

Height, Weight, and Body Mass Index of Elderly Persons in Taiwan

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Background. In Taiwan, distributions of body composition are usually generated for children, adolescent, and middle-aged groups. This study describes three anthropometric measures (i.e., height, weight, and body mass index [BMI]) of elderly persons in Taiwan.

Methods. The data was derived from a prospective cross-sectional, population-based geriatric survey funded by the National Department of Health in Taiwan in 1991. A total of 2,600 subjects were successfully evaluated. A descriptive analysis was performed to generate distributions of height, weight, and BMI of elderly persons. Based on these descriptive data, the prevalence of overweight and obesity was estimated, and a cross-national comparison on the prevalence of obesity was made.

Results. Age-group-specific means and standard deviations for height, weight, and BMI of Taiwanese elderly persons were presented. By gender, the elderly men were taller and heavier than the elderly women; however, the women had a higher mean value of BMI (kg/m²). The prevalence of overweight was 27.3% in men and 34.9% in women; the prevalence of obesity was 3.2% in men and 6.4% in women. The prevalence of obesity for the elderly men and women in Taiwan was lower than in Kuwait, Sweden, the United States, and the Native Americans, but higher than in Japan.

Conclusions. The comparison indicates cross-cultural differences existing in the prevalence of obesity, which may be due to aging, nutritional status, or environmental factors. For future research, the relationship of anthropometric data to socioeconomic status and behavioral factors will be examined.

ANTHROPOMETRY has been used at different ages for assessing health, nutrition, and social well-being. Height and weight are two of the most easily obtained anthropometric measures. Therefore, height and weight have been used extensively in screening and monitoring programs because overweight and obesity have been considered as risk factors for various diseases (1–5). In Taiwan, the distributions of body composition are usually generated for children, adolescents, and adults between the ages of 19 and 64 years, most of them from the perspective of nutrition (6–9). As an example, Huang and his colleagues (8) conducted a study on body weight, height, and body mass index (BMI) of Taiwanese aged 20–64 years that showed mean values of height, weight, and BMI were higher for men than for women. Also, it found that mean height decreased with age for all age groups for men and women, but the increasing trend in BMI was only up to 40–49 years of age for men and women. However, no extensive effort had been made for exploring the relationship between the change of BMI and aging.

Similar studies were also conducted in other countries (10–15). Kuskowska-Wolk and Bergstrom (10) assessed the changes in BMI and the prevalence of obesity in Swedish men and women (aged 16–84 years) and found that the mean BMI and the prevalence of overweight and obesity in adult men and women increased between 1980–1981 and 1988–1989, especially in the group aged 25–34 years (10). With respect to the U.S. population, Kuczmarski and his as-

sociates (16) confirmed that the mean values of BMI increased with each 10-year increment until 50 through 59 years of age for both men and women and then decreased with age. The trend in the prevalence of overweight followed a similar pattern. It should be noted that the reviewed studies investigated samples with a wide range of age groups and did not focus on the elderly population.

With respect to further cross-national literature evidence, several researchers called more attention to the elderly population and studied the changes in body composition related to aging (16–20). For cross-national comparison, Launer and Harris compared anthropometric data (height, weight, and BMI) from 19 geographically and ethnically varied samples of community-dwelling elderly people (19). Across the studies there were large differences in the prevalence of overweight and underweight, but in all studies the mean values of height and BMI decreased with age. Geographically, the Mediterranean samples were larger than samples from Western Europe, Asia, Africa, and the United States.

Therefore, it is important to generate more information on body composition of elderly persons in order to trace down the relationship of anthropometric data to clinical diagnosis and aging process. To contribute more empirical evidence to aging studies, the present study focuses on the body composition of an elderly population sample in Taiwan. Three objectives of the study are intended. First, we describe height, weight, and BMI of elderly persons in Tai-

wan. Second, the relationships between the three anthropometric parameters are examined by age and gender. Third, a comparison on the prevalence of obesity in the Taiwanese elderly population with other countries is made.

