Effects of Blood Parameters and Dietary Intake on Japanese Female College Students Showing Normal BMI with High Body Fat

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While leanness and obesity are viewed as problems in Japan, there has been insufficient clarification of the status of individuals showing a high body fat percentage with a body mass index (BMI) categorizing them as lean or normal, or what may be termed “normal-weight obesity”. The present study looked at 57 female university students with a standard body type (BMI greater than or equal to 18.5, and less than 25) and classified the subjects by body fat percentage (BFP) into three groups: BFP less than 25.0%; BFP greater than or equal to 25.0% and less than 30.0%; and BFP greater than or equal to 30.0%. We then examined the anthropometric measurements, blood parameters, body image, and intake of different food groups and amounts of energy and nutrients, and investigated the relationships of these factors with the body fat percentage. The serum high-density lipoprotein cholesterol level was significantly lower and the serum triacylglycerol and leptin levels were significantly higher in the group with BFP greater than or equal to 30.0% than in the groups with BFP less than 25%, or BFP greater than or equal to 25% and less than 30%. The survey of food intake showed that the consumption of fats, oils and fruits was significantly higher in the high BFP group. These results from blood biochemistry tests and the food intake survey suggest that appropriate nutritional education is necessary for those people with normal-weight obesity having BMI in the normal range (greater than or equal to 18.5 and less than 25).

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Keywords: normal BMI with high body fat, food and nutritional intake, anthropometric, blood parameters, body fat percentage

1. INTRODUCTION

In Western countries, obesity is defined as a body mass index (BMI) ≥30.0, but the Japan Society for the Study of Obesity has established diagnostic criteria for leanness in Japan as BMI<18.5, normal as 18.5≤BMI<25, and obesity as BMI≥25. According to the 2008 National Health and Nutrition Survey by the Ministry of Health, Labor and Welfare in Japan, 25% of women in their 20s are lean, with BMI<18.5. Lean women show a higher likelihood of giving birth to low birth-weight infants, and women who desire to be lean may become undernourished from the effects of disrupted eating habits and dieting. They may also give birth to children with a relatively high risk of developing lifestyle-related diseases in the future. The suggestion has been made that 70% of predisposing factors for various conditions considered as lifestyle-related diseases are associated with nutritional status in the fetal period and infancy, and that these diseases develop as a result of the burden from later living habits. This theory is called the fetal origins of adult disease (FOAD) theory, proposed by Barker et al. from the results of a large-scale epidemiological study. Considering this

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(421)
theory, preventing leanness in young women is thought to be important in Japan to prevent lifestyle-related diseases in the next generation. Based on the marked increase in leanness (BMI<18.5) among women in their 20s, the Ministry of Health, Labour and Welfare has lowered the baseline for the 2010 target value for leanness from 23.3% to 15% in the Healthy Japan 21 program, which was established in 2000. As dietary guidelines for pregnant women, the Ministry came out for the first time in 2006 with a proposal for the management of appropriate body weight from before pregnancy, and for an increase in the recommended body weight during pregnancy depending on the BMI of the pregnant woman.

The increase in the percentage of obese (BMI≥25) men in their 40s and 50s is also seen as a social problem in Japan. In the 2008 National Health and Nutrition Survey by the Ministry of Health, Labour and Welfare, the obesity rate was 35.9% among men in their 40s and 32.4% among men in their 50s. Compared with people in Western countries, more Japanese reportedly have mild obesity and an ethnic predisposition toward susceptibility to health problems arising from even mild obesity. Obesity in women is also reported as a risk factor for breast cancer and other conditions.

Whereas leanness and obesity are viewed as problematic, 40% of women in their 20s reportedly show "normal-weight obesity", in which there is a high body fat percentage (BFP) even in those judged to have low (BMI <18.5) or normal (18.5≤BMI<25) BMI. However, the status of normal-weight obesity remains inadequately understood, and reports on blood parameters are lacking. Some young women want to lose weight despite having a normal or lean body type, and nutritional education for proper awareness of body types is thus necessary. The present study, after dividing young women with normal body weights of 18.5≤BMI<25 into three groups of differing BFPs, surveyed anthropometric measurements, blood parameters, body image, and food intake, and compared each parameter between the three groups. We also measured the release of ghrelin, an appetite-stimulating hormone, and leptin, a ghrelin antagonist, and compared these between groups with the aim of clarifying relationships between various factors and normal-weight obesity.

