# Identification of Obesity: Waistlines or Weight?

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*Background.* Obesity can be divided into "general" and "central." Since abnormal glucose and lipid metabolism are more strongly associated with central obesity, it may not be adequate to use a general measure, such as a weight-for-height index, to assess for obesity. An index of central obesity, such as the waist-to-hip ratio, might be more appropriate.

*Methods.* Nurses measured height and weight for the body mass index (BMI=kilograms of mass divided by the square of the height in meters) and girths for the waist-to-hip ratio (WHR) in 414 patients aged 45 years and over. Patients completed an obesity-related questionnaire.

*Results.* Fifty-seven percent of patients had an elevated BMI. Fifty percent of men (95% confidence interval [CI], 46 to 55) and 78% of women (95% CI, 75 to 80) had central obesity based on elevated WHRs. Using an elevated WHR as the standard for central obesity, elevated BMI had a positive predictive value of only 64% and a negative predictive value of 68% in men. For women, the corresponding positive and negative predictive values were 84% and 31%, respectively.

*Conclusions.* The data indicate that the practice of using only scales to identify "overweight" patients should be reevaluated since doing so will miss patients at risk. In primary care patients, particularly those 50 years of age and over, weight-for-height indices such as the BMI result in underdiagnosis of central obesity.

*Key words.* Obesity; body constitution; family practice; primary health care. ( *J Fam Pract 1995; 41:357-363*)

One third to one half of all adults in the United States over age 45 have some degree of excess body fat.[1,2] This high prevalence of obesity, coupled with its causative contribution to a variety of serious chronic diseases, creates a major public health problem.[3,4] Proposed solutions to the obesity problem include increased primary care physician detection of obesity,[5] more patient education regarding the benefits of a healthier lifestyle,[6] and practical advice on how to consume a lower fat diet and increase daily physical activity.[7-10]

Physicians are familiar with the process of quantifying excessive body weight by referring to standard tables of desirable weights for height and sex, or using a weight-for-height index.[11-13] However, a growing body of literature indicates that abnormal glucose levels and lipid metabolism are more strongly associated with abdominal adipose tissue than with fat located on the periphery of the body.[14-18]

In 1956, Vague[14] hypothesized that the deleterious consequences of obesity, such as diabetes, atherosclerosis, gout, and uric-calculous disease, are more closely associated with excess abdominal adipose tissue, ie, android fat pattern, than with the overall level of body fat, ie gynoid fat pattern. More recent reports support Vague's position that abdominal adipose tissue is more metabolically active than fat tissue located elsewhere.[15-18]

Ostlund et al[17] found a strong inverse relationship between $HDL_2$ (high-density lipoprotein cholesterol

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subfraction two) levels and the waist-to-hip ratio (WHR) in healthy community volunteers aged 60 to 70 years. In addition to WHR, $HDL_2$ levels were related to plasma insulin levels and degree of glucose intolerance but were not related to body mass index (BMI) or total percentage of body fat. These results are consistent with the clinical concept of Syndome X, a common constellation of findings including "hyperinsulinemia, insulin resistence, decreased glucose tolerance, Type II diabetes mellitus, decreased HDL cholesterol, hypertriglyceridemia, and trucal obesity."[17(p233)]

A review by Egger[18] lists 19 epidemiologic studies published between 1983 and 1991 that link elevated WHRs to diabetes, cardiac events, high blood pressure, elevated lipids, stroke, or gallbladder disease. In 1993, Folsom et al[19] described their 5-year prospective study of body fat distributions and mortality in 41,837 women aged 55 to 69 years. The authors conclude that the waist-to-hip ratio is a better predictor of subsequent mortality than a weight-for-height index (ie, BMI), and that the WHR "should be measured as part of routine surveillance and risk monitoring in medical practice."[19(p483)]

There are no reports in the family practice literature describing the correspondence between general weight-for-height measures such as the BMI and central obesity measures such as the WHR. Does continued reliance on general weight-for-height measurements result in the inaccurate diagnosis of central obesity in some patients?

Both traditional and newer health education efforts assume that new patient knowledge is a prerequisite for behavioral change.[20–22] However, we lack good data on the level of patient knowledge regarding the fat and fiber content of foods.[20] Are obese and lean patients equally adept at identifying lower fat, higher fiber food groups?[23–25] Would additional dietary information help obese patients make better food choices? If obese patients actually have trouble identifying lower fat and higher fiber food groups, additional patient counseling should be focused on this issue.