METHODS

Sample and Data

The data for the present study were derived from a nationwide geriatric survey funded by the National Department of Health (i.e., equivalent to Ministry of Health) in Taiwan from 1989 to 1991. The original purpose of this geriatric epidemiological study was to evaluate disease patterns, health status, and lifestyle of the community elderly population aged 65 years or more. The study design was a prospective cross-sectional, population-based community survey. A stratified random sampling was used to select the study sample. The entire nation was first divided into four geographical regions. Within four regions, four cities (i.e., Taipei, Taichung, Kaohsiung, and Hualian, for each region) were designated in considering the availability of medical centers in each city. Each medical center served as the major study site to conduct the survey and collect targeted information of the sampled elderly persons dwelling in each city. Except for Hualian, the other three study sites were metropolitan areas. Therefore, the study sample may represent an urban community-dwelling elderly population.

The base administrative unit, Li, was used as the last stratum for random sampling. An elderly man and woman of each Li in the three study cities (i.e., Taipei, Taichung, and Kaohsiung) were recruited for the study. Two men and two women of each Li in Hualian were sampled because of its relatively small population size. The household data were obtained from city census bureaus, which were responsible for population registry of birth and death. Based on this random sampling design, 4,543 subjects were on the list and had been invited to participate in the study. At the end, a total of 2,600 participants completed the survey from April 1989 to June 1991, with a participation rate of 48.6%. Although the participation rate was modest, chi-squared statistics ($\chi^2 = 4.012$, $df = 4$, $p = .404$) indicated that the distributions of different age groups of participants did not significantly differ statistically from the entire elderly population in Taiwan. The data for the chi-squared test was based on the national census data derived from the National Department of Health in Taiwan.

Measurement and Analysis

The participants were invited to the designated medical centers for a comprehensive health status examination that was combined with physical, neurological, and laboratory evaluations. Also, a questionnaire on past medical history, alcohol consumption, cigarette smoking, and other questions related to lifestyle and health status was administered. Home visits and assessments were arranged for the subjects with physical or transportation problems (primarily because of bedridden status).

Three major anthropometric measures were used in the present study. At the time of taking comprehensive health examinations, height and weight of the participants were measured simultaneously by using Detecto scales (Detecto Scales,

Inc., Brooklyn, NY). Standing height without shoes was measured to the nearest 0.1 cm. Body weight was measured to the nearest 0.1 kg, with the participant wearing light clothes and without shoes. No adjustment was made for clothing weight. The participants (i.e., 49 of 2,600) receiving physical examinations at their home were asked by visiting physicians to self-report current height and weight for calculating BMI. The same procedures and equipment of measuring height and weight were used at four medical centers for the survey.

BMI is used to display body composition of a person. To calculate BMI, the weight (in kg) is divided by height (in m^2). To measure the prevalence of overweight and obesity, the criteria of the World Health Organization (WHO) were adopted (21). The sample falling in the BMI categories between 25 and 30 were considered overweight; those with a BMI over 30 were obese. Similar BMI criteria were also addressed in the executive summary released by the National Heart, Lung, and Blood Institute: overweight is defined as a BMI of 25 to 29.9, and obesity as a BMI of equal or greater than 30 (22). Moreover, the information on the prevalence of overweight and obesity of other countries was derived from literature review.

A descriptive analysis was performed to generate means and standard deviations (*SD*) of height, weight, and BMI of elderly persons by age and gender. Whisker plots were used to demonstrate the distributions of height, weight, and BMI by each age group. The differences in mean values of three anthropometric parameters among different groups were examined for both men and women by using analysis of variance (ANOVA). Furthermore, the Bonferroni method was used for the post hoc comparison between age groups. Finally, a cross-national comparison on the prevalence of obesity was made based on statistics discovered in empirical evidence, which includes the anthropometric data in Asia (Japan), the Middle East (Kuwait), Europe (Sweden), and the United States.

RESULTS

Of a total 2,600 elderly subjects included in the analysis, 1,322 were men and 1,278 were women. Approximately 42% of the sample were aged 65–69 years, 35% aged 70–74 years, 18% aged 75–79 years, 4% aged 80–84 years, and only 1% aged 85 years or more.

