Review

How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations

Wen-Harn Pan PhD[1,2] and Wen-Ting Yeh MS[1]

[1]*Division of Epidemiology and Genetics, Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan.*
[2]*Institute of Epidemiology and Institute of Microbiology and Biochemistry, National Taiwan University, Taipei, Taiwan*

Metabolic risks are greater in Asians than Caucasians at a given body mass index (BMI). It is generally accepted that the BMI cut-off points for defining overweight and obesity should be lower for Asians. However, the percent body fat at a given BMI and metabolic responses to fatness vary among the different ethnic groups in Asia. Therefore, roughly even-spaced multiple action points (i.e., BMIs of 23, 25, 27.5, 30, 32.5, 35 and 37.5) have been advocated for managing obesity in Asians. We propose here evidence-based ethnicity-specific action points for public awareness, screening, and treatment that take into consideration sensitivity, specificity, and positive/negative predictive values for cardiovascular disease and/or metabolic syndromes, which are the most prevalent adverse consequences of obesity.

Key Words: body mass index, evidence-based, metabolic syndrome, obesity definition, waist circumference

INTRODUCTION

Human body frame size and composition of bone, muscle and fat vary among different ethnic groups, ranging from a small-frame size in Asians to a large-frame size in Caucasians, and to an even larger-frame size in Islanders from the Asian Pacific region.[1] These differences likely result from multiple genetic and environmental factors that interact intimately with one another. It would be convenient to have a unified definition for obesity and metabolic syndromes similar to many other clinical conditions. Currently the most widely used index for obesity is the body mass index (BMI). Unfortunately, however, different levels of absolute or relative metabolic risk are observed in different ethnic groups at the same BMI.[2-6] It is customary to have two BMI cut-off points, one for overweight and one for obesity, but it is controversial whether to treat overweight patients when clear risk information is not delineated for different BMI levels. As such, new directives are needed for describing new obesity indices or demarcating new BMI cut-off points for defining obesity.

IDEAL MEASURES OF FATNESS AND/OR METABOLIC RISK

An ideal measure of obesity would be an index that reflects the degree of fatness, which is associated with adverse health risks in a unified way across gender, age, and ethnic groups. Such an index does not exist, however. The BMI was designed to control for frame size by dividing body weight (kg) by the square of the height (m).[7] BMI is closely associated with the degree of metabolic and cardiovascular risks.[8] However, due to variations in body shape and skeletal structure among different ethnic groups, BMI is not completely independent of height.[9] BMI is associated with height to a varying degree depending on the height range of each population. Therefore, it is not rational to force an international standard for all ethnic groups; rather, BMI can be used to define being overweight and obesity within each ethnic group.

A series of comparative data reveals that at a given BMI or percent body fat the risk for developing diabetes mellitus, insulin resistance, and hypertriglyceridemia is much greater in South Asians than in Europids.[6] Our study comparing data from NHANES III and the Nutritional and Health Survey in Taiwan showed that the Taiwanese, a group of East Asians, have a higher absolute and relative risk of co-existing hypertension, hyperglycemia, dyslipidemia and hyperuricemia than non-hispanic Caucasians and African Americans from the USA.[4] This phenomenon was also observed when BMI-metabolic risk relationships in these three ethnic groups were compared.[10] At a given BMI, the percent body fat in Asians (Indonesians and Singaporeans) is greater than in Caucasians.[1,11,12] Recent studies in Taiwanese,[2] Koreans[3] and Australian aborigines[5] further support this hypothesis.

Corresponding Author: Dr. Wen-Harn Pan, Division of Epidemiology and Genetics, Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan.
Tel: (886) 2 2789-9121; Fax: (886) 2 2782-3047
Email: pan@ibms.sinica.edu.tw
Manuscript received 2 May 2008. Initial review completed 4 August 2008. Revision accepted 16 September 2008.

