A Change by Aging or Sex Viewed from the Mean Values of Blood Test and Body Mass Index in Each Generation or Gender in Japan

Ryozo Hashimoto¹, Makoto Yasuda²

Background
Age, sex and regional variations have been generally believed to affect the data of annual health screenings. In this study, the key aim was to investigate the general tendencies in age- and sex-related differences in BMI and blood test values in Japan.

Methods
This study was performed on 10,783 females and 12,386 males, who were ambulant and visited our medical check-up center in 2009. The ages of the subjects selected for this study ranged from 20 to 85 years for females and 20 to 92 years for males. Five-year groupings were used for distributions of measured variables for both sexes but only one group was used for subjects of 20–29 years and those over 70 due to lower numbers of subjects. BMI and blood test means are presented for each variable by age and gender.

Results
In the middle-aged men group, the numbers of subjects who were obese and overweight (BMI ≥ 25) and obese (BMI ≥ 30) were greater than in other male age groups and female age groups. In women, however, BMI, TG, total cholesterol (TC) and ALP levels started to increase after 50 years old because of menopause and therefore, the proportion of obese (BMI ≥ 30) subjects was apparently lower than that in the middle-aged group.

Conclusion
It should be emphasized that middle-aged men require interventions for preventing obesity and that care should be taken in initiating treatment for obesity in postmenopausal women. (Ningen Dock 2011; 25:45-51)

Key Words: aging, menopause, body mass index, metabolic syndrome

It is well known that aging generated by entropy increasing¹ and gender influence general blood test and BMI values, and menopause is known to influence plasma lipid concentrations in both sexes². Individual regions have particular lifestyles that are reflected in the incidence of lifestyle related disease³ and lifestyle is thought to affect the results of annual health screenings, especially those for BMI, serum glucose and lipid profiles. Obesity has become a major health concern in industrialized societies and it is a major risk factor⁵ of metabolic disorders like metabolic syndrome (MetS), which are considered a world-wide public health problem for the 21st century⁴. One of the features of MetS is the age-related, sex-related, region-related and lifestyle-specific differences in its incidence⁶–⁸. However, it may be worth mentioning, in passing, that some studies have reported an association with cognitive physical and/or mental impairments and medications for older patients with MetS⁹. Therefore, a therapeutic approach for elderly adults with MetS remains to be established and in individual regions, recognizing differences in the health check-up measurements according to age or sex will be very important for determining the timing and methods of therapeutic interventions for diseases, especially obesity.

In this study the main objective was to investigate general tendencies in age- and sex-related differences in BMI and blood test values in Japan.

Methods
Our study was performed on 10,783 females and 12,386 males, who were ambulant and underwent an annual health check-up at our medical center at Kariya Toyota General Hospital or Takahama Branch in 2009. Effects of medications on the subjects’ baseline levels were not considered. The age ranges for the distributions of measured variables for both sexes but only one group was used for subjects of 20–29 years and those over 70 due to lower numbers of subjects. BMI and blood test means are presented for each variable by age and gender.

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In the middle-aged men group, the numbers of subjects who were obese and overweight (BMI ≥ 25) and obese (BMI ≥ 30) were greater than in other male age groups and female age groups. In women, however, BMI, TG, total cholesterol (TC) and ALP levels started to increase after 50 years old because of menopause and therefore, the proportion of obese (BMI ≥ 30) subjects was apparently lower than that in the middle-aged group.

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It should be emphasized that middle-aged men require interventions for preventing obesity and that care should be taken in initiating treatment for obesity in postmenopausal women. (Ningen Dock 2011; 25:45-51)

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From the ¹Department of Integrated Medicine, Kariya Toyota General Hospital Takahama Branch, and ²Department of Laboratory, Kariya Toyota General Hospital Takahama Branch.