Table 1. Mean Values of Height, Weight, and Body Mass Index (BMI) for Elderly Persons in Taiwan

Age Group (years)	<i>n</i>	Height (cm)	Weight (kg)	BMI (kg/m ²)
Men				
65–69	507	164.4 ± 5.9	64.1 ± 9.8	23.7 ± 3.2
70–74	481	163.7 ± 6.1	63.7 ± 10.7	23.7 ± 3.4
75–79	265	163.1 ± 7.0	62.6 ± 11.3	23.5 ± 3.7
80–84	55	162.6 ± 5.5	60.4 ± 10.0	22.8 ± 3.5
85+	14	160.6 ± 5.9	54.8 ± 6.9	21.3 ± 2.9
Total	1322	163.8 ± 6.2	63.4 ± 10.5	23.6 ± 3.4
Women				
65–69	578	152.5 ± 5.3	57.2 ± 8.8	24.6 ± 3.5
70–74	435	150.9 ± 5.5	55.7 ± 9.8	24.4 ± 3.9
75–79	203	149.0 ± 5.4	53.8 ± 8.5	24.2 ± 3.7
80–84	47	147.3 ± 7.1	50.8 ± 9.5	23.4 ± 4.1
85+	15	145.4 ± 2.9	45.7 ± 7.9	21.6 ± 4.1
Total	1278	151.2 ± 5.6	55.8 ± 9.3	24.4 ± 3.7

Mean Values of Height, Weight, and BMI

Classified by gender, mean values of height, weight, and BMI are presented in Table 1. The mean height for the elderly men and women was 163.8 cm ($SD = 6.2$) and 151.2 cm ($SD = 5.6$), respectively. Therefore, men were taller than women on average. The mean weight for the elderly men was 63.4 kg ($SD = 10.5$), whereas it was 55.8 kg ($SD = 9.3$) for the women. However, the women had a higher mean value of BMI compared with the men, that is, 24.4 ($SD = 3.7$) for women compared with 23.6 ($SD = 3.4$) for men.

The statistics presented in Table 1 also revealed mean values of height, weight, and BMI decreased with age for both men and women. With weight, the differences among age groups were even more notable in the women. The men's 65–69-year age group was almost 10 kg heavier than the group aged 85 and older. On the other hand, the women aged 65–69 years were 11.5 kg heavier than those aged 85 years and older.

Distribution by Whisker Plots

The distributions of height, weight, and BMI were plotted by age groups (Figures 1–3). Each figure is further described by gender. The mean value of height decreased with age for the men (Figure 1, top) as well as for the women (Figure 1, bottom). Similar decreasing trends were also found in the mean of

weight (Figure 2) and BMI (Figure 3), with visible differences between the men and women. The magnitude of decrease in the three measures of anthropometric data was relatively moderate before the age of 80. The decreasing rates were most significant for the age group moving from 80–84 years to the group aged 85 and older, especially for weight in the men.

Percentiles of the Mean BMI

Specific attention was placed on BMI. The percentiles of the mean BMI are calculated by age and gender as presented in Table 2. Generally, the values between the 25th and the 75th percentiles of the sample have been considered a normal range (8). Accordingly, the normal range for the mean BMI of the men was 21.4 to 25.6, and the normal range for the mean BMI of the women was 22.2 to 26.5. For the 50th percentile of the men, the mean BMI was from 20.4 to 23.6 for five age groups. On the other hand, the mean BMI of the 50th percentile of the women was from 21.9 to 24.4.

Differences in the Mean Values of Height, Weight, and BMI

The differences in mean values of height, weight, and BMI among different age groups were further examined by ANOVA analysis. By gender, the results of ANOVA analyses indicated that mean values of height, weight, and BMI