Individuals may react differently to fatness due to their genetic makeup, intrauterine (developmental) environment, diet and physical activity. A low-carbohydrate diet may desensitize adverse metabolic responses to fatness.[13] However, it is not clear whether this effect is due to low carbohydrate intake per se or due to a greater intake of protein-rich foods. The effectiveness of Dietary Approaches to Stop Hypertension (DASH), a diet that is rich in vitamins, minerals and fiber but low in saturated fat, illustrates the importance of minerals and micronutrients in blood pressure control.[14] Other studies have repeatedly shown that physical activity can improve insulin sensitivity without weight change.[15] Therefore, evolving lifestyle changes could theoretically influence how obesity is defined in addition to genetic makeup. The argument here is that the definition of obesity should be revisited periodically because metabolic risks can be modified by ever evolving changes in societal trends and living environment.

EVIDENCE-BASED MULTIPLE ACTION POINTS FOR OBESITY PREVENTION, SCREENING, AND MANAGEMENT

Current knowledge argues against unified BMI cut-offs to define obesity in various ethnic groups. However, it is not clear where to draw the line, because the relationship between BMI and metabolic risk is a continuum that varies in degree among different ethnic groups and populations. The debate on ethnicity-specific definitions of obesity has been lingering since early 2000. In the past, mainstream thought defined BMI cut-offs relative to the World Health Organization (WHO) values for Caucasians. For example, a BMI of 30 for Caucasians may be equivalent to a BMI of 25.5 for South Asians and a BMI of 27.3 for East Asians according to Deurenberg's data on percent body fat among different ethnic groups.[14,15] In 2000, the International Obesity Task Force (IOTF) proposed a much lower BMI cut-off to define obesity in South and East Asians (23 for overweight and 25 for obesity) and called for additional research on obesity index and outcomes.[16] Various definitions of obesity were gradually adopted for individual Asian countries based on local data and practical considerations.[17] WHO expert consultation group later identified additional potential public health action points (BMIs of 27.5, 32.5 and 37.5 kg/m^2) in addition to the 23.0, 25.0 and 30 BMI cut-offs,[17] while agreeing to retain the WHO BMI cut-off points of 25 and 30 as international standards. The rationale behind these evenly spaced action points has not been provided, however, and clinical meanings of obesity and overweight have not been carefully laid out. For example, although experts agree that the public should be educated to keep their BMI lower than the overweight cut-off point, arguments have arisen as to whether overweight patients should be treated and whether their medical costs should be covered.

We propose a set of action points (Table 1) based on the concept of primary prevention, screening, and aggressive treatment in conjunction with diagnostic criteria.[18]

Table 1. Reasoning, definitions, and implications of the suggested BMI action points for obesity

	Public awareness point	Screening point	Treatment point
Corresponding diagnostic criteria[†]	Balanced and maximized BMI for Se and Sp	Balanced and maximized BMI for PV+ and PV–	BMI cut-off point with a large PV+ (e.g., >85%)[‡]
Definition	Most people without any MS component (60%) have a BMI below this point. Most people with one or more MS (60%) have a BMI above this point.	Most people (67%) above this point have at least one MS component. Most people (67%) below this point have no MS.	The vast majority (>85%) of people above this point have one or more MS- related symptoms.
Recommended usage by this communication	This point should be the upper boundary of the desired BMI range.	Consultation for weight reduction and screening for elevated metabolic risk should be provided for those with a BMI above this point.	Obesity and metabolic risk should be aggressively managed for those with a BMI above this point.
Implications	Maximize the number of people that fall into a healthy BMI range (without MS).	It is cost-effective to use this cut-off point for metabolic disorder screening.	To ensure that those at very high risk are managed properly to reduce risks.
Comparison with traditional definition	Has been suggested as a cut-off point for defining overweight.[21]	--	WHO obesity cut-off point based on elevated relative risk for mortality. This recommended cut-off point is based on a "very high" proportion of co-morbidity.

[†]With regard to one or more cardiovascular disease and metabolic risk factors
[‡]Statistics were derived from data of the Nutrition and Health Survey in Taiwan 1993-1996
Se: sensitivity, Sp: specificity, PV+: positive predictive value, PV–: negative predictive value, MS: metabolic syndrome, and WHO: World Health Organization.

One first asks what health risks should be screened for and managed? We can start by listing a battery of clinical conditions related to obesity for which immediate management is required and management strategies are available. Cardiovascular risk factors or components of metabolic syndromes, such as high blood pressure, elevated fasting glucose level, low HDL-cholesterol, elevated fasting triglyceride level, and large waist circumference, are reasonable targets. In Taiwan, gout is a prevalent metabolic disorder[19] that is independently associated with an increased incidence of cardiovascular disease.[20] Thus, it is reasonable to also include hyperuricemia, along with other the metabolic disorders, as a target in Taiwan.

