Body mass index and obesity-related metabolic disorders in Taiwanese and US whites and blacks: implications for definitions of overweight and obesity for Asians[1–3]

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ABSTRACT

Background: Recommendations based on scanty data have been made to lower the body mass index (BMI; in kg/m^2) cutoff for obesity in Asians.

Objective: The goal was to compare relations between BMI and metabolic comorbidity among Asians and US whites and blacks.

Methods: We compared the prevalence rate, sensitivity, specificity, predictive values, and impact fraction of comorbidities at each BMI level and the BMI-comorbidity relations across ethnic groups by using data from the third National Health and Nutrition Examination Survey and the Nutrition and Health Survey in Taiwan (1993–1996).

Results: For most BMI values, the prevalences of hypertension, diabetes, and hyperuricemia were higher for Taiwanese than for US whites. In addition, increments of BMI corresponded to higher odds ratios in Taiwanese than in US whites for hypertriglyceridemia ($P = 0.01$) and hypertension ($P = 0.075$). BMI-comorbidity relations were stronger in Taiwanese than in US blacks for all comorbidities studied. BMIs of 22.5, 26, and 27.5 were the cutoffs with the highest sum of positive and negative predictive value for Taiwanese, US white, and US black men, respectively. The same order was observed for women. For BMIs >27, >85% of Taiwanese, 66% of whites, and 55% of blacks had at least one of the studied comorbidities. However, a cutoff close to the median of the studied population was often found by maximizing sensitivity and specificity. Reducing BMI from >25 to <25 in persons in the United States could eliminate 13% of the obesity comorbidity studied. The corresponding cutoff in Taiwan is slightly <24.

Conclusion: These data suggest a possible need to set lower BMI cutoffs for Asians, but where to draw the line is a complex issue. *Am J Clin Nutr* 2004;79:31–9.

KEY WORDS BMI, definitions, obesity, overweight, ethnicity, Asians, diabetes mellitus, hypertension, hyperuricemia, dyslipidemia

INTRODUCTION

Obesity has become an increasing public health problem internationally (1). Attention has been given to the adverse health consequences of a moderate increase in body mass index (BMI) in different ethnic groups (2). For example, it was suggested that a moderate increase in BMI makes South Asians more prone to insulin resistance and related diseases (3–7).

In early 1999, a recommendation was made to set criteria for Asians defining overweight as a BMI (in kg/m^2) of ≥23 and obesity as a BMI of ≥ 25 on the basis of the scanty data for Asians (8) that were available at that time. Taiwan recently adopted BMIs of 24 and 27 as the cutoffs for overweight and obesity, respectively. Whether to have separate definitions of overweight and obesity for minorities in multiethnic countries such as the United States is a related and even more complicated issue. Comparative studies are needed to delineate the differences in BMI-disease relations between minority race ethnic groups and whites, because the World Health Organization definitions for overweight and obesity were established by using data primarily from whites. In particular, the rationales and the implications for selecting BMI cutoffs to define overweight and obesity for nonwhite populations should be carefully laid out.

The objective of the present study was to compare the relation of BMI to several obesity-related metabolic disorders in different ethnic groups. The data for Taiwanese Asians came from the Nutrition and Health Survey in Taiwan (NAHSIT), which was carried out during 1993–1996 (9). The data for US non-Hispanic whites and non-Hispanic blacks came from the third National Health and Nutrition Examination Survey (NHANES III), which was carried out in the United States during 1988–1994. Issues on how to define overweight and obesity for Asians and across ethnic groups were examined by using information on the relative risk, sensitivity, specificity, predictive values, and impact fraction for the selected metabolic disorders at different BMI cutoffs.

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SUBJECTS AND METHODS

Nutrition and Health Survey in Taiwan, 1993–1996

NAHSIT was an island-wide survey in Taiwan of noninstitutionalized residents aged ≥4 y selected through a multistage, complex sampling design. Details on the design and operation of the survey have been published elsewhere (9). A sample of 9961 participants was obtained through door-to-door interviews, which corresponds to a 74% response rate. Of these, 4956 were adults aged ≥20 y, of whom 52.2% (2585) had complete clinical data of interest for this study. Blood pressure was measured by trained technicians using standard sphygmomanometers at each participant's home after the participant had rested for ≥5 min. An appropriately sized cuff was used for each participant. Two blood pressure measurements were made 30 s apart with the arm at the level of the heart. If the 2 measurements were >10 mm Hg apart, a third measurement was made. The 2 closest blood pressure values were averaged to obtain mean blood pressure. Other clinical data were obtained from a physical examination carried out in temporary clinics set up in the neighborhood of the survey sites.