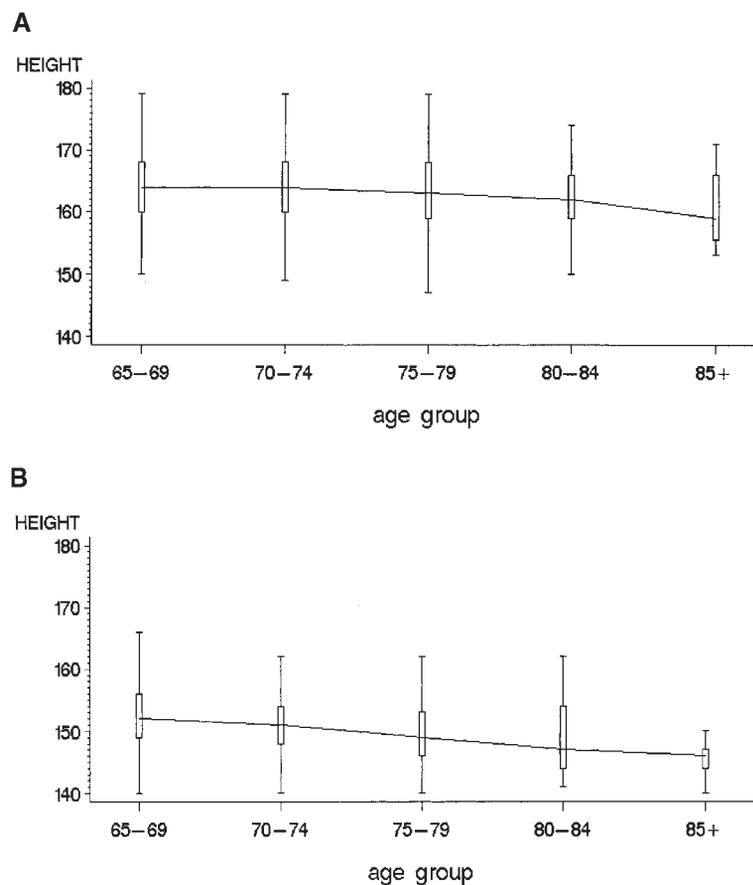


Figure 1. Distributions of mean height plotted by age group for elderly men, **A**, and women, **B**, in Taiwan.

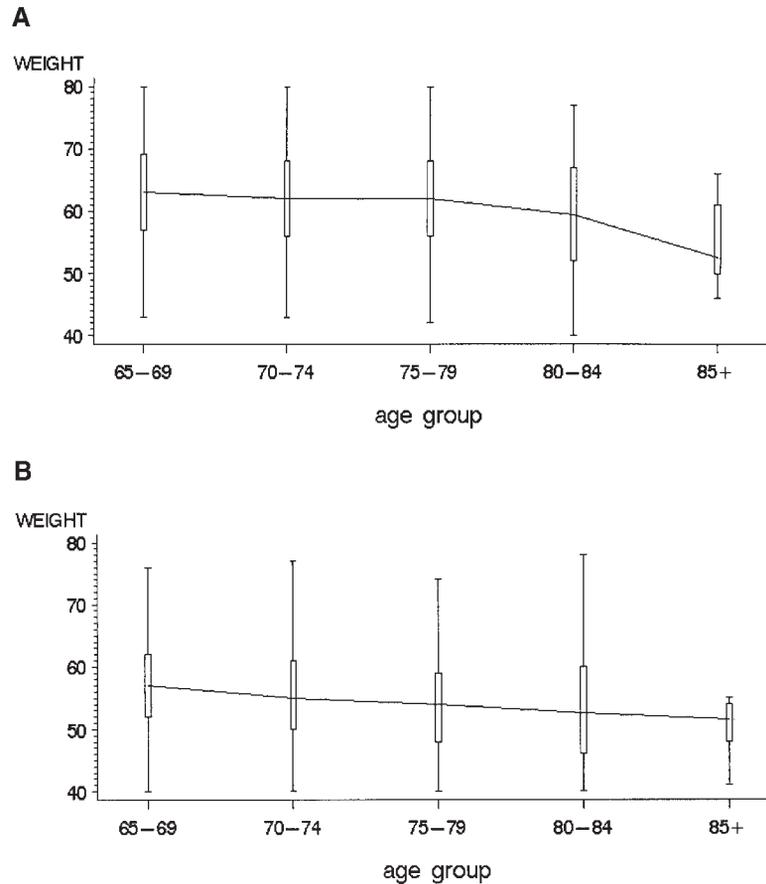


Figure 2. Distributions of mean weight plotted by age group for elderly men, **A**, and women, **B**, in Taiwan.

were significantly different among five age groups for both men and women ($p < .05$ or less). For women, significant differences in the mean values of height [$F(4,1222) = 23.65$], weight [$F(4,1220) = 11.58$], and BMI [$F(4,1217) = 2.47$] were found among the five age groups.

Furthermore, the Bonferroni method was used for the post hoc comparison between groups. For multiple comparisons, a significant level of .01 was used to declare statistical significance. In doing so, significant differences between pairwise groups were found in the mean values of height and weight for the elderly women, but not in the mean BMI. On average, the youngest group of women (65–69 years) was significantly taller than the other four age groups (that is, 70–74, 75–79, 80–84, and 85+ years; $p < .01$). By the same token, the women aged 65–69 years were also significantly heavier than three age groups (75–79, 80–84, and 85+ years; $p < .01$); those women aged 70–74 were significantly heavier than the age group 80–84 years ($p < .01$). For men, no significant differences in the mean values of height, weight, and BMI were found between groups. Because of this article's length limitations, we do not present the ANOVA tables and the detailed results of Bonferroni tests, but only describe the partial results.

