Epidemiology of Obesity in Japan

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Abstract: According to the 2000 National Nutrition Survey conducted in Japan, the percentage of overweight adults (body mass index [BMI]≥25) was 26.8% among men and 21.3% among women, while the percentage of obese persons (BMI≥30) was 2.2% for men and 3.5% for women among Japanese adults aged 20 years or older. In contrast, the percentage of underweight adults (BMI<18.5) was 4.8% for men and 10.3% for women, with the percentage of underweight individuals especially high among women aged 20–29 years (24.2%) and 30–39 years (17.5%). A comparison of the percentages of overweight adults in 1980, 1990, and 2000 revealed an increasing trend among men regardless of age group. This tendency was more marked in towns and villages than in large cities. Among women aged 20–49 years, the percentage of overweight individuals tended to decrease, with a marked increase noted in the percentage of those who were underweight. This tendency was more distinct in large cities than in towns and villages. Thus, Japanese women presented a contrasting picture of obesity and underweight. A large-scale cohort study done in Japan found a U-shaped dose-response relationship between BMI and all-cause mortality. The figures for all-cause mortality were lowest for men when BMI was 23.0–24.9 and for women when it was 21.0–22.9.

Key words: BMI (body mass index); Overweight/obesity; Underweight; All-cause mortality

Introduction

In order to evaluate obesity, a comprehensive assessment of body composition, distribution of body fat, partitioning of nutrient storage, energy intake, and energy expenditure is necessary.[1)] However, this paper focuses on body composition alone, with the method of assessment limited to the calculation of body mass index (BMI): BMI = (body weight [kg])/(height [m])^2. Measurement of height and weight is easy, inexpensive, and accurate, and highly accurate values can be obtained even through self-reporting. The reproducibility of such data is also adequate to allow useful comparison of differences between groups of people and between annual changes in a particular group. BMI is strongly correlated with total body fat

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as determined by densitometry or skinfold thickness, whereas its correlation with height is low.[2] Accordingly, BMI plays a central role in epidemiologic studies of obesity in adults.

This paper describes the percentage of overweight adults (BMI≥25.0) in Japan and annual variations in this percentage on the basis of data from national nutrition surveys conducted by the Ministry of Health, Labor and Welfare. Large-scale cohort studies on BMI and mortality from all causes are also reviewed. It is a well-established concept that obesity is associated with cardiovascular risk factors (e.g. hypertention, hyperlipidemia and glucose intolerance), metabolic syndrome, stroke, and myocardial infarction/angina pectoris. On the other hand, a negative correlation has been observed between obesity and cancer in certain organs.[3] Thus, it does not necessarily hold true that the lower the BMI the better. This paper attempts to provide an estimate of appropriate BMI from the standpoint of lowering all-cause mortality.

Percentages of Overweight, Obese, and Underweight Adults in Japan

According to the 2000 National Nutrition Survey, the percentages of overweight men and women (BMI≥25.0) aged 20 years or older were 26.8% and 21.3%, respectively (Table 1).[4] According to our calculations, the percentages of obese adults (BMI≥30.0) aged 30 years or older were 2.2% and 3.5% for men and women, respectively, (Table 1).[5] Table 2 shows the percentages of obese persons (BMI≥30.0) (international comparison) provided in a WHO technical report,[1] although it is difficult to compare Japanese data with those of other countries because of differences in figures for sex, age structure, and year of survey. Taking into account the years of survey (and the fact that obesity tends to be increasing in all countries), it can be said that the percentage of obesity is very low in Japan.