2. METHODS

(1) Subjects
Subjects are female college students in S city, S prefecture. Subjects comprised 57 female university students with a mean age of 19.23 ± 0.95 years (range, 18-22 years) and BMI within the range of 18.5 to<25.0. Informed consent form was shown to each voluntary, and all the subjects agreed to participate in our research. This study was conducted after receiving approval from the University of Shizuoka ethics committee.

(2) Anthropometric Measurements and Blood Sampling
Subjects fasted from 20:00 of the night before body measurements and blood collection. Height, weight, BFP, waist circumference, and blood pressure were measured the following morning between 08:00 and 10:00. Body weight and BFP were measured using a body fat analyzer (TFB-215; Tanita, Tokyo, Japan). This body fat analyzer measures body fat based on bioelectrical impedance, using four electrodes supplying a weak electric current at a frequency of 50 kHz. Impedance analysis measures electrical resistance when the weak electric current passes through the body, and estimates fat-free mass and fat mass from total body water (TBW). Though impedance method is a simple, easy, and useful assay, it was reported that unevenness had been found in measurements for the person having high percent of body fat. However, many reports have examined the validity of estimation formulae for TBW using impedance analysis. Thus we kept the measurement time constant to reduce the error of the percent of body fat in this study as less as possible and asked the subjects to cloth short sleeves and a jersey.

Furthermore, we applied such measurement not only for the subjects in this study but also for those in the previous study. Waist circumference was measured using a tape measure at the level of the navel. Blood pressure was measured using a digital automatic sphygmomanometer (HEM-5001; OMRON, Kyoto, Japan). Waist circumference and blood pressure were measured twice each, and the mean was calculated. Blood was collected between 07:00 and 10:00. Blood for ghrelin analysis was collected in vacuum blood collection tubes containing ethylenediamine tetracetic acid disodium salt and trasylol, and blood for other tests was collected in
vacuum blood collection tubes containing heparin. After collection, blood collection tubes for ghrelin analysis were immediately inverted and mixed, and those for other tests were left sitting at room temperature for 30 min after collection. Collection tubes were then centrifuged for 15 min at 4°C and 3,000 rpm. The plasma portion for ghrelin and the serum portion for other tests were then injected into microtubes and stored at -80°C until analysis. Analysis of total protein, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, triacylglycerol, free fatty acids, and hemoglobin was outsourced to SRL (Tokyo, Japan). Glucose was analyzed using a glucose measurement kit from Wako Pure Chemical Industries (Osaka, Japan), and leptin was analyzed using a Human Leptin (Highly Sensitive) Assay Kit (Immuno-Biological Laboratories, Gunma, Japan). Active ghrelin and des-acyl ghrelin were analyzed using an active ghrelin enzyme-linked immunosorbent assay kit and des-acyl ghrelin ELISA kit (Mitsubishi Kagaku Iatron, Tokyo, Japan), respectively.

(3) Body Image

Using the silhouette shapes of Stunkard et al. (Fig. 1)31, subjects were asked to select the silhouette number most closely resembling their own current body type, and the silhouette number of their ideal body type. There are 9 silhouettes in the figure. Silhouettes with higher numbers represent more obese body types31. The numbers of the silhouettes defined by Stunkard et al. were translated using the method into different BMI levels32.

