National Obesity Observatory

NHS

Measures of central adiposity as an indicator of obesity

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Executive summary

Obesity has long been identified as an important risk factor for a number of health problems. Body Mass Index (BMI), the most frequently used measure to determine levels of body fat, provides a proxy measure of total adiposity (the amount of fat around the body), but a number of studies have suggested that the accumulation of body fat around the waist (central or abdominal adiposity) may present a higher risk to health than fat deposited in other parts of the body.

High levels of central adiposity in adults are known to be associated with increased risk of obesity-related conditions including type 2 diabetes, hypertension and heart disease. Although measures of central adiposity are closely correlated with BMI, they have been shown to predict future ill health independently of BMI.

The best evidence to date suggests that measures of general and central adiposity should be used together in order to best identify individuals at increased risk of obesity-related ill health.

It is not clear from the research published to date what constitutes the best measure of central adiposity in terms of predicting ill health or mortality, and this may differ by age, sex, ethnicity, or by the disease being studied. Waist circumference has been most frequently investigated in the published literature and, given that this measure is more easily recorded and interpreted than alternatives such as waist-to-hip or waist-to-height ratios, this currently seems to be the most appropriate option among measures of central adiposity for most public health purposes.

The World Health Organization (WHO) has advised that an individual's relative risk of obesity-related ill health can be more accurately classified using both BMI and waist circumference than by either alone. WHO has developed a set of thresholds to categorise an individual's risk of obesity-related illness based on BMI and waist circumference. The National Institute for Health and Clinical Excellence (NICE) has also endorsed these thresholds for use in the UK. Using the WHO classification, over 50% of both men and women in England were at increased risk of obesity-related ill health, according to the Health Survey for England (HSE) 2007.

People of South Asian origin seem more prone to carrying excess fat centrally than the White population and show raised obesity-related risk at lower BMI and lower waist circumference levels. Therefore it is particularly important for South Asian populations in the UK to be aware of the health risks of increased waist circumference.

In terms of population monitoring, BMI has some advantages over measures of central adiposity. It involves less physical contact, and height and weight can be more reliably measured than waist circumference following basic training; measuring waist circumference reliably requires more extensive training. BMI is the most commonly used measure in national and international obesity prevalence statistics and so is most useful for historical trend analyses and

international comparisons. Making more use of measures of central adiposity would further our understanding of the epidemiology of obesity.

Why are we interested in measures of central adiposity?

BMI is a measure of weight (for height) rather than a measure of body fat. Excess fat, rather than excess weight, is linked to obesity-related ill health. Furthermore, BMI does not describe where fat is deposited, and as intra-abdominal fat is thought to be more likely to cause ill health than fat deposited in other parts of the body, measures such as waist circumference have some obvious advantages.

There are well documented links between high levels of central adiposity in adults, as measured by waist circumference, waist-to-height or waist-to-hip ratio, and risk of obesity-related conditions including type 2 diabetes, hypertension and heart disease. These links remain even once BMI is adjusted for, demonstrating that measures of central adiposity are independent predictors of future obesity-related ill health.

There is also an increasing body of evidence to show that such measures of central adiposity are also effective predictors of ill health for children.

What is the nature of the evidence for the use of indicators of central adiposity?

The European Prospective Investigation into Cancer and Nutrition (EPIC),[1] a large scale, prospective cohort study involving nearly 360,000 participants from nine European countries, provides some of the best evidence to date of the relationship between central adiposity and future ill health. This study concluded that both general adiposity and central adiposity are independently related to the risk of death and should be used together to identify individuals at risk of obesity-related ill health.

Waist circumference and BMI were found to be closely correlated and both show a similar and strong association with the risk of death. Waist-to-hip ratio was found to be less closely correlated with BMI, though still associated with the risk of death. Although not published in the main paper, the EPIC study also looked at waist-to-height ratio, and reported very similar findings to those found for waist circumference.[2]

The EPIC study found no independent links between hip circumference and the risk of death once adjustment was made for BMI. Hip circumference is arguably a measure of body stature rather than central adiposity and, as some published literature has shown that a larger hip circumference may be associated with health and longevity rather than ill health,[3] hip circumference has not been considered further in this paper.

