Report from a Centers for Disease Control and Prevention Workshop on Use of Adult Anthropometry for Public Health and Primary Health Care[1–4]

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BACKGROUND

On 6 and 7 May 1999, a group of researchers from 10 countries met in Atlanta to contemplate the simplified use of anthropometry to assess the risk of chronic disease associated with overweight and body fat distribution in adults. Anthropometry is defined as the study of human body measurements. The meeting was sponsored by the Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention (CDC).

The researchers based their discussion on 3 recent guidelines for assessing and treating overweight and obesity in adults. These guidelines were issued, separately, by the National Institutes of Health (*NIH 1998: Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults: the Evidence Report,* available at www.nhlbi.nih.gov/guidelines), the World Health Organization *(WHO 1997: Obesity, Preventing and Managing the Global Epidemic,* available at www.who.int), and the Scottish Intercollegiate Guidelines Network (*SIGN 1996: Obesity in Scotland: Integrating Prevention with Weight Management,* available at www.sign.ac.uk).

A novel aspect of these published guidelines is the combined use of cutoff points for body mass index (BMI; in kg/m^2) and waist circumference (WC) to indicate the health risks of overweight and obesity. The NIH and SIGN guidelines use BMI cutoff points for the initial assessment of overweight and obesity and recommend WC cutoff points as an alternative or supplementary indicator of health risk. They also suggest the use of WC as a simple measure for use in health promotion and primary care. The WHO report suggests using cutoff points for BMI and WC concurrently but declares that the use of WC to assess health risk would be population specific and depends on the presence or absence of other risk factors [eg, overweight, cardiovascular disease (CVD), and type 2 diabetes]. This issue, which became most evident during the workshop, is currently under investigation.

Workshop participants noted that a BMI-based classification of overweight, with or without a waist measurement, has been well accepted by the research community, although it has not been widely adopted by primary care physicians. The major objective of this workshop was to discuss whether current measures and criteria for overweight and obesity can be used consistently and adopted widely by health promoters and primary care practitioners. Anthropometric indexes such as BMI and WC relate to important health outcomes, are easy and relatively inexpensive to measure, and are easy to monitor over time by either the individuals themselves or their health care providers.

A second objective of the workshop was to examine how the proposed cutoff points for BMI and WC would predict specific outcomes (diabetes, heart disease, and mortality) in a diverse array of populations. It is important to note that the guidelines under consideration were based on limited data; consequently, the recommended cutoff points may not apply to all populations. For instance, the cutoff points recommended for WC come from a few European cross-sectional studies of white adults aged 20–60 y.

SUMMARY OF PROSPECTIVE EPIDEMIOLOGIC STUDIES PRESENTED

Anthropometric measurements have been the subject of much epidemiologic and pathophysiologic research involving obesity, overweight, body fat distribution, and health outcomes. Several workshop participants presented results from their population-based prospective studies in which the recommended cutoff points for BMI, WC, and waist-to-hip ratio (WHR) were used to predict incidences of diabetes, CVD, myocardial infarction, and total and cause-specific mortality. These studies examined populations from North America (persons of European, African, Hispanic, Japanese, and Native American ancestry), Europe (Finland, Sweden, Netherlands, and United Kingdom, which included subjects of South-Asian ancestry), Taiwan, and the multiethnic population of Mauritius.

A formal analysis of the pooled data (meta-analysis) was beyond the objectives of the workshop; however, despite obvious

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methodologic differences between studies, some consistent observations and generalizations can be made.

Type 2 diabetes

Considerable variation was observed among ethnic groups in the absolute incidence of type 2 diabetes at similar BMIs; specifically, higher incidence rates were seen among Pima Indians, Taiwanese, and Japanese Americans. Nevertheless, linear progression in the prevalence of diabetes with increasing BMI and WC was seen in all populations, and there was no evidence that this progression was affected by age in adults. Also, independent of the age group, subjects with similar WCs had comparable incidences of type 2 diabetes within each population.

