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Are Asians at greater mortality risks for being overweight than Caucasians? Redefining obesity for Asians

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Abstract

Objectives: To assess whether overweight Asians, assessed on the basis of WHO criteria, are at greater mortality risk than overweight Caucasians, and to determine whether alternative cut-off points (BMI = 23·0–24·9 kg/m^2 for overweight and BMI ≥ 25·0 kg/m^2 for obesity) suggested by the WHO Western Pacific Regional Office are appropriate.

Design: The cohort was followed prospectively until the end of 2001. All-cause and CVD mortality risks of the overweight and obese group, relative to the reference group (BMI = 18·5–24·9 or 18·5–22·9 kg/m^2), were assessed using Cox regression analysis, adjusting for age, smoking and gender. Excess deaths were estimated with a method proposed by the US Centers for Disease Control and Prevention.

Setting: National Health Interview Survey (NHIS 2001) and a middle-aged perspective cohort in Taiwan.

Subjects: Subjects comprised 36 386 civil servants and school teachers, aged 40 years and older, who underwent a medical examination during 1989–1992.

Results: In the WHO-defined overweight group, Asians showed a significant increase in all-cause mortality risk compared with Caucasians. Asians showed risks equivalent to Caucasians' at lower BMI (around 5 units). Every unit of BMI increase, at 25·0 kg/m^2 or above, was associated with a 9 % increase in relative mortality risk from all causes. Applying a cut-off point of 25·0 kg/m^2 for obesity would result a prevalence of 27·1 %, while the traditional WHO cut-off point of 30·0 kg/m^2 yielded obesity prevalence of 4·1 %. Excess deaths due to obesity accounted for 8·6 % of all deaths and 21·1 % of CVD deaths, based on the alternative cut-offs.

Conclusions: In this Asian population, significant mortality risks started at BMI ≥ 25·0 kg/m^2, rather than at BMI ≥ 30·0 kg/m^2. The study supports the use of BMI ≥ 25·0 kg/m^2 as a new cut-off point for obesity and BMI = 23·0–24·9 kg/m^2 for overweight. The magnitude of obesity-attributable deaths has been hitherto under-appreciated among Asians.

Keywords
Body mass index
Mortality risk
Overweight
Obesity

Obesity and smoking are two of the leading causes of preventable diseases in the Western world[1]. Excess deaths from smoking have been well documented in many populations, including Asians[2,3], but the magnitude of the excess deaths from obesity, an increasingly important burden of disease, is less well publicized[4–11], particularly among Asians. At the same BMI level, with BMI defined as weight/height^2, higher body fat percentage is found in Asians than in Caucasians[12–14] but their prevalence of obesity is much lower[15]. As a result, some studies have suggested to lower BMI cut-off points for Asians[16–20], while others disagree[21,22] or remain non-committal[23–25]. On reviewing the association of BMI with body fat and morbidity risks among Asian countries, a WHO expert consultation recently concluded that the BMI cut-off points defined by WHO (25·0–29·9 kg/m^2 for overweight, ≥30·0 kg/m^2 for obesity) should be retained as international classifications applicable to Asians, although 'potential public health action points' were identified[26]. Based similarly on morbidity data, however, the Western Pacific Regional Office of WHO (WPRO), led by the International Association for the Study of Obesity and the International Obesity Task Force, proposed differently, with BMI = 23·0–24·9 kg/m^2 for overweight and

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BMI ≥ 25·0 kg/m^2 for obesity[16]. The fact that the Taiwanese government has long adopted 24·0–26·0 and ≥27 kg/m^2 for defining overweight and obesity, respectively[27], is a strong indication that the WHO's one-size-fits-all scheme is not functional in Asia.

Much of the debate was based on the relationship between BMI and morbidity, and rarely on mortality[21,22], an important parameter that cannot be ignored in assessing the health impact of obesity. The difficulties encountered in reaching an evidence-based definition of obesity stemmed largely from the paucity of long-term mortality outcome data among Asians. In contrast, quite a number of reports are available on the relationship between obesity and mortality risks among Western populations[6,28–33]. In the present paper, we attempt to use a large cohort to assess whether Asians are at higher mortality risks than Caucasians at a given BMI and, if so, at which BMI level Asians start to show significant increase in mortality risks. The alternative cut-off point advocated by WPRO, which was based primarily on morbidity consideration[16], is evaluated with respect to its mortality implications and its appropriateness for redefining Asians. In addition, the excess deaths from obesity in Taiwan are estimated based on the population-attributable fraction method[2,3].

