Review Article

Rationale for Redefining Obesity in Asians

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Abstract

Introduction: There has been extensive research on defining the appropriate body mass index (BMI) cut-off point for being overweight and obese in the Asian population since the World Health Organisation (WHO) Expert Consultation Meeting in 2002. Materials and Methods: We reviewed the literature on the optimal BMI cut-off points for Asian populations. We searched PubMed, EMBASE, National Institute for Health Research Centre for Reviews and Dissemination (NHS CRD) Database, Cochrane Library and Google. Attempts to identify further studies were made by examining the reference lists of all retrieved articles. There were 18 articles selected for the review. Results: There were 13 studies which have identified the BMI cut-off points for Asian populations lower than the international BMI cut-off points recommended by the WHO. Many of the studies have recommended lowering BMI cut-off point specific for Asian populations. A few studies concurred with the recommended cut-off point for Asian populations recommended by International Association for the Study of Obesity (IASO), the International Obesity Task Force (IOTF) and the WHO in 2002. Asian populations were also noted to have higher cardiovascular risk factors than Western populations at any BMI level. Conclusions: Further research would be needed to look at the all-cause mortality at same BMI levels between Asians and Caucasians in order to evaluate the BMI cut-off recommendations for Asian populations. It is necessary to develop and redefine appropriate BMI cut-off points which are country-specific and ethnic-specific for Asians. These will facilitate the development of appropriate preventive interventions to address the public health problem posed by obesity.

Ann Acad Med Singapore 2009;38:66-74

Key words: Adult, Body mass index, Risk factors

Introduction

Obesity is a condition characterised by an excess of body fats. According to the World Health Organization (WHO), there were about 1.6 billion overweight adults aged 15 years and above and at least 400 million adults worldwide in 2005. Obesity poses a serious health burden as it is associated with an increased risk of chronic diseases such as diabetes mellitus, cardiovascular disease and some cancers.[1]

It is important to develop appropriate anthropometric measures for obesity in order to identify and prevent the development of obesity-related disorders.[2] Body mass index (BMI, weight in kilograms divided by height in metres squared) had been recommended by the WHO to classify body weight.[3] The current cut-off point recommended by the WHO is ≥25 kg/m^2 for being overweight and ≥30 kg/m^2 for obesity.[3] However, there was a debate about using the recommended BMI cut-off points for Asian populations in view of the following: high prevalence of type 2 diabetes mellitus and cardiovascular risk factors in Asian populations even with a BMI lower than 25 kg/m^2; variation of the relationship between BMI, percentage of body fats and body fat distribution in different populations; and prior attempts to determine the WHO cut-off points for Asian and Pacific populations.[3] The International Association for the Study of Obesity (IASO), the International Obesity Task Force (IOTF) and the WHO proposed BMI cut-points 23.0 to 24.9 kg/m^2 for being overweight and ≥25.0 kg/m^2 for obesity in adult Asians.[4]

In 2002, the WHO Expert Consultation concluded that there was no universal cut-off point for those overweight or obese in all Asian populations. The recommendations from the Consultation included following the current WHO cut-off points for overweight (≥25 kg/m^2) and obesity (≥30 kg/m^2) for international classification; providing additional BMI cut-off points of ≥23 kg/m^2 for "increased

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risk" and ≥27.5 kg/m^2 for "high risk" as thresholds for public health intervention; and developing country-specific BMI cut-off point for public health intervention.[3] Since 2002, there have been several studies which have attempted to identify an appropriate BMI cut-off point for Asian populations.[2,6-21] Therefore, we undertook a review of those studies that aimed to identify the optimal cut-off points developed for Asian populations since 2002.

Methods

The studies should aim to identify or recommend the optimal BMI cut-off point for Asian populations for the purpose of identifying those who are overweight, obese, people at risk of obesity-related diseases or public health action. The population was Asians adults and the intervention was body mass index. Cardiovascular risk factors, obesity-related disorders and mortality were used as outcomes to determine BMI cut-off points.