Address for Reprints: Ryozo Hashimoto, Department of Integrated Medicine, Kariya Toyota General Hospital Takahama Branch, 3–2–11 Hieda-cho, Takahama, Aichi 444–1321, Japan. Tel. +81–566–52–5522; Fax. +81–566–52–6392; E-mail. ryozo.hashimoto@toyota-kai.or.jp

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ses were performed using a Sysmex XE-2100 analyzer (Sysmex Corp., Hyogo, Japan) and Hitachi 7700 analyzer (Hitachi High-Technologies Corp., Tokyo, Japan), respectively. The reagents used were L-Type (Wako Pure Chemical Industries, Ltd., Osaka, Japan) for the measurement of ALT, AST, γ-glutamyltransferase (GGT), uric acid (UA), creatinine (CRE), glucose (GLU) and ALP, Detaminia (Kyowa Medex Co., Ltd., Tokyo, Japan) for the measurement of BUN, TG, total cholesterol (TC), LDL cholesterol (LDL-C) and HDL cholesterol (HDL-C), Silica Liquid (Kanto Chemical Co., Ltd., Tokyo, Japan), and ADAMS (Arkray, Co., Ltd., Kyoto, Japan) for measurement of HbA1c.

As mentioned above, female ages ranged from 20 to 85 years and male ages from 20 to 92 years old. Five-year groupings were used for distributions of measured variables for both sexes but only one group was used for subjects of 20–29 years and those over 70 due to lower numbers of subjects. Means are presented for each variable by age and gender.

This study was conducted after obtaining the approval of the Ethical Committee of our institution.

Results

The mean values of each group for both BMI and serum blood tests are shown in Table 1. Although the mean levels of items measured for each group were within normal limits, the majority varied with age.

Common Features in Both Men and Women

Mean electrolytes, WBC, total protein, and HDL-C levels did not vary with age or sex. In addition, UA levels were relatively stable with age. Serum levels for glucose, HbA1c, CRE and BUN increased with age (Figs. 1 and 2).

Features of Male Subjects

TG, LDL-C and BMI levels were higher in the 40 to 49 years age range (Fig. 3). ALT levels were higher in subjects aged 35 to 44 years old but lower in older subjects (Table 1). Table 2 shows the distribution of BMI levels by age bracket (20–29, 30–39, 40–49, 50–59, 60–69 and over 70 years old) and sex. The rate of overweight or obese subjects was higher in men of 40 to 49 years old. The portion of subjects with BMI ≤ 25 was 31.1%, and that of BMI 30 was 4.3%. In older age groups (50–59, over 70 years old), the figures were 28.8% and 18.8%, respectively. However, the rates for seriously obese subjects (BMI ≥ 30) were 2.6% for 50–59 years, and 0.4% for over 70 years, which were lower than in the middle-aged male group (Table 2).

Characteristics of Female Subjects

ALP levels were dramatically elevated in women over 50 years, and Hb, LDL-C, TG and BMI were also higher in this group (Figs. 3 and 4). In contrast to men, BMI levels in women were associated with increased age. The proportion of subjects with BMI ≤ 25 for 60–69 years old women was 19.0% (BMI ≤ 25: 2.1%) (Table 2), and the degree of obesity was less than that of middle-aged men. In other words, treatment for obesity in postmenopausal women was less frequent than in middle-aged men.

Discussion

In this study, we examined the distributions of BMI and blood levels of the various parameters by sex and age in 23,169 persons who underwent an annual health screening. The mean value for each measured item was considered to be representative of each group and using them, we showed the relationships between individual items and sex/age. We assumed the ideal person to be representative of each age/sex group was the one who presented the mean blood test and BMI values in each group, as if ‘types’ were induced from ‘tokens.’ We paid due attention to the Quetelet index as well as the concept of ‘L’homme moyen’ proposed by Adolphe Quetelet.

BMI is an indicator of obesity and is also associated with risk of developing MetS. MetS, which is characterized by a combination of visceral obesity, dyslipidemia, hypertension and dysglycemia, increases the risk of developing cardiovascular disease and is associated with type 2 diabetes. Also, obesity in which insulin resistance develops has been generally considered to be a major risk factor for developing MetS. Furthermore, even without MetS, obesity increases the risk of cardiovascular events. Therefore, we focused on BMI when assessing the risks of metabolic disorders.