Methods

Definition of obesity

Two definitions of obesity are used in the present study: the conventional one by WHO and an alternative one suggested by WPRO[16]. The WHO defines overweight as BMI between 25·0 and 29·9 kg/m^2 and obesity as BMI ≥ 30·0 kg/m^2, including sub-classifying obesity into obese I, II and III on the basis of BMI of 30·0–34·9, 35·0–39·9 and ≥40·0 kg/m^2, respectively. WPRO defines overweight as BMI between 23·0 and 24·9 kg/m^2, and obese I, II and III as BMI of 25·0–26·9, 27·0–29·9 and ≥30·0 kg/m^2, respectively.

Study subjects

National survey sample

Obesity prevalence was derived from nationally representative data collected in the National Health Interview Survey (NHIS 2001) in Taiwan[34], based on self-reported height and weight. The size of the surveyed sample was 13 875 for those 20 years of age and older.

Cohort study sample

The cohort consisted of a total of 71 361 (39 147 males and 32 204 females) civil servants and teachers. They took part in a government-sponsored annual physical examination programme during 1989–1992. A detailed description of the cohort is given elsewhere[35–37]. At the time of recruitment, nearly half (49 %) of the cohort subjects were less than 40 years old and nearly a tenth (9 %) were 60 years and older. The consistency of data quality was assured by following a standardized procedure by dedicated nurses using the same instruments in the one-and-only outpatient centre during physical examinations. This included the actual measurement of weight and height and blood pressure, and performing venepuncture for blood chemistry and cell counts. Assuring the completeness of answers on the questionnaire by the study subjects was also part of the standard protocol.

The questionnaire was self-administered, addressing demographic and lifestyle information. This included information such as physical activity levels, smoking history, alcohol consumption habits, dietary preferences, and whether there were any diseases known or medications taken. Only persons aged 40 years and over at the beginning of follow-up were included in the present study (n 36 386). Vital status as of 31 December 2001 and causes of death information were ascertained through matches between the cohort member and a computerized national death database. Causes of death had been coded according to the ninth revision of the International Classification of Diseases (ICD-9).

Statistical analyses

With the reference group comprising persons with BMI = 18·5–24·9 kg/m^2 or with BMI = 18·5–22·9 kg/m^2 for the WHO or WPRO definition, respectively, relative risks (RR) for each category of BMI were calculated using a Cox proportional hazards model, adjusted for age, sex, smoking, alcohol drinking and physical activity. This calculation was done for both the entire cohort and the non-smoking sub-cohort. Smokers were classified as current smokers, ex-smokers and non-smokers[36]. Drinking status was divided into drinkers (those who drank regularly) and non-drinkers (those who did not drink, drank occasionally or drank only at party time)[38]. Physical activity was defined for those who claimed to have engaged in moderate exercise for 30 min each time for at least three times per week.

The obesity-attributable fraction (OAF)[6–9], the proportion of excess deaths attributable to obesity (i.e. the use of the alternative WPRO definition of BMI ≥ 25·0 kg/m^2), was calculated from the obesity-associated relative risk (*RR*) and national obesity prevalence (*P*)[9]. The following formula used was:

$$\text{Total OAF} = \frac{\sum P_i(RR_i - 1)}{\sum [P_i(RR_i - 1) + 1]},$$

where i denotes the ith BMI category, with $i = 1$, 2 or 3 representing BMI = 25·0–26·9, 27·0–29·9 or ≥30·0 kg/m^2, respectively[3]. The obesity-related relative risks came from the cohort results presented in Table 3, and obesity prevalence was derived from the NHIS 2001[34]. The number of obesity-attributable mortality (OAM) was calculated as the product of OAF and obesity-related deaths based on 2001 national mortality data.

Results

Prevalence of obesity and overweight under different definitions

Table 1 shows the national prevalence of obesity for the Taiwanese population. Under the conventional WHO definition, 23·0 % of the adult population was classified as overweight (BMI = 25·0–29·9 kg/m^2) and 4·1 % as obese (BMI ≥ 30·0 kg/m^2), while the alternative WPRO definition yielded 20·8 % as overweight (BMI = 23·0–24·9 kg/m^2) and 27·1 % as obese (BMI ≥ 25·0 kg/m^2). There was a major difference in those defined as obese, with the WPRO definition (27·1 %) yielding a prevalence nearly seven times greater than the WHO definition (4·1 %). The proportion of those overweight and obese, according to the WPRO definition, increased with age and generally peaked at the age group of 50–59 years.

Mortality risk by BMI level

Mortality risks for the entire cohort and for the non-smoking sub-cohort according to BMI level are presented in Tables 2 and 3, and Figs 1 and 2.

