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Anthropometric Obesity Indices in Relation to Age and Gender in Japanese Adults

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Hsieh, S.D., Yoshinaga, H., Muto T. and Sakurai, Y. *Anthropometric Obesity Indices in Relation to Age and Gender in Japanese Adults.* Tohoku J. Exp. Med., 2000, **191** (2), 79-84 —— The body mass index (BMI), waist circumference, waist to hip ratio, waist to height ratio and skinfolds (near-umbilical and iliac areas) in three age groups (35-44, 45-54 and 55-64 years) were compared in 3117 men and 997 women in Tokyo. In both genders, height was significantly shorter, while the waist to hip ratio and waist to height ratio were significantly higher, in the older groups. In the men, there were no significant differences in BMI and waist circumference among the three age groups, but the iliac skinfold was significantly thinner in each older group, and the paraumbilical skinfold was thinner in the group aged 55-64 years. In the women, the paraumbilical skinfold was significantly thicker in each older group, while waist circumference and the iliac skinfold were significantly larger or thicker in the group aged 55-64 years, and BMI was larger in the groups aged 45-54 and 55-64 years. There were age-related discrepancies between BMI and other obesity indices in the different genders, in that only the waist to height ratio and waist to hip ratio increased with age in both genders. ———— obesity indices; age; gender; Japanese

Although body mass index (BMI) is widely used as a means of defining fat accumulation (WHO 1995), BMI does not always track the degree of fatness (Smalley et al. 1990). Moreover, the research data on this problem are not adequate. Here, we measured BMI and other anthropometric indices which have been used to define obesity and/or study health risks (Blair et al. 1984; Ohlson et al. 1985; Donahue et al. 1987; Deprés 1991; Hsieh and Yoshinaga 1995a, b, c, 1999; Lean et al. 1995; Ashwell et al. 1996a, b; Hsieh et al. 2000), in Japanese adults mostly living in the Tokyo metropolitan area. We intend to investigate the relationship between the predisposing factors of fat accumulation (age and

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gender) (Borkan et al. 1983; Dixon 1983; Shimokata et al. 1989) and the anthropometric indices of fat accumulation in these subjects.

Subjects and Methods

Subjects

The subjects of our study were 3117 men and 997 women aged from 35 to 64 years (Mean±S.D.: 48.4±7.0 years for men and 50.5±7.1 years for women), who underwent the routine health examinations at Toranomon Hospital in Tokyo between April 1994 and March 1995. Most were office workers and members of their families. The BMI of the men ranged from 14.8 to 37.7 kg/m^2 (Mean±S.D.: 23.1±2.5 kg/m^2), while that of the women ranged from 14.9 to 34.6 kg/m^2 (Mean±S.D.: 21.6±2.8 kg/m^2). The subjects were divided into 3 age groups (35–44, 45–54 and 55-64 years).

Procedures and statistical analysis

After an overnight fast for the health examination in the morning, waist circumference was measured at the level of the umbilicus with the subjects standing and breathing normally. Hip circumference was measured at the level of the greatest circumference of the hips. The skinfold thickness was measured twice, near the umbilicus and the upper margin of the ilium, using an Eiken type skinfold caliper (Meikosha Co., Ltd., Tokyo), and the mean value was used. Probabilities of significant differences were compared by one-way analysis of the variance among the groups and by the Tukey-Kramer honestly- significant-difference test between groups with JMP software (SAS Institute Inc., NC, USA).

Results

The subject distribution and the comparisons of anthropometric values in the three age groups of men are shown in Table 1. There were no significant differences among the groups in BMI and waist circumference. However, there were significant differences among the groups in the other indices. Hip circumference was significantly smaller in the group aged 55–64 years than in the other age groups. Height was significantly shorter, whereas the waist to hip ratio and waist to height ratio were significantly higher, in the older of any two age groups. The paraumbilical skinfold was significantly thinner in the group aged 55–64 years, and the iliac skinfold was significantly thinner in the older of any two age groups.

The subject distribution and the comparisons of anthropometric values in the three age groups of women are shown in Table 2. There were significant differences among the groups in all the anthropometric indices. As in the male groups, height was significantly shorter, whereas the waist to hip ratio and waist to height ratio were significantly higher, in the older of any two age groups. BMI was significantly larger in the groups aged 45–54 and 55–64 years than in the group aged 35–44 years. Waist circumference and hip circumference were

TABLE 1. *Anthropometric values in various age groups (men)*

Group	1	2	3		
Age (years)	35–44	45–54	55–64	p-value[a]	
n	993	1494	630		
Height (cm), mean (S.E.)	170.1 (0.2)	168.3 (0.1)	166.1 (0.2)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Body mass index (kg/m^2), mean (S.E.)	23.2 (0.1)	23.1 (0.1)	22.9 (0.1)	0.0816	
Waist circumference (cm), mean (S.E.)	84.0 (0.2)	84.5 (0.2)	84.4 (0.3)	0.2477	
Hip circumference (cm), mean (S.E.)	95.0 (0.1)	94.9 (0.1)	94.2 (0.2)	0.0011	1 vs. 3*, 2 vs. 3*
Waist to hip ratio, mean (S.E.)	0.883 (0.001)	0.890 (0.001)	0.895 (0.002)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Waist to height ratio, mean (S.E.)	0.494 (0.001)	0.502 (0.001)	0.508 (0.002)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Skinfolds (mm)					
Paraumbilical, mean (S.E.)	24.6 (0.2)	23.9 (0.2)	22.5 (0.3)	<0.0001	1 vs. 3*, 2 vs. 3*
Iliac, mean (S.E.)	20.3 (0.2)	18.5 (0.2)	17.0 (0.3)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*

[a]Ovarall significant difference based on one-way ANOVA.
*$p<0.05$ by Tukey-Kramer honestly-significant-diference test.