Anthropometric measurements were carried out after the subjects had removed their shoes and heavy clothes. The subjects were asked to wear an examination gown if their apparel was not appropriate for taking measurements. Body weight was measured to the nearest 0.1 kg, and body height was measured to the nearest 1 mm. BMI was calculated from measured weight and height as weight (kg)/height (m^2). Fasting whole blood glucose was measured immediately after the blood drawing by the glucose oxidase method with use of a glucose analyzer (model 23A; YSI, Yellow Springs, OH) in blood samples collected into sodium fluoride tubes. Fasting serum uric acid, triacylglycerol, and cholesterol values were measured with a Hitachi 747 analyzer (Hitachi, Tokyo) within 1 mo of the blood draw in collaboration with the clinical chemistry laboratory of the affiliated hospital of National Taiwan University Medical School.

Third National Health and Nutrition Examination Survey

NHANES III (1988–1994) is the seventh in a series of health examination surveys conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention. With the use of a complex, multistage sampling design, the survey aimed to provide estimates of the health and nutritional status of the civilian noninstitutionalized population of the United States aged ≥2 mo. Details of the survey design and questionnaires are published in the NHANES III *Plan and Operation* reference manual (10). A complete description of the survey and laboratory procedures is also available (11). In this articles, the terms *white* and *black* will be used to refer to non-Hispanic whites and non-Hispanic blacks, respectively.

Definitions for selected metabolic disorders

The same definitions were applied to data collected at baseline in both surveys. Hypertension was defined as use of an antihypertensive medication, having a systolic blood pressure ≥140 mm Hg, or having a diastolic blood pressure ≥90 mm Hg. Diabetes mellitus was defined as use of insulin or hypoglycemic agents, having a fasting plasma glucose concentration ≥7.0 mmol/L (NHANES III), or having a fasting whole blood glucose concentration ≥6.1 mmol/L (NAHSIT) (12). Hypercholesterolemia was defined as use of cholesterol-lowering medication or having a serum cholesterol concentration ≥6.21 mmol/L. Hypertriglyceridemia was defined as a serum triacylglycerol concentration ≥2.26 mmol/L. Hyperuricemia was defined as a serum uric acid concentration ≥392.6 μmol/L (women) or ≥458 μmol/L (men).

Statistical analysis

All analyses were carried out with SUDAAN version 7.5 (Research Triangle Institute, Research Triangle Park, NC), which was used to account for the effect of the complex sampling design in statistical testing and in deriving means and SEs. Missing values were handled separately in the analysis for each metabolic disorder. The sample sizes are listed in **Table 1**. For comparison across populations by BMI, the survey respondents were grouped into 6 BMI categories: 16–19.9, 20–21.9, 22–23.9, 24–25.9, 26–29.9, and 30–39.9; BMI values <16 or ≥40 were excluded. For other analyses, all BMI data were included. In comparing the prevalence of hypertension, diabetes, hyperuricemia, and dyslipidemia between populations, the data were standardized by age and sex to the 1980 US population, and design effect–adjusted SEs were computed. Two-sample *t* tests were then used to compare the rates either for overall comparison or for comparison at each BMI group. In comparing the distribution of age, sex, and BMI across populations, a chi-square test was used. *P* values ≤ 0.05 were used to indicate statistical significance in general, but a Bonferroni-corrected *P* value of 0.017 was used for the situation of 3 pairwise multiple comparisons.

Logistic regression was used to compare the prevalence rate ratios (odds ratios) per increment of BMI for each comorbidity outcome across racial groups. NHANES and NAHSIT data were pooled in the analysis, with race, sex, age, BMI, and BMI × race as the independent variables. We assumed that all primary sampling units were "sampled without replacement." However, the primary sampling units of NHANES were sampled with replacement. We therefore made the selection probability of the NHANES primary sampling units <0.05 to mimic the original sampling process.

Sensitivity, specificity, and positive and negative predictive values (13) relative to each of the selected conditions (hypertension, diabetes, hypercholesterolemia, hypertriglyceridemia, and hyperuricemia) were calculated every one-half unit of BMI from 20 to 30. A *t* test was used to compare the difference in predictive values as described previously.

The impact fraction was calculated by using data on the BMI distribution and on the risk ratios for each population. Logistic regression models that included linear and quadratic terms for BMI as a continuous variable were used to generate monotonic risk ratio estimates. The impact fraction (14, 15) for a selected cutoff was calculated as the excess prevalence of the condition associated with BMIs greater than the selected cutoff divided by the total prevalence of the condition. This is an estimate of the fraction of cases that could be removed if persons with BMI values above the cutoff were shifted to below the cutoff. In the impact fraction calculation, a subject was considered as a case if he or she had one or more of the selected metabolic conditions. In calculating sensitivity, specificity, predictive

TABLE 1
Sample size and weighted proportions of selected characteristics for Taiwanese, US whites, and US blacks[1]