With the conventional WHO definition and the reference group as 18·5–24·9 kg/m^2, the all-cause mortality risks increased with increasing BMI (Table 2). Relative risks for the overweight (RR = 1·23; 95 % CI 1·09, 1·38) and obese group (RR = 1·64; 95 % CI 1·19, 2·25) were both significantly increased. These data are plotted in Fig. 1 where, for comparison purposes, relative risks from the follow-up data of the US National Health and Nutrition Examination Survey (NHANES) cohort are also shown[6]. Relative risks for the overweight and two obese groups were all higher for Taiwan than for the USA, with an approximate difference of 5 units of BMI. For example, the RR at 25·0–29·9 kg/m^2 for Taiwan (1·23) was similar to or higher than that at 30·0–34·9 kg/m^2 for the USA (1·13), and the RR at 30·0–34·9 kg/m^2 for Taiwan (1·61) was similar to that at 35·0–39·9 kg/m^2 for the USA (1·63). The most notable difference was the significant increase in relative risk for the overweight group in Taiwan (1·23), but not in the USA (0·95). Age 60–69 years was selected among the three NHANES age groups available: 25–59 years, 60–69 years and ≥70 years[6]. Because the three sets of relative risks from the three age groups were grossly similar, the use of any one set of them would lead to the same conclusion for our comparison purpose. Specifically, instead of 0·95, 1·13 and 1·63 for age 60–69 years for BMI = 25·0–29·9 kg/m^2 (overweight), 30·0–34·9 kg/m^2 (obese I) and ≥35·0 kg/m^2 (obese II), respectively, RR at age 25–59 years was 0·83, 1·20 and 1·83 and at age ≥70 years was 0·91, 1·03 and 1·17, respectively. Significant increases in relative risk were similarly seen for the non-smoking sub-cohort (Table 2). Relative risks for CVD were also significantly increased, although with higher values than those seen for all causes.

With the alternative WPRO definition[16] and the reference group as 18·5–22·9 kg/m^2, there was no increase in risk for all-cause mortality for the overweight group (RR = 1·00; 95 % CI 0·87, 1·16), but significant increases for the three obese groups (Table 3). The RR increased stepwise, being 1·20 (95 % CI 1·03, 1·40), 1·27 (95 % CI 1·06, 1·53) and 1·64 (95 % CI 1·18, 2·27) for BMI of 25·0–26·9 kg/m^2 (obese I), 27·0–29·9 kg/m^2 (obese II) and ≥30·0 kg/m^2 (obese III), respectively. Every unit of BMI increase, at 25·0 kg/m^2 or above, was associated with a 9 % increase in relative mortality risks for all causes (Fig. 2). The risk for the overweight group in Taiwan no longer showed an increase (RR = 1·00), not unlike the corresponding risk in the USA (RR = 0·95). In contrast, the relative CVD risk in the overweight group was increased, with borderline significance.

Obesity-attributable mortality

Table 4 shows the mortality attributable to obesity by different causes of death. For all-cause mortality, a total of 9851 excess deaths were found to be the result of obesity, which accounted for 8·6 % of the total deaths in Taiwan. Obesity was found to be responsible for 5473 deaths or 21·1 % of all CVD deaths, 979 deaths or 10·7 % of all diabetes deaths, and 846 deaths or 2·6 % of all cancer deaths.

Discussion

In this Taiwanese population, significantly increased mortality risks were experienced not only by obese

Table 1 Distribution of BMI by age group in the general population†

	BMI (kg/m^2)					
Age (years)	15·0–18·4 (%)	18·5–22·9 (%)	23·0–24·9 (%)	25·0–26·9 (%)	27·0–29·9 (%)	≥30·0 (%)
20–29	13·5	57·7	12·7	7·1	5·2	3·8
30–39	5·6	48·6	20·2	13·1	8·3	4·2
40–49	2·9	40·5	24·0	17·1	11·3	4·2
50–59	3·2	33·8	26·4	18·4	13·0	5·2
60–69	2·3	36·1	27·8	17·7	12·1	4·0
≥70	8·5	41·9	22·5	15·4	8·5	3·2
Total	6·5	45·6	20·8	13·8	9·2	4·1

†Representative samples, based on self-reported height and weight, of the general population were selected, with 13 875 males and females combined. Source: National Health Interview Survey in Taiwan 2001[34].