TABLE 2. *Anthropometric values in various age groups (women)*

Group	1	2	3		
Age (years)	35–44	45–54	55–64	p-value[a]	
n	217	461	319		
Height (cm), mean (S.E.)	157.7 (0.3)	155.6 (0.2)	154.1 (0.3)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Body mass index (kg/m^2), mean (S.E.)	21.0 (0.2)	21.6 (0.1)	22.1 (0.2)	<0.0001	1 vs. 2*, 1 vs. 3*
Waist circurference (cm), mean (S.E.)	74.0 (0.5)	75.3 (0.4)	79.2 (0.5)	<0.0001	1 vs. 3*, 2 vs. 3*
Hip circumference (cm), mean (S.E.)	90.7 (0.4)	90.9 (0.3)	92.3 (0.3)	0.0006	1 vs. 3*, 2 vs. 3*
Waist to hip ratio, mean (S.E.)	0.815 (0.004)	0.827 (0.003)	0.857 (0.003)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Waist to height ratio, mean (S.E.)	0.470 (0.004)	0.484 (0.002)	0.514 (0.003)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Skinfolds (mm)					
Paraumbilical, mean (S.E.)	25.9 (0.7)	29.3 (0.5)	32.2 (0.6)	<0.0001	1 vs. 2*, 1 vs. 3*, 2 vs. 3*
Iliac, mean (S.E.)	16.3 (0.7)	18.0 (0.5)	20.0 (0.5)	<0.0001	1 vs. 3*, 2 vs. 3*

[a]Ovarall significant difference based on one-way ANOVA.
*$p<0.05$ by Tukey-Kramer honestly-significant-difference test.

significantly larger and the iliac skinfold was significantly thicker in the group aged 55–64 years than in either of the two other age groups. The paraumbilical skinfold was significantly thicker in the older of any two age groups.

Discussion

The shorter height of the older subjects may be due to the combined effects of difference in the start lines of stature in the different generations (Ministry of Health and Welfare 1989; Nutritional Research Group 1998) and age-related shrinkage. There was no significant change in BMI among the various age groups in men.

On the contrary, significantly larger BMI was found in the older women. The reasons may be the following: 1) The increase in the amount of fat with age may be greater in women than in men. 2) The increase in weight due to fat may be offset by a decrease in lean body mass with age, to a greater extent in men than in women. Specially, both muscle mass and bone mineral density decrease as an aging process in men and women, but the rate of decrease in lean body mass is greater in men (Forbes and Reina 1970; Cohn et al. 1980). 3) The increase in weight due to intra-abdominal fat may be offset by a decrease in subcutaneous fat in men. 4) The start lines of BMI may differ among our age groups, in that younger people might have a larger BMI due to a better nutritional environment than older people had when they were younger.

However, the increase in the total fat amount with age was lower in men than in women, causing a discrepancy in the change in BMI with age in the different genders. A national study showed an increase in the weight of Japanese after the World War II, but unfortunately, no BMI data were mentioned (Nutritional Research Group 1998). On the other hand, the study reported that the sum of the skinfold thickness (subscapular and triceps areas) did not show any clear change in men, and decreased only slightly in women in the same period. However, no data of statistical significance were mentioned.

Among various obesity indices, only the waist to hip ratio and waist to height ratio were significantly higher in the older of any two age groups in both genders. An increase in waist circumference with age may be masked by the following factors: 1) The start lines of waist circumference may differ among our age groups for the same reason as mentioned above, in that younger people might have a higher stature and a larger waist circumference due to a better nutritional environment than older people had when they were younger. 2) A reduction in the abdominal subcutaneous fat in older men may offset an increase in waist circumference due to intra-abdominal fat. Thus, the increase in intra-abdominal fat from middle age onward may be difficult to detect by waist circumference measurement without height adjustment in Japanese.

The skinfold thickness was thinner in the older men and thicker in the older women. This suggests that the same waist circumference may have different

meanings for fat distribution in people of different ages in the two genders. For example, older men may have more intra-abdominal fat than the younger men, even though they have the same waist circumference value. However, the condition may differ in women.

In addition to the study of BMI and the skinfold thickness of the subscapular and triceps areas in the national nutritional survey, our study provides data on the skinfold thickness in the abdominal area and other abdominal obesity indices for reference in relation to age and gender. It should be noted that our study showed an age-related discrepancy between BMI and the other obesity indices in the different genders.

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