Original Article

Criteria and classification of obesity in Japan and Asia-Oceania

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In 1997 when WHO initiated the formation of the International Obesity Task Force (IOTF), the Task Force proposed the cut-offs for overweight and obesity as BMI 25 and BMI 30, respectively. If we accept the criteria of BMI ≥ 30 to indicate obesity, it would appear that the prevalence of obesity in Japan of less than 3% has changed little during the last 40 years, and we cannot explain the rapid increase in incidence of obesity-associated chronic diseases such as diabetes, hypertension and hyperlipidemia. Thus, JASSO decided to define BMI ≥ 25 as obesity. This cut-off has been proposed for use in the Asia-Oceania Region, and WHO Western Pacific Region noted this proposal. According to this criterion the prevalence of obesity in Japan would average 20%, with a high of 30% in men over 30 years old, and women over 40 years old. Thus the rates would have increased four times in men and three times in women during these last 40 years. What has caused the increased prevalence of obesity in Japan? Several causes of obesity have been advanced: (i) overeating (ii) errors of eating pattern (iii) inactivity (iv) heredity, and (v) disturbance in thermogenesis. Hyperphagia and inactivity are two major risk factors for obesity. Hyperphagia may be an important factor in individuals. However, the average energy intake in adult people in Japan has not increased; in fact it has declined (2104 kcal/day to 1967 kcal/day) during these 40 years. During this period, the prevalence of obesity has increased three or more times as mentioned above. This indicates that inactivity may be the main cause for the increased incidence of obesity in Japan. Errors of eating pattern (irregular eating, night eating, etc.), including a high proportion of fat to total energy intake (8.7% increased to 26.5%), and a high incidence of β 3-adrenergic polymorphism, might also have contributed to the increased incidence of obesity in Japan.

Key words: Asia-Oceania, classification, criteria, Japan, obesity.

Introduction

In developed and developing countries, it is now recognized that the morbidity and mortality rates are increased in individuals classified as obese.[1–6] It is believed that the higher morbidity and mortality rates of obese people are due to the increased incidence of obesity-related (lifestyle-related) diseases. The factors that increase the morbidity rate of obese people include a high degree of obesity and abnormal fat distribution, such as upper body obesity and visceral obesity. Recently, the definition of 'pathological obesity' has been proposed in Japan.[7]

Definition and assessment of obesity

Obesity is excessive fat accumulation, and not simply being overweight. The average human body usually consists of 82% lean body mass, which is essential for sustaining daily life and physical activities, and 18% body fat, which in essence is energy stored for emergency situations.[8] Thus, obesity can be defined as 'over-storage of body fat beyond 18%'. Usually, body fat above 30% is considered obesity. According to this definition, obesity should be judged by measuring stored fat in the body. Although there are presently many methods for measuring body fat, no method can be conducted easily, accurately and inexpensively.

At present, obesity is therefore judged by three methods: (1) comparison with standard body weight, (2) physique index, or (3) measurement of subcutaneous fat thickness.

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Comparison with standard body weight has been the most popular method applied throughout the world. However, standard body weight is determined differently in each country. Even in Japan, there are several scales of standard body weight, such as the slightly modified Broca scale, the Matsuki scale,[9] the Minowa scale,[10] the Japan Ministry of Health and Welfare scale,[11] and the Meiji Life Insurance Company scale.[12] However, these scales were not necessarily arrived at based on scientific evidence.