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Table 2 Relative risks (RR) for all-cause and CVD mortality by BMI level, with 18·5–24·9 kg/m² as the reference group (WHO definition)

Cause	BMI (kg/m²)		Entire cohort				Non-smoker sub-cohort			
			No. of subjects	No. of deaths	RR†	95 % CI	No. of subjects	No. of deaths	RR‡	95 % CI
All causes (ICD-9: 001–998)	Total		36 386	1291			25 512	650		
	15·0–18·4		961	34	1·04	0·72, 1·51	741	15	0·88	0·52, 1·50
	18·5–24·9	Reference	25 182	761	1·00	–	18 700	409	1·00	–
	25·0–29·9	Overweight	9597	455	1·23*	1·09, 1·38	5711	208	1·32*	1·11, 1·56
	25·0–26·9		6423	291	1·20*	1·05, 1·38	3933	139	1·31*	1·08, 1·59
	27·0–29·9		3174	164	1·27*	1·07, 1·51	1778	69	1·33*	1·02, 1·73
	≥30·0	Obese	646	41	1·64*	1·19, 2·25	360	18	1·76*	1·10, 2·83
	30·0–34·9	Obese I	621	39	1·61*	1·16, 2·23	346	17	1·73*	1·06, 2·81
	≥35·0	Obese II	25	2	2·30	0·58, 9·21	14	1	2·46	0·35, 17·56
CVD (ICD-9: 401–448)	Total		36 386	287			25 512	137		
	15·0–18·4		961	7	1·18	0·55, 2·52	741	4	1·23	0·45, 3·39
	18·5–24·9	Reference	25 182	153	1·00	–	18 700	76	1·00	–
	25·0–29·9	Overweight	9597	116	1·45*	1·13, 1·86	5711	53	1·64*	1·15, 2·35
	25·0–26·9		6423	71	1·35*	1·01, 1·80	3933	32	1·44	0·94, 2·21
	27·0–29·9		3174	45	1·65*	1·17, 2·32	1778	21	2·06*	1·26, 3·35
	≥30·0	Obese	646	11	2·14*	1·16, 3·96	360	4	1·83	0·66, 5·01
	30·0–34·9	Obese I	621	11	2·22*	1·20, 4·09	346	4	1·90	0·69, 5·20
	≥35·0	Obese II	25	0	–		14	0	–	

ICD-9, ninth revision of the International Classification of Diseases.
*$P < 0·05$.
†Adjusted for age, gender, smoking, alcohol and physical activity.
‡Adjusted for age, gender, alcohol and physical activity.

individuals but also by overweight ones with BMI of 25·0–29·9 kg/m², as defined by WHO, and these risks were much higher than those of their US counterparts. In other words, at a given BMI above 25·0 kg/m², the respective mortality risks were much higher among these Asians. Every unit of BMI increase, at or above 25·0 kg/m², was associated with a 9 % increase in relative overall mortality risks. Most importantly, unlike overweight Americans[6], overweight Taiwanese, currently defined by WHO as those with BMI = 25·0–29·9 kg/m², showed significantly increased risks for all-cause mortality. If people in Taiwan represent Asians in general, they exhibited equivalent relative mortality risks at lower BMI (5 units or more) than their American counterparts (Fig. 1). These findings support the need to define obese Asians differently, by lowering the BMI cut-off point by 5 units from 30·0 to 25·0 kg/m², which happens to be the definition advocated by WPRO[16].

The similarity of the two relative risks at 5 units of difference in BMI was not our initial reason for suggesting to lower BMI. Two other reasons were more compelling. First we found that overweight people in Taiwan had a significant increase in all-cause mortality risk, unlike their American counterparts. This finding was supported by several reports[16,18,19]. Second, we found that obese individuals, when defined by the conventional WHO cut-off, constituted only 4 % in Taiwan, compared with 31 % in the USA. In other words, the current WHO definition for obesity would have very limited impact on weight-related health issues among Asians, because only a much small number of people (4 %) would be, in theory, affected. However, when we found that Asians tended to have higher body fat percentage[12–14] and more CVD risks[20] at a given BMI and that the increased risks were not limited to obese individuals but extended to a much larger group defined as overweight (23 %), we then felt that the definition needed to be changed if the term 'obesity' or 'overweight' is to impart similar health implications worldwide. This is consistent with the emphasis made by WHO, that 'the purpose of a BMI cut-off point is to identify, within each population, the proportion of people with an undesirable health risks that warrant a public health or clinical intervention'[39]. Reclassifying those obese Asians carrying similar increased risks to those of obese Caucasians is an important step in making obesity universally hazardous. The new definition not only would make the proportion of obese individuals (27 %) closer to that in the USA (31 %)[40], but also the levels of obesity risks more comparable.

