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America’s waistline has been expanding now for decades\(^1\), largely as a consequence of an obesogenic environment, with a car worshipping culture and take-away lifestyle par excellence\(^2\). No upper limit to the prevalence or extent of obesity is yet apparent, and many countries and communities worldwide are busily following the American lead. Accumulating research evidence suggests that the personal and economic costs of the obesity epidemic are immense\(^3\), driven by the obesity related increases in risk for conditions such as type 2 diabetes, the metabolic syndrome, cardiovascular disease (CVD), kidney disease, arthritis, cancer, asthma and sleep disordered breathing. In addition, there are decreases in self-esteem and quality of life.

Numerous very large cohort studies have also firmly established obesity as being a strong and robust predictor of both overall and CVD mortality in men and women\(^4-8\). In most of the studies reported to date, waist circumference was not measured, with obesity measured using the body mass index (BMI), a crude measure of overall obesity, which, as multiple studies have now shown, is often not the best predictor of obesity related outcomes\(^9-11\). In this issue of Circulation, Zhang et al. expand on the already considerable evidence suggestive of a strong positive relationship between overall obesity (using BMI) and mortality, with a report from the large Nurses’ Health Study examining the impact of abdominal obesity (using waist circumference) and each of all-cause, cancer and CVD mortality in US women\(^12\). The study is well powered to examine such associations, with over 3500 deaths during the 16 years of follow-up. As noted by the authors, this is one of only a handful of studies to examine the association of waist circumference and mortality, with the others mostly showing strong associations. Two studies failed to show an association between waist circumference and mortality, but these were conducted in much older populations, which, although they may have substantial mortality, were less likely to present the
full picture of obesity related premature mortality due to the changing associations between obesity and mortality with age\textsuperscript{13, 14}.

In the present paper, the authors have demonstrated among U.S. female nurses a clear step-wise increase in risk for each of cancer, CVD and overall mortality with increasing quintiles of waist circumference or waist:hip ratio. The J-shaped curve commonly seen in appropriately adjusted studies of BMI and mortality (which results largely from increased respiratory disease death among underweight individuals and increased CVD and cancer death among the overweight and obese) was not seen in this study. This demonstrates the difference in outcomes from overall obesity as compared with abdominal adiposity. Even though the results presented here suggest a roughly linear association between waist circumference and mortality, it needs to be acknowledged that there is a limit to the recommendation that a reduced waist circumference decreases mortality risk. Diseases such as anorexia and bulimia in more affluent societies, and the chronic malnutrition still present in much of the developing world, remind us that in another context, “underweight” can and does also present an increased mortality risk.

The important debate as to which of waist circumference, waist:hip ratio and BMI is the “better” measure of obesity is probably best divided into clinical and research questions. In the busy clinical setting, the importance of this question relates to whether the time consuming burden of multiple measures of obesity is indeed justified. Various practical and scientific considerations are relevant here. Firstly, the simplicity of the message delivered by measurement of waist circumference to the individual or patient is of paramount importance. For example, who is unable to relate to the experience of a pair of jeans that is feeling a little tight, or the belt that no longer quite fits? Both the BMI and waist:hip ratio are abstract concepts in comparison. Secondly, and just as importantly, abdominal obesity is a stronger predictor of obesity related outcomes, as demonstrated once again here by Zhang et al. Thirdly, and the only practical drawback with waist circumference, is that it is not easy to obtain an accurate waist measurement, with no standardized protocol practiced, and different studies using different locations to take the measurement\textsuperscript{15}. Even with a standard protocol, clinicians will differ in the measurement of an individual’s waist. Having said this, it is also true that obtaining an accurate weight measurement is also surprisingly difficult due to inaccuracies in scales used, the time
of day and variation in the amount of clothing removed before measurement. Height measurement is also not always entirely accurate. Finally there is the question of whether the measurement of waist in addition to BMI helps to identify an additional subset of the population at increased risk? The findings from Zhang et al. clearly demonstrate that among those women classified as “normal” after measurement of BMI, the risk of mortality (and CVD mortality in particular) increases if they are also classified as obese by waist circumference. The same is true among those classified as normal by waist circumference, but obese by BMI. This would appear to suggest that in women, both BMI and waist circumference both provide important components of mortality risk.