Under these circumstances, in 1992, the Japan Society for the Study of Obesity (JASSO) decided to propose a standard body weight scale based on scientific evidence and using easily calculated method until the methods for measurement of genuine body fat can be established. At that time
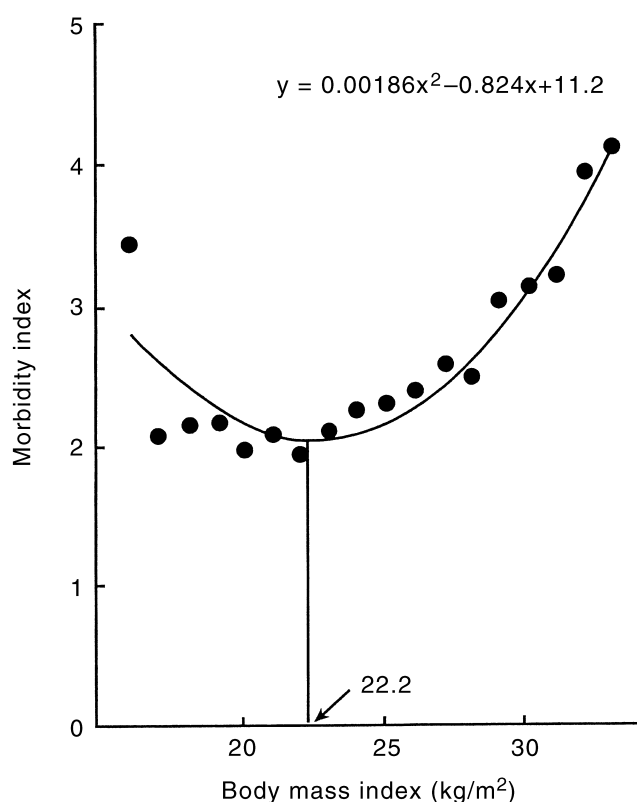

$$y = 0.00186x^2 - 0.824x + 11.2$$

Figure 1. Relation between body mass index (BMI) and morbidity in Japan (with the permission of Int J Obes).

in Japan, Tokunaga et al.[13] reported that the incidence of obesity-related diseases was observed least frequently when the body mass index (BMI), one of the physical indices applied as an obesity marker, is about 22 (Fig. 1). BMI is calculated by dividing body weight (in kilograms) by the square of the height (in centimeters). Tsukahara and Tamura[11] identified the BMI for ideal body weight, defined as 'highest longevity expectance' similar to the method used by the Metropolitan Life Insurance company in USA, at approximately 23.

Considering the viewpoint of quantity of life, JASSO defined standard body weight as 'a weight equivalent to the value of least incidence of the BMI morbidity rate (i.e. a BMI of 22), and recommended that standard body weight be determined by multiplying the square of height by 22 (height $(m)^2 \times 22$).[14] The JASSO proposed the criteria for obesity as 20% overweight against standard body weight in 1992. The value of BMI 26.4 is equivalent to 20% above standard body weight. In those days, the criteria of obesity were defined based on medical common sense but not on medical evidence.

Criteria and classification of obesity in Japan
In 1997, when WHO initiated the International Obesity Task Force (IOTF), the IOTF, with the assistance of the International Association for the Study of Obesity (IASO), proposed the criteria of overweight as a BMI between 25 and 30 and obesity as BMI equal to or above 30.[15] Using these criteria, however, it would appear that the prevalence of obesity in Japan would only be 1.79% in males and 3.00% in females.

In the same period, JASSO, with the assistance of Japanese Ministry of Health and Welfare, studied the relationship between the degree of obesity (BMI) and hypertension, diabetes and hyperlipidemia (triglycerides, HDL-cholesterol and total cholesterol).[16] A total of 150 000 men and women above 30 years of age were recruited from 15 cohorts in Japan. As shown in Table 1, the incidence of hypertension, hyperlipidemia (hypertriglyceridemia, hypo-HDL cholesterolemia and hyper-cholesterolemia) and hyperglycemia was increased in parallel with the increased in BMI. When we calculated the odds ratio in these diseases, BMI 22 (BMI 20–23.9) was estimated to have an odds ratio

Table 1. BMI and comorbidities

Incidence (%)		BMI	<15.9	16–17.9	18–19.9	20–23.9	24–25.9	26–27.9	28–29.9	>30	total division
Hypertension	male	78 855	13.2	17.7	17.9	22.6	30.6	35.6	42.2	46.9	total
	female	71 431	17.8	10.0	10.4	19.1	32.0	40.7	47.2	50.4	22.6
Hypercholesterolemia	male	76 076	10.7	11.3	14.5	23.6	29.4	32.0	36.3	36.8	25.6
	female	69 702	31.4	21.7	23.3	32.1	40.0	42.4	44.3	42.4	33.0
Hypo HDL-cholestetorotemia	male	76 066	1.8	3.6	4.2	9.3	15.7	19.7	24.1	28.1	12.3
	female	69 699	0.4	0.8	1.5	3.4	6.3	8.3	9.3	10.1	4.2
Hypertriglyceridemia	male	74 639	6.3	10.6	13.2	28.2	42.7	50.2	55.9	60.3	34.1
	female	67 417	5.9	5.0	8.7	18.9	31.8	36.9	41.3	44.2	21.3
Hyperglycemia	male	43 555	6.0	8.1	6.7	8.1	8.5	11.3	15.0	15.4	8.9
	female	25 101	8.2	3.6	3.3	4.7	8.6	11.8	16.4	19.4	6.0

