Detecting Cardiometabolic Syndrome Using World Health Organization Public Health Action Points for Asians and Pacific Islanders

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Objective: To assess the screening characteristics of World Health Organization (WHO) body mass index action points for cardiometabolic syndrome (CMS) in Native Hawaiians and people of Asian ancestry (ie, Filipino and Japanese).

Design and Setting: Cross-sectional data were collected from 1,452 residents of a rural community of Hawai'i between 1997 and 2000, of which 1,198 were analyzed in this study. Ethnic ancestry was determined by self-report.

Main Outcome Measures: Metabolic status was assessed using National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATPIII) criteria. Screening characteristics of WHO criteria for overweight and obesity were compared to WHO public health action points or to WHO West Pacific Regional Office (WPRO) cut-points.

Results: Among Asian-ancestry participants, WHO public health action points improved both sensitivity and specificity for detecting CMS. However, similar improvements were not observed for WPRO criteria for Native Hawaiians. Moreover, predictive values were high regardless of which criteria were utilized due to high CMS prevalence.

Conclusions: WHO public health actions points for Asians provide a significant improvement in sensitivity in detection of CMS. However, predictive value, which varies greatly with disease prevalence, should be considered when deciding which criteria to apply. (*Ethn Dis.* 2010;20:123–128)

Key Words: Cardiometabolic Syndrome, Obesity, Asians and Pacific Islanders

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Introduction

Obesity rates continue to rise in both developed and developing countries across the globe.[1] Increased body fat is strongly associated with the development of diabetes, heart disease and several other chronic conditions.[2] Increased body fat has also been associated with insulin resistance, which in turn is associated with the cluster of cardiovascular disease risk factors[3] now commonly referred to as the cardiometabolic syndrome (CMS). Appropriate guidelines for classification of overweight and obesity is essential for assessing the public health impact of increasing body fat, as well as for identifying individuals at risk for obesity-related chronic diseases.

In 1996, the World Health Organization (WHO) published guidelines defining obesity as a body mass index (BMI) $\geq$30 kg/m^2 and overweight as a BMI $\geq$25 kg/m^2.[4,5] However, recent large epidemiological studies have indicated that metabolic obesity may occur at much lower levels of body mass indices among Asian populations (eg, Japanese and Filipinos).[6–10] Extensive scientific evidence collected from Asian and Asian-American populations suggest that the percent body fat for a given BMI is higher among Asians compared to Caucasians,[6,7] while other studies have shown that the reverse is true for some Polynesian populations.[11]

These studies prompted the steering committee of the Western Pacific Region (WPRO) of the World Health Organization to recommend different BMI ranges for the Asia-Pacific region. The steering committee recommended BMI cut-offs for overweight and obesity among Asians at $\geq$23 kg/m^2 and $\geq$25 kg/m^2, respectively, and for Polynesians, at $\geq$26 kg/m^2 and $\geq$32 kg/m^2, respectively.[12] In 2005, WHO published a response to these recommendations that included a more flexible schema incorporating the previously suggested standard set of BMI cut-offs for overweight and obesity, as well as a set of BMI criteria for public health action points appropriate for Asian populations. The schema included lower cut-points for Asian populations but no corresponding action points were defined for Pacific Islanders.[13] The report also acknowledged that further research was needed to better establish more appropriate cut-points for identifying at-risk individuals and predicting morbidity and mortality.[13]

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Native Hawaiians represent the largest Pacific Islander population in the United States. We previously reported that obesity and obesity-related health disparities are highly prevalent in Native Hawaiians.[14–16] We also observed similar high prevalence of CMS among Native Hawaiians and Asian-Americans in rural Hawaii.[17] The objective of this study was to assess the screening characteristics of WHO body mass index action points in a sample of Native Hawaiians, Filipino, and Japa-

nese Americans (as compared to Caucasians) who have previously reported to have a high prevalence of CMS as defined by the National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATPIII) diagnostic criteria.[17]

METHODS AND PROCEDURES

The methods of the Kohala Health Research Project have been described previously.[18] In brief, the study entailed a cross-sectional survey and clinical examinations conducted between 1997 and 2000. All men and non-pregnant women aged ≥18 years old residing in North Kohala, Hawai'i were invited to participate. Native Hawaiian participants who had participated in a previous prevalence study of diabetes were contacted via telephone, mail, or a home visit for possible re-participation.[15] All other participants were solicited via telephone using a cross-reference directory, local public television announcements, flyers posted at community centers and stores, and presentations given to community organizations. For people who responded to the various solicitations, eligibility was determined over the phone and, if eligible and willing to participate, an appointment was made.