(4) Food and Nutritional Intake

Dietary habits for the preceding month were assessed using a previously validated, self-administered diet history questionnaire (DHQ). The DHQ is a 16-page structured questionnaire, consisting of the following seven sections: general dietary behaviors; major cooking methods; frequency of consumption and portion size for six alcoholic beverages; semi-quantitative frequency of intake for 121 selected food and non-alcoholic beverage items; dietary supplements; amount and frequency of consumption for 19 staple foods (rice, bread, noodles, and other wheat foods); and open-ended items for foods consumed regularly but not appearing in the DHQ. Measures of dietary intake for 150 food and beverage items, energy, and nutrients were calculated using an ad hoc computer algorithm for the DHQ based on the Standard Tables of Food Composition in Japan33-35.

(5) Statistical Analysis

Subjects were divided into three groups according to BFP: Group 1, 17%≤BFP<25% (normal group); Group 2, 25%≤BFP<30% (mild normal weight obesity group); and Group 3, BFP≥30% (normal weight obesity group) following the article of Takahashi et al36,37. This was based on criteria from studies on the utility of body fat measurements using body fat analyzers with a standing leg-to-leg inductive impedance system38. Following one-way analysis of variance for body weight measurement, blood biochemistry test items, and the food intake survey, a multiple comparison test (Tukey’s test) was conducted and comparisons were made between groups. A Chi-square test was conducted on the body image test.

Statistical analysis was performed using SPSS version 18.0J software (SPSS, Tokyo, Japan). The statistical criterion for all tests was set at P<0.05.

3. RESULTS

(1) Anthropometric Data

Height, weight, and BMI of subjects were comparable with the mean values for Japanese women in their 20s and 30s in the 2008 National Health and Nutrition Survey2.

No significant difference was seen between groups in height, but Group 3 showed significantly higher weight, BFP, and waist circumference than the other two groups (P<0.01). Systolic blood pressure was also significantly higher in Group 3 than in the other two groups (P<0.05) (Table 1).
(2) Blood Parameters  
Serum HDL cholesterol level was significantly lower and serum triacylglycerol level was significantly higher in Group 3 than in the other groups (P<0.05). Triacylglycerol levels were also shown to be similar to serum leptin levels. No significant differences were seen between groups in plasma ghrelin levels, but plasma des-acyl ghrelin levels tended to increase with higher BFP (Table 1).

(3) Body Image  
Most of the subjects in group 1 and 2 chose the third silhouette image as their current body type, while the fourth and fifth ones were chosen by the most subjects in group 3. There was a significant difference (P<0.05) among the current body types of three groups (Table 2). The second silhouette image was chosen by the most subjects in group 1 and 2 as their ideal body type, while, in group 3 the second and third images were chosen by 50% of the subjects, respectively. There was significant difference (P<0.05) among the ideal body types of three groups (Table 3). The number of the ideal body type a la Stunkard et al. was significantly less than that of the current body type in all groups. The differences between the ideal body type number and the current body type number among all groups were not significant. (Table 4).

(4) Food Intake  
Although total food intake weight was significantly higher in Group 3 than in Group 2 (P<0.05), no significant differences were seen between groups in energy or intake of other nutrients. Nutrient intake thus did not differ depending on differences in BFP.

In terms of the amount of food consumed by food group, consumption of potatoes was significantly higher in Group 1. Consumption of fats, oils and fruits was significantly higher in Group 3 than in Group 2. Although no significant difference was seen in the consumption of green and yellow vegetables, consumption tended to be higher in Group 1 (Table 5).

4. DISCUSSION

In Japan, many studies involving young women are related to leanness. Few reports have examined normal-weight obesity, in which the individual shows a high BFP despite a BMI within the normal range (18.5≤BMI<25.0). Young women often have a strong desire to become thin, and want to lose weight even when they are already lean or normal weight. Nutrition education on the importance of a balanced diet and recognition of a proper body image is important to prevent lifestyle-related diseases in the future. However, the desire to become thin is in
The result that anthropometric measurements

<table>
<thead>
<tr>
<th>Body Image No.</th>
<th>Group 1 17%≤BFPa&lt;25% (n=20)</th>
<th>Group 2 25%≤BFPa&lt;30% (n=27)</th>
<th>Group 3 BFPa≥30% (n=10)</th>
<th>Pearson χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 (5.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>15 (75.0%)</td>
<td>18 (66.7%)</td>
<td>2 (20.0%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4 (20.0%)</td>
<td>9 (33.3%)</td>
<td>4 (40.0%)</td>
<td>0.000</td>
</tr>
<tr>
<td>5</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>4 (40.0%)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>20 (100%)</td>
<td>27 (100%)</td>
<td>10 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

† Body image test used silhouette type by Stunkard et al.