Prevalence of Overweight and Obesity

According to the WHO cutoff points of overweight and obesity, the prevalence rates of the male and female samples

are presented in Table 3. Overall, the prevalence of overweight and obesity was 29.8% and 4.54%, respectively, for elderly persons in Taiwan. By gender, the prevalence of overweight ($25 \leq \text{BMI} \leq 30$) was 27.3% and 34.9% for men and women, respectively. The prevalence of obesity ($\text{BMI} > 30$) was 3.2% in men and 6.4% in women. The highest prevalence of overweight was found in women aged 65–69 years (36.4%), whereas the highest prevalence of obesity was found in women aged 70–74 years (7.6%).

Cross-National Comparison on Prevalence of Obesity

Based on empirical evidence, the prevalence of obesity in elderly Taiwanese was compared with the anthropometric statistics of selected countries, that is, Japan, Kuwait, Sweden, and the United States, as presented in Table 4. As mentioned previously, the prevalence of obesity in Taiwanese elderly women was greater than in Taiwanese elderly men. This difference was similar to the prevalence of obesity in other countries. According to the WHO criterion of obesity (i.e., $\text{BMI} > 30$), the prevalence of obesity for elderly men in Taiwan (i.e., 3.2%) was lower than in Kuwait (32.3%), Sweden (6.9%), the United States (5.4%), and the Native Americans (11.1%), but higher than in Japan (0.99%). Similarly for elderly women, the prevalence of obesity in Taiwan (6.4%) was lower than in Kuwait (40.6%), Sweden (14.6%), the United States (7.7%), and the Native Ameri-

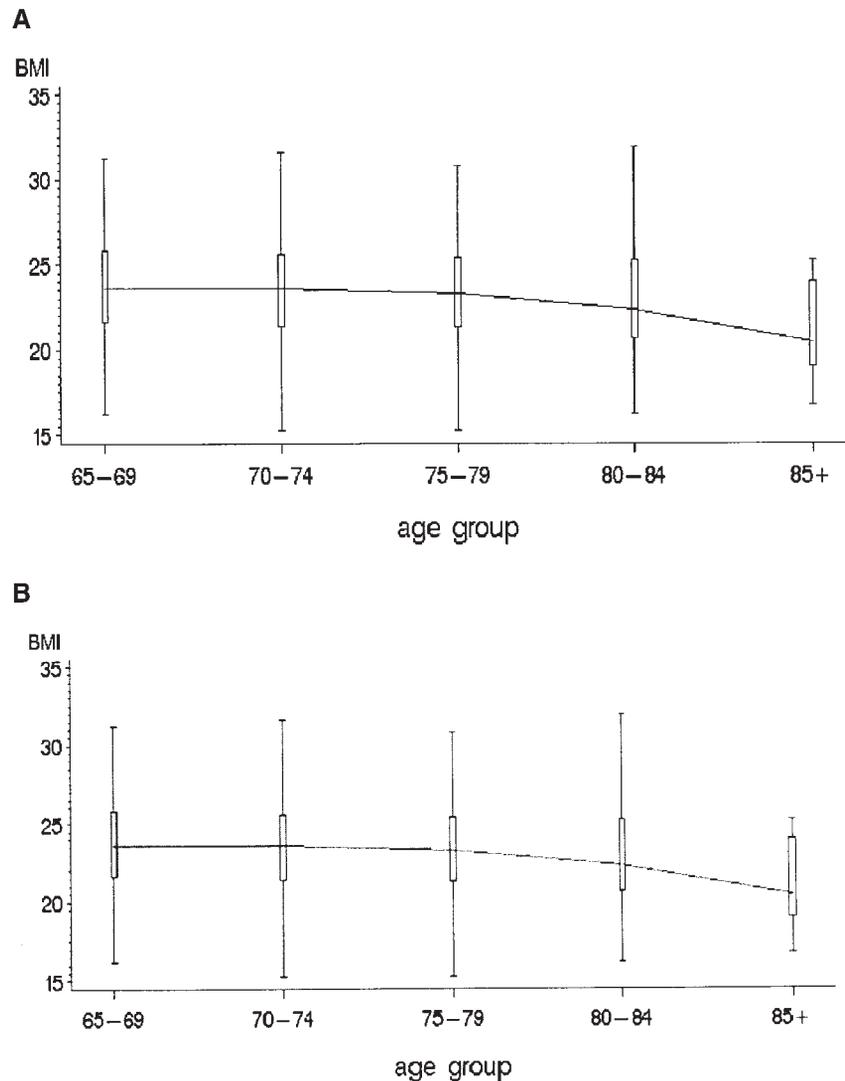


Figure 3. Distributions of mean body mass index (BMI) plotted by age group for elderly men, **A**, and women, **B**, in Taiwan.

cans (20.7%), but higher than in Japan (3.8%). The positioning of cross-national prevalence of obesity was consistent within men and women.