Participants fasted (with the exception of water) for 10–14 hours prior to the appointment. The clinical examination took approximately 2–3 hours. Blood was drawn in the fasting state and after a 75-gram oral glucose challenge. Plasma drawn from EDTA tubes were separated within 2 hours and one aliquot was stored at 4°C for lipid analyses within 7 days and the other aliquot frozen at −80°C for hormone analyses. Triglycerides and HDL-c levels were measured in duplicate using a Beckman Synchron CX4 Analyzer (Brea, CA) based on the manufacturer's enzymatic colorimetric reagents. Supernates containing HDL-c were obtained by precipitation of VLDL and LDL with dextran sulfate and magnesium chloride. The plasma concentration of insulin, C-peptide, and leptin levels were determined by radioimmunoassay (RIA) in duplicate. Insulin assays were performed using kits from Linco Research Inc. (St. Charles, MO), whereas C-peptide assays were performed using kits from Diagnostic Products Corporation (Los Angeles, CA). All measurements were performed with quality control procedures in place. Our laboratory also participated in the Center for Disease Control (CDC)-NHLBI lipid standardization program. Intra-assay and inter-assay coefficient of variances were all less than 10%.

Blood pressure was measured after participants were seated in a quiet area for at least 5 minutes and was measured in triplicate from the right arm of each individual per standardized protocol using a standard mercury sphygmomanometer.[19] The mean of the final two blood pressure measurements was used for statistical analyses.

Personal and family medical histories, an inventory of current medications, and sociodemographic information, including educational attainment, occupational history, household income, and ethnic ancestry, were obtained during an extensive interview. Ethnicity was established by self-report. Participants reporting mixed heritage were asked to estimate the percentage of each ethnic ancestral group. A total of 1,452 participants completed the entire examination and reported their ethnic ancestry: Caucasians (n=295), Japanese (n=190), Filipino (n=186), and Native Hawaiians (n=510). As an ethnic classification, we used the federal and State of Hawaii definition for Native Hawaiian, which is any person who descended from the indigenous Polynesian population residing in the islands of Hawai'i prior to initial western contact in 1778. A fifth group of 254 individuals, composed of a variety of ethnic groups as well as those with mixed, non-Hawaiian ancestry, were excluded from analyses.

For the purpose of this report, the prevalence of overweight and obesity, using both uniform and ethnic-specific criteria, was first estimated based on the remaining 1,181 participants with complete anthropometric measurements. National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATPIII) criteria for CMS were then applied to each of the weight classifications based on WPRO ethnic-specific criteria.[20] Participants were considered to exhibit CMS if three or more metabolic abnormalities were present. The NCEP-ATPIII definition of CMS and the criteria for these metabolic abnormalities are: 1) abdominal obesity - waist circumference >102 cm (40 in) for men and >88 cm (35 in) for women; 2) blood pressure ≥130 mm Hg systolic and/or ≥85 mm Hg diastolic; 3) fasting glucose ≥5.5 mmol/L (100 mg/dL); 4) triglycerides ≥1.69 mmol/L (150 mg/dL) 5) HDL cholesterol <1.03 mmol/L (40 mg/dL) for men and <1.29 mmol/L (50 mg/dL) for women. Similarly to a previous National Health and Nutrition Examination Survey (NHANES) report,[21] we included use of antihypertensive or anti-diabetic medication as indicators of metabolic abnormalities.

Anthropometric measurements were obtained while patient was standing. Waist circumferences were measured at the level of the navel and used as an estimate of central adiposity. Height and weight were measured with participants wearing light-weight clothing without shoes, and used to calculate BMI (kg/m^2). Participants were classified according to WHO criteria for overweight (BMI≥25), obese (BMI>30), moderate risk (BMI≥23) or high risk (BMI≥27.5). The WPRO recommended cut-points for Pacific Islanders (overweight, BMI≥26; obese, BMI≥32) were used for the ethnic specific criteria for Native Hawaiian.