Based on BMI cut-off points defined by WHO, the nature of the relationship between body weight and mortality in the Western world has been more in line with a J-shaped relationship, with the underweight showing some increases, but not necessarily significant, in all-cause mortality risks (<18·5 kg/m², RR = 1·38–2·30)[6], followed by the reference group (18·5–24·9 kg/m²), with no increase among the

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Table 3 Relative risks (RR) for all-cause and CVD mortality by BMI level, with 18·5–22·9 kg/m^2 as reference group (WHO Western Pacific Regional Office definition)

			Entire cohort				Non-smoker sub-cohort			
Cause	BMI (kg/m^2)		No. of subjects	No. of deaths	RR†	95 % CI	No. of subjects	No. of deaths	RR‡	95 % CI
All causes (ICD-9: 001–998)	Total		36 386	1291			25 512	650		
	15·0–18·4		961	34	1·05	0·72, 1·52	741	15	0·88	0·51, 1·51
	18·5–22·9	Reference	15 072	423	1·00	–	11 776	241	1·00	–
	23·0–24·9	Overweight	10 110	338	1·00	0·87, 1·16	6924	168	1·00	0·82, 1·22
	≥25·0	Obese	10 243	496	1·25*	1·10, 1·43	6071	226	1·35*	1·12, 1·62
	25·0–29·9		9597	445	1·23*	1·07, 1·41	5711	208	1·32*	1·09, 1·60
	25·0–26·9	Obese I	6423	291	1·20*	1·03, 1·40	3933	139	1·31*	1·06, 1·62
	27·0–29·9	Obese II	3174	164	1·27*	1·06, 1·53	1778	69	1·33*	1·01, 1·76
	≥30·0	Obese III	646	41	1·64*	1·18, 2·27	360	18	1·76*	1·09, 2·85
	30·0–34·9		621	39	1·61*	1·16, 2·25	346	17	1·73*	1·06, 2·84
	≥35·0		25	2	2·30	0·58, 9·23	14	1	2·47	0·35, 17·60
CVD (ICD-9: 401–448)	Total		36 386	287			25 512	137		
	15·0–18·4		961	7	1·37	0·63, 2·98	741	4	1·41	0·50, 3·99
	18·5–22·9	Reference	15 072	72	1·00	–	11 776	37	1·00	–
	23·0–24·9	Overweight	10 110	81	1·35	0·98, 1·87	6924	39	1·34	0·85, 2·11
	≥25·0	Obese	10 243	127	1·74*	1·29, 2·34	6071	57	1·91*	1·25, 2·90
	25·0–29·9		9597	116	1·69*	1·25, 2·28	5711	53	1·89*	1·23, 2·90
	25·0–26·9	Obese I	6423	71	1·57*	1·12, 2·19	3933	32	1·66*	1·02, 2·70
	27·0–29·9	Obese II	3174	45	1·92*	1·31, 2·81	1778	21	2·37*	1·38, 4·06
	≥30·0	Obese III	646	11	2·49*	1·32, 4·71	360	4	2·10	0·75, 5·93
	30·0–34·9		621	11	2·58*	1·36, 4·87	346	4	2·17	0·77, 6·12
	≥35·0		25	0	–		14	0	–	

ICD-9, ninth revision of the International Classification of Diseases.
*$P < 0·05$.
†Adjusted for age, gender, smoking, alcohol and physical activity.
‡Adjusted for age, gender, alcohol and physical activity.

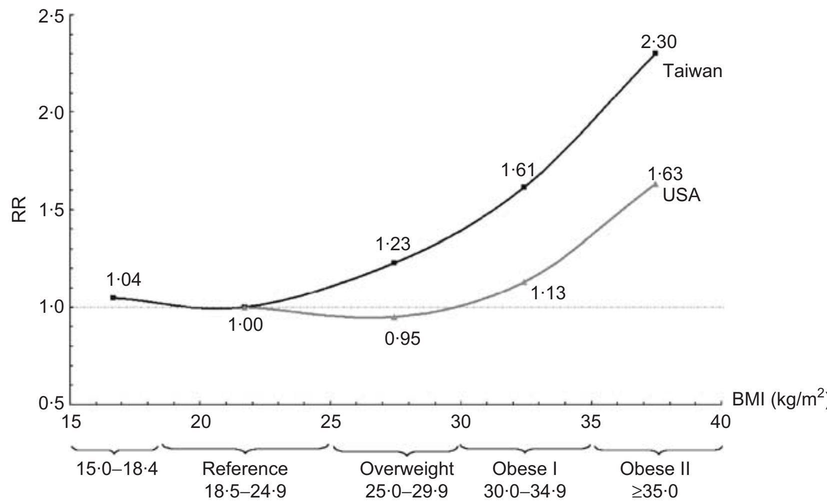

Fig. 1 Comparison of relative risks (RR) for mortality from all causes according to BMI level between Asians (Taiwan) and Caucasians (USA). In Asians, RR are adjusted for age, smoking status and gender, with BMI = 18·5–24·9 kg/m^2 as the reference group; in Americans, RR are adjusted for sex, smoking status, race and alcohol consumption, with BMI = 18·5–24·9 kg/m^2 as the reference group. For US data, RR at age 60–69 years were from the combined National Health and Nutrition Examination Survey I, II and III and selected from Flegal *et al.*[6]. The corresponding RR at age 25–59 years were 0·83, 1·20 and 1·83, and at age ≥70 years were 0·91, 1·03 and 1·17, for BMI of 25·0–29·9, 30·0–34·9 and ≥35·0 kg/m^2, respectively