Variable	Taiwanese	US whites	US blacks
Sample size (*n*)	3047	6706	4542
Age [*n* (%)]			
20–44 y	1118 (64.4)	2375 (53.2)	2697 (64.5)
45–64 y	1292 (24.4)	1796 (27.6)	1080 (22.8)
≥65 y	637 (11.2)	2535 (19.2)	765 (12.6)
Chi-square test	a	b	a
Sex [*n* (%)]			
Men	1432 (51.0)	3152 (48.6)	2091 (45.1)
Women	1615 (49.0)	3554 (51.4)	2451 (54.9)
Chi-square test	a	a	b
BMI, in kg/m^2 [*n* (%)]			
<16	22 (0.9)	16 (0.12)	13 (0.2)
16–19.9	414 (18.0)	493 (7.8)	326 (7.0)
20–21.9	527 (22.5)	837 (13.2)	447 (9.7)
22–22.9	322 (13.0)	503 (8.0)	293 (6.7)
23–23.9	351 (12.1)	534 (8.2)	292 (7.0)
24–25.9	603 (16.8)	1169 (17.4)	638 (14.6)
26–29.9	613 (12.7)	1738 (24.2)	1150 (25.4)
30–39.9	193 (3.8)	1269 (18.7)	1139 (24.0)
≥40	2 (0.2)	147 (2.5)	244 (5.2)
Chi-square test	c	b	a
Median			
Men	22.8	26.0	25.8
Women	22.4	24.6	27.6
Prevalence [*n* (%)]			
Hypertension[2]	1070/3017[3] (23.3)[b]	2450/6696 (25.0)[b]	1546/4536 (30.7)[a]
Hypercholesterolemia[4]	415/2823 (11.6)[c]	1728/6483 (22.4)[a]	815/4160 (18.1)[b]
Hypertriglyceridemia[5]	394/2617 (10.9)[b]	686/3812 (16.8)[a]	198/2594 (7.0)[c]
Hyperuricemia[6]	750/2820 (21.2)[a]	685/6385 (9.2)[c]	538/4091 (12.2)[b]
Diabetes[7]	290/2665 (5.7)[b]	278/2981 (6.6)[b]	214/1902 (9.6)[a]

[1] Proportions are weighted to the target populations that the Taiwanese, US white, and US black samples originated from. A chi-square test was used to compare distributions of age, sex, BMI, and disease prevalence across populations. Values with different letters are significantly different, $P = 0.017$ after Bonferroni correction. For disease prevalence, a, b, and c represent significant differences in descending order.
[2] Blood pressure ≥140 mm Hg/90 mm Hg or taking antihypertensive medication.
[3] Number of cases/total number of individuals with complete data.
[4] Fasting blood cholesterol ≥6.21 mmol/L or taking lipid-lowering medication.
[5] Fasting blood triglyceridemia ≥2.26 mmol/L or taking lipid-lowering medication.
[6] Fasting blood uric acid ≥458 μmol/L for men and ≥392.6 μmol/L for women or taking gout medication.
[7] Fasting whole blood glucose ≥6.1 mmol/L, fasting plasma glucose ≥ 7.0 mmol/L, or taking diabetes medication.

values, and the impact fraction of having at least one disorder, data with missing values for any variable were deleted.

RESULTS

Sample size and characteristics of the studied populations

The Taiwanese population studied included a lower percentage of older persons than did the US white population studied (Table 1). The Taiwanese population had lower proportions of persons in the high-BMI groups than did both the US white and the US black populations, and the US white population had lower proportions than did the US black population. Taiwanese and US whites had lower crude prevalence rates of hypertension and diabetes mellitus than did US blacks. The prevalence of hypercholesterolemia was lower in the Taiwanese than in either the US whites or the US blacks. However, the prevalence of hyperuricemia was much higher in the Taiwanese than in either the US whites or the US blacks.

Age- and sex-standardized prevalence estimates by BMI

For most of the high-BMI groups, the age- and sex-standardized prevalence rates of hypertension and hyperuricemia for Taiwanese were higher than those for US whites (**Figure 1**). The higher the BMI value, the greater the prevalence difference. In the BMI range of 30–40, the differences between the Taiwanese and the other groups in the prevalences of hypertension and hyperuricemia were >20 percentage points. In low-BMI groups, the Taiwanese had lower prevalences of hypertension than did the US blacks, but the prevalence rates increased faster with BMI for the Taiwanese than for the US blacks.