The purpose of the study was to describe the prevalence of general and central obesity in our middle-aged and older family practice patients; to compare general and central obesity measurements to determine whether the general obesity measurements are adequate for identifying patients with excess central adipose tissue; and to contrast the dietary knowledge of lean and obese patients.

## Methods

The research design was a cross-sectional study of consecutive age-eligible outpatients seen between January 1 and April 20, 1993, at two community hospital-based, medical school-affiliated, family practice centers in Akron, Ohio. Because obesity and related conditions, such as hypertension, type II diabetes, and hyperlipidemia, are more prevalent among middle-aged and older adults, the target population for this study was limited to patients 45 years of age and older.

During the study period, 972 age-eligible patients were seen at the two centers. Anthropometric and questionnaire data were collected from 414 patients. Not all age-eligible patients were given the opportunity to participate in the study because our recruiters were not able to cover all of the half-days that patients were seen at the two centers. A comparison of the sex and age distributions from the study sample with those from the target population of all age-eligible patients revealed no important differences in demographic characteristics. Thus, it is unlikely that our study data are distorted by selection bias.[26]

### *Data Collection*

After reading a statement describing the research, participating patients completed a questionnaire, and nurses took anthropometic measurements according to a standardized protocol.

Anthropometric data included height, weight, waist girth, and hip girth. Weight was measured to the nearest 0.5 lb by calibrated office scales , and height was measured to the nearest 0.5 in. by a wall-mounted stadiometer. Waist girth was defined as the smallest circumference (nearest 0.1 centimeter) between the rib cage and the iliac crests.[17] Hip girth was defined as the largest circumference between the waist and the thigh.[17] BMI ($kg/m^2$) was used to quantify general obesity, while central obesity was assessed according to WHR.[15–19]

Patients with an elevated BMI were identified by using the *Healthy People 2000* cutpoints.[1,3] Specifically, male patients with BMIs greater than 27.8 $kg/m^2$ were presumed to have some degree of general obesity; similarly, female patients with BMIs greater than 27.3 $kg/m^2$ were placed in the elevated BMI group.[1] Total mortality from all causes is lowest for white men and women with BMIs between 23 and 25 $kg/m^2$.[27]

Patients with an elevated waist-to-hip ratio were identified by using the WHR cutpoints for men and women suggested by Bray.[28] Specifically, male patients with WHRs greater than 0.950 were presumed to have some degree of central obesity, as were female patients with WHRs greater than 0.800.[28] Elevated WHRs have also been associated with increased mortality in both men and women.[19,29]

## *Patient Questionnaire*

The questionnaire included six demographic items; a 15-item food group checklist; 12 items related to beliefs about diet, exercise, and obesity; a 7-item cardiovascular disease history checklist; a 9-item medication/tobacco history checklist, four weight-loss history items, and two family-support items. Responses to the 15 food-group items were summed to create a food group selection score (FSCORE). Positive FSCOREs indicate recognition of a lower fat, higher complex carbohydrate, higher fiber diet.[7]

We developed the food group items specifically for this study because no short published scales addressed the constructs we wanted to measure, ie, general patient knowledge regarding the relationship between weight loss and lower fat, higher complex carbohydrate, higher fiber diets.[20] Patients were asked to indicate whether they should eat more or less of each nontraditional food group to "lose weight and keep it off." The food groups were the following: fresh fruit; restaurant food; green and yellow vegtables; beer/wine; whole-wheat bread; cakes/pies/cookies/ice cream; red meat/fried chicken; baked fish/chicken; rice/macaroni/spaghetti; regular soft drinks/soda pop; soft cheese/whole milk/butter/eggs; higher fiber cereals (eg, oatmeal); skim milk/low fat cheese/yogurt; beans/lentils/peas; and fast food/junk food.

## *Data Verification, Coding, and Analysis*

Most analyses were stratified by patient sex because of recognized differences between the two in adipose tissue type and distribution.[14,18] In some of the analyses, the sample sizes vary because of missing data. The random error associated with comparisons between proportions was evaluated by means of chi-square tests. The random error around single proportions was quantified by calculating 95% confidence intervals (CI) with an approximate binomial algorithm.[30] Mean food group scores between study groups were compared with one-way analysis of variance. Social class codes were assigned to patients based on a procedure that uses occupational information when it was available, and educational data for respondents not in the labor force.[31] All data were double-keyed and subjected to edit checks before statistical analysis using Epi Info, Version 5 (USD, Incorporated, Stone Mountain, Georgia) and SAS/STAT User's Guide, Version 6 (SAS Institute Inc, Cary, North Carolina).

