Original Article

Japanese Anthropometric Reference Data – Special Emphasis on Bioelectrical Impedance Analysis of Muscle Mass

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Abstract

PURPOSE: In order to provide anthropometric reference data of body composition of Japanese, values measured using bioelectrical impedance analysis (BIA) were summed.

METHODS: Healthy subjects leading a conventional lifestyle (4,365 males and 5,970 females) were selected. Their height and body weight were measured. Body fat amount, body fat percentage, lean body mass, water content, total muscle mass, bone mass, upper arm muscle mass, forearm muscle mass, thigh muscle mass, lower leg muscle mass, and quadriceps muscle mass were measured using BIA (Physion-XP or MD, Physion Co., Ltd., Kyoto) and weight-bearing index (WBI, quadriceps muscle maximal strength/body weight) was calculated.

RESULTS: Body fat amount showed an upward curve which plateaued in the age range of 40 to 79 years in both sexes. Lean body mass and water content decreased after 50 years in both sexes. Bone mass decreased from the 80’s in males and 60’s in females. Total muscle mass, upper arm muscle mass, forearm muscle mass, thigh muscle mass, and quadriceps muscle mass decreased from the 50’s to 60’s in both sexes. The extent was more prominent in males. Lower leg muscle mass was nearly constant in males and females. WBI gradually decreased from the 30’s in both sexes.

CONCLUSIONS: To date, large-scale body composition data of healthy Japanese subjects have not been available. Application of the present data to assessment of nutrition status in various daily clinical diseases and to training and rehabilitation are expected in the future.

KEYWORDS: bioelectrical impedance analysis, aging, muscle mass

Introduction

For the development of anti-aging medicine, establishment of diagnostic or assessment methods for the extent and risk factors of aging is urgent. This requires collecting and providing anthropometric data concerning sexual differences and changes accompanying aging. To date, the authors have so far organized and reported various Japanese anthropometric data. In “Japanese Anthropometric Reference Data (JARD) 2001”, nine reference items from healthy subjects (2,738 males, 2,754 females) (height, body weight, BMI, upper arm circumference, lower leg circumference, triceps skinfold thickness, subscapular skinfold thickness, upper arm muscle circumference, and upper arm plane dimension) were presented. 1) Standard values for mercury, lead, arsenic, cadmium, beryllium, and aluminum content in the hair of healthy Japanese subjects (2201 cases in males, 3645 cases in females) were presented. 2)

The purpose of the present paper was to provide standard anthropometric data of the Japanese body composition measured using bioelectrical impedance analysis (BIA). Although many types of BIA equipment are used today to assess body composition both domestically and abroad, we used Physion-XP or MD (Physion Co., Ltd., Kyoto). 3) 4) The values of skeletal muscle volume obtained using these models correlated well with those obtained by magnetic resonance imaging (MRI). This study focused on sexual differences and changes accompanying aging in muscle mass. Our results will be helpful background data for functional-age assessment of the muscular system in medical institutions practicing anti-aging medicine.
**Subjects and Methods**

A total of 10,335 healthy Japanese (4,365 males and 5,970 females) were analyzed. The subjects were distributed nationwide in more than 250 facilities such as universities, hospitals, and geriatric health care centers, and the data were collected during the period of December 2003 to October 2007. The subjects of filling the criteria (Table 1) alone were included in the data. Age distribution of the subjects is shown in Table 2.