The prevalence of hypercholesterolemia was in general lower for the Taiwanese than for the US whites and the US blacks in most BMI groups. The Taiwanese and the US whites had similar prevalences of hypertriglyceridemia in every BMI group, whereas prevalences were lower for the US blacks. In most BMI groups, the age- and sex-standardized rates of dia-

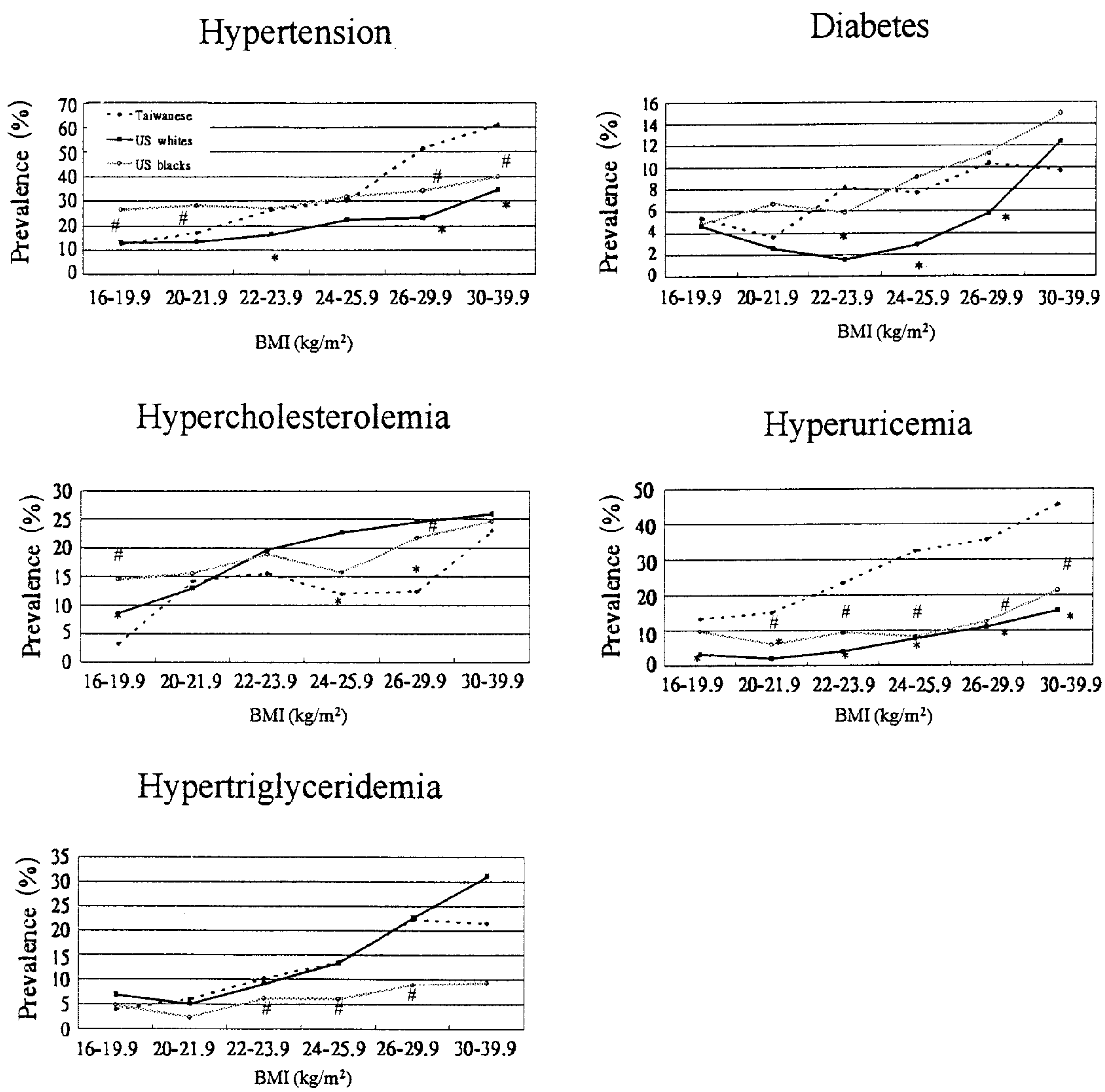

FIGURE 1. Age- and sex-standardized prevalences of various obesity-related comorbidities by BMI and ethnic group (●, Taiwanese; ■, US whites; ○, US blacks). *Significant difference between US whites and Taiwanese, $P < 0.017$ (after Bonferroni correction). #Significant difference between US blacks and Taiwanese, $P < 0.017$ (after Bonferroni correction).

betes were similar for the Taiwanese and the US blacks but were lower for the US whites.

Odds ratios per unit change in BMI for selected metabolic conditions

The odds ratios for each of the selected conditions were calculated for each increment of BMI (**Table 2**). Increments of BMI corresponded to significantly higher odds ratios in the Taiwanese than in the US blacks for all 5 metabolic conditions studied. When the Taiwanese and the US whites were compared, significance and borderline significance were shown for hypertriglyceridemia and hypertension, respectively.