Does this mean that measurement of both central and overall adiposity in the clinical setting is justified? On the surface, it would appear so, however to answer this question fully requires both an analysis of whether models that include both are significantly better than those that contain waist circumference alone (for example, comparing the area under the ROC curve for both models) as well as an examination of the implications in a population setting. The correlation between continuous BMI and waist variables in the Nurses’ Health Study was high, reported as 0.81 by Zhang et al. Yet, the concordance of waist and BMI in categorizing the population into normal, overweight and obesity using established cut-points is not nearly so high. In the national Australian AusDiab study, 95% of women who were classified as obese by BMI were also classified as obese by waist circumference, but conversely, only 58% of those deemed obese by waist circumference were also obese by BMI. Similarly, 85% of those classed as overweight by BMI are either overweight or obese by waist circumference, but only 63% of those overweight by waist are classified similarly or worse by BMI. The upshot of this is that even though BMI and waist are largely co-linear, someone classified as overweight, or even more particularly obese, by BMI is overwhelmingly likely to be similarly classified by waist circumference, but not vice versa. The main reason for this is that using the cut-points suggested for Europids, obesity defined using waist circumference identifies a much larger proportion of the population than does obesity defined by BMI. So even though the mortality risk may be higher in those identified as obese by both waist and BMI, in reality, measuring BMI in addition to waist will not identify a large additional population at higher risk (at least using currently recommended cut-
points\textsuperscript{18}), whereas using waist circumference alone will identify both those already identified by BMI as obese, plus a significant additional high risk population.

Summarization of all of these arguments leads to the conclusion that monitoring changes in waist size (whether or not the cut-points are taken into consideration) is as important, or even more important, than monitoring changes in weight and BMI. The findings of Zhang et al. confirm the importance of this, at least for women (analysis of similar male cohorts is therefore also required to confirm these findings for both sexes). The simple measurement of waist circumference should be strongly encouraged in the clinical setting, and also as a health promotion message to encourage prevention of the multiple obesity related outcomes such as type 2 diabetes, CVD, and also death.

An interesting and controversial facet of the relationship between obesity and mortality that was not addressed in the report of Zhang et al., is the changes in this relationship that occur with age. Obesity has different implications not only based on the degree of severity, but also on the age at which it develops. This is a reality and an issue that is seldom addressed, usually due to the absence of lifetime data, or inadequate numbers of subjects and events in order to analyze mortality by age group. Stevens et al. addressed this question in their analysis of the relationship between age, BMI and mortality in the large American Cancer Prevention Study, demonstrating that the strength of the relationship between mortality and BMI declined with age (even though it remained significant up to age 74 years)\textsuperscript{8}. This could explain the absence of an association between waist circumference and mortality seen in those two studies that only included elderly subjects\textsuperscript{13, 14}, and suggests that, while obesity needs to be recognized as an important risk factor for mortality (and other outcomes), this message needs to be particularly directed at younger populations. The heightened risk of obesity in younger populations is twofold – firstly, they have a lifetime in which the consequences of their obesity can be played out, and secondly, they have a longer time in which their adiposity can further increase. For these reasons, a push to curb childhood and adolescent obesity is of paramount importance.

A final mention of the novel findings regarding the strong relationship between central obesity and cancer mortality in the present study should be made. These results are of great importance and serve to further highlight the multi-faceted nature
of the consequences of an obesity epidemic. The multiple important messages about
the consequences of obesity present in this paper come at an opportune time, with
little evidence to date of the paradigm shift in thinking required to prevent a
worsening of the obesity-related crisis and to attack the environmental and
behavioural issues that are creating the obesogenic environment that surrounds us.