**Table 1  Conditions for counting anthropometric data**

1. **Measurer**
   1) persons who have studied how to use the Physion-XP or MD equipment by attending the study session or support meeting and have full knowledge of the model(s)
   2) In addition, persons recognized as eligible

2. **Subjects**
   1) healthy persons leading a conventional lifestyle
   2) person who can walk on their own with or without treatment aids
   3) person not using medical electronic equipment as follows:
      * implanted medical electronic equipment such as pacemakers
      * life-supporting medical electronic equipment such as artificial lung
      * wearable medical electronic equipment such as cardiography
   4) not implanted with metal such as in bolts and metallic prosthetic joints

**Table 2  Age distribution of subjects**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 – 19</td>
<td>381</td>
<td>160</td>
<td>541</td>
</tr>
<tr>
<td>20 – 29</td>
<td>800</td>
<td>837</td>
<td>1637</td>
</tr>
<tr>
<td>30 – 39</td>
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<td>40 – 49</td>
<td>649</td>
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<td>1405</td>
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<tr>
<td>50 – 59</td>
<td>568</td>
<td>1086</td>
<td>1654</td>
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<tr>
<td>60 – 69</td>
<td>636</td>
<td>1258</td>
<td>1894</td>
</tr>
<tr>
<td>70 – 79</td>
<td>370</td>
<td>757</td>
<td>1127</td>
</tr>
<tr>
<td>80 – 89</td>
<td>123</td>
<td>242</td>
<td>365</td>
</tr>
<tr>
<td>90 –</td>
<td>15</td>
<td>42</td>
<td>57</td>
</tr>
<tr>
<td>Total</td>
<td>4,365</td>
<td>5,970</td>
<td>10,335</td>
</tr>
</tbody>
</table>

Physion-XP or MD was used for the analysis of body compositions as described above. Impedance measurement was performed at a frequency of 50 kHz, current of 500 μA, and range of impedance was 10 to 1,500 Ω. Accuracy was ± 1% ± 0.5 Ω (50 to 1,000 Ω), or ± 2% ± 0.5 Ω (other impedance range), and resolution capability was 0.1 Ω.

Data recorded were subject name, birth date, gender, as well as height, body weight, right and left upper arm lengths, right and left forearm lengths, right and left thigh lengths, and right and left lower leg lengths measured using ordinary instruments. Before BIA, subjects were allowed to relax in the supine position, with upper limb and legs opened at about 30° and extremities extended. After 5 minutes in this position, subjects were measured for impedance value (Z) of each body segment using two lead BIA systems (the first was the distal, the second was the proximal). Duration required was within 1 minute for each measurement. The current-introducing (source) electrodes were placed on the dorsal surface of the right and left metacarpal and metatarsal bones. For the first distal lead measurement, voltage-sensing (detector) electrodes were placed on the lines joining the ulnar and radial styloid processes and the medial and lateral malleolus. In the second proximal lead measurement, source electrodes were the same as for the first measurement, but detector electrodes were placed on the proximal ends of the radius and tibia. In these measurements, the combination of source electrodes and detector electrodes was modified from the method of Organ et al. and managed by programming. In the first distal lead measurement, Z values of the right and left limbs were measured, and in the following proximal measurement, the Z values of upper arms and thighs were measured. The Z values of forearms and lower legs were calculated by subtracting the proximal lead measurement values from the distal lead values.

Lower limb muscles, especially the quadriceps muscle, play an important role in loaded movements such as walking, stepping exercises, and standing up, which are required in activities of daily living (ADL). Therefore, keeping the strength of the quadriceps muscle is recommended for the maintenance of QOL in the elderly. To assess the ability of ADL, the weight bearing index (WBI) was calculated. That is, the quadriceps femur muscle volume and maximum strength were calculated from segmental muscle mass values and body balances (right and left, upper and lower limbs, trunk and extremities balances), and then WBI was calculated from the formula: WBI = quadriceps muscle maximum strength + body weight.

The subjects were prospectively instructed to refrain from vigorous exercise, heavy alcohol intake, or taking a sauna or bath just before measurement; having a meal, high fluid intake, or waking up within two hours; and standing for an extended period as to cause swelling of lower limbs. They were also instructed to urinate or defecate before measurement, and remove any metal or magnetic items touching the skin for correct measurement. When the difference in temperature between outdoors and the examination room was 10 degrees or more, BIA was performed 30 minutes or more after entrance into the room. The room was kept at 30-85% RH (with no condensation) and 15-30°C (about 25°C).