of 1, and odds ratio of around 2 times higher was observed with BMI 25 for hypertension, hypertriglyceridemia and hypo-HDL-cholesterolemia, 29 for hypercholesterolemia, and 27 for diabetes. All these values fell into the category of overweight or preobese by WHO classification.[15] If we consider BMI ≥ 30 as obesity according to WHO criteria, we cannot explain the rapid increase in incidence of obesity-related diseases in Japan, since prevalence of obesity with this criteria would be less than 3%, as described above.

As shown in Fig. 2 the prevalence of subjects with BMI ≥ 25 in these cohorts was 21.43% in males and 18.85% in females, which implies that about 20% (one-fifth) were obese in Japan. These figures can explain the rapidly increased incidence of obesity-related chronic diseases (lifestyle-related diseases) like diabetes, hypertension and hyperlipidemia. Taken together, JASSO decided to define BMI ≥ 25 as obesity.[7] The proposed criteria for obesity is shown in Table 2 in comparison with the WHO criteria

We replaced 'overweight' in the WHO classification by 'obesity' in the JASSO classification. In summary, we have four grades of obesity, while WHO has three grades of obesity. Recent results based on the 1999 Japan Nutritional Survey showed that the prevalence of obesity (BMI ≥ 25) reached almost 30% in males 30–60 years of age and in females 50–70 years of age (Fig. 3).[17] The situation appears to have been worsening.

(%)
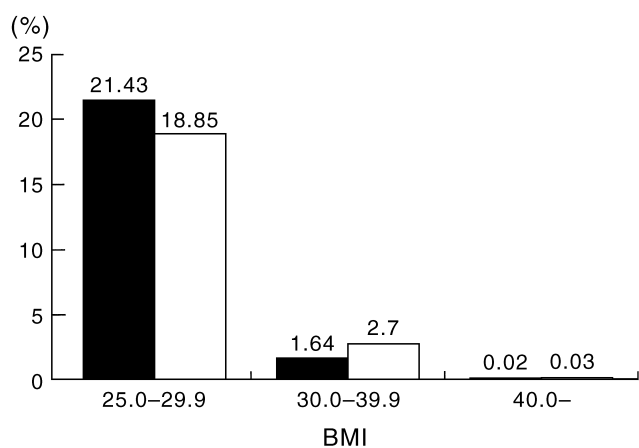
Figure 2. Prevalence of obesity from 15 cohorts study in Japan by the criteria of JASSO and WHO classifications.

Table 2. Classification of obesity in JASSO and in WHO

BMI	JASSO	WHO
< 18.5	Underweight	Underweight
18.5 ≥ – < 25	Normal weight	Normal weight
25 ≥ – < 30	Obese class 1	Pre-obese
30 ≥ – < 35	Obese class 2	Obese class I
35 ≥ – < 40	Obese class 3	Obese class II
≥ 40	Obese class 4	Obese class III

To examine whether this criteria can apply to the peoples of the Asia-Oceania region, the member countries of this region of IASO met twice in Hong Kong. We compared the data of seven countries (Japan, Korea, Philippines, Indonesia, Hong Kong, Malaysia and Thailand), and have come to the conclusion that the definition of BMI ≥ 25 as obesity is appropriate in the Asia-Oceania region where the main energy intake comes from carbohydrates (about 60%). We decided on the criteria of overweight as BMI between 23 and 25, since the data of Hong Kong clearly showed the incidence of obesity-related diseases significantly increased in subjects with BMI ≥ 23 (Table 3).[18] Thus, we propose that BMI ≥ 25 should be the cut-off for obesity in the peoples of Asia-Oceania region in addition to those in Japan.

With these developments, JASSO laid down the Tokyo Declaration, and the IASO committee of the Asia-Oceania region published an obesity guideline entitled, 'The Asia-Pacific Perspective Redefining Obesity and Its Treatment', to emphasize that obesity should be treated seriously.