Coronary heart disease, myocardial infarction, and cardiovascular disease

Because of considerable variation in the definitions of CVD endpoints for the studies presented at the workshop, it was difficult to compare the outcomes from the various populations. Some studies reported mortality and others reported morbidity. Nevertheless, it appeared that, at least in women, the incidence of nonfatal coronary heart disease increased as both BMI and WC increased. This relation appeared to be independent of age. Data were insufficient to enable generalizations about the associations with CVD mortality.

All-cause mortality

The investigators also presented total mortality results, which showed inconsistent findings for WC and BMI. Among white European and American women, the relation with WC was a slightly positive trend; for BMI, fairly strong J- or U-shaped distributions were observed. Striking inverse associations between BMI and all-cause mortality were observed in Pima Indians. The relative contributions of different causes of death to total mortality varied greatly across ethnic groups, making direct comparisons difficult.

Other health outcomes

Type 2 diabetes, coronary heart disease, and mortality are among the most important sequelae of obesity and abdominal fatness. Other important related health conditions include musculoskeletal disorders (eg, arthritis and lower-back pain), limitations of respiratory function, and reduced physical functioning and quality of life. In very few of the prospective studies was the relation between obesity and these other conditions evaluated; however, associations were found in white US and European populations. The association between obesity and these less-studied conditions may contribute importantly to reduced productivity at work (eg, absenteeism and disability) and to a financial burden on health care. In some instances, however, the adverse consequences of these conditions may decline rapidly with weight loss. This relatively fast improvement could be a good motivator for overweight persons to prevent further weight gain or to lose weight.

CAUSAL BASIS FOR THE EPIDEMIOLOGIC ASSOCIATIONS

The commonly reported statistical association between high BMIs or WCs and poor health may reflect a direct link between overweight, body fat distribution, and disease. Alternatively, obesity (or abdominal adiposity) may indicate a cumulative exposure to environmental or lifestyle-related behavioral factors, such as socioeconomic status, stress, physical inactivity, and nutrition. Such factors may directly influence the risk of disease among genetically susceptible individuals. Whether direct or indirect, the association seems real and provides opportunities for prevention of illness through individual or community interventions. Thus, WCs or BMIs may be useful both in the clinical assessment of disease status and in serving as indicators of exposures that are amenable to preventive interventions.

It must be acknowledged that BMI and WC are highly correlated with each other, at least within the ranges typically observed in industrialized societies. Because of this close correlation, it is difficult to separate the effects that each may have on health. Individuals with high BMIs and low WCs (or vice versa) are rare in the general population. It is clear, however, that BMI and WC may reflect different etiologies and body compositions, particularly at the lower end of their distributions. Variation in BMI may represent lean or fat mass but not fat distribution, whereas variation in WC tends to reflect both total and regional (abdominal) fatness, especially in higher age ranges. More importantly, WC and BMI seem roughly equivalent as risk factors for chronic disease. Nevertheless, such equivalency has not been well studied at the extremes of WC and BMI distributions or among the oldest adults. In some circumstances, for instance, both measurements could be discrepant with body fat mass. There are subjects with a low BMI and a disproportionately high body fat mass as well as subjects with a moderately high BMI and relatively low fat mass. On the other hand, WC may have no additional value as a body fat indicator in subjects with an extremely high BMI.

Some workshop participants pointed out the possible advantages of using anthropometric ratios or alternative dimensions to WC, such as the sagittal abdominal diameter. Suggested ratios were the WHR, the waist-to-thigh ratio, the waist-to-height ratio, and the sagittal abdominal diameter-thigh ratio. The rationale for using these ratios is that the numerator reflects a combination of total and abdominal fat mass and the denominator reflects overall body size or a body tissue mass (eg, muscle) that must be accounted for. Because measurement errors may be compounded in a ratio, and because the interpretation of these ratios in pathophysiologic terms is difficult, the public health applications of these ratios might be limited. Simple measurements are more likely to be useful in public health efforts.

Unadjusted correlations between WC and stature were weak in large populations (stature explaining $<1\%$ of the variability in WC). However, in age-standardized samples, WC was moderately but significantly correlated with stature (correlation coefficient ≈ 0.2 in men and 0.1 in women). This association implies that tall people possibly are more likely (or short people less likely) to be misclassified as abdominally obese when a simple waist measurement cutoff is applied. In the age range of 20–60 y, such misclassification may be minor but certainly needs a more thorough evaluation.