Sensitivity and specificity of BMI cutoffs in predicting selected metabolic disorders

Shown in **Table 3** are the BMI cutoffs corresponding with the maximum sum of sensitivity and specificity for screening subjects with the studied condition. For the Taiwanese, the best cutoffs were BMIs between 23.0 and 23.8. For the US whites (25.5–27.9) and the US blacks (26.3–29.0), the values for these cutoffs were much higher. The order of the cutoffs corresponded with that of the median BMI in the Taiwanese (women: 22.4; men: 22.8), the US whites (women: 24.6; men: 26.0), and the US blacks (women: 27.6; men: 25.8). These BMI cutoffs for screening persons having at least one of the studied conditions in Taiwanese (women: 22.6; men: 22.8), US whites (women: 24.9; men: 26.0), and US blacks (women: 28.0; men: 25.9) coincided closely with the median BMI value for the group.

Positive and negative predictive values at various BMI cutoffs

As the BMI cutoffs increased, positive predictive value increased and negative predictive value decreased gradually for

TABLE 2
Odds ratios (95% CI) per unit change in BMI for hypertension, diabetes, hypercholesterolemia, hypertriglyceridemia, and hyperuricemia[1]

Metabolic disorder	Taiwanese	US whites	US blacks
Hypertension	1.24 (1.11, 1.39)	1.11 (1.09, 1.14)	1.07 (1.05, 1.09)
P	—	0.0751[2]	0.0115[3]
Diabetes mellitus	1.13 (1.09, 1.17)	1.15 (1.13, 1.17)	1.08 (1.05, 1.10)
P	—	0.4439	0.0305
Hypercholesterolemia	1.10 (1.05, 1.15)	1.05 (1.04, 1.07)	1.02 (1.00, 1.04)
P	—	0.1111	0.0067
Hypertriglyceridemia	1.20 (1.14, 1.26)	1.11 (1.09, 1.14)	1.05 (1.03, 1.07)
P	—	0.0100	0.0001
Hyperuricemia	1.16 (1.12, 1.19)	1.13 (1.10, 1.15)	1.09 (1.06, 1.11)
P	—	0.1336	0.0006

[1] A logistic regression model was used to estimate the odds ratios for BMI-disease relations in each race group (race, sex, age, and race × BMI) and to examine the differences between racial groups on the magnitude of the relations (race, sex, age, BMI, and race × BMI). BMI and age were continuous variables, and the others were dummy variables.

[2] *P* value corresponding to the comparison between the $\hat{\beta}$ of US whites and that of Taiwanese.

[3] *P* value corresponding to the comparison between the $\hat{\beta}$ of US blacks and that of Taiwanese.

all 3 ethnic groups (**Figure 2**). For both men and women, for most BMI cutoffs, the positive predictive value for identifying subjects who had at least one of the selected conditions was significantly higher for the Taiwanese than for the US whites or the US blacks. At low BMI values, the negative predictive value tended to be lowest for the US blacks, both male and female, but no significant difference was detected. At higher BMI values, the negative predictive value was lower for the Taiwanese than for the US whites and the US blacks, with significant differences in males only. The BMI cutoffs at which positive and negative predictive value were equal to each other were ≈22.5, 26.0, and 27.5 for Taiwanese, US white, and US black men, respectively. For Taiwanese, US white, and US black women, these BMI cutoffs were ≈24.8, 28.5, and somewhere >30, respectively.

Impact fraction for lowering BMIs from above cutoffs to below cutoffs

The impact fraction is plotted against chosen BMI cutoffs in **Figure 3**. At high BMI cutoffs, the impact fraction was much smaller for the Taiwanese than for the US whites. If the BMI cutoff were lowered further, however, the relative impact on disease prevention would become progressively greater for the Taiwanese. At a BMI of 21.5, the impact fraction for the Taiwanese reached the level of that for the US blacks. At no BMI in the figure did the impact fraction for the Taiwanese

TABLE 3
BMI cutoffs (in kg/m^2) balancing sensitivity (Se) and specificity (Sp) in predicting hypertension, hyperuricemia, diabetes, hypertriglyceridemia, and hypercholesterolemia[1]

	Men			Women		
	Se	Sp	Balancing point	Se	Sp	Balancing point
Taiwanese (*n* = 1202 M, 1365 F)						
Hypertension	0.63	0.6	23.3	0.68	0.70	23.7
Hyperuricemia	0.61	0.62	23.3	0.59	0.58	23.0
Diabetes	0.62	0.63	23.7	0.66	0.65	23.8
Hypertriglyceridemia	0.62	0.65	23.5	0.61	0.61	23.4
Hypercholesterolemia	0.55	0.53	23.0	0.60	0.58	23.0
Any disorder	0.67	0.68	22.8	0.63	0.64	22.6
US whites (*n* = 1330 M, 1507 F)						
Hypertension	0.60	0.62	26.6	0.64	0.63	25.6
Hyperuricemia	0.64	0.62	26.9	0.67	0.67	26.9
Diabetes	0.67	0.67	27.6	0.74	0.72	27.9
Hypertriglyceridemia	0.66	0.64	26.7	0.68	0.67	26.3
Hypercholesterolemia	0.57	0.57	26.4	0.61	0.61	25.5
Any disorder	0.64	0.64	26.0	0.67	0.66	24.9
US blacks (*n* = 798 M, 978 F)						
Hypertension	0.59	0.59	26.3	0.6	0.60	28.2
Hyperuricemia	0.66	0.67	27.3	0.65	0.60	29.0
Diabetes	0.62	0.60	26.8	0.65	0.58	28.9
Hypertriglyceridemia	0.61	0.61	26.8	0.55	0.54	28.1
Hypercholesterolemia	0.62	0.60	26.6	0.57	0.56	28.4
Any disorder	0.61	0.61	25.9	0.58	0.58	28.0