The limb muscle mass data obtained by BIA correlated well with the values measured using MRI. The correlation coefficient for the upper limbs, lower limbs, upper arms, and thighs were 0.940, 0.917, 0.968, and 0.901, respectively, all were > 0.9.

Collected data were recorded in the OpenOffice.org Calc (Sun Microsystems Inc.), and statistical analysis was performed using software Dr.SPSSII (SPSS Japan Inc.). For each age range, mean, central values, SD, maximum, minimum, percentile (5, 10, 25, 75, 90, 95), and quartile of each measurement item were calculated.

**Results**

Height, body weight, and body weight index (BMI) values of the subjects are shown in Table 3-5.

Body fat amount showed an upward curve which plateaued at the age range of 40 to 79 years in both sexes (Figure 1), while body fat percentage (Figure 2) tended to increase with age. The regression line and correlation coefficient of age and body fat percentage were:

\[ y \% = 0.2219x \text{ [year]} + 9.4762, \quad r = 0.6322 \text{ (males)} \]
\[ y \% = 0.139x \text{ [year]} + 18.412, \quad r = 0.4502 \text{ (females)} \]
### Table 3  Height (cm)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Case No.</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Percentile</th>
</tr>
</thead>
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<td>16 – 18</td>
<td>381</td>
<td>163.95</td>
<td>10.43</td>
<td>150.00</td>
<td>180.00</td>
<td>146.00</td>
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<td>402</td>
<td>165.32</td>
<td>10.72</td>
<td>150.00</td>
<td>180.00</td>
<td>147.00</td>
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<td>22 – 24</td>
<td>423</td>
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<td>10.91</td>
<td>150.00</td>
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<td>28 – 30</td>
<td>462</td>
<td>170.50</td>
<td>11.29</td>
<td>150.00</td>
<td>180.00</td>
<td>150.00</td>
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### Table 4  Body Weight (kg)

<table>
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<th>Age (years)</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Percentile</th>
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<td>22 – 24</td>
<td>64.20</td>
<td>12.60</td>
<td>150.00</td>
<td>180.00</td>
<td>148.00</td>
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<tr>
<td>25 – 27</td>
<td>66.50</td>
<td>12.90</td>
<td>150.00</td>
<td>180.00</td>
<td>149.00</td>
</tr>
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<td>28 – 30</td>
<td>68.80</td>
<td>13.20</td>
<td>150.00</td>
<td>180.00</td>
<td>150.00</td>
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</table>
### Table 5  Body Mass Index (BMI) (kg/m²)

<table>
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<th>Total values</th>
<th>Age 16 – 19</th>
<th>Case No.</th>
<th>Median</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Percentile</th>
<th>5%</th>
<th>10%</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
<th>95%</th>
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<tbody>
<tr>
<td>Males</td>
<td>Age (years)</td>
<td>Case No.</td>
<td>Mean</td>
<td>Median</td>
<td>SD</td>
<td>Minimum</td>
<td>Maximum</td>
<td>Percentile</td>
<td>5%</td>
<td>10%</td>
<td>25%</td>
<td>75%</td>
<td>90%</td>
<td>95%</td>
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<tr>
<td>16 – 19</td>
<td>381</td>
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<tr>
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</table>

### Lean body mass tended to decrease after 50 years old in both males and females (Figure 3). The regression line and correlation coefficient of age and lean body mass were:

\[ y = -0.2355x + 65.215, r = -0.5842 \text{ (males)} \]

\[ y = -0.0955x + 44.724, r = -0.5842 \text{ (females)} \]
Muscle mass (Figure 5) tended to decrease gradually from age 30’s in males, and 50’s in females. The regression line and correlation coefficient of age and muscle mass were:

\[ y \text{ [kg]} = -0.0497x \text{ [year]} + 28.466, r = -0.2254 \text{ (males)} \]
\[ y \text{ [kg]} = -0.0248x \text{ [year]} + 18.179, r = -0.1817 \text{ (females)} \]

