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A pilot study in relationship among changes in visceral fat area, waist circumference and body weight in Japanese freshmen students

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ABSTRACT

We investigated the relationship among delta (delta represents changes in parameters) visceral fat area, waist circumference and body weight in Japanese freshmen students. Visceral fat was measured at the umbilical level using computerized tomography scanning at baseline study and 6 months later. Body weight and height, as well as waist circumference were also measured. We found that visceral fat area, waist circumference, and body weight significantly correlated with each other at baseline, and 6 months later, delta visceral fat area and changes in % visceral fat area significantly correlated with delta waist circumference and delta body weight in female and in total subjects. In addition, based on the predictive linear equations from the regression analysis, we found that 1kg of delta body weight corresponded to 0.83 cm of delta waist circumference, and 1kg of delta body weight and 1cm of delta waist circumference corresponded to 9.41% and 7.80% of changes in visceral fat area, respectively, in total subjects. The present results suggest that delta visceral fat area is closely related to delta body weight and delta waist circumference in Japanese freshmen students.

Keywords: Visceral Fat Area; Body Weight; Waist Circumference; Predictive Equation; University Students

1. INTRODUCTION

Metabolic syndrome has become a public health challenge in Japan. A survey conducted by the Ministry of Health, Labor and Welfare Office showed that about 9 million people in Japan are suffering from metabolic syndrome, and 10 million people are at risk of developing it [1]. Reducing visceral fat has been recommended as a critical approach to prevention of the metabolic syndrome [2].

Adolescence is an important period in human life in which changes in body composition occur [3]. The extent of asymptomatic atherosclerotic lesions in the coronary vessels increased markedly in young people with multiple cardiovascular risk factors [4]. A close association of visceral fat accumulation with dyslipidemia and hyperinsulinemia in adolescents [5,6] suggests that optimal prevention efforts should be particularly made for young people. We previously observed that visceral fat accumulation in university students was relevant to the changes of hepatic enzymes, uric acid, triglyceride, and blood pressure [7]. However, it is not clear whether change of visceral fat area is linked to anthropometric parameters in university students. This pilot study aimed to evaluate the relationship between changes in visceral fat area and anthropometric parameters among Japanese freshmen students.

2. METHODS

2.1. Participants

Fifty-eight freshmen students from a university in Japan (10 men and 48 women, 18.4 ± 0.1 years of age) participated in this study at baseline. No subjects received any medications for diabetes, hypertension, and/or dyslipidemia. Ethical approval was obtained from the Ethical Committee of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sci-

ences, and a written informed consent was obtained from all participants as well as from their legal guardians. At the time of enrollment in the study, all participants were given a lecture on the importance of physical activity to their health, and were distributed a pamphlet showing a practical way on how to increase their daily activity.

2.2. Measurement Procedures

Height, body weight, waist circumference, and visceral fat area were measured. Waist circumference was taken in the standing position at the midpoint between the lowest rib margin and the iliac crest at the end of normal expiration. The intra-abdominal visceral fat and the subcutaneous fat areas were measured by CT scanned at the umbilical levels using a CT scanner (SOMATOM AR. SP, SIEMENS, Munich, Germany). CT films were converted into digital images, and both visceral and subcutaneous fat areas were measured with image analysis software OPTIMAS version 6.5 (Media Cybernetics, Silver Spring, MD, USA). The intraperitoneal area with the same density as the subcutaneous fat (S) layer was defined as the visceral fat area [8]. All measurements were repeated 6 months later.

2.3. Data Analysis

Data analysis was based on 56 students (9 males and 47 females, 18.4 ± 0.1 years of age) since 2 subjects were dropout 6 months later. Data comparison between baseline and follow-up was performed by paired *t* test. Changes in parameters between baseline and follow-up are expressed as delta. Spearman correlation analysis was used to examine the association among variables. Linear regression analysis was employed to derive predictive equations that could estimate the relationship between changes in visceral fat area and anthropometric variables.

3. RESULTS

We found that visceral fat area significantly correlated with body weight (r = 0.933, $p < 0.001$ in males; r = 0.468, $p < 0.01$ in females) and waist circumference (r = 0.717, $p < 0.05$ in males; r = 0.539, $p < 0.001$ in females) at baseline. Correlation coefficient between visceral fat area and body weight was 0.478 ($p < 0.001$) and that between visceral fat area and waist circumference was 0.435 ($p < 0.01$) in total subjects. Six-month later, waist circumference was increased in female and total subjects, and visceral fat area tended to be decreased but the difference was not significant (**Table 1**).