* BFPa=Body fat percentage

Chi-square test
(significant 3 groups differences: 17%≤BFPa<25% vs 25%≤BFPa<30% vs BFPa≥30%)

† Adjusted residual≤-2.0

‡ Adjusted residual≥2.0

Table 3. Body image test † (ideal body type) in Japanese female college students

<table>
<thead>
<tr>
<th>Body Image No.</th>
<th>Group 1 17%≤BFPa&lt;25% (n=20)</th>
<th>Group 2 25%≤BFPa&lt;30% (n=27)</th>
<th>Group 3 BFPa≥30% (n=10)</th>
<th>Pearson χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2 (10.0%)</td>
<td>2 (7.4%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>16 (80.0%)</td>
<td>23 (85.2%)</td>
<td>5 (50.0%)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>2 (10.0%)</td>
<td>2 (7.4%)</td>
<td>5 (50.0%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>0.024</td>
</tr>
</tbody>
</table>

† Body image test used silhouette type by Stunkard et al.

* BFPa=Body fat percentage

Chi-square test
(significant 3 groups differences: 17%≤BFPa<25% vs 25%≤BFPa<30% vs BFPa≥30%)

† Adjusted residual≤-2.0

‡ Adjusted residual≥2.0

fact strong, and young women often have strong feelings about maintaining their current weight or becoming thinner. In these circumstances, nutrition education is difficult. Subjects in this study were women in their 20s to 30s with BMI within the normal range, taken from a subset showing average body types. Blood markers, body image, and food intake were compared between groups with different BFPs. Using these results, we identified problems depending on BFP even in people with normal body weight, with the aim of contributing evidence for nutrition education in young women.

The result that anthropometric measurements
accumulated risk factors to atherosclerosis in people with normal weight, Miyawaki et al. reported a significant correlation between visceral fat tissue and both systolic and diastolic blood pressures, even in people with normal body weight.40) Meanwhile, Miyatake et al. studied the relationship between visceral fat tissue accumulation and blood biochemistry tests among Japanese university students, finding a significant correlation between increased with BFP. However, blood pressure, particularly systolic blood pressure, was also shown to increase significantly with BFP. Among serum lipid parameters, HDL cholesterol level decreased and triacylglycerol level increased as BFP increased.

Blood pressure and serum lipid parameters are said to be significantly correlated with visceral fat in particular.6,39) In a study analyzing the contribution of accumulated risk factors to atherosclerosis in people with normal weight, Miyawaki et al. reported a significant correlation between visceral fat tissue and both systolic and diastolic blood pressures, even in people with normal body weight.40) Meanwhile, Miyatake et al. studied the relationship between visceral fat tissue accumulation and blood biochemistry tests among Japanese university students, finding a significant correlation between

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**Table 4. Body image test (current body type-ideal body type) in Japanese female college students**

<table>
<thead>
<tr>
<th>Current body type-ideal body type</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Pearson χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17%≤BFP&lt;25%</td>
<td>25%≤BFP&lt;30%</td>
<td>BFP≥30%</td>
<td></td>
</tr>
<tr>
<td>-3.00</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td>1 (10.0%)²</td>
<td></td>
</tr>
<tr>
<td>-2.00</td>
<td>4 (20.0%)</td>
<td>9 (33.3%)</td>
<td>5 (50.0%)</td>
<td>0.077</td>
</tr>
<tr>
<td>-1.00</td>
<td>14 (70.0%)</td>
<td>18 (66.7%)</td>
<td>4 (40.0%)</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>2 (10.0%)²</td>
<td>0 (0.0%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20 (100%)</td>
<td>27 (100%)</td>
<td>10 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