On the other hand, the percentages of underweight men and women (BMI<18.5) aged 20

Table 1 Distribution of BMI Categories by Sex and Age Group

	Age of years	Total (No. of subjects)	Underweight (BMI<18.5)	Normal (18.5≤BMI<25.0)	Overweight (BMI≥25.0)	Obese (BMI≥30.0)
Male	Total	100.0% (3,763)	4.8%	68.5%	26.8%	2.2%
	20–29	100.0 (512)	6.3	75.2	18.6	—
	30–39	100.0 (556)	4.1	68.5	27.3	3.1
	40–49	100.0 (627)	2.7	68.4	28.9	2.5
	50–59	100.0 (775)	3.9	66.2	29.9	2.6
	60–69	100.0 (740)	3.2	66.1	30.7	2.4
	≥70	100.0 (553)	9.6	68.7	21.7	0.2
Female	Total	100.0% (4,542)	10.3%	68.5%	21.3%	3.5%
	20–29	100.0 (554)	24.2	69.0	6.9	—
	30–39	100.0 (703)	17.5	69.6	12.9	2.8
	40–49	100.0 (766)	5.5	74.3	20.2	4.0
	50–59	100.0 (962)	5.4	71.0	23.6	3.6
	60–69	100.0 (799)	5.8	63.2	31.0	4.2
	≥70	100.0 (758)	9.2	63.5	27.3	2.9

Note: Pregnant women were excluded. Data on obesity were limited to the persons aged 30 years or older.
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002./*Cardiovascular Disease Prevention Study Group (ed.): *Complete Data from the 5th Basic Survey of Cardiovascular Disease — Numerical Profile of the Status of Cardiovascular Disease*. Chuohoki Publishers, Tokyo, 2003.)

years or older were 4.8% and 10.3%, respectively. In relation to age group, the percentage was particularly high in women between 20 and 29 years of age (24.2%) and 30 and 39 years of age (17.5%) (Table 1).

Table 2 International Comparison of Prevalence (%) of Obese Persons (BMI≥30.0)

Country	Year of survey	Age of years	Male	Female
US	1988–1994	20–74	19.9	24.9
Canada	1986–1990	20–70	15.0	15.0
Brazil	1989	25–64	5.9	13.3
UK	1995	16–64	15.0	16.5
Germany	1992	25–65	20.5	26.8
Netherlands	1995	20–29	8.4	8.3
Sweden	1988–1989	16–84	5.3[*1]	9.1[*1]
Australia	1989	25–64	11.5	13.5
Japan	1993	≥20	1.8	2.6
Japan	2000	≥15	2.3[*2]	3.3[*2]

[*1]Percentage of persons with BMI≥28.6.
(From WHO: *Obesity: Preventing and Managing the Global Epidemic — Report of a WHO Consultation*. WHO, Geneva, 2000./ [*2]-Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

Table 3 presents mean BMI values and standard deviations according to sex and age obtained from the 2000 National Nutrition Survey.[4)]

Annual Changes in the Percentages of Overweight and Underweight Adults in Japan

Figure 1 compares the percentages of overweight adults (BMI≥25.0) in Japan for the years 1980, 1990, and 2000.[4)] Among men, the percentage of overweight adults tended to increase in every age group, although the increase has slowed over the past decade in those in their 20s and 40s. Among women, the percentage of overweight adults tended to decrease in the younger generations, but not among those aged 60 years or older. For women in their 60s, the increasing tendency reversed between 1990 and 2000, and the

Table 3 Mean BMI and Standard Deviation by Sex and Age Group

Age of years	Male			Female		
	No. of subjects	Mean value	Standard deviation	No. of subjects	Mean value	Standard deviation
Total	4,036			4,730		
15–19	273	20.7	3.0	292	20.4	2.6
20–29	512	22.4	3.4	514	20.5	3.2
30–39	556	23.4	3.3	650	21.5	3.5
40–49	627	23.5	3.3	760	22.7	3.5
50–59	775	23.6	3.0	960	23.6	17.3
60–69	740	24.2	13.5	797	23.6	3.5
≥70	553	22.6	3.0	757	23.1	3.5
(Re-sorted)						
≥20	3,763	23.2	3.2	4,542	22.5	3.6
60–64	405	24.9	18.0	447	23.4	3.3
65–69	335	23.3	3.2	350	23.9	3.7
70–74	266	23.1	3.0	336	23.6	3.5
75–79	161	22.5	3.1	227	23.2	3.2
≥80	126	21.5	2.8	194	22.0	3.6

Note: Subjects were 15 years old or older, and pregnant women were excluded.
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

increase in the percentage among women aged 70 years or older during this period was smaller than in the previous decade. These changes may reflect a diet-oriented trend among Japanese women.