Definition of pathological obesity

The next issue to be determined was how to differentiate pathological obesity from simple obesity. In addition to the degree of obesity, fat distribution is also an important factor for the incidence of obesity-related diseases. Obesity is classified into two types by fat distribution:

(1) upper body obesity, or abdominal obesity, or male-type obesity, in which fat mainly accumulates in the upper abdominal area (so-called 'apple type obesity'); and

(2) lower body obesity, or female-type obesity in which fat mainly accumulates in the gluteal area (so-called 'pear type obesity') (Fig. 4).[19]

The incidence of obesity-related diseases is more frequently associated with upper-body obesity than lower-body obesity.[20,21] Previously it was assumed that these two types could be differentiated by applying the waist-hip ratio (W/H), but it turned out that waist circumference is a more appropriate indicator.[22] In Japan, waist circumference over 85 cm in males and over 90 cm in females is classified as upper body obesity.[7]

It has also been reported that upper body obesity can be classified into two types by abdominal computer tomographic (CT) scanning:

1. visceral fat obesity, in which fat mainly accumulates around the visceral organs in the abdominal cavity; and

2. subcutaneous fat obesity in which fat mainly accumulates in the abdominal wall[23] as shown in Fig. 5.
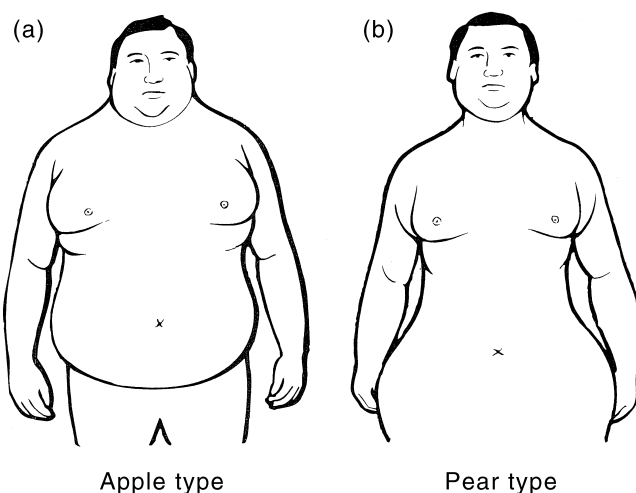
Previously visceral obesity was differentiated by the ratio of visceral fat area (V) and subcutaneous fat area (S):(V/S).[23] It has also turned out that total visceral fat area is more appropriate to use in differentiating the two types of upper body obesity.[24] Total visceral fat area over 100 cm[2] is classified into visceral obesity in Japan.[7] Visceral fat obesity has been reported to be more dangerous, because it is more closely correlated with the incidence of obesity-related diseases in Japan.[25] We believe that a similar situation will be found in the peoples of the Asia-Oceania region, where the
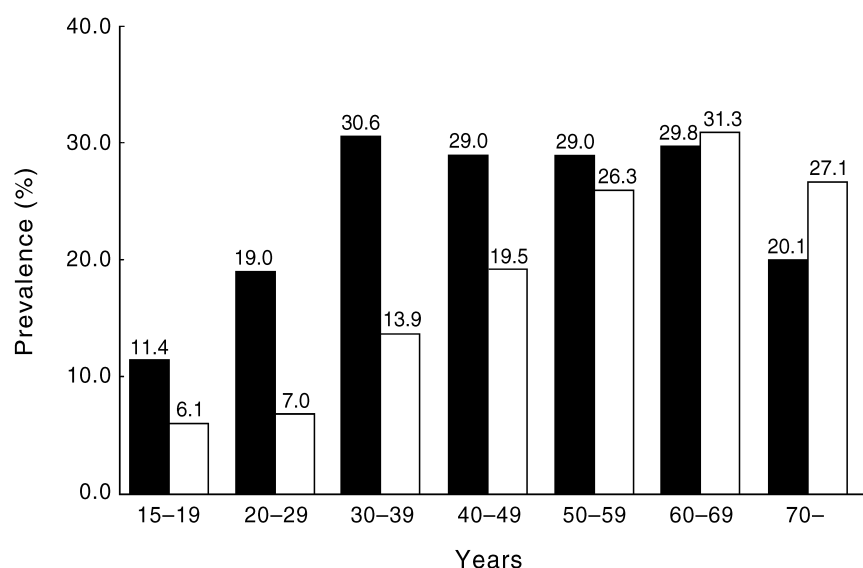
Figure 3. Prevalence of obesity in Japan according to the Japanese Nutritional Survey in 1999.