* Body image test used silhouette type by Stunkard et al.
* BFP=Body fat percentage
* Chi-square test (significant groups: differences: 17%≤BFP<25% vs 25%≤BFP<30% vs BFP≥30%)
* Adjusted residual=2.0

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**Table 5. Nutrient and food intakes in Japanese female college students**

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>17%≤BFP&lt;25%</td>
<td>25%≤BFP&lt;30%</td>
<td>BFP≥30%</td>
</tr>
<tr>
<td></td>
<td>(n=20)</td>
<td>(n=27)</td>
<td>(n=10)</td>
</tr>
<tr>
<td>Total food intake (g)</td>
<td>2412±964³⁰³</td>
<td>2167±731³³³</td>
<td>3040±1177³³³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>1882.1±591.7</td>
<td>1683.6±341.9</td>
<td>2023.0±771.2</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>58.0±17.0</td>
<td>53.3±14.0</td>
<td>60.1±19.9</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>69.1±26.0</td>
<td>59.5±17.2</td>
<td>73.9±22.8</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>253.2±82.8</td>
<td>225.4±43.6</td>
<td>270.1±123.8</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>584.5±292.7</td>
<td>523.0±232.1</td>
<td>603.1±372.4</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>6.4±2.3</td>
<td>5.6±1.7</td>
<td>6.4±2.2</td>
</tr>
<tr>
<td>Salt (g)</td>
<td>8.7±2.9</td>
<td>8.6±2.6</td>
<td>8.4±2.4</td>
</tr>
<tr>
<td>Saturated fatty acid (g)</td>
<td>22.6±10.1</td>
<td>18.8±7.2</td>
<td>24.9±13.2</td>
</tr>
<tr>
<td>Polyunsaturated fatty acid (g)</td>
<td>13.3±4.9</td>
<td>11.5±2.9</td>
<td>14.1±2.6</td>
</tr>
<tr>
<td>Total fiber (g)</td>
<td>11.9±4.9</td>
<td>9.8±3.3</td>
<td>10.2±4.5</td>
</tr>
<tr>
<td>Food groups (g)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grains</td>
<td>271.1±137.4</td>
<td>275.3±112.6</td>
<td>291.2±167.3</td>
</tr>
<tr>
<td>Potatoes</td>
<td>40.0±24.3³⁰³</td>
<td>23.9±16.6³³³</td>
<td>23.2±14.8³³³</td>
</tr>
<tr>
<td>Sugar and preserves</td>
<td>33.2±18.1</td>
<td>26.8±19.5</td>
<td>23.3±14.5</td>
</tr>
<tr>
<td>Sweets</td>
<td>100.4±91.4</td>
<td>80.8±50.1</td>
<td>126.5±102.3</td>
</tr>
<tr>
<td>Fats and oils</td>
<td>21.2±10.2³³³⁴</td>
<td>18.3±6.9³³³⁴</td>
<td>25.3±11.1³³³⁴</td>
</tr>
<tr>
<td>Fruits</td>
<td>125.9±73.1³³³⁴</td>
<td>80.1±56.6³³³⁴</td>
<td>184.2±196.6³³³⁴</td>
</tr>
<tr>
<td>Green and yellow vegetables</td>
<td>99.6±44.1</td>
<td>68.4±47.7</td>
<td>74.2±43.8</td>
</tr>
<tr>
<td>Other vegetables</td>
<td>118.4±55.5</td>
<td>101.8±48.5</td>
<td>134.2±107.7</td>
</tr>
<tr>
<td>Total vegetables</td>
<td>218.0±79.7</td>
<td>170.2±77.8</td>
<td>208.4±136.9</td>
</tr>
</tbody>
</table>