[1] The sample sizes listed are for the analysis combining all disorders. The sample sizes for the individual disorders are the same as those in Table 1.

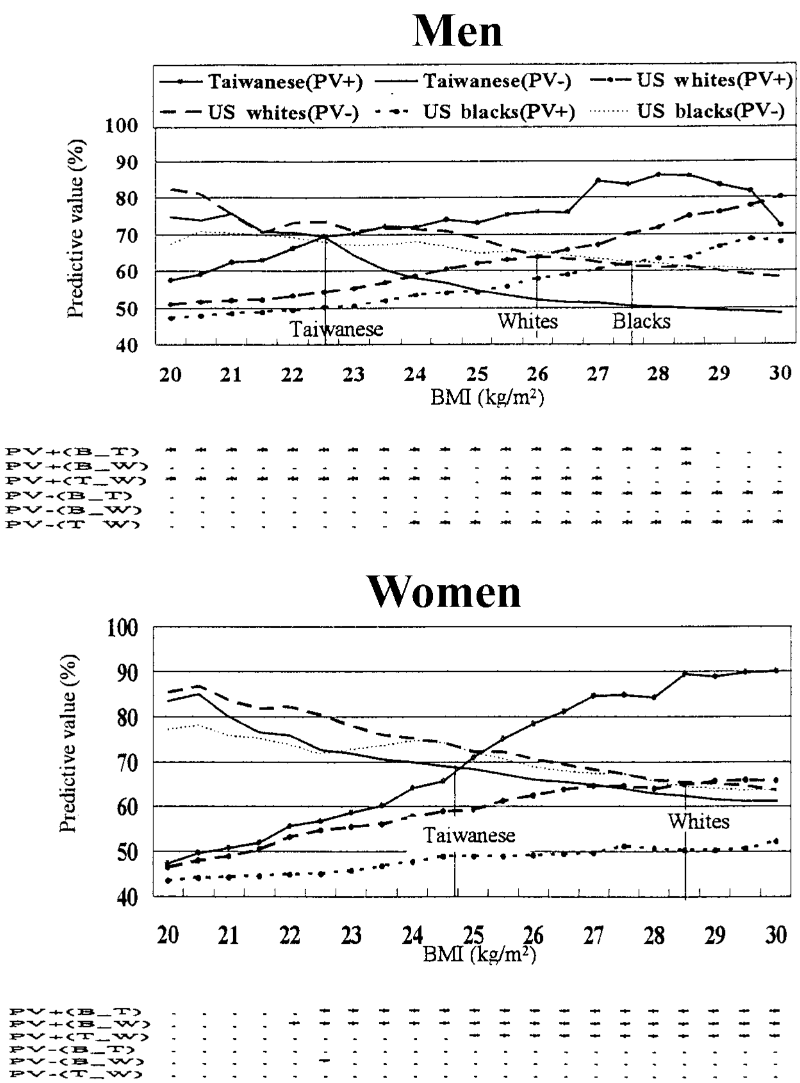

FIGURE 2. Positive (PV+) and negative (PV-) predictive value for the presence of one or more of the selected conditions at a given BMI in Taiwanese (T), US whites (W), and US blacks (B). *Significant difference between the groups listed at the left in the table below each graph at the BMI indicated, $\alpha = 0.017$ after Bonferroni correction.

surpass that for the US whites. At a BMI of 25, the World Health Organization cutoff for overweight, the impact fraction for whites was ≈13%. The corresponding BMI cutoff in the Taiwanese for a 13% impact fraction was slightly <24.

DISCUSSION

We found that the Taiwanese had much higher age-standardized prevalences of hypertension, hyperuricemia, and diabetes than did the US whites at most BMI values. In addition, increments of BMI corresponded with higher odds ratios in the Taiwanese than in the US whites for hypertriglyceridemia, hypertension, hypercholesterolemia, and hyperuricemia, although differences in the last 2 were not significant. Significantly stronger BMI-comorbidity relations were also shown in the Taiwanese than in the US blacks for all of the metabolic disorders studied.