Table 1. Summary of selected population characteristics by major ethnic group, Kohala, HI 1997–2000

Risk Factor	Caucasian ($n = 295$)	Filipino ($n = 186$)	Native Hawaiian ($n = 510$)	Japanese ($n = 190$)
Age, years	49.4 (.88)	53.7 (1.10)†	44.7 (.66)	58.9 (1.09)†
Fasting glucose, mg/dL	99.1 (1.9)	110.3 (2.4)†	111.5 (1.4)†	108.5 (2.3)†
Two-hour glucose, mg/dL	97.1 (2.8)	125.7 (3.7) †	115.5 (2.3)†	134.9 (3.7)†
HDL cholesterol, mg/dL	52.6 (.9)	50.3 (1.1)	44.9 (.6)†	50.9 (1.1)
LDL cholesterol, mg/dL	120.0 (2.1)	124.2 (2.7)	122.0 (1.6)	119.6 (2.7)
Triglyceride, mg/dL	110.0 (7.2)	164.4 (9.1)†	154.9 (5.4)†	173.0 (9)†
Total cholesterol, mg/dL	193.4 (2.4)	210.7 (3)†	192.8 (1.8)	207.4 (2.9)†
Systolic BP, mm Hg	116.7 (1.2)	131.5 (1.5)†	129.2 (.9)†	136.2 (1.4)†
Diastolic BP, mm Hg	72.7 (.6)	78.5 (.8)†	79.5 (.5)†	79.1 (.8)†
Body mass index (kg/m^2)	25.5 (.4)	26.1 (.5)	31.3 (.3)†	25.7 (.5)
Waist Circumference (cm)				
Men	93.4 (1.03)	91.1 (1.44)	100.9 (1.08)†	90.9 (1.33)
Women	83.9 (1.04)	87.1 (1.14)†	94.9 (.99)†	86.1 (1.30)
Waist/Hip				
Men	.97 (.004)	.98 (.007)	.99 (.003)†	.99 (.005)
Women	.88 (.004)	.92 (.006)†	.90 (.003)†	.91 (.005)†
Percent on hypertension medications	4.8	23.1†	17.3†	3.2†
Percent on diabetes medications	1.4	9.1†	11.1†	7.9†
Percent with cardiometabolic syndrome	13.9	39.3†	41.9†	34.7†

Note: Data are shown as mean (standard error) or %; waist circumference was adjusted by sex.
† $P<.01$ comparing Caucasians to all other Asian/Pacific Island ancestry groups.

Statistical Methods

Sensitivity, specificity, positive and negative predictive values were calculated for each set of BMI cut-points, and exact 95% confidence intervals were calculated using the methods of Clopper and Pearson.[22] The Caucasian group was used as reference to all Asian/Pacific Island ancestry groups. Comparisons of each of the like characteristics were considered statistically significant when confidence intervals were not overlapping.

RESULTS

Population characteristics are shown in Table 1. To summarize, with the exception of HDL, cholesterol and waist circumference, all non-Caucasian ethnic groups had significantly higher means for most of the cardiovascular risk factors examined, resulting in significantly higher prevalence of CMS. The sensitivity and specificity of the uniform and ethnic specific BMI cut-points for detecting CMS were first estimated for Native Hawaiians.

As shown in Table 2, the two screening characteristics of the NHLBI cut-point defining overweight and obesity combined are both lower among Japanese and Filipino participants, and when both groups were combined, were significantly lower than that observed for Caucasians and significantly lower than that observed for Native Hawaiians. When both Asian ethnic groups were combined, a statistically significant improvement in sensitivity (from about 75 to nearly 90%) was observed when using ethnic specific criteria (BMI≥23 rather than ≥25). This was, however, accompanied by a significant decrease in specificity. When the screening characteristics of the two criteria for obesity alone were examined (Table 2), the improvement in sensitivity among Asians was even more dramatic, increasing nearly 2-fold from a very low 27.3% to more than 51.1%, without a significant decline in specificity in this case.

In contrast, among Native Hawaiian participants, the standard criteria for overweight and obese combined provided slightly higher sensitivity than when applied to Caucasians, but the specificity was significantly lower than that estimated for all other ethnic groups. Use of the WPRO cut-point for overweight and obesity recommended for Polynesians did not alter either the sensitivity or specificity for detecting CMS. Moreover, when comparing the two sets of criteria for obesity alone for Native Hawaiians, the sensitivity actually decreased significantly from 77.5% (NHLBI) to only 60.6% (WPRO), while specificity remained relatively unchanged.