Table 3. Proposed classification of weight by BMI in adult Asians

Classification	BMI (kg/m^2)	Risk of comorbidities
Underweight	<18.5	Low (but increased risk of other clinical problems)
Normal range	18.5–22.9	Average
Overweight:	≥23	
At risk	23–24.9	Increased
Obese	25–29.9	Moderate
Obese	≥30	Severe

Apple type   Pear type

Figure 4. Illustration of upper body (apple-type) obesity and lower body (pear-type) obesity.

main energy intake comes from carbohydrates. Under these circumstances, JASSO proposed the criteria for pathological obesity as follows: In the case of BMI ≥ 25, if either the following conditions exist, we call it 'pathological obesity':
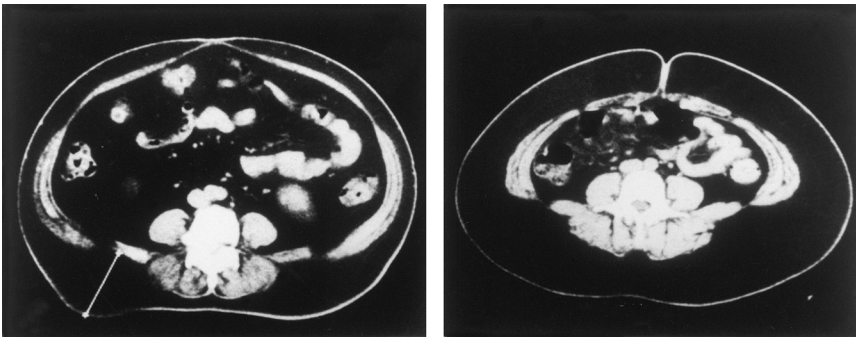
1. when the condition is associated with obesity-related diseases such as diabetes, hypertension hyperlipidemia, etc. or
2. when visceral fat obesity is confirmed by CT scanning even without obesity related diseases.[7]

Causes of obesity in Japan

What causes the increased prevalence of obesity in Japan? Several causes have been advanced: (i) overeating; (ii) errors of eating pattern; (iii) inactivity; (iv) heredity; and (v) disturbance in thermogenesis.