The findings from the EPIC study confirm the findings of numerous earlier studies which reported strong links between measures of central adiposity and future obesity-related ill health. Some of this research suggests that measures of

central adiposity may actually be better predictors of obesity-related ill health than BMI.[4,5,6] Notably, waist circumference and waist-to-hip ratio were both found to be more strongly associated with the risk of myocardial infarction than BMI in the INTERHEART study, a retrospective case control study covering 52 countries and 27,000 subjects.[7]

Despite such evidence, these findings cannot necessarily be applied universally. The published studies that investigate measures of central adiposity vary greatly in terms of the exact demographics of the study populations as well as the outcomes examined and the methodology used. As a result, whilst links between measures of central adiposity and obesity-related ill health are undoubtedly proven, whether these measures alone can provide a superior indication of this risk than BMI is still uncertain.

The best evidence to date therefore suggests that measures of general and central adiposity should be used together in order to best identify individuals at increased risk of obesity-related ill health.

It is not clear from the available evidence which measures of central adiposity are best used as a predictor of disease risk. Waist circumference is most commonly used, and its simplicity has advantages in terms of measurement and interpretation. However waist-to-hip or waist-to-height ratios provide some adjustment for the shape of the body and appear in some studies to be superior to waist circumference at predicting future disease risk. These indices do, though, require two measurements to be taken which may result in increased measurement error and they may be more difficult than waist circumference to communicate to the general public.

Further research is needed to determine which measure(s) of central adiposity should be used to identify at risk individuals, and whether these measures are better predictors than BMI for some or all obesity-related conditions, or whether they should be used in conjunction with BMI.

How do we define increased levels of central adiposity?

A waist circumference of 94 cm or more for men and 80 cm or more for women is commonly used as an indicator of increased risk of obesity-related health problems, with 102 cm or more for men and 88 cm or more for women said to be indicative of substantially increased risk. These thresholds have been recommended by NICE for use in clinical settings and are recommended for use in other countries, including the USA and Australia. NICE also refer to a threshold for the waist-to-hip ratio of 1.0 for men and 0.85 for women,[8] above which increased risk to health is indicated.

Although these thresholds provide the best current guidelines for assessment of increased disease risk in individuals, they will need to be reassessed as new research is published. The recent EPIC study broadly supports the current thresholds for waist circumference, showing an increase in all cause mortality above a waist circumference of around 94 cm for men and 78 cm for women after adjustment for BMI. However, this study does show an increase in risk of

death above a waist-to-hip ratio of approximately 0.95 for men and 0.80 for women, and the current recommendation for waist-to-hip ratio may need to be reviewed if further evidence supports this finding.

In addition these thresholds may not be equally suitable for all populations or individuals. People of South Asian origin are more prone to carrying excess fat centrally than the White population and show raised obesity-related risk at lower BMI and lower waist circumference levels. Therefore it is particularly important for South Asian populations in the UK to be aware of the health risks of increased waist circumference. The International Diabetes Foundation (IDF) has proposed ethnicity specific threshold levels for use in the diagnosis of metabolic syndrome.[9] For adults of South Asian origin these are 90cm or more for men, and 80cm or more for women.

In light of the evidence that an individual's relative risk of developing obesity-related health problems could be more accurately classified using both BMI and waist circumference than either measure alone, the WHO have recommended the following thresholds to assess the risk of obesity-related ill health, which NICE also endorsed in their obesity guidance.

WHO classification for risk of obesity-related ill health

Classification	BMI (kg/m^2)	Waist circumference (cm)		
		Men:	94–102	> 102
		Women:	80–88	> 88
Underweight	< 18.5		No increased risk	No increased risk
Healthy weight	18.5–24.9		No increased risk	Increased risk
Overweight	25–29.9		Increased risk	High risk
Obesity	> 30		High risk	Very high risk

The risk categories proposed by the WHO are relative – i.e. individuals classed as being at 'very high risk' have a far higher risk of obesity-related ill health as compared to those classed as being at 'no increased risk'. To put this level of risk into context, the risk of ill health even for those individuals in the 'very high risk' category may still be less than that for other groups, such as heavy smokers, if all other factors are equal.

There are no evidence based thresholds for waist circumference measurements in children. As with BMI, the relationship between waist circumference and adiposity for children will change with age so it is not possible to use a fixed set of thresholds as used for adults.