IMPLICATIONS FOR PREVENTIVE EFFORTS WITHIN PRIMARY HEALTH CARE

Workshop participants argued that anthropometry provides a natural opportunity to routinely incorporate prevention into clinical management. A large proportion of the adult population sees a primary care provider (eg, a physician, a nurse, a dietitian, or another health care professional) annually or biennially. These

repetitive encounters may provide opportunities to monitor changes in weight and other anthropometric dimensions, such as WC. This way, both clinicians and patients may be able to identify or anticipate a health hazard that is possibly related to changes in weight or WC, even if the patient has not yet exceeded a threshold for overweight. Some participants voiced the need to develop protocols for the repetitive measurement of WC or BMI during routine physician-patient encounters, just as pediatricians use routine measurements to monitor the growth of children. These protocols should be evaluated for their effect on everyday clinical practice and their contribution to improving the health status of patients. These evaluations should include assessment of both immediate and long-term health benefits. Compared with more traditionally studied chronic conditions (eg, type 2 diabetes and CVD), little is known about the effect of weight management on conditions related to quality of life (eg, musculoskeletal disorders, joint problems, stress, low self-esteem, and depression), which may improve faster when weight management is successful.

It will be interesting to determine whether anthropometry can enhance the accuracy of risk equations and assist the primary care provider in making decisions involving individual patients. Relatively inexpensive measurements, such as BMI and WC, might be useful as a first step in determining health risks that can be confirmed by more complex and costly tests, such as blood analyses or physiologic challenges. For instance, healthy people could be ranked by their increasing BMIs or WCs to create a useful but crude scale of increasing insulin resistance, a known health risk for several metabolic conditions; however, using more complex tests, case by case, is the only way to measure the actual degree of insulin resistance and its complications.

Several examples of attempts to use anthropometry in public health were presented at the workshop. For example, in New Zealand and Scotland, efforts are under way to implement guidelines that incorporate anthropometry in primary health care. The initiative in Scotland was designed principally for population-based health promotion but has been used to recruit patients for weight-management programs in primary care. The New Zealand approach has the potential to integrate anthropometry into multivariate scores for estimating absolute risk, which would be of great value in clinical practice. In Finland, a multivariate approach that includes anthropometry to estimate health risk currently is being used. The public health effect of these initiatives is yet to be evaluated.

IMPLICATIONS FOR POPULATION-BASED HEALTH PROMOTION

Anthropometric indexes may be used for health promotion and primary care at 3 levels:

1) At the individual level, these measures can be promoted both for health care providers' use in clinical applications and for patients' use in self-monitoring over time. For instance, measurement of WC in addition to body weight or BMI may have the desirable effect of focusing the patient on the health benefits of a stable or reduced waistline. For this purpose, it may be necessary to agree on WC cutoff points that will trigger specific actions by individuals.
2) At the community level, simple anthropometric measurements can help identify subpopulations in which the risk of chronic disease is concentrated, allowing these individuals to benefit from targeted interventions to reduce health risks. Again, cutoff points are probably necessary to trigger actions, although the actions may not always be directed at (or adopted by) the individuals.
3) At the population level, secular trends in body measurements can be tracked to help evaluate societal and environmental changes that affect individual energy balances and to monitor the effects of large-scale prevention strategies. In either case, cutoff points may be valuable in characterizing changes and trends within the population but may be less useful for determining epidemiologic associations. For example, age-specific prevalences of high WCs or BMIs in a population can be used to assess the overall health burden associated with obesity. Subsequently, population-level interventions may be needed urgently to prevent individual weight gains beyond a certain threshold in large segments of the population, particularly among the young.