When attention was focused on underweight adults (BMI<18.5) (Fig. 2), the percentage of such men tended to decrease, whereas it increased markedly among women in their 20s and 30s. Over the past decade, the percentage of underweight adults also increased slightly among women in their 40s and 50s. Thus, a contrasting picture of obesity and undernutrition — "undernutrition in an age of gluttony" — has emerged among young women in Japan.

Figure 3 shows the percentages of overweight adults in large cities, smaller cities, and towns and villages (N. Yoshiike: personal communication). Among men aged 20–49 years, the percentage of those overweight increased

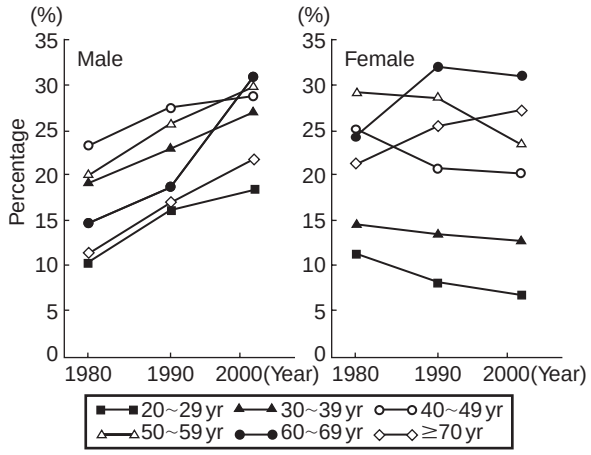

Fig. 1 Annual changes in the percentage of overweight adults (BMI≥25.0)
(From Health and Nutritional Information Study Group (ed.): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

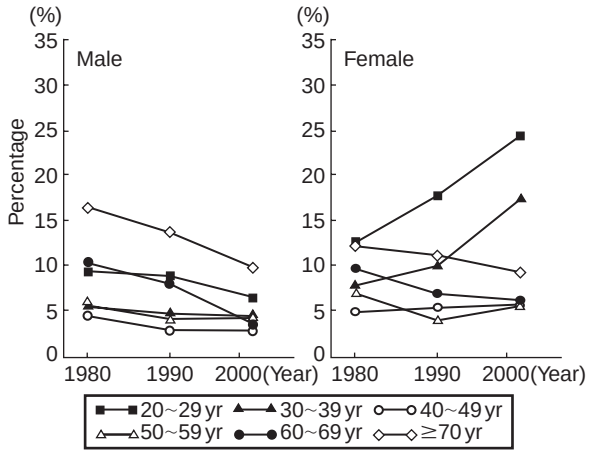

Fig. 2 Annual changes in the percentage of underweight adults (BMI<18.5)
(From Health and Nutritional Information Study Group (ed): *Current Status of National Nutrition — Results of the 2000 National Nutrition Survey*. Dai-Ichi Shuppan Publishing, Tokyo, 2002.)