Estimates of positive and negative predictive values (PPV and NPV, respectively) are shown in Table 3. When

uniform criteria for overweight and obesity combined were applied, PPV was significantly lower for Caucasians compared to all other ethnic groups, while NPV declined significantly for Asian-Americans. When the predictive values were estimated using the criteria for obesity alone was examined, the observed PPV was again lowest among Caucasians, but the difference was significant only compared to that observed for Native Hawaiians, while significant declines were observed in NPV among Hawaiians and the Asian-Americans alike.

Use of ethnic specific cut-points did not significantly alter estimates of either measure of predictive value for any of the classification schemes examined, and ethnic differences in the predictive values were also unchanged as a consequence.

DISCUSSION

The findings of this study show that the use of the WHO public health action points resulted in significantly increased sensitivity and decreased specificity compared to the uniform criteria for overweight and obesity among Asian-ancestry participants, but with little effect on predictive value. Thus, these findings support the use of WHO public health action points among Asian-Americans, at least with regards toward identifying individuals with CMS.

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The estimates of all the screening characteristics for the WHO action points were remarkably similar among the participants of Japanese and Filipino ancestry, despite representing very heterogeneous groups with respect to language, culture, and country of origin. In contrast, a recent study by Shiwaku et al comparing the WHO standard criteria and WPRO ethnic specific for overweight and obesity reported significant differences in the performance of these criteria as predictors of a similar set of obesity-related metabolic disorders among factory workers in Japan and Mongolia.[23] It is interesting to note that both ethnic groups in our study were recruited from the same rural community, while the Shiwaku study population was derived from highly disparate regions, suggesting that environmental factors may alter the relationship between body weight and risk for CMS.

While the WHO-suggested action point of BMI≥23 employed here increased sensitivity significantly, a recent Canadian study that examined the relationship of BMI with glucose metabolism and plasma lipid profiles suggested even lower BMI cut-points for Asians – as low as 20.6 among Chinese for identifying those at risk for glucose intolerance.[24] However, setting the BMI criteria too low might hamper the utility of BMI as a useful clinical tool as evidenced by the decline in specificity observed in our study. We have demonstrated that, at least with regards to CMS in Asian-Americans in our study population, the WHO-suggested public health action points provide a significant im-

Table 2. Comparison of sensitivity and specificity by ethnic ancestry group with exact 95% confidence limits for detecting cardiometabolic syndrome using WHO public health action points for Asians and WHO Western Pacific Regional Office recommendations for Pacific Islanders (Hawaiians/Part-Hawaiians)

	Uniform criteria		Ethnic specific criteria	
Ethnic group	**Sensitivity**	**Specificity**	**Sensitivity**	**Specificity**
Overweight/obese/moderate risk/high risk combined				
Caucasian	92.7 (80.1–98.5)	61.4 (55.1–67.4)	Unchanged	Unchanged
Hawaiian/part Hawaiian	96.3 (92.9–98.6)	30.8 (25.6–36.5)	Unchanged	Unchanged
Filipino	75.3 (63.9–84.7)	56.6 (47.0–66.0)	91.2 (83.0–97.0)	38.1 (29.1–47.7)
Japanese	75.8 (63.6–85.5)	61.3 (52.1–69.9)	87.9 (77.5–94.6)	34.7 (26.4–43.7)
Asian (Filipino+Japanese)	75.5 (67.5–82.4)	59.1 (52.5–65.4)	89.9 (83.7–94.4)	36.3 (30.2–51.4)
Obese/high risk only				
Caucasian	41.5 (26.3–58.0)	89.7 (85.4–93.2)	Unchanged	Unchanged
Hawaiian/part Hawaiian	77.5 (71.4–82.9)	81.7 (76.5–86.1)	60.6 (53.7–67.1)	81.2 (76.2–85.5)
Filipino	27.4 (17.6–39.1)	88.4 (81.1–93.7)	45.2 (33.5–57.3)	83.2 (75.0–89.6)
Japanese	27.3 (17.0–39.6)	92.7 (86.7–96.6)	57.6 (44.7–69.7.)	83.9 (76.2–89.9)
Asian (Filipino+Japanese)	27.3 (20.1–35.5)	90.7 (86.3–94.1)	51.1 (42.5–59.6)	83.5 (78.2–88.0)

Table 3. Comparison of positive and negative predictive values by ethnic ancestry group with exact 95% confidence limits for detecting cardiometabolic syndrome using WHO public health action points for Asians and WHO Western Pacific Regional Office recommendations for Pacific Islanders (Hawaiians/Part-Hawaiians)