Hyperphagia and inactivity are two major risk factors for obesity. Hyperphagia may be an important factor in severe obesity in individuals. However, the average energy intake of adult people in Japan has not increased, in fact it has declined during the last 45 years, according to the results of National Nutritional Survey in Japan (Fig. 6).[17] During this period, the prevalence of obesity has increased around four times in males and three times in females. This indicates that inactivity may be the main cause for the increased prevalence of obesity in Japan. It is recognized that Japanese people in this modern age live in energy-saving societies. They enjoy excellent transportation system for moving, automatic machine systems in the work place, and good electrical equipment for housework.
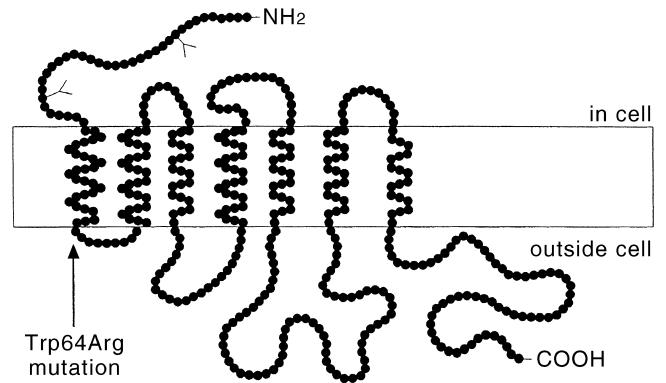
Figure 5. Illustration of visceral fat obesity and subcutaneous fat obesity by abdominal CT scanning.
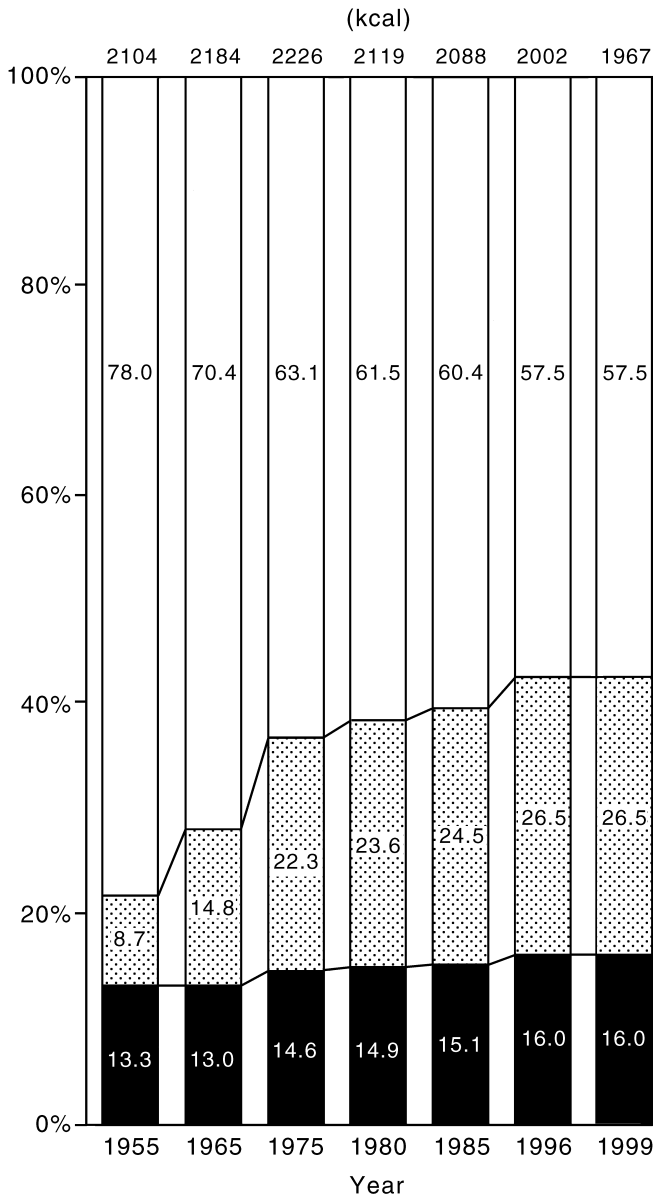
Figure 6. Average daily energy intake and fat content in Japan between 1955 and 1999 according to Japanese Nutritional Survey.

Figure 7. Illustration of the structure of β 3-adrenergic receptor and its mutation.

Figure 6 also tells us that an increased proportion of fat to total energy intake may also contribute to the increased prevalence of obesity in Japan. During the 1970s, Japanese economic growth rapidly expanded. At the same time, fat intake increased to 20% of energy intake, and prevalence of obesity remarkably increased during this period. Apart from the increase in fat intake, erroneous eating pattern such as irregular meal-taking, skipping breakfast, gorging or night eating, which induce energy saving metabolism in modern people, also contributed to the increased prevalence of obesity in Japan.

Another contributing factor is genetic disorder. The β 3-adrenergic receptor is the site of thermogenesis in diet-induced conditions or under cold-exposure conditions. Figure 7 illustrates the structure of the β 3-adrenergic receptor. Point mutation of tryptophan to arginine at the 64th amino acid sequence reduces the capacity of thermogenesis due to gene abnormality. This single polymorphism was first reported in Pima Indians in USA.[26] The incidence of this polymorphism is reportedly very high in Pima Indians, and around 80% of them become obese with diabetes by the time they are 40 years of age. Yoshida *et al.* reported that the incidence of this abnormality was around 20% among

Japanese.[27] This high incidence may also contribute to the increased prevalence of obesity in Japan.

Conclusion

JASSO has decided to define BMI ≥ 25 as obesity and classified obesity into 4 grades, whereas WHO defined BMI ≥ 30 as obesity and classified obesity into 3 grades. We propose that BMI ≥ 25 is the appropriate criteria for obesity in Japan and the Asia-Oceania region, where the main energy intake mainly comes from carbohydrates. If we accepted the higher cut-off, the prevalence of obesity would appear to be low, whereas the prevalence of obesity-related health problems in Japan and Asia-Oceania region is similar to those in Western societies.

Inactivity including lack of exercise may be the main cause for this mild obesity. Erroneous eating patterns in modern life and genetic abnormality among the Japanese may also contribute to the increased prevalence of obesity in Japan.

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