Delta waist circumference also significantly correlated with delta body weight in males (r = 0.802, $p < 0.01$), females (r = 0.603, $p < 0.0001$), and total subjects (r = 0.588, $p < 0.0001$), respectively. Delta visceral fat area also significantly correlated with delta body weight (r = 0.405, $p < 0.01$ in females; r = 0.391, $p < 0.01$ in total subjects) and delta waist circumference (r = 0.393, $p < 0.01$ in females; r = 0.474, $p < 0.001$ in total subjects). Changes in % visceral fat area significantly correlated with delta body weight (r = 0.401, $p < 0.01$ in females; r = 0.407, $p < 0.01$ in total subjects) and delta waist circumference (r = 0.557, $p < 0.0001$ in females; r = 0.477, $p < 0.001$ in total subjects).

Table 1. Changes in parameters in 56 Japanese freshmen students.

	Baseline	6-month Follow-up
Total (n = 56)		
Age (y)	18.4 ± 0.1	
Height (cm)	159.4 ± 1.0	159.8 ± 1.0
Body weight (kg)	55.5 ± 1.4	55.3 ± 1.4
Waist circumference (cm)	67.5 ± 1.0	69.2 ± 1.0**
Visceral fat area (cm^2)	23.7 ± 2.8	21.3 ± 1.9
Male (n = 9)		
Age (y)	18.2 ± 0.1	
Height (cm)	170.5 ± 2.0	170.7 ± 2.0
Body weight (kg)	68.6 ± 4.4	68.0 ± 4.3
Waist circumference (cm)	78.6 ± 3.1	78.3 ± 2.7
Visceral fat area (cm^2)	32.8 ± 14.3	26.1 ± 9.3
Female (n = 47)		
Age (y)	18.4 ± 0.1	
Height (cm)	157.3 ± 0.8	157.7 ± 0.8
Body weight (kg)	53.0 ± 1.1	52.9 ± 1.1
Waist circumference (cm)	65.3 ± 0.8	67.5 ± 0.8**
Visceral fat area (cm^2)	22.0 ± 2.1	20.4 ± 1.5

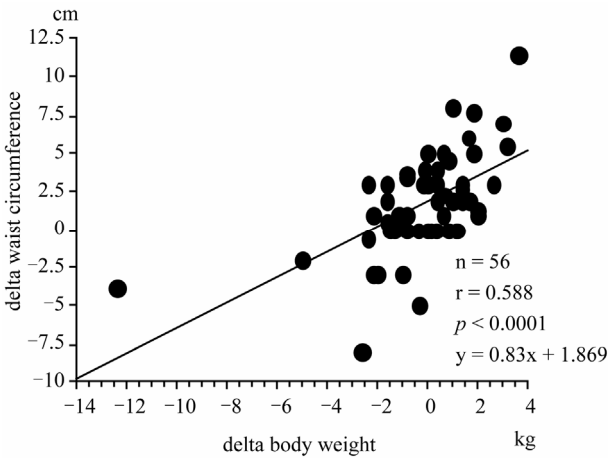
Data are expressed as means ± standard error. Statistical difference was determined by paired Student's *t*-test. ** $p < 0.001$.

Regression equations derived from the slopes of regression line for prediction of changes in parameters indicated that 1 kg of delta body weight corresponded to 0.83 cm of delta waist circumference (**Figure 1(a)**), 1.83 cm^2 of delta visceral fat area (**Figure 1(b)**), and 9.41 % of changes in visceral fat area in total subjects (**Figure 1(d)**), respectively. In addition, 1 cm of delta waist circumference corresponded to 1.57 cm^2 of delta visceral fat area (**Figure 1(c)**) and 7.80 % of changes in visceral fat area in total subjects, respectively (**Figure 1(e)**).

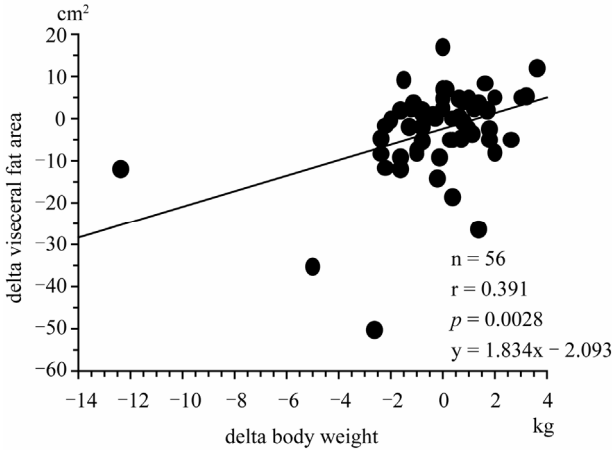
4. DISCUSSION

There are few studies investigating the relationship

between delta visceral fat area and delta anthropometric parameters in university students. The close relationship among changes in visceral fat area, waist circumference and body weight found in our study raises a possibility that using delta anthropometric parameters to detect the



(a)



