

Invited Commentary

Ethnicity and the BMI–body fat relationship

(First published online 10 February 2009)

Obesity and its related comorbidities are becoming increasingly prevalent in most regions of the world, prompting the development of policies for the prevention of excess weight gain. Accordingly, understanding the true associations between the most commonly used measure of adiposity, BMI and body fat, and their joint association with morbidity is critical to developing informed and effective public health policies for any population. Over the past two decades, it has become clear that populations exhibit different relationships between BMI and body fat. Despite the observed differences, a recent WHO Expert Consultation decided to retain the universal BMI cut-off points of 25 kg/m² for overweight and 30 kg/m² for obesity⁽¹⁾. The report by Rush *et al.*⁽²⁾ in this issue provides further evidence that universal BMI cut-off points for overweight and obesity may not be appropriate for all ethnic groups.

Due to the ease of measurement of weight and height (and the paucity of data on directly measured body fat), BMI (weight (kg)/height² (m²)) has been adopted as the metric of choice for defining overweight and obesity^(3,4). While BMI is considered useful as a population-level measure of obesity, it has been recognised for quite a while that it does not capture the wide variation in fat distribution and it may not correspond to the same degree of adiposity or health risk across different individuals or populations⁽⁴⁾. It is generally assumed that body fat and not body mass *per se* is the important determinant of health risk⁽⁴⁾. In general, the reported associations between BMI and body fat, as expressed as a percentage of total body mass, tend to be quite robust with correlations ranging between 0.7 and 0.9^(5–7). However, ethnic groups tend to differ in the percentage of body fat at any given BMI⁽⁸⁾. While it is tempting to attribute all of the differences in this relationship to factors inherent in the specific populations (genetic backgrounds influencing body-build proportions and thereby impacting relative BMI), it is possible that environmental factors, such as variation in diet and activity, also contribute to the observed differences. The report by Rush *et al.*⁽²⁾ lends support to this idea.

The results of a WHO Expert Consultation on BMI cut-off points for use in Asian populations were published in 2004⁽¹⁾. It has been repeatedly documented that Asians of many ethnicities have higher body fat levels at any given BMI than do whites^(2,6,9–13). Asian Indians consistently exhibit the greatest deviation from whites, with up to 5% higher body fat at any BMI value^(2,9,10) as well as increased risk of type 2 diabetes and CVD at lower BMI. This is relevant because the preponderance of data used to establish BMI cut-off points for increased risk of adverse health outcomes were collected in white populations in the Europe or the

USA⁽³⁾. The application of the universal cut-off points therefore underestimates the prevalence of overweight and obesity in Asian populations. Despite this understanding, the WHO Expert Consultation recommended maintaining the existing BMI cut-off points for international classification of overweight and obesity. They did, however, suggest that BMI ≥ 23 and ≥ 27.5 kg/m² be added as points for public health action in Asian populations and noted the need for additional data.

In contrast to Asians, there is strong evidence that Pacific Island populations, specifically those of Polynesian ancestry, have lower body fat and more muscle mass than whites^(2,11,14). The physiognomic reasons for these observed differences in the BMI–body fat relationship between Asians, Pacific Islanders and Europeans are not obvious. It has been suggested that relative leanness, muscularity and leg length may contribute to the variability⁽⁹⁾. However, Rush *et al.*⁽²⁾ showed that the addition of appendicular skeletal muscle mass to the models only partially attenuated the differences, while leg length had no effect. Relatively little comparative work on this topic has been conducted among other populations. Significant differences in body fat distribution have been reported between black and white South African women; however, the BMI–body fat relationships did not differ greatly⁽¹¹⁾. The lack of black–white differences has also been observed in the USA⁽¹⁵⁾. By contrast, the BMI–body fat association was found to vary between Nigerians, Jamaicans and African Americans, with the US sample having the highest proportion of body fat of the three at any BMI⁽¹⁶⁾.

Much of the focus, to date, on the question of how to define overweight and obesity in non-European populations has been on inherent differences between ethnic groups rather than on the environmental context in which populations live. Interestingly, Rush *et al.*⁽²⁾ showed that the BMI–body fat relationship among Maori from Auckland was more similar to the Europeans than the Pacific Islanders, with whom they share a common ancestry. The dissimilarity observed between Maori and Pacific Islanders, particularly among the men, may be due in part to differential proportions of European admixture or it may possibly be due to multi-generational exposure to urban and westernised lifestyles. As described previously, differences in the BMI–body fat association have been noted among populations whose ancestors originated from West Africa⁽¹⁶⁾. Despite a similar genetic background⁽¹⁷⁾, African Americans had higher body fat at any given BMI than did Jamaicans, and both had higher levels than rural Nigerians. Additionally, in contrast to studies among Chinese adults in Singapore⁽⁹⁾ or New York⁽¹⁸⁾, it

has been reported that Chinese immigrants to Vancouver did not differ from white Canadians, nor did native Chinese in Beijing differ from the Dutch adults⁽¹⁹⁾. It is quite possible that the differences observed between studies result from different methods of assessing body composition. It may also be possible that the differences are due to unmeasured environmental effects resulting from differential migration patterns⁽²⁰⁾.

A recent review of proposed cut-off points for other measures of adiposity (waist circumference and waist-to-hip ratio) to define increased risk for chronic disease found a great deal of variability by ethnicity⁽²¹⁾. The variability in cut-off points appeared to be related to the mean waist circumference of each population examined; the lower the mean waist circumference, the lower the associated inflection point for increased risk. As populations migrate to new environments and change with regard to weight and height over generations, the relationship between BMI and body fat may also be affected. It is unclear how these potential generational changes and ethnic-specific differences in the BMI–body fat relationship influence risk of chronic diseases, particularly type 2 diabetes. Pacific Islanders and Asian Indians in New Zealand are at the opposite extremes of the BMI–body fat relationship, but both suffer from very high rates of type 2 diabetes^(22,23). It may well be that a large body size with relatively low body fat, as well as excess body fat in relatively small bodies predispose populations to diabetes. Only comprehensive studies in multiple populations in differing environments will allow this to be tested.

Although universal cut-off points for defining overweight and obesity do not allow for a nuanced understanding of the prevalences or problems associated with obesity, particularly in non-white populations, they are based on the best existing evidence. The international data available for the reassessment of the universal cut-off points are, however, limited. Rush and colleagues contribute to the present knowledge base and support for the idea of population-specific cut-off points for obesity, particularly for Asian Indians. It seems unlikely that Asian populations and Pacific Islanders are the only populations that differ from the presently accepted standards with regard to these associations. Very little comparative work has been done in African or South American populations, for example. The WHO's 2004 call for more research to be conducted in diverse populations seems quite important and necessary if the relationships between BMI, body fat and chronic disease are to be better defined. Along with measures of anthropometry and body composition, it is important to better understand both the genetic relationships between populations and the environments in which they are living.

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