# Results

## *Patient Characteristics*

Patient demographics, medical histories, and current medications by sex are presented in the Table. Approximately 75% of the study patients were in the following three age groups: 50 to 59, 60 to 69, and 70 to 79. Slightly more than 20% of patients were black, and approximately one third of all study patients had less than a high school education. Examination of the social class distribution revealed that three fourths (76.4%) of the female patients and more than one half (59.2%) of male patients were in the lower middle or working-poor social classes (degree of freedom [*df*] 4, chi-square test $P<.001$). A typical distribution [32] of chronic diseases and medications was observed: a higher proportion of men reported a positive history of "blocked vessels to the heart" ($P=.009$) or a heart attack ($P=.001$), whereas a higher proportion of women reported the use of other noncardiovascular medications ($P<.02$).

Table. Characteristics of the Patient Sample by Sex

| Patient Characteristic | Women, % (n=284) | Men, % (n=130) |
|---|---|---|
| Age Group, y | | |
| 45–49* | 20.8 | 18.5 |
| 50–59 | 26.4 | 23.8 |
| 60–69 | 25.0 | 26.2 |
| 70–79 | 21.8 | 26.2 |
| ≥80 | 6.0 | 5.4 |
| Race | | |
| White | 74.6 | 75.4 |
| Black | 22.2 | 21.5 |
| Other | 3.2 | 3.1 |
| Education | | |
| Less than high school | 34.5 | 28.5 |
| High school | 38.0 | 40.8 |
| Beyond high school | 27.5 | 30.8 |
| Medical history† | | |
| High blood pressure | 56.7 | 60.0 |
| Diabetes | 16.5 | 23.1 |
| High cholesterol | 39.8 | 37.7 |
| Coronary artery disease | 8.8‡ | 17.7 |
| Other heart disease | 10.6 | 11.5 |
| Heart attack | 5.3§ | 15.4 |
| Stroke | 2.8 | 1.5 |
| Current medication type† | | |
| High blood pressure | 48.6 | 51.5 |
| Heart disease | 13.0 | 18.5 |
| High cholesterol | 10.2 | 6.9 |
| Diabetes | 15.1 | 17.7 |
| Other | 39.1¶ | 26.9 |
| Cigarette smoker | 21.1 | 16.9 |

**Two patients in the age range 40 to 44 years were included in the analyses to avoid a small loss of statistical power.*
*†Some patients had more than one medical condition and were being treated with more than one medication.*
‡$\chi^2=6.9$ (df=1), P=.009.
§$\chi^2=11.8$ (df=1), P=.001.
¶$\chi^2=5.8$ (df=1), P<.02.

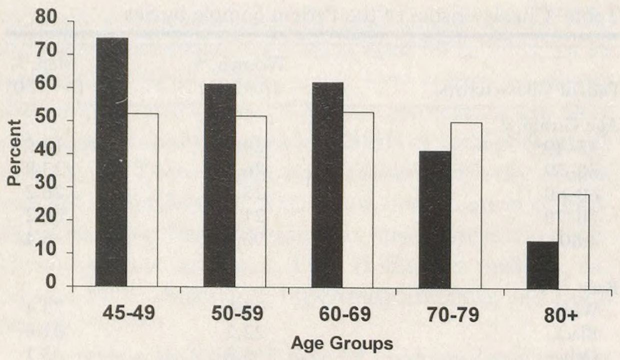


Figure 1. Frequency of elevated body mass index and waist-to-hip ratios by age group for men. Solid black bars indicate body mass index; white bars, waist-to-hip ratio.

## *The Prevalence of Obesity*

More than one half of all study patients had some excess peripheral or central adipose tissue: 56.2% (95% CI, 52 to 61) of the 130 male patients and 57.6% (95% CI, 55 to 61) of the 283 female patients had elevated BMIs. Overall, 50.4% (95% CI, 46 to 55) of men (n=129) and 77.7% (95% CI, 75 to 80) of women (n=283) had elevated WHRs.

Figure 1 shows the frequency of elevated BMIs and WHRs by 10-year age group for men; Figure 2 shows the corresponding information for women. Statistical tests supported a linear *decrease* in general obesity (elevated BMI) over age groups in both men ($\chi^2$ for trend=10.3; $P$=.001) and women ($\chi^2$ for trend, 3.9; $P$=.05). In contrast, the trend test supported a linear *increase* in central obesity (elevated WHRs) over age groups among women ($\chi^2$=13.4; $P$=.003). This was not found in men ($\chi^2$=0.4; $P$>.05). These data are consistent with the proposition that BMIs and WHRs measure different types of adipose tissue.