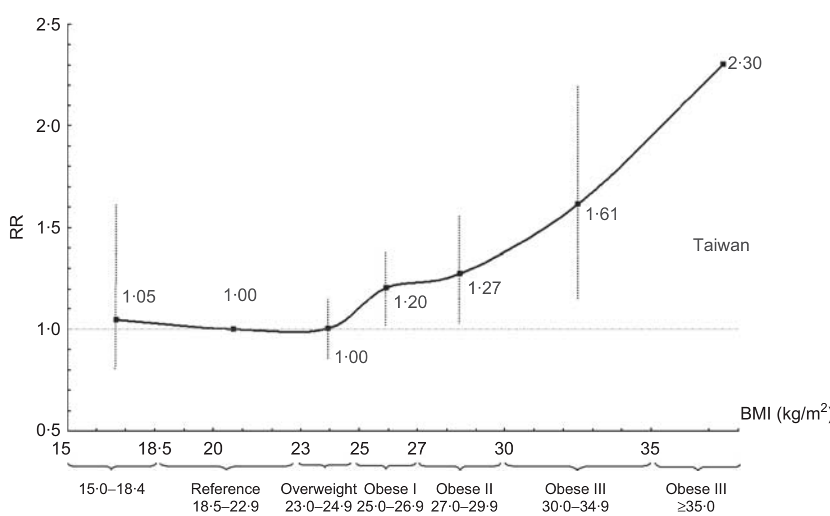

Fig. 2 Relative risks (RR) for mortality from all causes among Taiwanese based on alternative BMI cut-offs

overweight (25·0–29·0 kg/m^2, RR = 0·97 or 0·83–0·95)[6,28] and then a stepwise increase among the obese (≥30·0 kg/m^2, RR = 1·20–1·28; 30·0–34·9 kg/m^2, RR = 1·03–1·20; ≥35·0 kg/m^2, RR = 1·17–1·83)[6,28]. The fact that the WHO-defined overweight group showed no increase in all-cause mortality has been repeatedly shown among Western populations[6,30,31,33,41] but not widely appreciated. In a meta-analysis of twenty-six studies, a major finding was that 'little evidence of increased risks was found among the overweight group (RR = 0·97)'[28]. The same conclusion was reached in analysing the three NHANES surveys on nationally representative samples (RR = 0·83–0·95)[6]. In contrast, few studies have systematically examined such a relationship among East Asians, particularly on assessing the risks of those overweight. Some Asian studies did show a J-shaped or U-shaped relationship, but characterizing more of the excess risks among underweight Asians[21,42]. Part of the reason for this increase among the underweight is that those studies showing a marked U-shaped relationship contained more underweight individuals (e.g. 11·6 % in China cohort)[21] than comparable Western studies (2·2–3·0 % in NHANES), by including many who were not healthy to start with and were vulnerable for onslaught by malnutrition or infectious diseases.

The way overweight or obesity was alternatively defined in our study fits the definition proposed by WPRO[16] and Shiwaku *et al.*[19]. By way of mortality

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Table 4 Obesity-attributable mortality by different causes of death

BMI (kg/m²)	Prevalence (%)	All causes (ICD-9: 001–998) RR†	OAF‡ (%)	OAM§	CVD (ICD-9: 401–448) RR	OAF (%)	OAM	Diabetes (ICD-9: 250) RR	OAF (%)	OAM	All cancer (ICD-9: 140–208) RR	OAF (%)	OAM
15·0–18·4	3·6	1·05			1·37			0·63			0·88		
18·5–22·9	38·2	1·00			1·00			1·00			1·00		
23·0–24·9	25·1	1·00			1·35			0·75			0·91		
25·0–26·9	17·3	1·20	3·4		1·57	8·9		0·59			1·10	1·8	
27·0–29·9	11·5	1·27	3·1		1·92	9·6		1·28	3·1		1·02	0·2	
≥30·0	4·3	1·64	2·7		2·49	6·0		3·07	8·2		1·14	0·6	
Total‖			8·6	9851		21·1	5473		10·7	979		2·6	846