First, we found gender-specific differences in measured item levels. In males, there was a definite correlation between obesity and middle-age. In the middle-aged men group, the proportion of subjects with obesity (BMI ≤ 25) was larger than that in the other male age groups and female age groups. In addition, there was a clear tendency towards obesity in the middle-aged men, though this tendency was reduced in elderly subjects. The reason for BMI decreasing in older subject groups could be aging-related physiological phenomena and/or therapeutic approaches. Also, some people had to be withdrawn from the annual health screening because of illness due to obesity. For the above reasons, our information on this matter was limited. The obesity observed in middle-aged men would probably require therapeutic interventions. This is very important in preventing metabolic disorders, so therapeutic approaches such as lifestyle interventions and/or drug therapy should be carefully conducted in middle-aged men.

Turning now to sex hormones, a few remarks should be made concerning menopause. Low testosterone levels are risk factors for developing MetS in males. Testosterone has a favorable effect on the make-up of lipid profiles and a preventive effect with respect to cardiovascular events in postmenopausal men. This is in contrast to women in whom testosterone could have an adverse effect regarding lipid profile-induced atherosclerosis. We were not able to determine a relationship between obesity and menopause in men because BMI, TC, TG, and LDL-C levels did not increase in postmenopausal men in this study.

Specific female characteristics were observed. BMI, TG, TC and ALP levels started to increase in women after the age of 50. In addition, the percentage of obesity (BMI ≤ 25) in postmenopausal women was lower than that in middle-aged men. Known to influence plasma lipid concentrations, menopause is associated
Table 1. Mean values of BMI and blood test by age and sex: participants aged 20 to 92 years old visited our center for annual health check-up in 2009

<table>
<thead>
<tr>
<th></th>
<th>female</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>min. of n</td>
<td>max. of n</td>
<td>age (years)</td>
</tr>
<tr>
<td></td>
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<td>30-34</td>
<td>35-39</td>
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<td>20.76</td>
</tr>
<tr>
<td>UA</td>
<td>1213</td>
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<td>4.09</td>
</tr>
<tr>
<td>BUN</td>
<td>1185</td>
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</tr>
<tr>
<td>CRE</td>
<td>1080</td>
<td>0.587</td>
<td>0.587</td>
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<tr>
<td>TP</td>
<td>797</td>
<td>7.26</td>
<td>7.21</td>
</tr>
<tr>
<td>ALB</td>
<td>773</td>
<td>4.42</td>
<td>4.38</td>
</tr>
<tr>
<td>AST</td>
<td>1950</td>
<td>17.7</td>
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<tr>
<td>ALT</td>
<td>1950</td>
<td>13.7</td>
<td>13.9</td>
</tr>
<tr>
<td>ALP</td>
<td>1167</td>
<td>183.2</td>
<td>175.9</td>
</tr>
<tr>
<td>γ-GTP</td>
<td>1949</td>
<td>15.9</td>
<td>16.8</td>
</tr>
<tr>
<td>GLU</td>
<td>1891</td>
<td>84.1</td>
<td>84.8</td>
</tr>
<tr>
<td>LDL-C</td>
<td>1366</td>
<td>96.1</td>
<td>101.6</td>
</tr>
<tr>
<td>TC</td>
<td>1268</td>
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<tr>
<td>TG</td>
<td>1927</td>
<td>61.5</td>
<td>66.4</td>
</tr>
<tr>
<td>HDL-C</td>
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<tr>
<td>HbA1c</td>
<td>1275</td>
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<td>4.98</td>
</tr>
<tr>
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<td>1936</td>
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</tr>
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<td>1936</td>
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</tr>
<tr>
<td>PLT</td>
<td>1936</td>
<td>24.39</td>
<td>24.07</td>
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min. of n: a minimum number of participants, max. of n: a maximum number of participants.
with elevated TC and LDL-C and in postmenopausal women, reduced estrogen levels increases the risk of developing MetS. It was thus highly likely that the increased BMI, TG and TC levels we observed were caused by menopause. Also, the increased ALP levels presumably resulted from postmenopausal osteoporosis due to lower levels of estrogen.

