OBJECTIVE — We developed a new method of estimating visceral fat area (VFA) using multifrequency bioelectrical impedance (BI).

RESEARCH DESIGN AND METHODS — We considered abdominal composition as a parallel circuit model composed of VFA and subcutaneous fat area and calculated the impedance of VFA (IPVFA) from this model. The methods were tested against measures of VFA by computed tomography (CT). Multiple regression analysis was performed on 103 participants to estimate VFA. We cross-validated the regression equation against CT-measured VFA in 30 additional participants.

RESULTS — The regression equation was VFA = 3.57 × sagittal abdominal diameter + 311.97 × waist-to-height ratio + 0.71 × age + 23.93 × sex + 1.57 × IPVFA (250 kHz) − 174.35 (r = 0.904; P < 0.01). We observed a strong correlation by cross-validation (r = 0.905).

CONCLUSIONS — Our method using BI is a simple and convenient method for accurately estimating VFA.

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CONCLUSIONS — In this study, because subcutaneous fat layer thickness affected the impedance when electrodes were placed on the abdomen (6), we considered abdominal composition as a parallel circuit model and calculated IP_{VFA} using the formula for a parallel circuit. Therefore, we eliminated the effect of SFA by this model.

In Japan, waist circumference at the umbilicus level was used to screen for VFA \( \geq 100 \) cm\(^2\) because CT has some problems such as radiation exposure (15). However, our regression equation demonstrated higher sensitivity and specificity than waist circumference.

A major strength of our study is that the number of study participants was more than in any previous study (4–6,13). Additionally, we cross-validated the regression equation and obtained a strong correlation (\( r = 0.905, P < 0.01 \)). On the other hand, our study has several limitations. First, the study participants were young (mean age \( \pm SD: 30.3 \pm 10.8 \) years), and the proportion of VFA \( \geq 100 \) cm\(^2\) was small (16.5%), so we may not be able to adapt this regression equation for middle-aged people who have a higher proportion of VFA \( \geq 100 \) cm\(^2\) than young people. Second, the data are limited to the Japanese population, which may have different VFA characteristics than other populations.

Our new method using BI is a simple and convenient method for accurately estimating VFA. We can easily screen excess accumulation of VFA, which is associated with metabolic syndrome. The method may be a useful tool for primary prevention of metabolic syndrome.

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Figure 1—Correlation plot between VFA observed by CT and VFA estimated by impedance.

Estimated VFA area by impedance

estimated by IP_{VFA} (14). We calculated the sensitivity and specificity at VFA \( \geq 100 \) cm\(^2\) by the regression equation (15). The correlation between impedance and VFA and SFA was examined by Pearson correlation coefficient. All \( P \) values were two-tailed, and \( P < 0.05 \) was accepted as statistically significant.

RESULTS — The weakest and strongest correlation between impedance obtained at the five frequencies and VFA and SFA were \( r = 0.734–0.747 \) (IP_{VFA}) and \( r = 0.834–0.872 \) (IP_{SFA}), respectively.

The regression equation was VFA = 3.57 \( \times \) sagittal abdominal diameter + 311.97 \( \times \) WHtR + 0.71 \( \times \) age + 23.93 \( \times \) sex + 1.57 \( \times \) IP_{VFA} (250 kHz) – 174.35 \( r = 0.904, P < 0.01 \) (Fig. 1).

Also, we observed a strong correlation in the cross-validation subsample \( (r = 0.905, P < 0.01) \). The Bland-Altman method showed a mean difference and 1.96 SD of 0.00 \( \pm 40.78 \) cm\(^2\). There was no increasing bias for heavier participants. We observed a high sensitivity and specificity (0.941 and 0.988, respectively) when we discriminated VFA \( \geq 100 \) cm\(^2\) or \(<100 \) cm\(^2\) by the regression equation. Meanwhile, waist circumference (W) at the umbilicus level (men: W \( \geq 85 \) cm, women: W \( \geq 90 \) cm) is used for screening of VFA \( \geq 100 \) cm\(^2\) in Japan (15), thus sensitivity and specificity were 0.882 and 0.919, respectively, by W in our participants.
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