ICD-9, ninth revision of the International Classification of Diseases.
†Adjusted for age, gender, smoking, alcohol and physical activity.
‡Obesity-attributable fraction $= P(RR-1)/[P(RR-1)+1]$, where P denotes prevalence of obesity in the general population (those aged 40 years and above were used for both P and RR).
§Obesity-attributable mortality = OAF × mortality. Number of deaths for all causes in Taiwan was 114 327, for CVD was 9113, for diabetes was 9115 and for all cancer was 32 993 in 2001.
‖Total OAF $= \sum P_i(RR_i - 1)/\sum[P_i(RR_i - 1)+1]$ where i denotes the ith BMI category with $i = 1$, 2 or 3 representing BMI = 25·0–26·9, 27·0–29·9 or ≥30·0 kg/m² respectively, for estimating the total OAF.

experience from our cohort, the validity of the WPRO classification has been affirmed. With the new definition for Asians, the relative risks for the overweight group (RR = 1·00) and obese group (RR = 1·25) were virtually the same as the ones found in the meta-analysis summarizing twenty-six studies of Western populations using the WHO definition (RR = 0·95–0·98 for overweight groups and RR = 1·20–1·28 for obese groups)[28] or in an industrial cohort (RR = 0·94 for overweight and RR = 1·25 for obese group)[33]. The similarity of relative mortality risks between obesity defined as BMI ≥ 25·0 kg/m² in this Asian population and as BMI ≥ 30·0 kg/m² in Western populations led to the conclusion that BMI ≥ 25·0 kg/m² is the most appropriate alternative cut-off point for defining obesity among Asians. In addition, overweight as defined by WPRO (BMI = 23·0–24·9 kg/m²) showed an increase in CVD but not all-cause mortality risks for the entire cohort and the non-smoking sub-cohort.

In Fig. 1, we selected relative risks from NHANES subjects at age 60–69 years because Flegal *et al.* did not present the data for the total population across all age groups[6]. However, the RR at age 60–69 years were not that much different from those of the other two age groups (25–59 and ≥70 years). Thus, the choice of any age group from the NHANES cohort[6] would enable us to reach a similar conclusion: that the RR (from any one of the three age groups) for overweight was not increased (0·83, 0·95, 0·91), similar to that at 23·0–24·9 kg/m² in Taiwan (1·00); the RR for obese I was increased (1·20, 1·13, 1·03), similar to that at 25·0–29·9 kg/m² in Taiwan (1·23); and the RR for obese II was significantly increased (1·83, 1·63, 1·17), similar to that at 30·0–34·9 kg/m² in Taiwan (1·61).

The body builds of Asians seem remarkably similar within Chinese, Japanese or Koreans in the Western Pacific region[25]. The proportion of combined overweight/obese individuals under the WHO definition among Taiwanese actually reflects that among Chinese[43], with an identical 28 % for both populations in the 35–74 years age group. Given these similarities, Chinese are expected to share our proposal for redefining obesity. However, a recent Chinese study which implied to retain the WHO definition for Asians[21] analysed a population comprising a mixture of two different worlds[44]. It consisted of a large number of normal-weight individuals (BMI = 18·5–23·9 kg/m²) with markedly increased mortality risks, even higher than those in the overweight group (BMI = 25·0–29·9 kg/m²), masking the risks of overweight. This unusual observation of increased risks among those of normal weight was probably unique to the rural poor in China[21]. As a result, the observation made in our study on conventionally defined overweight (BMI = 25·0–29·9 kg/m²) being associated with significantly increased risks could not be made in the former cohort[21] because it included an excessively large population of rural poor, who suffered not so much from obesity as from underweight-related diseases, such as malnutrition[42]. In addition, the use of 24·0–24·9 kg/m² as the reference group[21], an unorthodox choice, must have so skewed the results that its conclusion could be regarded as irrelevant to our discussion.

The reason why Asians are at higher risks than Caucasians at a given BMI value can only be speculative, but the following possibilities exist. First, Asians have a higher percentage of fat at a given BMI[12–14,45], with proportionately higher cardiovascular risk[19]. Second, Asians have either more risk factors at a given BMI when it is 25·0 kg/m² or higher, or Asians show higher values of the individual risks than Caucasians, a subject extensively investigated and generally supported[16,20,26,46,47]. Third, Asians engage in less physical activity than Caucasians: more than half (51·9 %) of adults in Taiwan admitted having no leisure-time physical activity in the past two weeks when surveyed, while only a tenth (9·7 %) engaged in achieved physical activity at the recommended intensity[34].

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The resulting energy expenditure levels are much lower, with 19 % meeting recommended physical activity in Taiwan, in contrast to 45 % in the USA[48], based on similarly conducted NHIS data. Less exercise implies that Asians are less fit than Americans and, therefore, more vulnerable in mortality outcome.