Changes in bone mass was gradual in both sexes (Figure 6), with the value beginning to decrease from 80’s in males and from 60’s in females. The regression line and correlation coefficient of age and bone mass were:

\[ y \text{ [kg]} = -0.0497x \text{ [year]} + 28.466, r = -0.1761 \text{ (males)} \]
\[ y \text{ [kg]} = -0.0106x \text{ [year]} + 7.9035, r = -0.1761 \text{ (females)} \]

Basal metabolic rate (Figure 7) tended to decrease from the 40’s in males, and the 50’s in females. The regression line and correlation coefficient of age and basal metabolic rate were:

\[ y \text{ [kcal/day]} = -4.9229x \text{ [year]} + 1725.5, r = -0.4797 \text{ (males)} \]
\[ y \text{ [kcal/day]} = -1.8964x \text{ [year]} + 1252.9, r = -0.2681 \text{ (females)} \]

Upper arm muscle mass (Figure 8) began to decrease from the 50’s in males, but was maintained comparatively well in females after the 50’s. The regression line and correlation coefficient of age and upper arm muscle mass were:

\[ y \text{ [kg]} = -0.0017x \text{ [year]} + 0.8458, r = -0.1865 \text{ (males, right)} \]
\[ y \text{ [kg]} = 0.0004x \text{ [year]} + 0.4053, r = 0.0762 \text{ (females, right)} \]
\[ y \text{ [kg]} = -0.0017x \text{ [year]} + 0.8279, r = -0.1972 \text{ (males, left)} \]
\[ y \text{ [kg]} = 0.0003x \text{ [year]} + 0.3971, r = 0.0648 \text{ (females, left)} \]

Forearm muscle mass (Figure 9) began to decrease from the 60’s in males, but was maintained comparatively well in females after 60’s. The regression line and correlation coefficient of age and forearm muscle mass were:

\[ y \text{ [kg]} = -0.0003x \text{ [year]} + 0.591, r = -0.0574 \text{ (males, right)} \]
\[ y \text{ [kg]} = 0.0004x \text{ [year]} + 0.361, r = 0.1480 \text{ (females, right)} \]
\[ y \text{ [kg]} = -0.0002x \text{ [year]} + 0.5749, r = -0.0400 \text{ (males, left)} \]
\[ y \text{ [kg]} = 0.0005x \text{ [year]} + 0.3494, r = 0.1772 \text{ (females, left)} \]
Trunk muscle mass (Figure 12) was kept at an almost constant level until the 50’s in males, and showed slightly higher values after the 60’s, but in females tended to decrease consistently after the 60’s. The regression line and correlation coefficient of age and trunk muscle mass were:

\[
\begin{align*}
y_{[kg]} &= -0.0095x_{[year]} + 6.5586, r = -0.1621 \text{ (males, right)} \\
y_{[kg]} &= -0.0066x_{[year]} + 3.9799, r = -0.1965 \text{ (females, right)} \\
y_{[kg]} &= -0.0097x_{[year]} + 6.4587, r = -0.1664 \text{ (males, right)} \\
y_{[kg]} &= -0.0063x_{[year]} + 3.8889, r = -0.1902 \text{ (females, left)}
\end{align*}
\]

Quadriiceps muscle mass (Figure 13) tended to decrease from 50 in both sexes, but the tendency was more prominent in males. The regression line and correlation coefficient of age and quadriiceps muscle mass were:

\[
\begin{align*}
y_{[kg]} &= -0.0069x_{[year]} + 2.314, r = -0.3497 \text{ (males, right)} \\
y_{[kg]} &= -0.0034x_{[year]} + 1.5446, r = -0.2540 \text{ (females, right)} \\
y_{[kg]} &= -0.0068x_{[year]} + 2.3014, r = -0.3470 \text{ (males, left)} \\
y_{[kg]} &= -0.0034x_{[year]} + 1.5424, r = -0.2508 \text{ (females, left)}
\end{align*}
\]