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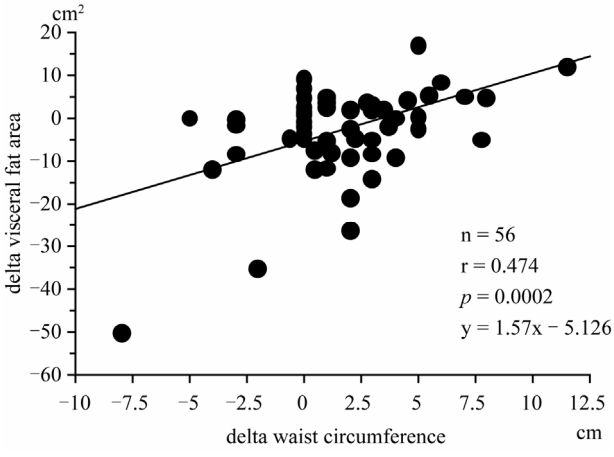
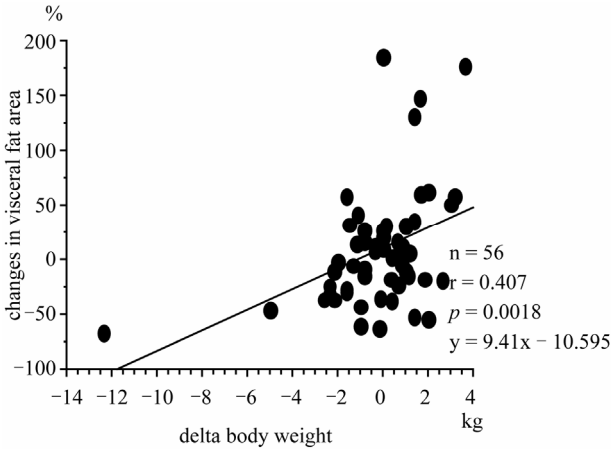
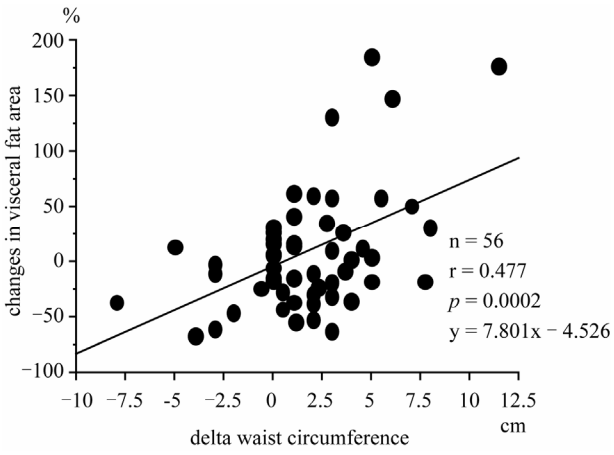


(c)



(d)



(e)

Figure 1. Association among changes in visceral fat area, waist circumference and body weight in Japanese university students. (a) Delta waist circumference vs delta body weight; (b) Delta visceral fat area vs delta body weight; (c) Delta visceral fat area vs delta waist circumference; (d) Changes in % visceral fat area vs delta body weight; (e) Changes in % visceral fat area vs. delta waist circumference.

change of visceral fat accumulation in university students. In a 6-months weight reduction trial, Rissanen *et al.* founded that 8.4 kg (9.0%) of weight loss corresponded to 18.0% of visceral fat area reduction in 38 middle-aged obese women [9]. We also reported a reduction of 3.3 kg of body weight, 4.2 cm of waist circumference, 22.8 cm^2 and 18.8% of visceral fat area in 61 overweight middle-aged men by a 1-year exercise intervention program [10]. The present findings from university freshmen—1 kg of delta body weight corresponded to 1.83 cm^2 of delta visceral fat area and 9.41 % of changes in visceral fat area were different with the previous results of the middle-aged men. Particularly, change in % visceral fat area corresponding to 1kg of delta body weight in university students seems to be comparatively higher than

those middle-aged Japanese men [8]. Such a difference may imply that clinical impact of delta body weight on visceral fat accumulation in university students is worthy of note.

In female participants, the waist circumference significantly increased at 6 months although it did not change in males. One of the explanations might be that there was an increased trend in percent of energy intake from fat and particularly from saturated fatty acid found in female participants (Data not shown). Varady *et al*. reported that subjects with high-fat diet lost more weight than those with low-fat diet, however, waist circumference was significantly decreased in subjects with low-fat diet only [11].

The small number of subjects, especially the male students, limits the ability to generalize these findings, and the freshmen may also differ from their older classmates. In addition, although we found the association among changes in visceral fat area, waist circumference and body weight in university freshmen, we could not provide information on the proper reduction threshold of body composition for preventing future metabolic syndrome.

In conclusion, delta visceral fat area is closely linked to delta body weight and delta waist circumference in university freshmen. These findings might be applicable to public health practice settings to evaluate the effect of prevention against the metabolic syndrome. Further studies are under consideration to confirm whether delta body weight and delta waist circumference can be used to detect change of visceral fat accumulation in university students.

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