DISCUSSION

Extensive information on body composition is needed for evaluation of nutritional and functional status. In particular, the potential change in body composition may lead to associated changes in some other risk factors of diseases, especially for elderly persons. However, little is known about the value of anthropometric data for predicting the health status of older people. As the first step toward evaluating the use of anthropometric indicators in aging studies, the present study provides the distributions of height, weight, and BMI of elderly persons in Taiwan. Furthermore, data for prevalence of obesity for elderly persons in Taiwan and comparisons with some countries were generated.

By classification of age and gender, certain common patterns of height, weight, and BMI were found in this study.

On average, the elderly men were taller and heavier than the elderly women. The changes in the mean of height and weight also can be translated into the changes in the mean BMI. In the present study, however, the women had a higher value of mean BMI compared with the men, which was different from the findings indicated in Huang's study (8). However, Huang's study examined a sample aged 20–64 years, rather than an elderly sample as in the present study. If the focus is narrowed to the age groups older than 45 years, the women did have higher mean values of BMI (23.2–23.9) than the men (22.4–23.1), which may be due to the increasing trend in BMI only up to older adults (8,15). After middle age, decreasing trends in BMI were found for both men and women; however, different decreasing rates in men and women varied by samples. For future research, it would be of interest to determine why the mean values of the elderly Taiwanese women's BMI were higher than the men's.

In addition to the differences by gender, the changes in the mean values of height, weight, and BMI were further

Table 2. Percentiles of the Mean Body Mass Index (BMI) for Elderly Persons in Taiwan

Age Group (years)	Percentile						
	5th	10th	25th	50th	75th	90th	95th
Men							
65-69	18.6	19.8	21.6	23.6	25.8	27.9	29.1
70-74	18.3	19.6	21.4	23.6	25.6	28.2	29.7
75-79	17.7	19.1	21.3	23.3	25.4	27.5	29.3
80-84	17.4	18.4	20.6	22.3	25.3	27.1	27.8
85+	16.8	18.4	19.1	20.4	24.0	25.1	25.2
Mean	18.3	19.6	21.4	23.5	25.6	27.9	29.3
Women							
65-69	19.1	20.4	22.3	24.4	26.6	28.9	30.5
70-74	18.0	20.0	22.2	24.1	26.5	29.2	31.1
75-79	18.5	19.3	21.9	24.2	26.5	28.9	30.8
80-84	16.4	17.3	20.1	24.4	26.4	28.6	29.2
85+	16.2	16.2	19.4	21.9	24.4	25.9	25.9
Mean	18.4	20.0	22.2	24.3	26.5	28.9	30.6

examined by five age groups. Across age groups, consistent decreasing trends were found in height, weight, and BMI, which may be due to bone and/or muscle loss. The magnitude of change was most significant for the age group from 80-84 years to the group aged 85 and older, but was moderate before the age of 80. The results of ANOVA analysis confirmed that mean values of height, weight, and BMI were significantly different among five age groups for both men and women ($p < .05$).

Overweight and obesity are associated with a series of diseases and adverse health outcomes as confirmed in previous studies. Corresponding to different decreasing trends in the mean BMI for men and women addressed previously, the women had a higher prevalence of overweight and obesity compared with the men. The prevalence of overweight was 34.9% in elderly women compared with 27.3% in elderly men. A similar pattern of distribution was found in the prevalence of obesity; that is, 6.4% in women versus 3.2% in men.

The prevalence of overweight and obesity also varied in different elderly populations. To show ethnic and geographic variations in height, weight, and BMI, a cross-national comparison on the prevalence of obesity was also presented in this study. Based on the WHO criterion of obesity and empirical findings (10-11,13,18,20), the prevalence of obesity for the elderly men and women in Taiwan was lower than in Kuwait, Sweden, the United States, and the Native Americans, but higher than in Japan. For instance, the prevalence of obesity for elderly men in Kuwait was ten times more than that of Taiwan (32.3% vs 3.2%).