In contrast to one out of six deaths (16 %) attributable to smoking in Taiwan[2], obesity was responsible for 8·6 % or one out of twelve deaths. Thus, the number of deaths from obesity was slightly over half of those due to smoking. In the USA, the most recent estimate of obesity- and smoking-attributable mortality was 112 000 and 440 000, respectively[3,6]. When the obesity–smoking relationship is compared between Taiwan and the USA, with the number of OAM being a quarter of that of smoking in the USA (112 000/440 000) but slightly more than half in Taiwan (9851/18 880), the relative importance of obesity in this Asian population becomes apparent. It is to be noted that although we presented prevalence data starting from age 20 years, it was for completeness purpose. All our mortality data and relative risks were consistently based on age 40 years or older.

That Asians have less cardiovascular mortality than Caucasian is part of the racial difference the present study set out to investigate, particularly when racial difference was reflected in the outcome of obesity mortality. The use of relative risks in the present study rather than absolute risks in highlighting such a difference should be more appropriate. The CVD defined in the present study includes stroke. Stroke is much higher in Taiwan and hence CVD mortality reported herein reflected mainly that of stroke.

There is a clear and linear gradient in CVD mortality risks with increasing BMI. A similar increase was seen in diabetes, only starting from BMI ≥ 27·0 kg/m^2 or greater. This finding is of particular interest, because while subjects with diabetes were invariably associated with overweight, their causes of death were believed to be accorded with CVD at lower BMI but became diabetes at higher BMI as the underlying cause. This finding is of particular interest, because physicians in Taiwan tend to assign 'diabetes' more as an underlying cause of death when filling out death certificates, rather than CVD, compared with other countries[37], but apparently such a preference is primarily limited to those more obese-looking individuals, with BMI ≥ 27·0 kg/m^2.

The present study has several strengths, including the large sample size and its prospective design. The subjects in the cohort were relatively homogeneous. The BMI used in the study was the result of actual measurement of height and weight, rather than from self-reported values. In addition, the ascertainment of vital status was conducted through linking with the national death registry that has almost 100 % completeness. Some limitations existed and should be considered in the interpretation of the study findings. One issue is the external validity of the study or generalization of our results, which might be limited because the cohort subjects were of relatively higher education with above-average socio-economic status. However, because the risk estimates were based on internal comparison with persons having similar socio-economic status, the increased risks of overweight and obesity of the cohort, with relatively homogeneous background, can be a reasonable estimate for the general population in Taiwan. Second, the size of relative risks depended heavily on the choice of reference group. In the present study we chose BMI = 18·5–22·9 kg/m^2, a much lower cut-off point than most previous studies. Nevertheless, this was able to differentiate the mortality risks. Third, self-reported body weight and height were used in estimating the national obesity prevalence, which may have understated obesity prevalence and attributable mortality. As a result, the health impact of obesity should have been larger than what is reported in the paper.

There were several studies, from China[46], Singapore[13], Japan[19], Hong Kong[47], Korea[24] and Taiwan[18], referring to different definitions of overweight and obesity. These reports, which used different cut-off points for Asian populations other than the one suggested by WHO, pointed to a need for a revised cut-off for Asians based more on outcome evidence than on morbidity, which was less consistent across studies in its definition. The present study, with the use of relative mortality risks from a large cohort, found that the cut-off point coincided with the one suggested by the WPRO, developed by a panel of experts.

In conclusion, until a large multinational collaborative study linking BMI and mortality, such as the one in progress under the Obesity in Asia Collaboration in the Asia-Pacific Region[25], the present study supports the need to lower the BMI cut-off point to 25·0 kg/m^2 for obesity, in line with the WPRO recommendation, and to 23·0–24·9 kg/m^2 for overweight. This is because significant risks started from 25·0 kg/m^2, and the risk increased stepwise as BMI increased. These increased risks are similar to the ones observed for the Western population, but using 30·0 kg/m^2 as the cut-off point for BMI in defining obesity. For a given BMI, Asians not only have a greater percentage of body fat, but are also at greater risk of dying from all causes and from CVD. The number of excess deaths from obesity, when compared with smoking, is proportionately larger in this population than in Western populations, reflecting obesity being relatively more important and having higher mortality risks among Asians. Furthermore, because all-cause mortality risks increased in overweight Asians, but not in Caucasians, when overweight was defined by WHO, the new cut-off point would be in line with the same trend, i.e. increased mortality risks for the obese but not the overweight for both Caucasians and Asians. Part of this is because we need to send a message as early as possible to the newly defined overweight people – a warning that they need to be vigilant in maintaining their weight – and to rectify the old definition for subjects where health damage has been inflicted already.

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