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

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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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Cardiovascular diseases; Health promotion; Nutrition; Obesity

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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 (Björntop 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.

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?

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 by itself as a possible replacement for BMI.

Jean-Pierre Després and his colleagues (Després *et al* 1990, Després 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

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

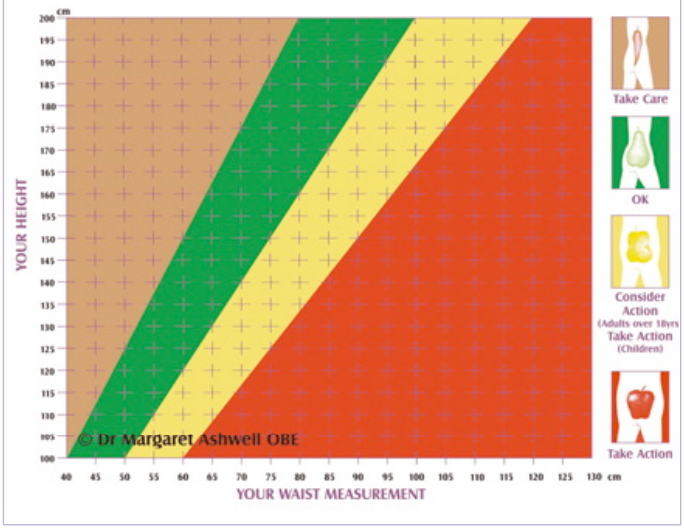
Can you think of any practices where advances in science have simplified nursing in terms of the resources needed to assess health risk? In this example the need for weighing scales can be replaced with a tape measure. Has the measure of temperature or blood pressure got more or less complicated with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

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/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 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.

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*

2003), Jamaica (Sargeant *et al* 2002), Korea (Jeong *et al* 2005), Iran (Hadaegh *et al* 2006), Germany (Bosy-Westphal *et al* 2006, Schneider 2007), Thailand (Aekplakorn *et al* 2007), Australia (Neville *et al* 2006), the US (Diaz *et al* 2007), Iraq (Mansour and Al-Jazairi 2007), Iran (Hadaegh *et al* 2006) Korea (Lee *et al* 2008b) and Brazil (Pitanga and Lessa 2006).

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 WHtR is better than BMI, waist circumference and WHpR at predicting CVD risk. Lee *et al* (2008a) have lent support to the previously proposed boundary value of WHtR of 0.5 (Hsieh 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 (Hsieh 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 (Sayeed *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 WHtR 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 WHtR may allow the same boundary value/s for health risk in children and adults. There is growing evidence that WHtR 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

Aekplakorn W, Pakpeankitwatana V, Lee CM *et al* (2007) Abdominal obesity and coronary heart disease in Thai men. *Obesity*. 15, 4, 1036-1042.

Ashwell M (1995) A new shape chart for assessing the risks of obesity. *Proceedings of the Nutrition Society*. 54, 86a.

Ashwell M (1996) Leaping into shape. *British Nutrition Foundation Nutrition Bulletin*. 21, suppl 1, 32-38.

Ashwell M, Cole TJ, Dixon AK (1985) Obesity: new insight into anthropometric classification of fat distribution shown by computed tomography. *British Medical Journal*. 290, 6483, 1692-1694.

Ashwell M, Gibson S (2009) 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. *Obesity Facts*. 2, 2.

Ashwell M, Hsieh SD (2005) 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. *International Journal of Food Sciences and Nutrition*. 56, 5, 303-307.

Ashwell M, Lejeune S, McPherson K (1996) Ratio of waist circumference to height may be better indicator of need for weight management. *British Medical Journal*. 312, 7027, 377.

Bertsias G, Mammas I, Linardakis M, Kafatos A (2003) Overweight and obesity in relation to cardiovascular disease risk factors among medical students in Crete, Greece. *BMC Public Health*. 3, 3, 3.

Björntorp P (1988) The associations between obesity, adipose tissue distribution and disease. *Acta Medica Scandinavica, Supplementum*. 723, 121-134.

Bosy-Westphal A, Geisler C, Onur S *et al* (2006) Value of body fat mass vs anthropometric obesity indices in the assessment of metabolic risk factors. *International Journal of Obesity*. 30, 3, 475-483.

Chei CL, Iso H, Yamagishi K *et al* (2008) Body fat distribution and the risk of hypertension and diabetes among Japanese men and women. *Hypertension Research*. 31, 5, 851-857.

Cox BD, Whichelow M (1996) Ratio of waist circumference to height is better predictor of death than body mass index. *British Medical Journal*. 313, 7070, 1487.

Cox BD, Whichelow MJ, Ashwell M, Prevost AT, Lejeune SR (1997) Association of anthropometric indices with elevated blood pressure in British adults. *International Journal of Obesity and Related Metabolic Disorders*. 21, 8, 674-680.