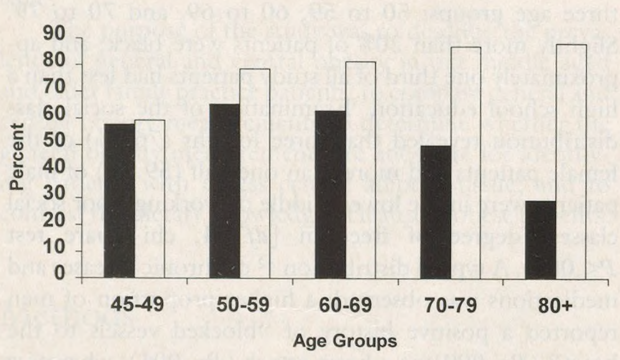


Figure 2. Frequency of elevated body mass index and waist-to-hip ratios by age group for women. Solid black bars indicate body mass index; white bars, waist-to-hip ratio.-

## *General and Central Obesity Compared*

Assuming that an elevated WHR is the "gold standard" for the presence of excess central adipose tissue, is a general weight for height measurement, such as the BMI, sufficiently sensitive and specific to diagnose and follow central obesity in family practice settings? Among study men (n=129), an elevated BMI had a sensitivity of 72.3%, specificity of 59.4% for excess central adipose tissue. Given the underlying prevalence (50.4%) of elevated WHRs, the positive and negative predictive values were 64.4% and 67.9%, respectively. Among study women (n=282), an elevated BMI had a sensitivity of 62.1%, a specificity of 58.7%, a positive predictive value of 84.0%, and a negative predictive value of 30.8%. The low negative predictive value among women (95% CI, 27 to 35) is a reflection of both the high underlying prevalence (77.7%) of elevated WHRs, and the lower sensitivity of an elevated BMI. The discrepancy between elevated WHRs and BMIs is especially apparent among older women who have lower BMIs but elevated WHRs (Figure 2).

A detailed comparison of elevated BMIs and WHRs in each sucessive age group (2 × 2 × 5) for all patients revealed total misclassification errors ([true positives + false positives]/[size of age group]) of 42.7%, 34.9%, 36.9%, 33.3%, and 45.8%. More interesting was the result that the ratio of false-negative to false-positive observations in sucessive age groups increased remarkably. The false-negative:false-positive ratios were 15:20, 22:15, 24:14, 29:3, and 11:0; ie, relying on elevated BMIs to identify patients with elevated WHRs produces a greater number of false negatives and fewer false positives when the "diagnostic test" is applied to sucessively older patients. Among the oldest patients (≥80 years), all of the misclassification errors were false negatives.

## *Patients Identify the Best Diet*

Study patients were adept at identifying "the best diet to lose weight and keep it off." For 11 of the 15 food group items, the percentage of patients indicating the nutritionally correct response was greater than 90%. The four items with lower endorsements were (more) rice/macaroni/spaghetti (52.7%; 95% CI, 50 to 55); (more) beans/lentils/peas (82.4%; 95% CI, 80 to 84); (less) soft cheese/whole milk/butter/eggs (86.5%; 95% CI, 85 to 88); and (more) whole-wheat bread (89.1%; 95% CI, 88 to 91).

## *Food Group Scores and Obesity*

We examined the relationship between mean FSCOREs and obesity measured by elevated BMIs or WHRs. There was no statistical relationship between mean food group selection scores and the obesity groups, ie, our lean and obese family practice patients appeared to be equally adept at identifying the lower fat, higher fiber food groups that are recommended to help manage obesity.[7,13,24,25]

## Discussion

In a sample of family practice patients 45 years of age and older, the prevalence of general and central obesity was quite high: 70% of men and 87% of women had either elevated BMIs, elevated WHRs, or both. Elevated BMIs were *less frequent* among both older men and older women, whereas elevated WHRs were *more frequent* among older women. Using an elevated WHR as the gold standard for central obesity, an elevated BMI had a sensitivity of 72% in men (95% CI, 66 to 78) and 62% in women (95% CI, 59 to 65). In the subgroup of women aged 70 years and older, the sensitivity of an elevated BMI plummeted to 52% (95% CI, 46 to 59). Thus, stratifying the study data by sex and age group revealed that elevated BMIs and WHRs were particularly discordant among older women. Finally, neither general obesity nor central obesity was associated with food group selection.

### *Obesity in Middle-Aged and Older Persons*

A higher prevalence of central obesity, ie, elevated WHRs, among older female primary care patients is consistent with the reported increase in median WHR in each successive age-decade through to the age of 69 in the general population.[28] The absence of a corresponding central obesity trend in male patients may be a result of either the smaller male sample size or a selection process that filters older men with elevated WHRs out of the primary care setting. White et al[33] have shown how differential referral to subspeciality medicine, eg, cardiology, differential male reluctance to seek primary care, or differential male mortality could produce contrasting epidemiologic profiles in primary care patients and the general population.