Search Strategy

We performed an exploratory search for the relevant search terms. The population, intervention and outcome categories were filled with alternative terms considering the terminology and spelling variations. These included Asian, obesity and Body Mass Index. The following databases were searched: PubMed, EMBASE, the Cochrane Library on CD-ROM, and the National Institute for Health Research Centre for Reviews and Dissemination (NHS CRD) that includes National Institute for Health Research Economic Evaluation Database (NHS EED), Database of Abstracts of Reviews of Effects (DARE) and the Health Technology Assessment Database (HTA). A search was also done on Google. A combination of MeSH terms and free texts was used with Boolean operators "OR" or "AND". We restricted the studies from year 2002 onwards and for adults. There was no limitation by language or publication type. This preliminary search yielded 1203 studies. The 2 reviewers had conducted the literature review and selected 60 articles. Attempts to identify further studies were made by examining the reference lists of all retrieved articles. A citation search from the retrieved articles was also performed. There were 28 suitable studies (26 primary studies and 2 meta-analyses) which were from full-text. The search ended on 2 July 2008.

Using a checklist developed by Fowkes and Fulton,[5] we evaluated the methodological quality of the primary studies. The checklist covering the following areas were assessed: appropriateness of study design, representativeness of study sample, quality of measurements and outcomes, acceptability of control group, completeness and distorting influences (e.g. confounding). There were 16 articles which met more than half of the criteria in the checklist (Table 1).[2,6-20]

Description of Studies

There were 11 cross-sectional studies,[2,6-15] 4 cohort studies,[16-19] and 1 cohort and cross-sectional study[20] and 2 meta-analyses[21,22] published between 2002 and 2007 (Table 2). These were conducted in China,[6-7,16,20-22] Taiwan,[8-9,21] Korea,[17,18] Japan,[2,19] Pakistan,[10] Singapore,[11,12] Thailand,[13] Canada,[14,15] and the United States (US).[8] The studies varied in size ranging 1213829 to 291 subjects. Their ages ranged from 15 to 95 years old. In 8 studies, the samples of subjects were obtained from nationwide studies in China,[6,16] Taiwan,[8,9] the US,[8] Korea,[18] Pakistan[10] and Singapore.[11,12] Ethnic differences in BMI or relationship between BMI and risk factors of metabolic disorders were explored in some of the studies.[11,12,14,15,17]

The methodology differed in the studies. There were 13 studies which investigated the relationship between BMI values and the risk of obesity-related disorders.[2,6-15,17,20,21] Four studies looked at the risk of mortality with BMI.[16-19,22]

There was also heterogeneity in the methods of analysis among the studies. There were 5 studies which conducted receiving operating characteristics (ROC) analysis to determine the optimal cut-off point, taking into account the best combination of sensitivity and specificity and the shortest distance in the ROC curves.[6,7,9,10,13] Regression analysis was used in the other studies to relate BMI values to the risk of obesity-related disorders.[2,8,11,14-19,20,22]

Results

It was noted from 2 studies that Asians had higher levels of cardiovascular risk factors compared to Caucasians at any given BMI value.[14,15] Four studies observed a U-shaped or J-shaped association between BMI and all-cause mortality.[16,18,19,22] Subjects who were underweight and overweight and/or obese had higher all-cause mortality compared to those who were of normal weight. The lowest all-cause mortality was found in subjects at BMI ranging from 23.0 to 24.9 kg/m^2.[16,18,19] Such patterns were similar to findings in studies on western populations where the lowest all-cause mortality was at BMI 23.0 to 27.0 kg/m^2.[16,23-25] In the study in Korea by Oh,[17] the lowest mortality for men occurred at BMI 25.0 to 26.9 kg/m^2.