	Predictive value for uniform criteria		Predictive value for ethnic specific criteria	
Ethnic group	Positive	Negative	Positive	Negative
Overweight/obese/moderate risk/high risk combined				
Caucasian	27.9 (20.6–36.3)	98.1 (94.6–99.6)	Unchanged	Unchanged
Hawaiian/part Hawaiian	51.0 (46.0–55.9)	91.8 (84.5–96.4)	Unchanged	Unchanged
Filipino	52.9 (42.8–62.8)	78.0 (67.5–86.4)	48.9 (40.3–57.6)	87.8 (75.2–95.4)
Japanese	51.0 (40.7–61.3)	82.6 (73.3–89.7)	41.7 (33.4–50.4)	84.3 (71.4–93.0)
Asian (Filipino+Japanese)	52.0 (44.9–59.0)	80.5 (73.8–86.1)	45.3 (39.3–51.1)	86.0 (77.6–92.1)
Obese/high risk only				
Caucasian	39.5 (25.0–55.6)	90.5 (86.2–93.8)	Unchanged	Unchanged
Hawaiian/part Hawaiian	69.5 (63.3–75.3	81.6 (76.5–86.1)	70.6 (63.5–77.0)	73.4 (68.2–78.1)
Filipino	60.6 (42.1–77.10	65.4 (57.3–72.9)	63.5 (49.0–76.4)	71.1 (61.6–77.7)
Japanese	66.7 (46.0–83.5)	70.6 (62.9–77.4)	65.5 (51.9–77.5)	78.8 (70.8–85.4)
Asian (Filipino+Japanese)	63.3 (49.9–75.4)	68.0 (62.6–73.1)	64.5 (54.9–73.4)	74.4 (68.8–79.6)

provement in sensitivity with no significant effect on specificity.

One unanticipated finding was the observation that the ethnic-specific BMI cut-points did not improve sensitivity or specificity among Native Hawaiians, and actually decreased sensitivity using the WPRO cut-point for obesity. While no improvement in any of the screening characteristics was observed among Native Hawaiians when applying ethnic-specific cut-points, it should be noted that only 10 participants reported 100% Hawaiian ancestry, while most of the Native Hawaiians reported less than half Hawaiian ancestry, which is the case for the larger Native Hawaiian community in Hawaii. Thus, this population might not be representative of other Pacific Islander or even other Polynesian populations because of their diverse ethnic admixture. Furthermore, the WPRO recommendation to use higher criteria for Polynesians was primarily based on reports from body composition studies revealing higher lean body mass among Polynesians compared to Europeans,[11] rather than associations with metabolic indicators. Further research will be needed to assess the validity of these recommendations.

The generally high positive predictive values observed among the Native Hawaiian, Filipino, and Japanese participants reflect the high prevalence of CMS in these populations relative to Caucasians living in the same community. While sensitivity and specificity are important screening characteristics to consider in evaluating the relative usefulness of each scheme of risk classification, the final decision on which scheme to choose must consider other factors as well, such as the purpose of its application, whether for research or clinical application, the type and prognosis of the disorder for which the screening method will identify, the costs of follow-up diagnostic testing, and the prevalence of this disorder. Moreover, the predictive value will also vary greatly for various populations depending on the prevalence of CMS or other similar obesity-related disorders. In this study, the population in this rural community may differ from the more urban Honolulu population that could affect the prevalence of CMS. Thus, the same BMI cut-points may differ in predictive value even within different districts of the state. However, it should be noted that while these findings may not be generalizable with regards to predictive value, the sensitivity and specificity estimates in this study should be unaffected by prevalence of CMS, and therefore generalizable to other similar Asian-ancestry populations.

Another factor that may affect the prevalence of CMS, and in turn the predictive value of the BMI cut-points under consideration, is the criteria for defining CMS. For example, our study utilized modified NCEP-ATP III criteria that included use of medications for hypertension and diabetes. In theory, this criteria should have shown a higher estimated prevalence of CMS, however, we observed an increase in overall prevalence of CMS of $<1\%$ than when medication use was not taken into consideration (data not shown).

In conclusion, the current WHO guidelines provide public health and medical institutions a flexible scheme for screening individuals and populations at risk for obesity-related chronic diseases. Furthermore, the decision on which set of cut-points to utilize should consider the frequency of disease in the population in order to optimize predictive value as well as increase sensitivity.