A screening point should be one that can effectively identify people with one or more abnormalities but that excludes people without these conditions. One can define the screening point as a balancing point that maximizes both positive and negative predictive values for the aforementioned cardiovascular diseases and metabolic conditions. The positive predictive value is defined as the proportion of people with the designated disorder relative to those with a high BMI value, and the negative predictive value is the proportion of people without such disorders relative to those with a low BMI value. That is to say once this screening cut-off point is adopted by physicians, most of the people that screen positive will have one or more clinical conditions requiring management, including lifestyle intervention and/or medical treatment. In contrast, most of those with a BMI value below the screening cut-off point should not have any of these clinical disorders. It is essential to minimize both false positive and false negative rates in order to avoid missing patients in need of management and to prevent wasted medical resources, respectively. Using data from the Nutrition and Health Survey in Taiwan 1993-1996[4] and cardiovascular risk factors/metabolic disorders as the management targets, we find that 67% of people with a BMI above 23.3 have at least one elevated cardiovascular disease or metabolic risk factor and 67% of the people with a BMI below 23.3 have no risk factors (Figure 1). Medical resources should also be taken into consideration when setting this screening point.

At the right extreme of the BMI spectrum, an aggressive BMI treatment point could be considered at the point beyond which almost every individual has some sort of clinical disorder and/or multiple risk factors. This point would have a very high positive predictive value. For example, at least 85% of Taiwanese people with a BMI greater than 27 have at least one cardiovascular risk factor or metabolic syndrome (positive predictive value $\geq$ 0.85-0.90) .[4]

A balancing point that maximizes sensitivity and specificity has been used in many studies to select the overweight cut-off point.[21] Sensitivity is defined here as the proportion of people with BMI values above the cut-off relative to people with metabolic or cardiovascular disorders, whereas specificity is the proportion of people with BMI values below the cut-off point relative to people free of cardiovascular and/or metabolic disorders. In our view, this balancing point is a suitable public awareness point because people who do not have any metabolic disorder most likely have a BMI below this point and people with metabolic risk factors have a comparably high probability of having a BMI above this point. For cardiovascular disease risk factors, this balancing point is a BMI between 22.6 and 22.8 for Taiwanese, but is much higher for non-Hispanic Caucasians and African Americans in the USA.[4] We thus should educate people to