There were 13 studies which identified BMI cut-off points appropriate to their countries or ethnic groups (Table 2).[2,6-9,10-13,15,17,21,22] Most of the BMI cut-off points identified were lower than the international BMI cut-off point recommended by WHO for being overweight (≥25 kg/m^2) or obese (≥30 kg/m^2).[2,6-9,10-13,15,17,21,22] However, a few studies[2,16] concurred with the recommended cut-off points for Asian populations by IASO, IOTF and WHO.[4]

The BMI cut-off point for being overweight in studies

Table 1. Appraisal of Studies Based on Checklist Developed by Fowkes and Fulton[5]

Study No.	**1**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Criteria	**Li et al[20] (2002)**	**Wildman et al[6] (2004)**	**Weng et al[7] (2006)**	**Gu et al[16] (2008)**	**Pan et al[8] (2004)**	**Tseng[9] (2006)**	**Oh et al[17] (2004)**	**Jee et al[18] (2006)**
Study design appropriate to objectives								
Objective (common design)								
Prevalence (cross sectional)	0	0	0		0	0		
Prognosis (cohort)	0			0			0	0
Treatment (controlled trial)								
Cause (cohort, case-control, cross-sectional)								
Study sample representative?								
Source of sample	0	0	0	0	0	+	0	0
Sampling method	+	0	0	0	+	0	+	+
Sample size	+	+	+	0	+	+	+	+
Entry criteria/exclusions	0	0	0	0	0	0	0	0
Non-respondents	+	+	+	+	+	0	0	+
Control group acceptable?								
Definition of controls	NA	NA	NA	NA	NA	NA	NA	NA
Source of controls	NA	NA	NA	NA	NA	NA	NA	NA
Matching/randomisation	NA	NA	NA	NA	NA	NA	NA	NA
Comparable characteristics	NA	NA	NA	NA	NA	NA	NA	NA
Quality of measurements and outcomes?								
Validity	0	0	0	0	0	0	0	0
Reproducibility	0	0	0	0	0	+	0	+
Blindness	+	+	+	0	+	+	+	+
Quality control	+	+	+	0	+	+	0	0
Completeness?								
Compliance	NA	NA	NA	NA	NA	NA	NA	NA
Drop outs	+	NA	NA	+	NA	NA	+	+
Deaths	+	NA	NA	0	NA	NA	+	0
Missing data	+	0	+	0	+	+	0	+
Distorting influences?								
Extraneous treatments	NA	NA	NA	NA	NA	NA	NA	NA
Contamination	NA	NA	NA	NA	NA	NA	NA	NA
Changes over time	NA	NA	NA	NA	NA	NA	NA	NA
Confounding factors	0	0	0	0	0	0	0	0
Distortion reduced by analysis	0	0	0	0	0	0	0	0

***** ++: Major Problem; +: Minor Problem; 0: No Problem; NA: Not Applicable

by Deurenberg-Yap et al,[11] Deurenberg-Yap and Deurenberg,[12] Wildman,[6] Li et al,[20] and Zhou[21,22] ranged from 23 to 27.9 kg/m^2. A study on patients with obesity-related disorders determined the BMI cut-off points for obesity in these patients: 24.5 kg/m^2 for men and 25 kg/m^2 for women with type 2 diabetes mellitus by Tseng[9] in Taiwan. There were also studies on determining BMI cut-off points targeted at identifying Asians at high risk of obesity-related disorders. These gave a range of BMI values of 21 to 28 kg/m^2.[7-8,10,13,21]

The BMI cut-off points for Asians were not determined in some studies.[14,16,18,20] The study by Razak et al[14] in Canada

Table 1 (cont.). Appraisal of Studies Based on Checklist developed by Fowkes and Fulton[5]