Second, items like electrolytes and total proteins involved in basic living activities are not affected by aging and do not vary according to age or sex. However, the following results probably indicate age-related progressive loss of function: serum glucose, HbA1c and CRE levels increased with age; TG, TC, LDL-C, ALT, RBC, platelet and serum albumin levels decreased with age.

Our survey revealed that healthy postmenopausal women had a tendency towards obesity and dyslipidemia. Also, recent studies have found that older people with MetS indeed have sufficient risk factors for the development of cardiovascular diseases, and there

Fig. 1. Graph expressing mean glucose (GLU) and HbA1c levels in each age/sex group. Both GLU and HbA1c levels steadily increased with aging. The left-side vertical axis of the graph indicates the serum levels of glucose (mg/dl) and that on the right-side HbA1c levels (% JDS). JDS: Japan Diabetes Society.

Fig. 2. Graph showing mean BUN and creatinine (CRE) levels in each age/sex group. There is an increase in the values of BUN and CRE according to aging. The left-side vertical axis of the graph indicates the serum levels of BUN (mg/dl) and that on the right-side CRE levels (mg/dl).
have been some reports of medical therapy for elderly patients with MetS increasing cognitive dysfunction. Hence, a variety of approaches should be considered for the treatment of elderly patients with MetS. One can definitely state that procedures for elderly people with MetS are different from those for middle-aged people and care needs to be taken with them.

Actually, in our investigation, the mean BMI level of females in the 60–69 years group was higher than in other female age groups (20–29, 40–49 years), though the percentage of severe obesity (obese, BMI ≥ 30) was lowest among all female groups. Thus, it was quite possible that the tendency of menopausal females to be overweight was a characteristic physiological

Table 2. Proportions of BMI values by age and sex

<table>
<thead>
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<th>female</th>
<th>male</th>
</tr>
</thead>
<tbody>
<tr>
<td>age (years)</td>
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<td>30–39</td>
</tr>
<tr>
<td>n</td>
<td>913</td>
<td>1963</td>
</tr>
<tr>
<td>25 □ (30 □ )</td>
<td>8.8 (2.3)</td>
<td>9.6 (2.2)</td>
</tr>
<tr>
<td>BMI ≥ 18.5 □ , ≥ 25 □</td>
<td>61.3</td>
<td>71.5</td>
</tr>
<tr>
<td>BMI ≥ 18.5 □</td>
<td>28.9</td>
<td>19.0</td>
</tr>
</tbody>
</table>

In brackets: percentage of subjects with BMI ≥ 30. There is an increase in rate of overweight, obese subjects in the middle-aged group.

Fig. 3. Graph showing mean BMI, LDL cholesterol (LDL-C) and TG levels in each age/sex group. The peak BMI levels are shown for middle-aged men and elderly women. LDL-C and TG are correlated with a change in BMI. The left-side vertical axis of the graph indicates the serum levels of LDL-C and TG (mg/dl) and that on the right-side BMI.
phenomenon. It should be mentioned in passing that MetS is not a distinct entity but consists of various components. As a consequence, physicians should focus on what individual MetS components must be treated and also the optimum therapeutic approach for each elderly patient requiring such focus on individual components.

Our findings in the annual health screening of 23,169 persons in Japan revealed clear characteristic age- and sex-related differences in distributions of BMI and blood tests. Therefore, one should pay due attention to age- and sex-related differences in the levels of these parameters whenever data are assessed.

By way of conclusion, we should reiterate that middle-aged men require interventions for preventing obesity, whereas with postmenopausal women, one must exercise care in starting treatment for obesity.

Acknowledgment

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Conflict of Interest

The authors declare no conflict of interest.

References


Fig. 4. Graph showing mean ALP and Hb levels in each age/sex group. In postmenopausal women, there is an immediate sharp increase in ALP. The left-side vertical axis of the graph indicates the serum level of ALP (U/l) and that on the right-side for Hb levels (g/dl).