In summary, at all 3 levels it is recommended that BMI and WC thresholds be established on the the basis of the ethnic or racial background of the population and used to trigger actions that would counter excessive weight gains. Nevertheless, the widespread application of these anthropometric indexes is problematic. BMI is calculated by using a formula that may be difficult to explain to patients and even to some clinicians, although a widespread dissemination of simple and user-friendly BMI tables could help solve this problem. WC, on the other hand, can be measured in a variety of ways, but not all of them are equally reliable or suited to primary care purposes. The best ways are those that use bone landmarks as references. For example, the WHO guidelines recommend the measurement of WC at the midpoint between the lowest rib and the iliac crest (the highest point of the illium) and the third US National Health and Nutrition Examination Survey uses a point just above the right ilium on the midaxillary line.

AREAS IN WHICH APPLIED RESEARCH ON ANTHROPOMETRY IS NEEDED

Applied research on anthropometry is needed in the following areas:

1) investigations of how simple anthropometry can be used to engage individuals, health care providers, policymakers, and populations in health-promotion activities aimed at fighting obesity;
2) pooled or parallel analyses of epidemiologic data from existing studies to better describe the diverse factors [eg, ethnicity, age, and environment (local disease patterns, early exposures, and economic transition)]that may affect the relation between anthropometry and health;
3) measurements of changes over time in individuals or populations to add a dynamic (time-dependent) aspect to risk assessment;
4) in addition to assessments of the risk of traditional mortality and morbidity endpoints, assessments of the risk of other important outcomes related to quality of life (eg, back pain) that also seem related to overweight;
5) examinations of the extent to which various simple anthropometric indicators are confounded by height and the resulting effect of misclassifying individuals as obese or nonobese;
6) considerations of ethnic and racial differences when anthropometric measures are used to assess health status; and
7) incorporation of various simple anthropometric indicators into current national and community health surveys.

CONCLUSIONS

The 3 published guidelines discussed at the workshop are a good starting point for the use of simple adult anthropometry in primary care settings. The evidence presented at the workshop confirmed the cutoff points set for BMI and WC in many studied populations. However, there were strong indications that these cutoff points should be set differently for Asian populations or persons of Asian ancestry living in Western countries. The health risks in these populations already seem elevated at low BMIs or WCs. Efforts are currently under way to evaluate specific cutoff points for some Asian populations and a report was issued recently (*The Asia-Pacific Perspective: Redefining Obesity and Its Treatment*, available at www.idi.org.au or www.iotf.org).

For anthropometry to be of maximum value in public health promotions, body measurements must be well standardized. Height and weight already are 2 fairly well-standardized measures, but there is not yet agreement on a bone landmark to make the measurement of WC highly reliable and reproducible. The issue of establishing a single, universal bone landmark for measuring WC must be resolved.

Despite the unresolved issues, workshop participants considered BMI and WC to be appropriate anthropometric indicators of health risk in the sense that they are relatively easy to use, discriminate reasonably between low- and high-risk individuals, and are well-known to the research community. Participants also noted that BMI is gaining acceptance by the mass media. For its potentially important role in health promotion and primary health care activities, WC should be adopted as a valuable tool for assessing the health risks of overweight, provided that appropriate cutoff points are established. WC is relatively easy to measure, requires only a tape, assesses health risks related to both total and regional fat, and conveys a concept of obesity that is easy to understand.

The data presented at the workshop showed that BMI and WC appear to be useful in assessing the risk of type 2 diabetes and other conditions associated with insulin resistance, such as dyslipidemias, in all populations examined. Their associations with clinical cardiovascular disease and total and cause-specific mortality were less conclusive. This is not surprising given the different definitions of CVD used in the studies and the heterogeneity of causes of death across populations. In addition, the value of these 2 anthropometric indexes for the assessment of the risk of other weight-related conditions (including arthritis, back pain, shortness of breath, and functional disabilities) should be evaluated thoroughly.

In short, the assessment of health risks by using anthropometry is a well-established and time-honored concept in the scientific literature. In recent years, anthropometric indicators such as BMI and WC were repeatedly shown to be simple yet powerful predictors of common adult chronic conditions in all populations studied. This report calls for the next step: to vigorously promote and monitor the widespread use of these health indicators in routine primary care and public health activities. This step will require additional input from the scientific community, not only to fill knowledge gaps like the ones pointed out in this report but also to help in the implementation and evaluation of such a large-scale application of anthropometry.

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