A waist circumference dataset is available as part of the British 1990 Growth Reference (UK90) which can be used to grade individual children on a centile scale; however there are currently no recommended centile thresholds to grade children as being at increased risk.[10] A recent study of British children aged 5-16 suggested that a waist-to-height ratio of 0.5 or greater might prove a useful

threshold for increased disease risk for children, but this suggestion requires further validation.[11]

What is known about the trend and prevalence of increased central adiposity?

The Health Survey for England (HSE) measured waist circumference for adults in 1993-4, 1997-8 and 2001-7. Between 1993 and 2007 the proportion of the population with a raised waist circumference increased from 20% to 33% for men (waist circumference more than 102 cm) and from 26% to 41% for women (waist circumference more than 88 cm) - a rise of about three-fifths in both groups.

Over the same period the proportion of men classed as obese using BMI rose from 13% to 24%, and the proportion of women from 16% to 24% – nearly a doubling in men and an increase of a half in women.

BMI appears to have been rising more quickly for men than for women since the early 1990s. In contrast, the proportion classed as obese by waist circumference appears to have increased at a similar rate for both sexes.

The 2007 HSE reports that the proportion of the population with a raised waist circumference increased through the age groups from 16-24 to 65-74 years. However the proportion of individuals aged 75+ with a raised waist circumference was lower than that in the age group 65-74 for both men and women. A similar pattern with age was also observed among those with raised BMI.

In 2007 the HSE also published figures for the prevalence of obesity defined using the WHO categories for BMI and waist circumference combined. 19% of men were estimated to be at increased risk, 13% at high risk and 21% at very high risk. For women, 15% were at increased risk, 16% at high risk and 23% at very high risk.

From the 2007 HSE, 1% of men and 2% of women had a BMI of 18.5-24.9 kg/m² but a very high waist circumference, putting them at increased risk of obesity-related health problems despite having a normal BMI.

The HSE has measured waist circumference for young people aged 11-15 since 2005, but to date there has been no published analysis of these data. NOO is planning to undertake such work in conjunction with the Health and Social Surveys Research Group at University College London in the near future.

Substantial increases in waist circumference have been reported for boys aged 11-16 years between 1977 and 1997 and for girls of the same age between 1987 and 1997.[12] Similar increases have been reported for children aged 2-5 years between 1987 and 1997.[13] In both cases the observed increases in waist circumference were greater than the increases in BMI in the same children. This suggests that measurement of BMI alone may be underestimating the underlying rise in obesity prevalence over this period of time.

When should we use measures of central adiposity?

As recommended by the WHO and NICE, for adults in clinical settings, using both BMI and waist circumference is likely to provide a better indication of increased risk of obesity-related ill health than either measure alone.

Other measures of central adiposity may be equally good indicators of increased risk of obesity-related ill health as is waist circumference. However, there are no evidence-based thresholds to classify individuals as being at increased risk using BMI alongside the waist-to-hip and waist-to-height ratios.

The absence of readily available age specific thresholds or growth charts for children makes it difficult to use measures of central adiposity for children in a clinical context.

In terms of population monitoring, BMI has some advantages over measures of central adiposity. BMI is slightly less invasive, and height and weight can be measured with a good level of reliability with basic training. Measures of central adiposity (which often require waist and hip measurements) generally require more physical contact and require the subject to remove or lift up outer clothing, which raises challenges for population level surveillance. Hip and waist measurements also show greater degrees of intra- and interobserver[i] error and so require more extensive training to ensure accuracy of measurements. Furthermore, BMI is the most commonly used measure in national and international obesity prevalence statistics thus allowing historical trend analyses and international comparisons.

In conclusion, the use of waist circumference by clinicians, alongside BMI, is a useful contribution to their diagnostic toolkit to identify people at increased risk of obesity-related ill health. It is particularly important for South Asian populations in the UK to be aware of the health risks of increased waist circumference.

It is likely that BMI will remain the principal summary measure of obesity levels in the population for some years to come, but this may change as the evidence base for measures of central adiposity becomes more robust and as statistics that use these indices are published more frequently. Further analysis of available data on levels of central adiposity, such as HSE data, and further primary research on this subject should be encouraged.

[i] Intraobserver error refers to the differences in interpretation by an individual making observations of the same phenomenon at different times. Interobserver error refers to differences in interpretation by two or more individuals making observations of the same phenomenon.

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