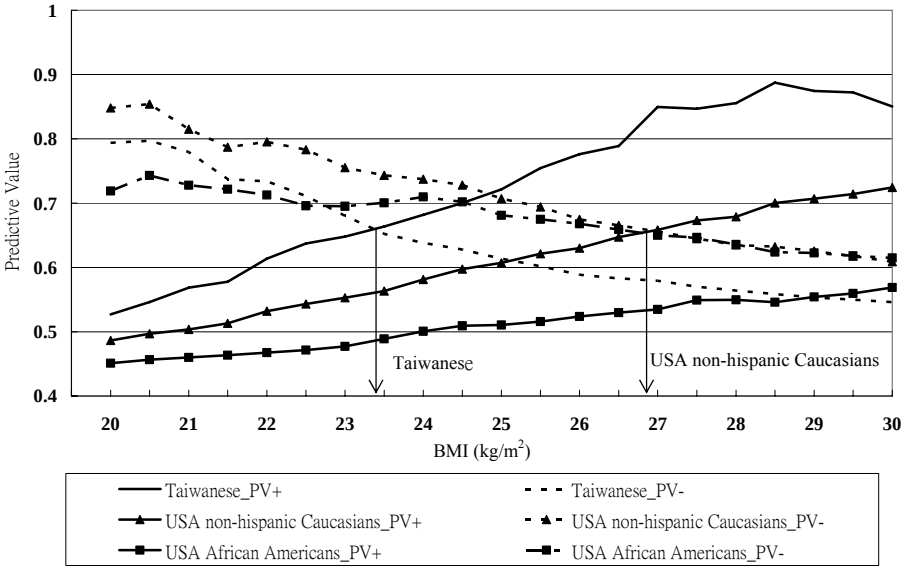

Figure 1. Positive (PV+) and negative (PV–) predictive values of BMI levels for the presence of one or more metabolic diseases in three populations: Taiwanese, non-hispanic Caucasians from the USA, and African Americans from the USA. Arrows indicate BMI cut-off points with equal PV+ and PV-. Metabolic diseases include:
(1) Hypertension: SBP $\geq$ 140, DBP $\geq$ 90 mmHg, or taking antihypertensive medication.
(2) Diabetes: fasting plasma glucose $\geq$ 126 mg/dl or taking diabetic medication.
(3) Hypertriglyceridemia: fasting serum triglyceride level $\geq$ 200 mg/dl or taking lipid-lowering drugs.
(4) Hypercholesterolemia: fasting total serum cholesterol level $\geq$ 240 mg/dl or taking cholesterol-lowering drugs.
(5) Hyperuricemia: fasting serum uric acid level $\geq$ 7.7 or 6.6 mg/dl for males and females, respectively.

maintain a BMI value below the balancing point. However, the best strategy to ensure that BMI values for most people remain below this awareness point is to advocate an ideal BMI range where the upper limit is the balancing point for sensitivity and specificity.

CONCLUSION

Prospective data linking BMI and mortality has been used as a foundation for establishing BMI cut-off points.[22] What typically occurs, however, is that a series of clinical events, including chronic disease and drastic weight loss, take place prior to death and complicate the relationship between anthropometric indices and mortality. Keeping an ideal body weight or BMI can lower the risk of developing metabolic syndromes, which are associated with increased disease incidence and mortality. Thus, it is reasonable to define obesity in conjunction with its immediate cardiovascular and metabolic risks, rather than mortality.

Although prevalence estimates of obesity in Asians are not as high as those in the USA and Europe according to BMI values, metabolic risks are much greater in Asians at a given BMI, probably due to the interplay of genetic susceptibility and environmental factors related to diet and sedentary lifestyle. Therefore, it is justifiable to lower the BMI cut-offs for defining overweight and obesity in Asians. Levels may vary, depending on ethnicity, diet and lifestyles. Furthermore, the public and health practitioners do not easily grasp the meaning of overweight and obese. We are proposing the use of evidence-based ethnicity-specific action points for public awareness, screening, and aggressive treatment, to take into account practical needs for primary prevention, high-risk group intervention, and patient management. Waist circumference should also be considered as an alternative to BMI because abdominal fat accumulation is a core component of metabolic syndromes and its association with waist circumference is usually the same or greater than the association with BMI.

AUTHOR DISCLOSURES

Wen-Harn Pan and Wen-Ting Yeh declare no conflicts of interest.