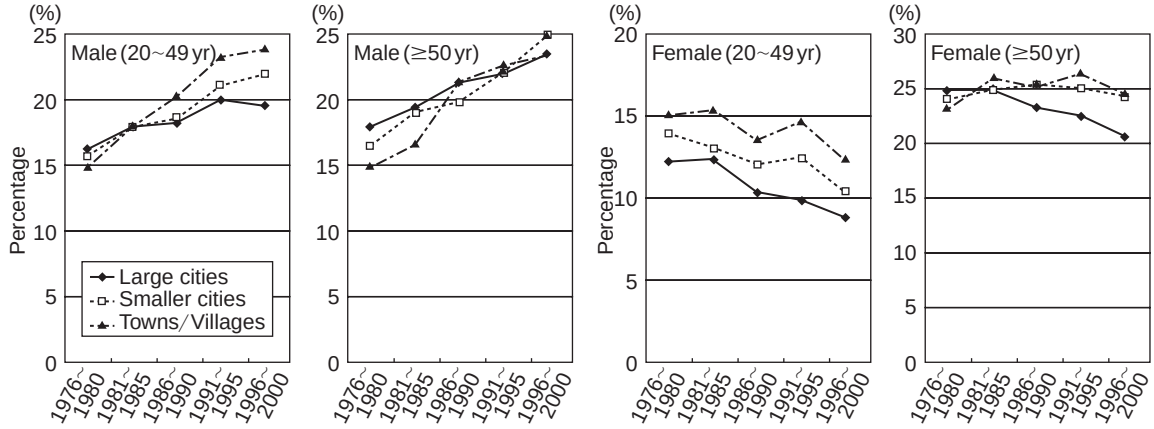

Fig. 3 Annual changes in the percentage of overweight adults (BMI≥25.0)
(Data calculated by N. Yoshiike, from the results of the 1976–2000 National Nutrition Surveys conducted by the Ministry of Health, Labor and Welfare)

markedly in towns and villages. The reason for this increase is presumed to be an increased use of cars (for commuting, etc.) and insufficient physical activity, in addition to decreased work intensity and shortened working hours in primary industries such as farming. Among women, the percentage of those overweight generally tended to decrease. The percentage was particularly low in women aged 20–49 years living in large cities. Among women aged 50 years or older, the percentage of those overweight also decreased in large cities. It has become apparent that the issue of increasing obesity is specific to men living in towns and villages, while that of underweight individuals is specific to women living in large cities. Measures to control obesity at the population level in this country should take into account sex, age (generation), and living environment. Undernutrition in young women may become an important issue in maternal and child health.

Large-Scale Cohort Studies on BMI and All-Cause Mortality

A very large sample size is necessary when people are classified according to BMI into a large number of categories and the all-cause mortality for each category is determined. The study design most suitable for determining

Table 4 BMI and All-Cause Mortality (US Caucasian Adults, 1982–1996)

	BMI	<18.5	18.5–20.4	20.5–21.9	22.0–23.4	23.5–24.9	25.0–26.4
Male	No. of deaths	93	305	734	1,523	2,085	2,250
	Person-year	5,438	19,847	61,863	148,107	216,788	239,158
	Age-adjusted mortality	1,270	1,133	1,022	953	956	1,007
	Multivariate-adjusted relative risk*	1.26	1.19	1.09	1.01	1.00	1.04
	95% confidence interval	1.02–1.56	1.05–1.34	1.00–1.18	0.95–1.07	—	0.98–1.10
Female	No. of deaths	680	2,054	3,003	3,344	3,133	2,522
	Person-year	55,362	314,575	495,542	507,570	422,903	302,692
	Age-adjusted mortality	923	732	671	653	673	727
	Multivariate-adjusted relative risk*	1.36	1.10	1.00	0.97	1.00	1.07
	95% confidence interval	1.25–1.48	1.04–1.16	0.95–1.05	0.93–1.02	—	1.01–1.13
	BMI	26.5–27.9	28.0–29.9	30.0–31.9	32.0–34.9	35.0–39.9	≥40.0
Male	No. of deaths	1,738	1,338	592	398	153	19
	Person-year	181,735	125,967	56,682	32,878	11,079	1,315
	Age-adjusted mortality	1,058	1,255	1,300	1,619	2,076	2,065
	Multivariate-adjusted relative risk*	1.09	1.28	1.32	1.66	2.17	2.58
	95% confidence interval	1.02–1.16	1.19–1.37	1.21–1.45	1.49–1.85	1.84–2.56	1.64–4.06
Female	No. of deaths	2,173	1,913	1,225	953	462	144
	Person-year	261,253	215,245	130,432	95,505	48,414	14,372
	Age-adjusted mortality	755	837	908	1,083	1,216	1,399
	Multivariate-adjusted relative risk*	1.10	1.21	1.30	1.53	1.76	2.00
	95% confidence interval	1.04–1.17	1.14–1.28	1.22–1.39	1.42–1.65	1.60–1.94	1.69–2.36