It has been known for some time that, after control for BMI, Asians have a higher prevalence of hypertension than do whites (16, 17), which indicates a greater effect of factors other than obesity, either genetic or environmental. An extraordinarily high prevalence of hyperuricemia in Taiwan has only recently emerged (9, 18, 19). The extent of the change in the prevalence of hyperuricemia indicates the interplay of genes and environment. The high incidence (20, 21), prevalence (22–26), and mortality (27) of diabetes mellitus and undiagnosed diabetes mellitus (28) have been well documented in recent years in Taiwanese. Short statue and central obesity (28) are among the risk factors. Consistent with the above literature, our results indicate that Taiwanese (or Asians) may respond more severely in either an absolute or a relative sense to the same degree of BMI elevation than do US whites or US blacks regarding the component disorders of the metabolic syndrome.

Studies have shown that given the same level of BMI, Chinese and many other Asian groups have a higher percentage of body fat than do whites (29, 30). Intrauterine malnutrition (31, 32), recent lifestyle associated with low physical activity and a low-fiber diet (33), and genetic differences are among the potential etiologic factors of this phenomenon. The issue of

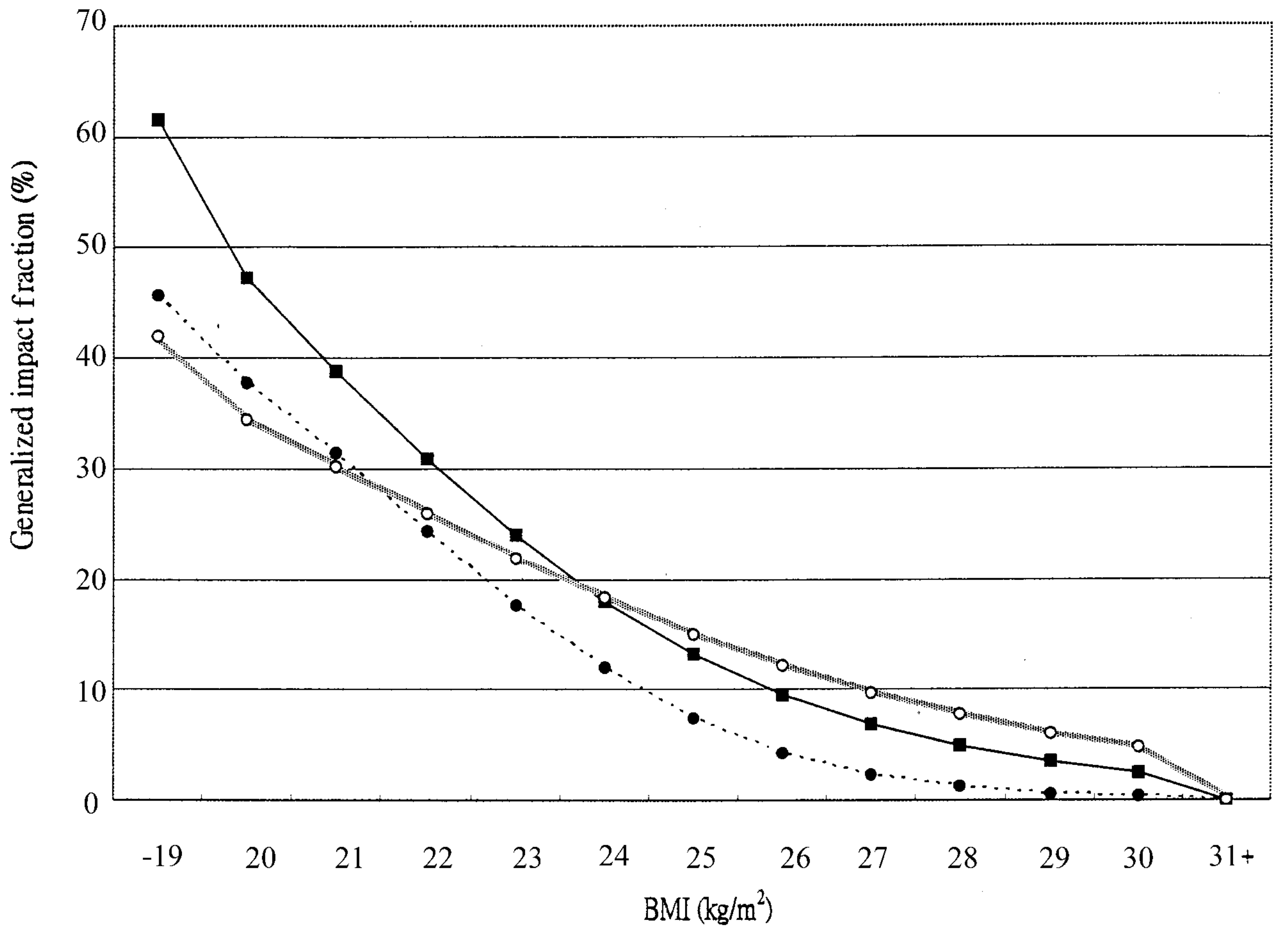

FIGURE 3. Impact fraction for eradicating BMI values above cutoffs for the presence of one or more of the selected conditions at a given BMI in Taiwanese (●), US whites (■), and US blacks (○).