To simplify the comparison, only the WHO cutoff point of obesity was used for the current study. However, caution is needed in interpreting the results of comparisons, because different criteria of obesity are applied in various countries. A fixed cutoff for underweight and overweight is very likely to vary by gender, age, geographic location, and ethnic background in samples of older persons, as indicated in previous studies (8,19,20). For example, the obesity criteria used in Taiwan (BMI >28) and Japan (BMI >26.4) differ from the WHO criterion, and may be intended to adjust for

Table 3. Prevalence of Overweight and Obesity for Elderly Persons in Taiwan

Age Group (years)	Overweight (25 ≤ BMI ≤ 30)		Obesity (BMI >30)	
	Men n (%)	Women n (%)	Men n (%)	Women n (%)
65-69	136 (27.6)	204 (36.4)	15 (3.0)	32 (5.7)
70-74	132 (28.4)	140 (33.0)	18 (3.8)	32 (7.6)
75-79	65 (25.6)	65 (35.3)	7 (2.8)	12 (6.5)
80-84	14 (28.0)	15 (34.1)	1 (2.0)	1 (4.6)
85+	2 (16.7)	2 (22.2)	0 (0.0)	0 (0.0)
Subtotal	349 (27.3)	426 (34.9)	41 (3.2)	77 (6.4)
Total	775 (29.8)		118 (4.54)	

Note: The presented percentages indicate the ratio for each age group only.

the effects of generic, cultural, and geographic differences on estimation of obesity.

Further, if the ethnic-specific values of BMI are used for comparison, a different picture is revealed, such as is the case in the United States. The BMI cutoff for obesity in the United States is higher than the WHO criterion; that is, 31.1 for the men and 32.3 for women. If the obesity criterion of the National Heart, Lung, and Blood Institute is adopted by the United States (22), the prevalence of obesity for elderly persons in the United States would be higher than the presented results. In other words, a higher threshold of obesity criterion may generate a moderate prevalence of obesity superficially, but a higher prevalence rate of obesity exists in the long run. Consequently, those who are overweight or obese, and who probably are at risk of certain chronic diseases, cannot be identified in the early stage, which may cause problems with health promotion and disease prevention. Therefore, more caution is needed to establish a cross-culturally valid criterion of obesity to evaluate the fitness of body composition for older people.

The relative low prevalence of obesity in Taiwan may be on account of multiple factors, including genetic potential, nutritional status, lifestyle, and environmental influences. However, it is beyond the scope of this study to examine the relationships between the prevalence of obesity and possible factors. For future research, a longitudinal study focusing on the changes of anthropometry and its relationships to the aging process is suggested.

The major limitation of the present study may be due to an urbanized elderly sample. However, it should be noted that the difference between urban and rural areas are not as distinct as in the United States or other Western countries, because Taiwan is intensively populated. Certainly, different degrees of urbanization create variation in residents' socio-economic status and lifestyle. However, impacts of social or economic factors on obesity need further investigation for future research.

Nonetheless, the study sample did not differ significantly from the entire elderly population in terms of age distribution. The distributions of the three anthropometric measures presented here can serve as a basis for further research. Stratified proportion sampling to the size of the elderly population at large is also suggested for a more generalized sample of elderly men and women.

Table 4. Cross-National Comparison on the Prevalence of Obesity

Country	BMI Cutoff	Year	Age	Men (%)	Women (%)	Reference
Taiwan	<30 kg/m ²	1992	65+	3.2	6.4	Present study
Japan	<30 kg/m ²	1989/93	65+	0.99	3.8	Minoru and Yasushi (20)
Kuwait	<30 kg/m ²	1993/94	<60	32.3	40.6	Al-Isa (13)
Sweden	M<30 kg/m ² W<28.6 kg/m ²	1988/89	65+	6.9	14.6	Kuskowska-Wolk and Bergstrom (11)
United States	M<31.1 kg/m ² W<32.3 kg/m ²	1987	65+	5.4	7.7	Broussard et al. (18)
Native Americans	M<31.1 kg/m ² W<32.3 kg/m ²	1987	65+	11.1	20.7	Broussard et al. (18)

Note: BMI = body mass index.

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