The subjects were never-smokers who had no history of cancer, heart disease, stroke, chronic bronchitis, pulmonary emphysema, bronchial asthma, or weight loss of over 10 lb (4.53 kg) in the previous year.
Age-adjusted mortality is expressed in deaths per 100,000 person-years.
*Multivariate-adjusted relative risk: Using Cox proportional hazard model. Adjusted variates: Age, education level, physical activity, alcohol consumption, marital status, aspirin therapy, fat intake, vegetable intake, and estrogen replacement therapy (women).

(From Calle, E.E. *et al.*: *N Engl J Med* 1999; 341:1097–1105.)

the optimal value of BMI for longevity, using total mortality as an index, is the cohort study. In addition, those with diseases, such as cancer, that may lead to undernutrition or underweight at baseline should be excluded from the cohort. Since it is impossible to perform a thorough examination of every subject in the cohort to determine the presence/absence of disease, it is necessary to exclude from analysis subjects who die in an early phase of the follow-up period. Only a few studies fulfill these requirements.

Calle *et al.*[6] studied a cohort of 457,785 male and 588,369 female volunteers from all areas of the US who had never smoked and had no history of disease. The follow-up period was between 1982 and December 1996. Table 4 shows the results for Caucasian men and women. Among Caucasian men, the relative risk (RR; after being adjusted for confounding variables) of total mortality was lowest when BMI was 23.5–24.9. The relative risk at a BMI of 22.0–23.4 or 25.0–26.4 was slightly higher, but not statistically significantly different, than that at a BMI of 23.5–24.9. The dose-response relationship showed a J-shaped curve, with an RR of 1.26 at BMI<18.5 (lowest BMI category) and an RR of 2.58 at BMI≥40.0 (highest BMI category). Among Caucasian women, RR was lowest when BMI was 22.0–23.4. However, there was no statistically significant difference from the reference (RR = 1.00) at BMI of 23.5–24.9. The dose-response curve was J-shaped, showing an RR of 1.36 at BMI<18.5 and RR of 2.00 at BMI≥40.0.

Tsugane *et al.*[7] reported the results of a 10-year follow-up of the cohort of the JPHC Study (Japan Public Health Center-Based Prospective Study on Cancer and Cardiovascular Diseases) supported by the Ministry of Health,

Table 5 BMI and All-Cause Mortality (Japanese Adults, 1990–1999)

	BMI	14.0–18.9	19.0–20.9	21.0–22.9	23.0–24.9	25.0–26.9	27.0–29.9	30.0–39.9
Male	All deaths during follow-up							
	No. of deaths	67	184	268	202	121	74	27
	Person-year	6,324	27,132	48,984	53,740	32,856	16,320	3,854
	Multivariate-adjusted relative risk*	2.26	1.57	1.33	1.00	1.14	1.38	1.97
	95% confidence interval	1.66–3.08	1.25–1.98	1.09–1.63	—	0.90–1.45	1.03–1.83	1.27–3.06
	Excluding deaths occurring in the first 5 years of follow-up							
	No. of deaths	41	116	158	129	81	40	14
	Multivariate-adjusted relative risk*	2.35	1.66	1.30	1.00	1.19	1.19	1.51
	95% confidence interval	1.58–3.49	1.24–2.22	1.01–1.69	—	0.90–1.61	0.81–1.73	0.81–2.82
Female	All deaths during follow-up							
	No. of deaths	42	66	111	99	82	58	25
	Person-year	10,005	31,399	54,863	52,436	33,238	20,866	6,619
	Multivariate-adjusted relative risk*	1.94	0.98	0.99	1.00	1.30	1.33	1.91
	95% confidence interval	1.30–2.89	0.69–1.40	0.74–1.32	—	0.96–1.76	0.94–1.88	1.22–2.99
	Excluding deaths occurring in the first 5 years of follow-up							
	No. of deaths	23	44	64	68	51	28	16
	Multivariate-adjusted relative risk*	1.46	0.91	0.82	1.00	1.13	0.90	1.72
	95% confidence interval	0.87–2.46	0.59–1.39	0.57–1.17	—	0.78–1.64	0.57–1.44	0.99–2.98