The weight bearing index (WBI) (Figure 14) showed a gradual decrease from 30 in both sexes, but showed a slight increase in the 90’s. The regression line and correlation coefficient of age and WBI were:

\[
\begin{align*}
y &= -0.0016x_{[year]} + 0.9408, r = -0.3028 \text{ (males, right)} \\
y &= -0.0015x_{[year]} + 0.8301, r = -0.3119 \text{ (females, right)} \\
y &= -0.0015x_{[year]} + 0.9536, r = -0.2936 \text{ (males, left)} \\
y &= -0.0015x_{[year]} + 0.8285, r = -0.3048 \text{ (females left)}
\end{align*}
\]
For the convenience to the international comparison for a muscular amount, the weight conversion value was indicated in Figure 15 (male) and Figure 16 (female). For both men and women, a remarkable part to decrease by aging was trunk muscle (abdomen muscle and back muscle) and thigh muscle. Standard deviation tended to be larger in cases with 80 years old or more.

**Discussion**

**Bioelectrical impedance analysis (BIA)**

We first discuss the bioelectrical impedance analysis method (BIA method) used in this study. Tissues with high water content such as blood, cerebrospinal fluid, and muscles have higher electric conductivity than those with low water content such as fat, bone. Bioelectrical impedance analysis is a method that enables the prediction of body composition non-invasively by measuring the impedance (resistance) of tissues during application of a very weak electric current to the body. In the initial developmental period of BIA, a single electric frequency system was widely used in assessing the body fat percentage, but the problem of large inter-individual differences because of susceptibility to water distribution was encountered. BIA has since been improved in accuracy by introduction of multiple electric frequencies. More recently, cross-sectional images created through the creation of three-dimensional construction of impedance values have been demonstrated.

In addition, repeated comparative studies using CT scans to test for body fat amount values have allowed the relatively accurate assessment of body fat amount by BIA. As BIA is non-invasive, it is now widely applied in nutritional assessment in children, assessment of obesity, fat-free mass assessment, and assessing nutritional status in chronic hemodialysis patients.

Accurate measurement of total body water content is possible now. BIA has also been used to estimate edema in patients with lymphatic obstruction and the amount of intra- and extracellular water in patients with chronic obstructive pulmonary disease.

In recent years, BIA has become a standard method for measuring the fat-free (bone + muscle) tissue mass of the extremities. Significant correlation ($r = 0.87$) between fat-free tissue mass values predicted by BIA and the cross sectional area of muscle plus bone assessed by CT method has been shown. Recently, correlations of bioelectric impedance to muscle mass have been investigated. Electric resistance of extremities was shown to correlate with muscle volume as assessed by MRI, and the extremity impedance index (limb length/impedance) has been highly correlated with muscle mass measured using Dual Energy X-ray Absorptiometry (DEXA) (male $R^2 = 0.79$, female $R^2 = 0.72$). However, improvement is still required in the accuracy of BIA with a small number of electrodes, because values are more easily affected by body position or muscle array than with MRI. In an effort to improve the accuracy of BIA, comparative investigations of BIA with body composition values measured using the DEXA or MRI method have been repeated. Results have shown that segmental (upper- and lower-limb) analysis as well as the whole body data obtained with eight-electrode BIA equipment are as accurate as those with DEXA method. Concerning the lower limb muscle mass measurement, the values obtained using segmental BIA are significantly and positively correlated to those with MRI but tend to be a little higher.

The measurement of skeletal muscle volume by the four-limb twelve-electrode BIA method (present equipment) is highly correlated to the results from MRI method, and has been applied to the prediction of trunk skeletal muscle volume and whole body skeletal muscle volume.