³BFP=Body fat percentage
* Values represent mean ± standard deviation. Means with different letters are different at P<0.05 by Tukey's multiple range test.
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visceral fat area and uric acid, triacylglycerol, and blood pressure in males, but no significant correlation between visceral fat area and blood pressure in females. In the present study, although visceral fat was not measured, the fact that the subjects were young women suggests that the amount of visceral fat was relatively low, and the amount of subcutaneous fat high. This suggests the need for nutrition education to increase awareness of the load on fat metabolism even in people with normal body proportions. The present study measured levels of serum leptin, which is secreted from fat cells as an appetite-suppressing hormone, and plasma ghrelin, which acts to stimulate appetite. Leptin levels are reportedly high in obese individuals, while ghrelin levels are high in lean people. In this study, serum leptin levels were shown to increase with BFP, and were significantly higher in Group 3 than in the other two groups. Moreover, although no significant difference was seen in serum des-acyl ghrelin levels, ghrelin tended to increase with BFP. Monti et al. surveyed the relationships of BMI and waist circumference to ghrelin and leptin in 233 adult BFP. Monti et al. reported that relationship to be strong. However, the present study did not see this kind of significant relationship between nutrients and food groups. One reason may have been that the number of subjects in our study was limited by selecting only people with normal body proportions. The number of subjects in this subset was also a limitation for the present study.

Furthermore, we kept the measurement time constant, and asked the subjects to cloth short sleeves and a jersey to reduce the error of the measurement of the percent of body fat. We note that the reliability of this study much depends on that of TANITA TBF-215 used in the measurement of the percent of body fat. The measurement of body fat percentage that we used in this study has a limit.

Even though individuals with normal-weight obesity in Group 3 were aware that their own body type was not enough to establish a significant statement. In summary, young Japanese women with normal body proportions (18.5≤BMI<25) were classified by BFP into three groups (BFP <25.0; 25.0≤BFP<30.0; or BFP≥30.0), and relationships between BFP and blood parameters, nutrient intake, and body image were investigated. Serum lipid and leptin levels were found to be higher in patients with normal-weight obesity and 18.5≤BMI<25.0 or BFP≥30.0, as individuals who tended to overestimate their own body type as being fat. Overconsumption of fats, oils and fruits in people with normal-weight obesity indicated the need for such individuals to acquire better eating habits. The number of subjects in this study was not enough to establish a significant statement.

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Effects of Blood Parameters and Dietary Intake on Japanese Female College Students Showing Normal BMI with High Body Fat


女子大学生の正常体重肥満者における
血液パラメーターと食物摂取状況の影響

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日本では、やせや肥満が問題視される一方、BMI は「やせ」や「正常」と診断されるものの、体
脂肪率が高い「正常体重肥満」の実態やその特性は、十分に明らかにされていない。そこで、本研
究では女子大学生を対象に普通体型 (18.5 ≦ BMI<25) の者を体脂肪率別に 3 分類し、身体状況、
血液パラメーター、体型認識、食品群および栄養素等摂取状況の実態を把握し、体脂肪率との関連に
ついて検討を行った。対象者は、BMI が 18.5-24.9 の範囲内に属する女子大学生 57 名である。調
査項目は、身体計測、血液生化学検査、ボディイメージ調査、食物摂取状況調査である。統計解析は、
体脂肪率 3 分位（Body Fat Percentage: BFP<25.0, 25.0 ≦ BFP<30.0, BFP ≧ 30.0）に分類し、体脂肪
率分類別の各パラメーターにおける比較検討を行った。その結果、血清中 HDL-Chol 濃度におい
ては、BFP<25.0%group, 25.0 ≦ BFP<30.0group に比較し、BFP ≧ 30.0group が有意に低値を示し、
血清中中性脂肪濃度、レプチン濃度は有意に高値を示した。食物摂取状況調査においては、BFP 高
値のほど油脂、果実類の摂取量が有意に多かった。本研究結果より、BMI が正常域であっても正常
体重肥満者は血液生化学検査や食物摂取状況調査の結果より、今後適切な栄養教育の必要性が示唆
された。

キーワード：正常体重肥満、食物摂取状況、身体計測、血液パラメーター、体脂肪