Study Number	11	12	13	14	15	16	17	18
Criteria	**Tsugane et al[19] (2001)**	**Yang et al[2] (2007)**	**Jafar et al[10] (2006)**	**Deurenberg-Yap et al[11] (2002)**	**Deurenberg-Yap[12] (2003)**	**Aekplakorn et al[13] (2006)**	**Razak et al[14] (2005)**	**Razak et al[15] (2007)**
Study design appropriate to objectives								
Objective (common design)								
Prevalence (cross sectional)		0	0	0	0	0	0	0
Prognosis (cohort)	0							
Treatment (controlled trial)								
Cause (cohort, case-control, cross-sectional)								
Study sample representative?								
Source of sample	0	0	0	0	0	0	0	0
Sampling method	+	0	0	0	0	0	0	0
Sample size	+	+	+	+	+	+	+	+
Entry criteria/exclusions	0	0	0	0	+	+	0	0
Non-respondents	+	+	+	+	+	+	+	+
Control group acceptable?								
Definition of controls	NA	NA	NA	NA	NA	NA	NA	NA
Source of controls	NA	NA	NA	NA	NA	NA	NA	NA
Matching/randomisation	NA	NA	NA	NA	NA	NA	NA	NA
Comparable characteristics	NA	NA	NA	NA	NA	NA	NA	NA
Quality of measurements and outcomes?								
Validity	0	0	0	0	0	0	0	0
Reproducibility	+	0	0	0	0	+	0	0
Blindness	+	+	+	+	+	+	+	+
Quality control	+	+	0	0	+	0	+	+
Completeness?								
Compliance	NA	NA	NA	NA	NA	NA	NA	NA
Drop outs	+	NA	NA	NA	NA	NA	NA	NA
Deaths	0	NA	NA	NA	NA	NA	NA	NA
Missing data	+	+	+	+	+	+	+	+
Distorting influences?								
Extraneous treatments	NA	NA	NA	NA	NA	NA	NA	NA
Contamination	NA	NA	NA	NA	NA	NA	NA	NA
Changes over time	NA	NA	NA	NA	NA	NA	NA	NA
Confounding factors	0	0	0	0	0	0	0	0
Distortion reduced by analysis	0	0	0	0	0	0	0	0

***** ++: Major Problem; +: Minor Problem; 0: No Problem; NA: Not Applicable

suggested more research would be needed to determine the optimal cut-off point. The study by Gu et al[16] did not comment that the BMI cut-off points for being overweight (23.0 to 24.9 kg/m^2) recommended by IASO, IOTF and WHO were appropriate for all ethnic groups while the study by Jee et al[18] commented that the study findings might be of use in evaluating the WHO recommendation of cut-off values for being overweight and obese.

Discussion

Our review has shown that Asian populations had greater cardiovascular risk factors than western populations at any

Table 2. Findings of Studies Conducted on Asians

					Findings on optimal body mass index (BMI) cut-off points based on:	
Study no.	**Country**	**First author (y)**	**Study design**	**Study subjects**	**Cardiovascular risk factors or obesity-related disorders**	**Mortality**
1	China	Li[20] (2002)	Cross-sectional, Cohort	2856 subjects and 629 non-diabetic subjects aged 25-70 years	Hypertension and diabetes mellitus (DM):27.0 kg/m^2 for obesity 25-27kg/m^2 or 23-27 kg/m^2 for overweight	
2	China and Taiwan	Zhou[21] (2002)	Meta-analysis	239,972 adults aged 20-70 years from 13 population studies	Hypertension, DM, lipoprotein disorders: 24.0 kg/m^2 for overweight 28.0 kg/m^2 for obesity	
3	China	Zhou[22] (2002)	Meta-analysis	76,227 adults from 4 prospective cohorts	Coronary heart disease and stroke: 24-27.9 kg/m^2 for overweight ≥28 kg/m^2 for obesity	24-27.9 kg/m^2 for overweight ≥28 kg/m^2 for obesity
4	China	Wildman[6] (2004)	Cross-sectional	15,239 adults aged 35 to 74 years in a national survey	≥2 of the following (hypertension, dyslipidaemia, DM): 24 kg/m^2 for both men and women for overweight	
5	China	Weng[7] (2006)	Cross-sectional	529 non-pregnant, non-lactating rural and urban adults aged 20-64 years who did not have diagnosed diabetes in a community survey	≥1 of the following (hypertension, high triacylglycerol, high glucose, insulin resistance, high low-density lipoprotein (LDL)-cholesterol:23 kg/m^2	
6	China	Gu[16] (2006)	Cohort	154,736 Chinese subjects aged 40 years and above from the general population at all 30 provinces in China who had participated in a national survey		Not available.Associated with increased all-cause mortality: >27 kg/m^2 in men and >30 kg/m^2 in women. Those with BMI <18.5 kg/m^2 or 18.5-22.9 kg/m^2 had significantly raised all-cause mortality than those with BMI 24.0-24.9 kg/m^2. Study concurred with use of a single common criteria recommended by IOTF, IASO and WHO and did not support lowering cut-off point for obesity.
7	Taiwan and USA	Pan[8] (2004)	Cross-sectional	2585 adults aged ≥20 years who participated in national survey in Taiwan and US.	≥1 of the following (hypertension, hyperuricaemia, DM, hypertriglyceridaemia, hypercholerstrolaemia): 22.8 kg/m^2 in Taiwanese men and 22.6 kg/m^2 in Taiwanese women	
8	Taiwan	Tseng[9] (2006)	Cross-sectional	1183 patients with type 2 diabetes mellitus aged 18 to 87 years from random sampling across Taiwan	Coronary artery disease in adults with type 2 diabetes mellitus: 24.5 kg/m^2 for men and 25 kg/m^2 for women	