Després JP, Moorjani S, Lupien PJ, Tremblay A, Nadeau A, Bouchard C (1990) Regional distribution of body fat, plasma lipoproteins, and cardiovascular disease. *Arteriosclerosis*. 10, 4, 497-511.

Després JP (2001) Health consequences of visceral obesity. *Annals of Medicine*. 33, 8, 534-541.

Diaz VA, Mainous AG 3rd, Baker R, Carnemolla M, Majeed A (2007) How does ethnicity affect the association between obesity and diabetes? *Diabetic Medicine*. 24, 11, 1199-1204.

Freedman DS, Kahn HS, Mei Z *et al* (2007) Relation of body mass index and waist-to-height ratio to cardiovascular disease risk factors in children and adolescents: the Bogalusa Heart Study. *The American Journal of Clinical Nutrition*. 86, 1, 33-40.

Garnett SP, Baur LA, Cowell CT (2008) Waist-to-height ratio: a simple option for determining excess central adiposity in young people. *International Journal of Obesity*. 32, 6, 1028-1030.

Garrow JS (1981) *Treat Obesity Seriously – a Clinical Manual*. Churchill Livingstone, Edinburgh.

Groeneveld IF, Solomons NW, Doak CM (2007) Determination of central body fat by measuring natural waist and umbilical abdominal circumference in Guatemalan schoolchildren. *International Journal of Pediatric Obesity*. 2, 2, 114-121.

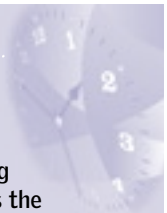
Hadaegh F, Zabetian A, Harati H,

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 (Nambiar *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 point 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.

Azizi F (2006) Waist/height ratio as a better predictor of type 2 diabetes compared to body mass index in Tehranian adult men – a 3.6-year prospective study. *Experimental and Clinical Endocrinology and Diabetes.* 114, 6, 310-315.

Han TS, van Leer EM, Seidell JC, Lean MEJ (1995) Waist circumference action levels in the identification of cardiovascular risk factors: prevalence study in a random sample. *British Medical Journal.* 311, 7017, 1401-1405.

Hara M, Saitou E, Iwata F, Okada T, Harada K (2002) Waist-to-height ratio is the best predictor of cardiovascular disease risk in Japanese schoolchildren. *Journal of Atherosclerosis and Thrombosis.* 9, 3, 127-132.

Ho SY, Lam TH, Janus ED; Hong Kong Cardiovascular Risk Factor Prevalence Study Steering Committee (2003) Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. *Annals of Epidemiology.* 13, 10, 683-691.

Hsieh S, Yoshinaga H (1999) Do people with similar waist circumference share similar health risks irrespective of height? *Tohoku Journal of Experimental Medicine.* 188, 1, 55-60.

Hsieh SD, Yoshinaga H (1995a) Abdominal fat distribution and coronary heart disease risk factors in men-waist/height ratio as a simple and useful predictor. *International Journal of Obesity and Related Metabolic Disorders.* 19, 8, 585-589.

Hsieh SD, Yoshinaga H (1995b) Waist/height ratio as a simple and useful predictor of coronary heart disease risk factors in women. *Internal Medicine.* 34, 12, 1147-1152.

Huang KC, Lin WY, Lee LT *et al* (2002) Four anthropometric indices and cardiovascular risk factors in Taiwan. *International Journal of Obesity Related Metabolic Disorders.* 26, 8, 1060-1068.

Jeong SK, Seo MW, Kim YH, Kweon SS, Nam HS (2005) Does waist indicate dyslipidemia better than BMI in Korean adult population? *Journal of Korean Medical Science.* 20, 1, 7-12.

Joshi PP (2008) Is waist to height ratio a better and more practical measure of obesity to assess cardiovascular or diabetes risk in Indians? Author reply *Journal of the Association of Physicians of India.* 56, March, 203-204.

Kagawa M, Byrne NM, Hills AP (2008) Comparison of body fat estimation using waist:height ratio using different 'waist' measurements in Australian adults. *British Journal of Nutrition.* 100, 5, 1135-1141.

Kahn HS, Imperatore G, Cheng YJ (2005) A population-based comparison of BMI percentiles and waist-to-height ratio for identifying cardiovascular risk in youth. *Journal of Pediatrics.* 146, 4, 482-488.

Khan A, Haq FU, Pervez MB *et al* (2008) Anthropometric correlates of blood pressure in normotensive Pakistani subjects. *International Journal of Cardiology.* 124, 2, 259-262.

Lee CM, Huxley RR, Wildman RP, Woodward M (2008a) Indices of abdominal obesity are better discriminators of cardiovascular risk factors than BMI: a meta-analysis. *Journal of Clinical Epidemiolgy.* 61, 7, 646-653.

Lee K, Song YM, Sung J (2008b) Which obesity indicators are better predictors of metabolic risk?: healthy twin study. *Obesity.* 16, 4, 834-840.