In the general US population, the relationship between elevated BMIs and age varies by sex and ethnic group.[1] Among white women, the prevalence of elevated BMIs increases with age and peaks around age 59. Among black men, the prevalence of elevated BMIs does not change very much over age groups.[1] However, among white men and black women, there is a step-wise increase in the prevalence of elevated BMIs that starts in young adulthood and continues through old age.[1] The relatively early decline in elevated BMIs, which begins in the 50- to 59-year-old group and was seen in our male patients, may reflect the selection processes that differentiate primary care from general population samples.[33] Additional descriptive information from other family practice sites could help resolve these issues.

### *Which Anthropometric Measurement?*

The study data indicate that the practice of using indicators of general obesity to identify "overweight" patients should be reevaluated. In primary care patients, particularly those 50 years of age and older, weight-for-height indices such as the BMI result in the underdiagnosis of central obesity. Relying on elevated BMIs to identify patients with elevated WHRs produces a greater number of false negatives and fewer false positives when the "diagnostic test" is applied to sucessively older patients. Because of the high prevalence of central obesity in middle-aged and older women, the positive predictive value of an elevated BMI in women is excellent (84%). However, among the oldest women (≥70 years) the concordance between elevated BMIs and WHRs breaks down, resulting in a negative predictive value of 23% (95% CI, 17 to 31). Among men, where the prevalence of elevated WHRs is lower (50%), the positive predictive value of an elevated BMI is less impressive (64%), but the gain in diagnostic information is slightly larger (14% among men vs 6% among women).

### *Patient Knowledge and Obesity*

On average, our patients had very little difficulty identifying the lower fat, higher complex carbohydrate, higher fiber diet that is recommended to help people lose weight and keep it off.[7,13] Moreover, obese and lean patients had the same food group selection scores. These empirical observations support the proposition that when dealing with obese patients, the provision of general dietary information is probably less useful than specific advice or problem-solving tailored to their current behavior and beliefs.[22] At the very least, our data indicate that there are large groups of obese family practice patients who do not need any more general dietary information about lower fat–higher fiber food groups. Specific dietary information tailored to the patient's lifestyle and stage of behavior change may be more useful.[9–10,22,34]

### *Caveats*

Conclusions drawn from our data should be qualified by the recognition that cross-sectional studies of patient volunteers may give distorted impressions of the target population of all age-eligible patients. However, comparison of available demographic information from the study sample to the target population suggested that the sample is representative of all age-eligible patients. Imperfect measurements are another potential threat to the internal validity of any clinical study. Our food group selection items were designed to measure specific constructs, but no gold standards were available to assess the true accuracy of the summary scores.[20] We did find an inverse relationship between the food group scores and patient education or social class that supports the construct validity of the summary scores. Empirical relationships between elevated BMIs, WHRs, and an index of visceral obesity support the construct validity of these measurements.[35]

### *Generalizability*

Gilchrist et al[36] recently combined visit data from seven community hospital-based, medical school–affiliated family practice residency sites, including the two centers from which our study patients were recruited. The authors compared the pooled family practice residency sample with a national sample of family and general practice office visits. The authors reported no important differences between the pooled residency visits and the national sample. These data suggest that the results from the current study are meaningful for other family physicians.

## Conclusions

These data indicate that the identification of central obesity will be improved when WHR measurements are included in routine primary care assessments, particularly those for older women. The marginal costs of adding an WHR measurement to one or two office visits per year for all adult patients with conditions related to central obesity, such as hypertension, diabetes, and hyperlipidemia, may be acceptably low. However, we do not know whether increased physician and patient awareness of the patient's current WHR and the recommended WHR cutpoints would improve the management of obesity and related chronic diseases over the long term.

Because 80.0% of our male patients and 77.3% of our female patients with elevated WHRs also had hypertension, diabetes, or elevated blood cholesterol, it may be helpful to integrate systematic obesity management into care for these obesity-related chronic problems. Both patients and family physicians are familiar with the periodic follow-up required to manage hypertension and diabetes. We believe that approaching obesity as a chronic disease and focusing on exercise and dietary problem-solving can assist patients who are attempting to reach their nutritional and activity goals.[34,37] Physicians may also increase their likelihood of reimbursement by integrating obesity management with standard care for hypertension, diabetes, and hyperlipidemia.

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