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REFERENCES

1. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser*. 2000;894: i–xii, 1–253.
2. Overweight, obesity, and health risk. National Task Force on the Prevention and Treatment of Obesity. *Arch Intern Med*. 2000;160(7): 898–904.
3. Reaven GM. Banting Lecture: role of insulin resistance in human disease. Banting lecture 1988. *Diabetes*. 1988;37:1595–1607.
4. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. *World Health Organ Tech Rep Ser*. 1995;854:1–452.
5. National Heart, Lung, and Blood Institute, National Institute of Diabetes and Digestive and Kidney Diseases. Obesity education initiative. In: Clinical Guidelines on the Identification, Education, and Treatment of Overweight and Obesity in Adults: the Evidence Report. Bethesda, Md: National Heart, Lung, and Blood Institute, in cooperation with the National Institute of Diabetes and Digestive and Kidney Diseases, 1998;NIH publication No. 98-4083.
6. Chang CJ, Wu CH, Chang CS, et al. Low body mass index but high percent body fat in Taiwanese subjects: implications of obesity cutoffs. *Int J Obes Relat Metab Disord*. 2003; 27(2):253–259.
7. Deurenberg P, Deurenberg-Yap M, Guricci S. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. *Obes Rev*. 2002;3(3): 141–146.
8. Klatsky AL, Armstrong MA. Cardiovascular risk factors among Asian Americans living in northern California. *Am J Public Health*. 1991;81(11):1423–1428.
9. Wang J, Thornton JC, Russell M, Burastero S, Heymsfield S, Pierson RNJr. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparisons of anthropometric measurements. *Am J Clin Nutr*. 1994;60(1):23–28.
10. Wang J, Thornton JC, Burastero S, et al. Comparisons for body mass index and body fat percent among Puerto Ricans, blacks, whites and Asians living in the New York City area. *Obes Res*. 1996;4(4):377–384.
11. Swinburn BA, Ley SJ, Carmichael HE, Plank LD. Body size and composition in Polynesians. *Int J Obes Relat Metab Disord*. 1999;23(11):1178–1183.
12. Health Communications Australia Pty Limited. The Asia-Pacific perspective: redefining obesity and its treatment. International Diabetes Institute, Co-sponsored jointly by the Regional Office for the Western Pacific (WPRO),World Health Organization, the International Association for the Study of Obesity and the International Obesity Task Force, 2000.
13. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363(9403): 157–163.
14. Grandinetti A, Chang HK, Chen R, Fujimoto WY, Rodriguez BL, Curb JD. Prevalence of overweight and central adiposity is associated with percentage of indigenous ancestry among native Hawaiians. *Int J Obes Relat Metab Disord*. 1999;23(7):733–737.
15. Grandinetti A, Chang HK, Mau MK, et al. Prevalence of glucose intolerance among Native Hawaiians in two rural communities. Native Hawaiian Health Research (NHHR) Project. *Diabetes Care*. 1998;21(4):549–554.
16. Mau MK, Grandinetti A, Arakaki RF, Chang HK, Kinney EK, Curb JD. The insulin resistance syndrome in native Hawaiians. Native Hawaiian Health Research (NHHR) Project. *Diabetes Care*. 1997;20(9):1376–1380.
17. Grandinetti A, Chang HK, Theriault A, Mor J. Metabolic syndrome in a multiethnic population in rural Hawaii. *Ethn Dis*. 2005;15(2):233–237.
18. Kaholokula JK, Haynes SN, Grandinetti A, Chang HK. Ethnic differences in the relationship between depressive symptoms and health-related quality of life in people with type 2 diabetes. *Ethn Health*. 2006;11(1):59–80.
19. Frolich ED, Grimm C, Labarthe DR, Maxwell MH, Perloff D, Weidman WH. Recommendations for human blood pressure determination by sphygmomanometer. *Hypertension*. 1988;11:210A–222A.
20. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). *JAMA*. 2001;285(19):2486–2497.
21. Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. *JAMA*. 2002;287(3):356–359.
22. Clopper C, Pearson E. The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika*. 1934;26:404–413.
23. Shiwaku K, Anuurad E, Enkhmaa B, et al. Overweight Japanese with body mass indexes of 23.0–24.9 have higher risks for obesity-associated disorders: a comparison of Japanese and Mongolians. *Int J Obes Relat Metab Disord*. 2004;28(1):152–158.
24. Razak F, Anand SS, Shannon H, et al. Defining obesity cut points in a multiethnic population. *Circulation*. 2007;115(16): 2111–2118.

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