Table 2. contd.

					Findings on optimal BMI cut-off points based on:	
Study no.	**Country**	**First author (y)**	**Study design**	**Study subjects**	**Cardiovascular risk factors or obesity-related disorders**	**Mortality**
9	Korea	Oh[17] (2004)	Cohort	773,915 men and women aged 30 to 59 years who were members of the Korea National Health Insurance Corporation	Not definitely identified for risk of hypertension. DM and hypercholesterolaemia. However, a BMI of 25.0 kg/m^2 was proposed as cut-off point in view of the need to counter the rapid rise in obesity and obesity-related diseases.	The participants with BMI 25.0-26.9 kg/m^2 for men and 20.0-22.9 kg/m^2 for women had the lowest mortality risk. Koreans were not found to have higher risk of death than whites. However, a BMI of 25.0 kg/m^2 was proposed as cut-off point in view of the need to counter the rapid rise in obesity and obesity-related diseases.
10	Korea	Jee[18] (2006)	Cohort	1,213,829 men and women aged 30-95 years from the Korean Cancer Prevention Study		Not available. The participants with BMI 23.0-24.9 kg/m^2 had the lowest risk of death from any cause. The risk of death from respiratory causes was lower at increasing BMI whereas the risk of death from atherosclerotic cardiovascular causes and cancer was higher in participants with higher BMI.
11	Japan	Tsugane[19] (2002)	Cohort	19,500 men and 21,315 women aged 40-59 years in 4 public health centre areas		Not available. Increased relative risk of mortality: 30.0-39.9 kg/m^2 and 27.0-29.9 kg/m^2 in men, and 30.0-39.9 kg/m^2 in women. Study did not demonstrate a need to lower BMI cut-off point for obesity in Asians.
12	Japan	Yang[2] (2007)	Cross-sectional	3608 subjects (2387 men: 42.3 ± 0.2 years and 1221 women: 41.6 ± 0.3 years) who were not on prescription for obesity-related diseases in a community setting	Blood pressure, total cholesterol, LDL -cholesterol, LDL-cholesterol/ HDL-cholesterol, triglyceride: 23.0-24.9 kg/m^2 in men and women	
13	Pakistan	Jafar[10] (2006)	Cross-sectional	8972 people aged 15 years or above in a national survey	Hypertension: 21.2 kg/m^2 in men and women. DM:22.1 kg/m^2 in men and 22.9 kg/m^2 in women.	
14	Singapore	Deurenberg-Yap[11] (2002)	Cross-sectional	291 subjects between 18 and 75 years of age in a national survey	≥1 of the following (raised total blood cholesterol, raised total cholesterol to HDL-cholesterol ratio, raised triglycerides, hypertension, DM): 22-24 kg/m^2. The study proposed BMI ≥23 kg/m^2 for overweight and ≥27 kg/m^2 for obesity	

Table 2. contd.