how to define overweight and obesity in Asians and minority groups is not easily resolved by examining the relations between BMI and related disorders. In our study and in those of others (8, 34), there was no clear threshold in the BMI-comorbidity relations that would readily allow selection of a BMI cutoff. It is most likely that body fat, in interaction with age, sex, and other risk factors, increases the risk of metabolic disorders. We should know more about these interactions to simplify the strategy of defining obesity.

A few studies have used the approach of maximizing the sum of sensitivity and specificity. Ko et al (8) suggested using a BMI of 23 to define overweight in screening for diabetes, hypertension, dyslipidemia, and albuminuria. However, we found that the BMI distributions of the diseased and the healthy in our populations overlapped considerably (data not shown). Therefore, depending on the population studied, this approach will pick up a value close to the BMI median of that given population and designate around one-half of the population as overweight. It seems that the concept of balancing sensitivity and specificity in this setting of complex etiology is not as straightforward and applicable as in the case of clinical diagnostics.

Positive predictive value is a function of the prevalence of a given disorder. For any single metabolic disorder in the present study, and particularly for young adults, the positive predictive value was relatively low (data not shown). However, when several disorders were examined together, the positive predictive values for having one or more become reasonably good. Of every 10 subjects defined as overweight or obese by having a BMI ≥24, 6-7 had one or more of the studied conditions. On the other hand, of every 10 subjects defined as not overweight by having a BMI <24, 3-4 still had one of the conditions. In general, the performance of BMI in screening the studied disorders ranked the best for the Taiwanese, next best for the US whites, and the poorest for the US blacks if one screened by using the BMI cutoffs that balanced positive and negative predictive value. Around 69% of Taiwanese and 63–65% of US whites could be accurately classified as having or not having the disorders included in this study. However, estimates of predictive values do not provide absolute guidance as to whether BMI cutoffs should be lower for Asians and, if so, how much lower. The choice of the best cutoff depends in part on the prevalence and the cost of the selected conditions, which may vary over time and with the kind of disorders studied. In addition, whether the best cutoff is the one with equivalent proportions of false positive and false negative values is also a complex issue.

The impact fraction of any given BMI corresponds to the percentage of persons that will be removed from the original diseased population if their BMIs are lowered to below the cutoff. Because the percentage of persons with a high BMI is much less in Taiwan than in the United States, the impact fraction is also much less. A BMI cutoff slightly <24 is required to achieve the same impact fraction (13%) that US whites can obtain at a BMI of 25. Nonetheless, one needs to know more about the cost-effectiveness of BMI reduction to truly understand its impact.

One major limitation of the present study is that the comparability of 2 surveys is not easy to assess, although each followed stringent protocols. In addition, we did not address the issue of confounding factors such as smoking and drinking habits, physical activity, socioeconomic status, and menopausal status, because these issues are not only complex but also may not be satisfactorily addressed as a result of the differences in culture and questionnaire designs. However, the effect of these related systematic errors, if any, should not affect the results of relative risk per unit change of BMI, which was based on comparisons within surveys.

In conclusion, the results for odds ratios, predictive value, and impact fraction tend to support the use of lower BMI cutoffs for Taiwanese (or Asians). However, there is no easy way to determine how low the cutoffs should be. The BMI with equivalent positive and negative predictive value may be a realistic cutoff for defining overweight. After all, the major purpose of a cutoff is for screening. However, the impact (or cost) of false-positive and false-negative screening should be weighed when predictive value data are used. Another possibility is to take a pragmatic approach and consider the proportion of the population for which a country (or a society) can afford interventions. In Taiwan, one-quarter of the population has a BMI >25, one-third has a BMI >24, and one-half has a BMI >23. Consideration of national resources and of any possible negative impacts can help to determine which BMI cutoff to choose in terms of defining overweight. At the same time, a population approach to reduce overall BMI and waist circumference can be simultaneously implemented. Careful examination of the relations between body fat accumulation and distribution and BMI across ethnic groups is essential for disentangling this problem of defining obesity.

W-H Pan initiated and directed the study and was the main writer of the manuscript. KMF contributed to the analysis of the NHANES III data and the writing of the manuscript. H-YC, a biostatistitian, contributed to the analysis of the NAHSIT data and the selection of statistical methods for comparison between surveys. W-TY was extensively involved in the data collection for NAHSIT and carried out the data analyses. C-JY and W-CL contributed to the part of the article on the impact fraction.

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