Lin CH, Chou CY, Lin CC, Huang CC, Liu CS, Lai SW (2007) Waist-to-height ratio is the best index of obesity in association with chronic kidney disease. *Nutrition.* 23, 11-12, 788-793.

Lin WY, Lee LT, Chen CY *et al* (2002) Optimal cut-off values for obesity: using simple anthropometric indices to predict cardiovascular risk factors in Taiwan. *International Journal of Obesity and Related Metabolic Disorders.* 26, 9, 1232-1238.

Lu M, Ye W, Adami HO, Weiderpass E (2006) Prospective study of body size and risk for stroke amongst women below age 60. *Journal of Internal Medicine.* 260, 5, 442-450.

Maffeis C, Banzato C, Talamini G;

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 0.5 (children) and 0.6 (adults) to indicate different action levels of risk, is urgently required **NS**

Time out 6

Now that you have completed the article, you might like to write a practice profile. Guidelines to help you are on page 60.

Obesity Study Group of the Italian Society of Pediatric Endocrinology and Diabetology (2008) Waist-to-height ratio, a useful index to identify high metabolic risk in overweight children. *Journal of Pediatrics* 152, 2, 207-213.

Mansour AA, Al-Jazairi MI (2007) Cut-off values for anthropometric variables that confer increased risk of type 2 diabetes mellitus and hypertension in Iraq. *Archives of Medical Research.* 38, 2, 253-258.

McCarthy HD, Ashwell M (2006) A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message – 'keep your waist circumference to less than half your height'. *International Journal of Obesity.* 30, 6, 988-992.

Nambiar S, Truby H, Abbott RA, Davies PSW (2009) Validating the waist-height ratio and developing centiles for use amongst children and adolescents. *Acta Paediatrica.* 98, 1, 148-152.

Neville KA, Cohn RJ, Steinbeck KS, Johnston K, Walker JL (2006) Hyperinsulinemia, impaired glucose tolerance, and diabetes mellitus in survivors of childhood cancer: prevalence and risk factors. *Journal of Clinical Endocrinology and Metabolism.* 91, 11, 4401-4407.

Patel S, Unwin N, Bhopal R *et al* (1999) A comparison of proxy measures of abdominal obesity in Chinese, European and South Asian adults. *Diabetic Medicine.* 16, 10, 853-860.

Pitanga FJG, Lessa I (2006) Waist-to-height ratio as a coronary risk predictor among adults. *Revista da Associacão Médica Brasileira.* 52, 3, 157-161.

Pua YH, Ong PH (2005) Anthropometric indices as screening tools for cardiovascular risk factors in Singaporean women. *Asia Pacific Journal of Clinical Nutrition.* 14, 1, 74-79.

Sargeant LA, Bennett FI, Forrester TE, Cooper RS, Wilks RJ (2002) Predicting incident diabetes in Jamaica: the role of anthropometry. *Obesity Research.* 10, 8, 792-798.

Savva SC, Tornaritis M, Savva ME *et al* (2000) Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. *International Journal of Obesity and Related Metabolic Disorders.* 24, 11, 1453-1458.

Sayeed MA, Mahtab H, Latif ZA *et al* (2003) Waist-to-height ratio is a better obesity index than body mass index and waist-to-hip ratio for predicting diabetes, hypertension and lipidemia. *Bangladesh Medical Research Council Bulletin.* 29, 1, 1-10.

Schneider HJ, Glaesmer H, Klotsche J *et al* (2007) Accuracy of anthropometric indicators of obesity to predict cardiovascular risk. *Journal of Clinical Endocrinology and Metabolism.* 92, 2, 589-594.

Seidell JC, Bakker CJ, van der Kooy K (1990) Imaging techniques for measuring adipose – tissue distribution – a comparison between computed tomography and 1.5-T magnetic resonance. *The American Journal of Clinical Nutrition.* 51, 6, 953-957.

Vague J (1956) The degree of masculine differentiation of obesities: a factor determining predisposition to diabetes, atherosclerosis, gout, and uric calculous disease. *The American Journal of Clinical Nutrition.* 4, 1, 20-34.

Weili Y, He B, Yao H *et al* (2007) Waist-to-height ratio is an accurate and easier index for evaluating obesity in children and adolescents. *Obesity*. 15, 3, 748-752.

World Health Organization (2000) *Obesity. Preventing and Managing the Global Epidemic.* Report of a WHO Consultation on Obesity, June 3-5 1997, Geneva.

Wu HY, Chen LL, Zheng J, Liao YF, Zhou M (2007) Simple anthropometric indices in relation to cardiovascular risk factors in Chinese type 2 diabetic patients. *Chinese Journal of Physiology.* 50, 3, 135-142.

Zhu S, Heymsfield SB, Toyoshima H, Wang Z, Pietrobelli A, Heshka S (2005) Race-ethnicity-specific waist circumference cutoffs for identifying cardiovascular disease risk factors. *The American Journal of Clinical Nutrition.* 81, 2, 409-415.