Study no.	Country	First author (y)	Study design	Study subjects	Findings on optimal BMI cut-off points based on: Cardiovascular risk factors or obesity-related disorders	Mortality
15	Singapore	Deurenberg-Yap[12] (2003)	Cross-sectional	4723 subjects sampled from a national survey	≥1 of the following (raised total blood cholesterol, raised total cholesterol to HDL-cholesterol ratio, raised triglycerides, hypertension, DM): 22-24 kg/m^2. The study proposed BMI ≥23 kg/m^2 for overweight and ≥27 kg/m^2 for obesity	
16	Thailand	Aekplakorn[13] (2006)	Cross-sectional	5305 subjects aged ≥35 years in a national survey	Hypertension, diabetes, dyslipidaemia, or ≥2 of these risk factors:22-23 kg/m^2 in men and 24-25 kg/m^2 in women.	
17	Canada	Razak[14] (2005)	Cross-sectional	Canadian men and women aged 35-75 years, consisting of 342 South Asians, 317 Chinese, 326 Europeans and 301 Aboriginals from a study in 4 communities in Canada	Not available. At any BMI level, the South Asians, Chinese, Aboriginals had markedly higher levels of the following (fasting glucose, HbA1c, ratio of total cholesterol to HDL) than Europeans. The study proposed that more evidence would be needed to determine optimal cut-off point for Chinese and South Asian.	
18	Canada	Razak[15] (2007)	Cross-sectional	1078 subjects between 35 and 75 years of age in a study in 4 regions in Canada	South Asians. Glucose factor: 21.0 kg/m^2 Lipid factor: 22.5 kg/m^2 Blood pressure factor: 28.8 kg/m^2 Chinese. Glucose factor: 20.6 kg/m^2 Lipid factor: 25.9 kg/m^2 Blood pressure factor: 25.3 kg/m^2	

BMI level.[14,15] Our review has also found that subjects who were underweight and overweight and/or obese had higher all-cause mortality compared to those who were of normal weight.[16,18,20] On the contrary, 1 study observed Koreans were not at greater risk of obesity-related disorders and mortality than whites in the US.[17] Further research, particularly on the comparison in all-cause mortality at the same BMI levels between Asians and Caucasians, would be needed to evaluate the BMI cut-off recommendations for Asian populations.

The differences in BMI cut-off points proposed in different Asian populations in our study may reflect the underlying ethnic-specific variations in body fat percentage in relation to BMI, as well as the different lifestyle factors in different Asians populations. Of note, there was heterogeneity in the populations, methodology and analysis in the studies, which might give rise to varying cut-off points.

Appropriate BMI cut-off points in Asians are needed to measure obesity prevalence, in screening and other public health intervention. However, it is difficult to determine the cut-off point due to the need to take into account consequences of false positive and false negative screening. One study has proposed approaching this issue by considering the extent to which intervention could be provided by the country or society.[8]

Some studies in this review have recommended lowering BMI cut-off points for Asians.[6,8,10-12] They concurred with studies conducted in Asia before 2002 which also proposed BMI cut-off points lower than those used in the Caucasian populations. These include studies done in Singapore[26] (BMI ≥23 and ≥27 kg/m^2 for being overweight and obese respectively) and Hong Kong[27] (BMI ≥24 kg/m^2 for obesity in working adults).

It has been suggested that other methods such as waist circumference,[26] waist-stature ratio[28] and waist-to-hip ratio,[28] be used as screening or diagnostic tools for obesity. From an unpublished local prospective data (with an average of more than 10 years' follow-up), we found that the better predictor for all-cause mortality for both men and women is waist circumference compared with other predictors such as waist-to-hip ratio and BMI. This shows a sharp increase in mortality risk from waist circumference of around 90 and 80 cm for men and women, respectively. More research would be needed to look into developing effective, accurate and reliable methods to define obesity.

One limitation of the cross-sectional studies in this review was that the temporal association between BMI and obesity-related disorders could not be studied in cross-sectional studies.[7] It is hoped that more well-conducted cohort studies could be conducted to look at the relationship between BMI and obesity-related disorders and mortality. Furthermore, the results from some of the smaller studies could not be extrapolated to the general population. Publication bias was also a limitation in our review as we could only retrieve English articles although we did not limit our search by English. Further research could be conducted to look at the non-English studies.

Conclusions

Asian populations had higher cardiovascular risk factors than Western populations at any BMI level. Further research would be needed to look at the all-cause mortality at the same BMI levels between Asians and Caucasians in order to evaluate the BMI cut-off recommendations for Asian populations. It is necessary to develop and redefine appropriate BMI cut-off points which are country-specific and ethnic-specific for Asians. These will facilitate the development of appropriate preventive interventions to address the public health problem posed by obesity.

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