Until now, a variety of BIA equipment has been developed and used in the assessment of muscles in muscle dystrophy patients, body composition in patients with pulmonary emphysema, and skeletal muscle mass in elderly people. With the Physion-XP and MD, current and respective impedance values were weighed and the contribution rate of impedance values was adjusted in order to obtain results highly correlated with those with the MRI methods. These models have been used for the assessment of body composition in athletes and in the elderly requiring care at home. Precise evaluation of body muscle volumes might be helpful in making plans for muscle training.
Nutritional assessment and anthropometry

At present, nutritional therapy or nutritional management without nutrition assessment is considered to be groundless and meaningless. Anthropometry is used as a basis for nutritional assessment to understand the nutritional status of patients in clinical settings and of general consumers in healthcare for appropriate nutrition support. High-calorie infusion via a central venous line was first introduced into clinical use in the US in the late 1960s. Since then, this method has become widely accepted all over the world based on its nutritional usefulness. In Japan, a number of patients with gastrointestinal disease became critically ill due to postoperative nutritional disorders in the 1970s. Nutritional disorders were also observed in internal medicine and pediatrics. After its introduction to Japan, high-calorie infusion not only improved nutritional status, but also enhanced therapeutic efficacy. The safety of high-calorie infusion was improved as infusion-related complications or adverse events were dealt with by modifying infusion devices/drugs and establishing appropriate methods for administration/management. In addition to high-calorie infusion, enteral feeding and elemental feeding have progressed since the 1980s, creating the concept of "nutrition support".

Reference values are necessary to assess health condition and nutritional status. Therefore, there should be criteria available to decide when to initiate nutritional treatment, assess improvement in nutritional status, and determine which to select if any new therapeutic method is developed. Anthropometry, serum albumin, and serum vitamin have been proposed as reference data for nutrition assessment. In the Physical Status Report (1995) from the WHO Technical Report Series, it is recommended to use reference values of body composition for assessment of health condition and nutritional status. As Asians have a very different physique to other ethnic groups, data specific to Asians are essential.

Various efforts have been made to collect Japanese reference values for body composition. First, Kim et al. published reference data on height, body weight, triceps skinfold thickness, arm circumference, and arm muscle circumference from 4791 healthy adults (3,700 males and 1,091 females) in 1982. In 1997, Sugiyama et al. performed anthropometry in the elderly (601 males and 914 females) to review the significance and problems of anthropometry and assessment methods. In 2001, we described the significance and methods of anthropometry based on our belief that anthropometry is essential to nutritional assessment and that it is important to screen obese or undernourished persons, plus assess the efficacy of nutritional treatment.

Against this background, the Japanese Society for Nutritional Assessment organized the Anthropometric Reference Value Review Board to establish Japanese anthropometric reference values. The board calculated the present Japanese anthropometric reference values based on data from 5,492 valid subjects (2,738 males and 2,754 females) aged 18 to 85 using accepted internationally available methods. Results are provided in JARD2001 (Japanese Anthropometric Reference Data 2001).

Several reports have been published on nutrition assessment using JARD 2001. In 448 elderly people enrolled in healthcare facilities for the elderly, anthropometry was performed for comparison according to the level of need for nursing care. Each anthropometric parameter decreased with an increase in the level of need for nursing care, especially in the elderly at levels 4 and 5, in whom nutritional status markedly deteriorated. In 85 patients with hepatic cirrhosis, anthropometry was performed for nutritional assessment using JARD 2001, showing that nutritional status was worse in patients with more severe hepatic cirrhosis.

Comparison between present anthropometric results and JARD 2001

Compared to the JARD 2001 data, our present data show that height was not different in males or females, whereas body weight was slightly higher in males and females aged 40 or older. As a result, BMI was relatively high in those aged 40 or older. As both sets of data were from healthy subjects, the difference might reflect a change in physique due to body weight increase over 5 years. In both evaluations, body weight decreased in older people. Body weight and BMI were similar in females aged 75 or younger, but were lower in males aged 60 or older than in younger males, an earlier decrease in males.