*Multivariate-adjusted relative risk: Using Cox proportional hazard model. Adjusted variates: Region of survey, age, smoking status, alcohol consumption, education level, sports/recreational physical activity, and weight gain or loss of over 5 kg after 20 years of age.

(From Tsugane, S. *et al.*: *Int J Obes Relat Metab Disord* 2002; 26: 529–537)

Labor and Welfare (Table 5). A total of 27,063 men and 27,435 women aged 40–59 years living in Iwate, Akita, Nagano, Ishikawa, and Okinawa Prefectures were surveyed at baseline in January 1990 and followed until December 1999. In men, the relative risk of all-cause mortality was lowest (RR = 1.00) when BMI was 23.0–24.9. The dose-response curve was U-shaped, showing an RR of 2.26 at a BMI of 14.0–18.9 (lowest BMI category) and an RR of 1.97 at a BMI of 30.0–39.9 (highest BMI category). This U-shaped association did not change after excluding deaths occurring in the first 5 years of follow-up. In women, the relative risk was lowest (RR = 0.98) when BMI was 19.0–20.9. There was also a U-shaped dose-response relationship, with an RR of 1.94 at a BMI of 14.0–18.9 and an RR of 1.91 at a BMI of 30.0–39.9. Again, the U-shaped association was hardly changed after excluding deaths that occurred during the first 5 years of follow-up. However, the lowest relative risk (RR = 0.82) was obtained when BMI was 21.0–22.9.

Thus, there is clear evidence from the above-mentioned studies and a number of other studies that there is a J-shaped or U-shaped dose-response relationship between BMI and all-cause mortality. It has been noted that pneumonia and stroke (particularly intracerebral hemorrhage) are responsible for the increased all-cause mortality among underweight persons.[8,9] This was also demonstrated in epidemiologic studies of stroke carried out in Japan during its era of high-speed economic growth.[10–12]

Conclusion

The percentages of obese men and women (BMI≥30.0) in Japan who are 30 years old or older are 2.2% and 3.5%, respectively (Table 1). These figures are much lower than those found in Western countries. The percentage of overweight men (BMI≥25.0) is tending to increase, particularly in rural rather than urban areas. Although obesity is not a current public health issue in Japan, it is possible that it may surface as a future problem. Therefore, greater importance should be attached to counteracting obesity through preventive measures rather than through the treatment of obesity itself. The target should be men in particular. The percentage of obesity is decreasing among young women, a feature that seems peculiar to Japan. Thus, there is a double structure of obesity and a new type of "undernutrition." For Japanese women, the need to control underweight is greater than that for obesity control.

The dose-response relationship between BMI and all-cause mortality is generally J- or U-shaped, suggesting that not only obesity but also underweight is an important issue in preventive medicine. Lower all-cause mortality seems to be associated with a BMI of 23.0–24.9 in adult men and 21.0–22.9 in adult women in Japan. Being "slightly plump" is favorable for men in terms of mortality in both Japan and the US. Although WHO has prescribed a normal range of BMI of 18.50–24.99,[1] the BMI figures for Japanese people correspond to the upper one-third of this range.

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