less than half your height’. Another boundary value of 0.6 indicates that adults should ‘take action’.

A second advantage of these suggested boundary values, is that the estimated proportion

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**Time out 1**

Write a list of all the health risks you can think of that are associated with central obesity.

Have you included the metabolic risks such as type 2 diabetes as well as the mechanical risks such as immobility?
of the population ‘at risk’ from health problems associated with obesity is similar to that estimated by the traditional BMI, meaning that a similar amount of public health resources can be redirected to the sub-population who will benefit more. Therefore governments need not get alarmed that they will have to pay more, but they can be reassured their money is being spent on the most needy cases. Another point is that the proportion of men at risk using WHtR is usually greater than the proportion of women, reflecting the greater propensity for men to have central obesity (Ashwell 1996).

**Shape chart and calculator**

Unlike waist circumference, WHtR can be converted into ‘consumer-friendly’ tools. The Ashwell® Shape Chart is similar to that used for BMI but with the important difference that the chart requires the user to match his or her waist measurement against his or her height rather than weight (Figure 1).

The data and advice in the Ashwell® Shape Chart can also be transformed into the Ashwell® Shape Calculator, the only product of its type on the market at present. This allows the nurse and patient to identify which category they fall into: chilli, pear, pear-apple or apple, and what action they must take or consider. The brown ‘chilli’ category (Figure 1) indicates that the individual does not need to decrease their waistline, but should take care.

**Time out 2**

Can you think of any practices where advances in science have simplified nursing in terms of the resources needed to assess health risk? In this example the need for weighing scales can be replaced with a tape measure. Has the measure of temperature or blood pressure got more or less complicated with current techniques?

**Waist circumference-to-height ratios versus body mass index**

UK survey data on around 2,000 men and women allows the authors to demonstrate an important new public health message that the use of the WHtR conveys compared with the traditional BMI (Ashwell and Gibson 2009). Data from the nationally representative National Diet and Nutrition Survey, collected in 2000/01, allowed the authors to investigate how the BMI and two proxy indicators of central fat distribution, namely the waist circumference and the WHtR, are associated with each other and with CVD risk factors.

**Time out 3**

Discuss with your nursing colleagues how to reassure patients who are pear-shaped that they are not at high health risk. How will you make patients who are apple-shaped more aware that their health risks are serious. You can use the list of health risks for patients who are apple-shaped from Time out 1.

**Evidence base**

Supporting evidence for the potential use of WHtR has come from cross-sectional studies in adults from, among others, Greece (Bertsias et al

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**FIGURE 1**

The Ashwell® Shape Chart

Screening CVD health risk by BMI alone would ‘miss’ 35% of men and 14% of women who are within the normal BMI range (18.5 to 25kg/m²) but have central fat distribution, defined by a boundary value of WHtR greater than 0.5. In the total population, this equates to 17% of all men and 6% of all women who would be inadequately screened by BMI alone (Ashwell and Gibson 2009).

Furthermore, in a combined analysis of men and women, having central fat distribution (Ashwell and Gibson 2009) 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 WHtR focuses attention and resources on men and women who are apple-shaped and it would make it clear that women who are pear-shaped have less health risks than those who are apple-shaped.
A recent meta-analysis (Lee et al 2008a) comparing pooled data from ten studies of various anthropometric indices and CVD risk in adults, showed that WHR is better than BMI, waist circumference and WHtR at predicting CVD risk. Lee et al (2008a) have lent support to the previously proposed boundary value of WHR of 0.5 (Hishe and Yoshinaga 1995b, McCarthy and Ashwell 2006).

Ethnicity

Research from Asian countries, has shown that even in populations with low rates of obesity and moderate BMIs, such as Japan (Hishe and Yoshinaga 1995a, Chei et al 2008), Hong Kong (Ho et al 2003), Taiwan (Lin et al 2002, Huang et al 2002, Lin et al 2007), Pakistan (Khan et al 2008), Bangladesh (Sayed et al 2003), Singapore (Pua and Ong 2005), China (Patel et al 1999, Ho et al 2003, Lin et al 2007, Wu et al 2007), and India (Joshi 2008), the measurement of WHR can be an important early indicator of lifestyle related disorders and could be an important public health approach to preventing diabetes and CHD.

Action taken now in these countries could save millions of pounds later and resources could be targeted to these populations who might not believe that they are at risk.

Children

A new development is that WHR may allow the same boundary value/s for health risk in children and adults. There is growing evidence that WHR can be used to predict risk in children (Savva et al 2000, Hara et al 2002, Kahn et al 2005, Freedman et al 2007, Weili et al 2007, Maffeis et al 2008). Since the height and waist circumference of children increases continually as they age, the same

References


Hadaegh F, Zabetian A, Harati H.
boundary value (WHtR=0.5) could be used to indicate increased risk across all age groups (McCarthy and Ashwell 2006, Garnett et al 2008).

A study of nearly 3,000 Australian children aged eight to 16 years (Namibi et al 2009) concluded that WHtR is the best index in clinical and population health studies, and that WHtR boundary values just below 0.5 can identify children with a higher percentage of body fat who are at greater risk of developing weight-related, cardiovascular co-morbidities at an earlier age. However, there is not enough data for children under five to be sure, and also growth patterns are too varied in the under fives to be prescriptive.

The latest versions of the Ashwell® Shape Chart and calculator have been modified to include height and waist circumferences appropriate for children aged five years and upwards. The words for the pear-apple category (WHtR greater than 0.5) have now been extended to indicate that this value should indicate ‘take care’ or ‘consider action’ for adults, whereas for children it indicates ‘take action’. This difference is based on the proportion of children and adults who fall above this boundary value.

### Time Out 4

Consider how you will standardise the measurement of waist circumference in your workplace. Measure your nursing colleagues and consider which is the most reproducible but also the most acceptable method.

### Measuring waist circumference

There is no definitive, universally accepted site for measuring waist circumference. It is commonly measured at two different sites in children and adults. The World Health Organization (2000) recommends measurement to be taken at the ‘natural waist’, which is at the mid-point between the tenth rib (lowest rib margin) and the iliac crest. The second method, takes the measurement at the level of the umbilicus. Sometimes instructions are given to measure waist circumference at the narrowest part of the waist. If this 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.

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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 so that patients can be motivated by witnessing a reduction in their waist circumference measurement.

**Time out 5**

Reflect on how to promote the message that the measurement of waist circumference is more important than that of weight. Can you think of ways of promoting the simple message of ‘keep your waist circumference to less than half your height’ in your workplace?

Standardisation of the measurement of waist circumference will become even more important and several studies have already addressed this issue (Groeneveld et al 2007, Kagawa et al 2008). It is particularly important that this standardisation includes population groups such as older patients and the very obese.

**Conclusion**

The use of WHtR and the Ashwell® Shape Chart could be an important new public health tool that has global applicability for all adults and children over five years (Ashwell and Hsieh 2005). Further validation and adoption, particularly of the suggested boundary values of 0.3 (children) and 0.6 (adults) to indicate different action levels of risk, is urgently required NS.