Triceps skinfold thickness peaked in males in their 30s and females aged around 60 in JARD 2001, whereas body fat amount peaked in both sexes in their 40s to 70s in the present evaluation. This may be accounted for the fact that while TSF is a measure to assess subcutaneous fat in upper limbs, body fat amount is a measure to assess both visceral and subcutaneous fat. In the present evaluation, body fat percentage increased with age in both sexes. This, together with the fact that lean body weight, total body water, muscle mass, and bone mass decreased with age, suggests that increased body fat percentage and decreased muscle and bone are likely to be age-related changes.

In the assessment of muscle mass, more specifically muscle mass in the upper limbs, arm muscle circumference peaked in males in their 30s to 40s and in females aged around 50 in JARD 2001, whereas muscle mass in the right and left arms started to slowly decrease in the 30s for males and 50s for females in both the present evaluation and AMC in JARD 2001, with both parameters showing a similar trend. Although muscle mass in legs was generally stable in both sexes in the present evaluation, leg circumference peaked in males in their 30s to 40s and decreased with age in females in JARD2001. This difference might be attributable to the fact that leg circumference reflects both muscle and fat in the lower limbs.

Thigh muscles are the largest voluntary muscles, with muscle mass significantly affecting ADL. Thigh muscle mass was not assessed in JARD 2001, but was included in the present evaluation. Both the thigh muscle mass and quadriceps muscle mass decreased with age in males and peaked in females in their 40s. Males had a rapid decrease in their 60s. WBI also decreased with age in both sexes.

Clinical application of the present anthropometric results

JARD 2001 is useful for the bedside nutritional assessment of patients, and is applicable to assessment and follow-up in the elderly and sick, especially undernourished patients. In patients with hepatic cirrhosis, it was reported that TSF and AMC decreased, with the degree of decrease affecting prognosis. In contrast, the present evaluation may provide useful reference data for assessment of body fat amount and muscle mass in daily life, particularly in the assessment of overnutrition, such as obesity or metabolic syndrome. It has been reported that prevalence increases in males and females with a body fat percentage of 20% or more and 25% or more, respectively. As shown in the present evaluation, however, body fat percentage increases with age, reaching this threshold at a mean age bracket of the 40s in males and 50s in females. If body fat percentage increases with age, as indicated by the present evaluation, which was not designed to
measure changes in body composition over time, the standard body fat percentage classified by age and its relationship to certain diseases are issues to be addressed. While the degree of decrease in bone density from the mean in adults aged between 20 and 44 [Young adult mean (YAM)] is used to make a diagnosis of osteoporosis in daily practice, it may be important from the perspective of anti-aging to maintain bone fat percentage even in the 20s to 30s age brackets. Thigh muscle mass and WBI are applicable to the assessment of muscle mass in the middle-aged and elderly, i.e. muscle mass required to maintain and enhance ADL, as well as anti-aging muscle training. In addition, these parameters may be applicable to the assessment of recovery in rehabilitation of afflicted limbs, as muscle mass on the right or left sides can be assessed separately.

In the present data of the bone mass in women, the decrease after 50 years old seemed rather mild and different from the so-called rapid decrease peculiar to the post-menopausal women.

Concerning the apparatus used, the measured values of body fat amount were verified by the underwater weight method and the values of muscle mass were verified by the MRI method, however, the values of bone mass, water content and basal metabolic rate were secondarily calculated by using these measured values. The values of bone mass were dependent with muscle mass, and the errors can be larger if the decrease of bone mass is prominent compared with changes of muscle mass. We have to be careful for interpretation of the results of bone mass in the post-menopausal women. Another point is a problem of sampling that more than half were measured in the sports gyms. In these samples, the physical activity is higher, keeping the ovary function high and the post-menopausal decrease of the bone mass may be mild compared with general women.

References