REFERENCES

1. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta analysis among different ethnic groups. Int J Obes Relat Metab Disord. 1998;22:1164–71.
2. Chang CJ, Wu CH, Chang CS, Yao WJ, Yang YC, Wu JS, Lu FH. Low body mass index but high percent body fat in Taiwanese subjects: implications of obesity cutoffs. Int J Obes Relat Metab Disord. 2003;27:253–9.
3. Chung S, Song MY, Shin HD, Kim DY, He Q, Heshka S, et al. Korean and Caucasian overweight premenopausal women have different relationship of body mass index to percent body fat with age. J Appl Physiol. 2005;99:103–7.
4. Pan WH, Flegal KM, Chang HY, Yeh WT, Yeh CJ, Lee WC. Body mass index and obesity-related metabolic disorders in Taiwanese and US whites and blacks: implications for definitions of overweight and obesity for Asians. Am J Clin Nutr. 2004;79:31–9.
5. Piers LS, Rowley KG, Soares MJ, O'Dea K. Relation of adiposity and body fat distribution to body mass index in Australians of Aboriginal and European ancestry. Eur J Clin Nutr. 2003;57:956–63.
6. Simmons D, Williams DR, Powell MJ. The Coventry Diabetes Study: prevalence of diabetes and impaired glucose tolerance in Europids and Asians. Q J Med. 1991;81:1021–30.
7. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. Int J Obes. 1985;9:147–53.
8. Jonsson S, Hedblad B, Engstrom G, Nilsson P, Berglund G, Janzon L. Influence of obesity on cardiovascular risk. Twenty-three-year follow-up of 22,025 men from an urban Swedish population. Int J Obes Relat Metab Disord. 2002; 26:1046–53.
9. Diverse Populations Collaborative Group. Weight-height relationships and body mass index: some observations from the Diverse Populations Collaboration. Am J Phys Anthropol. 2005.;128:220–29.
10. Pan WH, Yeh WT, Weng LC. Epidemiology of metabolic syndrome in Asia. Asia Pac J Clin Nutr. 2008;17(S1):37–42
11. Deurenberg P, Deurenberg Yap M, Wang J, Lin FP, Schmidt G. The impact of body build on the relationship between body mass index and percent body fat. Int J Obes Relat Metab Disord. 1999;23:537–42.
12. Gurrici S, Hartriyanti Y, Hautvast JG, Deurenberg P. Differences in the relationship between body fat and body mass index between two different Indonesian ethnic groups: the effect of body build. Eur J Clin Nutr 1999.;53:468–72.
13. Foster GD, Wyatt HR, Hill JO, McGuckin BG, Brill C, Mohammed BS, Szapary PO, Rader DJ, Edman JS, Klein S. A randomized trial of a low-carbohydrate diet for obesity. N Engl J Med. 2003;348:2082–90.
14. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. N Engl J Med. 2001;344:3–10.
15. Kelley DE, Goodpaster BH. Effects of physical activity on insulin action and glucose tolerance in obesity. Med Sci Sports Exerc. 1999;31:S619–23.
16. WHO, IOTF/IASO. The Asia-Pacific perspective: Redefining Obesity and its treatment. 2000.
17. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363:157–63.
18. Pan WH. Multiple action points for public education, screening, and vigorous treatment of obesity in Asian populations: Taiwanese experience. Proceedings of the 3rd Asian-Oceania Conference on Obesity. 2005;145-154.
19. Chang HY, Pan WH, Yeh WT, Tsai KS. Hyperuricemia and gout in Taiwan: results from the Nutritional and Health Survey in Taiwan (1993-96). J Rheumatol. 2001;28:1640–46.
20. Chien KL, Hsu HC, Sung FC, Su TC, Chen MF, Lee YT. Hyperuricemia as a risk factor on cardiovascular events in Taiwan: The Chin-Shan Community Cardiovascular Cohort Study. Atherosclerosis. 2005;183(1):147–55.
21. Huang KC, Lee MS, Lee SD, Chang YH, Lin YC, Tu SH, Pan WH. Obesity in the elderly and its relationship with cardiovascular risk factors in Taiwan. Obes Res. 2005;13: 170–78.
22. Lew EA, Garfinkel L. Variations in mortality by weight among 750,000 men and women. J Chronic Dis. 1979;32: 563–76.

Review

How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations

Wen-Harn Pan PhD[1,2] and Wen-Ting Yeh MS[1]

[1]*Division of Epidemiology and Genetics, Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan.*
[2]*Institute of Epidemiology and Institute of Microbiology and Biochemistry, National Taiwan University, Taipei, Taiwan*

肥胖定義之省思？延伸亞太地區之建議，建立有實證基礎的三個肥胖指標行動點，以教育民眾、篩選高風險民眾、治療肥胖

近年的文獻顯示，當控制在固定的身體質量指數（BMI）時，亞洲人的代謝徵候群風險比白種人高， 因此一般認為要以較低的 BMI 切點定義亞洲人的過重與肥胖才好。然而，對於亞洲地區的不同族群而言，即使控制在固定的身體質量指數數值之下，身體脂肪含量和代謝反應仍然有些差距。因此，專家建議從多個大致上間隔相當的「行動點」(包括 23， 25， 27.5， 30 和 32.5， 35， 37.5)挑選合宜各國的切點來管理肥胖。 在這裡我們提出以預測心臟血管疾病及代謝症的危險因子之敏感度，特異度，陽性預測值、陰性預測值數據為實證基礎，訂出屬於個別人群的三個身體質量指數行動點以教育民眾、篩選高風險民眾、治療肥胖。

關鍵字：身體質量指數，實證醫學，代謝症候群，肥胖定義，腰圍