ORIGINAL ARTICLE

Body Composition Changes with Lifestyle Therapy for Obesity

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Objective: Given the complicated relationship between body composition and mortality, changes in fat mass (FM) and fat-free mass (FFM) would be important parameters. Body compositions measurement may provide prognostic information. The primary aim was to observe the nature of body composition changes with weight reduction by lifestyle therapy.

Materials and Methods: Obese patients who visited in Obesity Clinic, Srinagarind Hospital were enrolled in this retrospective observational study. Body composition changes during lifestyle therapy was measured by bioelectrical impedance analysis (BIA). Fat mass index (FMI) and fat-free mass index (FFMI) were calculated and used as normalization for FM and FFM, respectively.

Results: Mean body weight of 121 patients was 113.8 kg and mean body mass index was 42.3 kg/m^2. At 3-month, 49.6% of patients achieved 3% weight loss. At 6-month, 54.1% of the patients could achieve 5% weight reduction. There was a significant reduction in FMI afterward weight reduction at 6-month (mean difference 4.03 kg/m^2; 95% CI 1.39 to 6.68) while FFMI had non-significant change (mean difference 0.50 kg/m^2; 95% CI -1.25 to 2.25). At 6-month, patients who achieved 5% weight reduction had significant loss of FMI compared with who did not achieve (4.12 kg/m^2 ±0.47 vs. 0.42 kg/m^2 ±0.25; p-value <0.001).

Conclusion: Lifestyle therapy could maintain FFM and lose FM in those who achieved weight reduction. Application of body composition analysis for daily practice will provide information of changes in the two distinct major body compartments. Maintenance of FFM with persistent FM reduction will be beneficial for long-term clinical outcomes.

Keywords: Body composition; Weight reduction; Obesity; Fat mass; Fat-free mass; Lifestyle therapy

J Med Assoc Thai 2023;106(Suppl.1):S94-9

Website: http://www.jmatonline.com

Obesity contributes to several metabolic and cardiovascular sequelae such as diabetes, coronary artery disease, heart failure(1), etc., leading to premature death and public health problems. The prevalence of obesity tends to be higher in modern populations worldwide, including Thailand(2). The prevalence of obesity in Thai adults was 41.8% in women and 32.9% in men and was found to be increasing(3). Body mass index (BMI) has been widely used as obesity diagnostic criteria. However, all those individuals did not display the same clustering of metabolic and cardiovascular risk factors. Both linear and U-shaped relation between BMI and mortality were found in several studies(4,5). Results from previous research brought some controversy about the relationship and limitation of BMI. Those obese people who did not develop risk factors or health issues were found out that they had fat distribution differed from those with metabolic syndrome(6). Centralized distribution of adipose tissue, higher fat deposition within the trunk than the extremities, favors visceral fat accumulation which leads to an inflammatory state and insulin resistance associated with the risk of chronic disease regardless of fatness(7). One potential explanation is the difference in fat mass (FM) and fat-free mass (FFM) ratio(6). Many studies explored the association between body composition and mortality(8-12). The relation between FFM reduction and mortality was well demonstrated in patients with chronic diseases, elderly residents, and obese patients with cancer(10). On the other hand, midarm muscle circumference, an indicator of muscle mass, was significantly associated with a lower risk of mortality(13,14). Fat-free mass index (FFMI) showed a reversed J-shaped association with mortality in the mutually adjusted model(13). With recent data, FM and FFM determined BMI-mortality relationship while BMI did not identify body composition(15). These findings reinforced the pertinence of body composition measurement in clinical practice.

Successful weight reduction is the best protective factor of obesity complications. In addition, significant improvement in quality of life, body image, and

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How to cite this article:

Sukkul P, Rattanachaiwong S, Hongsprabhas P, Pisprasert V. Body Composition Changes with Lifestyle Therapy for Obesity. J Med Assoc Thai 2023;106:S94-9.

DOI: 10.35755/jmedassocthai.2023.S01.13802

psychological status also follows weight reduction[16]. Epidemiologic evidence suggested that long-term weight reduction improved obesity-related morbidity and mortality[8,17]. Still, there is little evidence, particularly in Asian people, that weight reduction is associated with increased FFM or decreased FM due to the lack of longitudinal studies relating changes in weight along with body composition changes[9].

A cornerstone of obesity treatment aiming at weight reduction is lifestyle therapy. It is sustainably effective but uncontrollable toward individuals and often unsuccessful. In following-up with those patients, body weight, body mass index, and body composition would provide more objective information. It brings up the question whether changes in body weight are associated with changes in fat mass which strongly predict mortality. Body composition measurement techniques allow tissue measurement by analyzing the two major body compartments, FM and FFM, distinctly. Obesity clinic in Srinagarind Hospital was set up since 2015 to treat obese patients in the Northeastern region of Thailand. In the authors' clinic, body composition was regularly measured by bioelectrical impedance analysis (BIA) to evaluate nutritional status. The present study assessed changes in FM, FFM afterward weight reduction was achieved to answer the question.

Materials and Methods

Study population

Patients visiting obesity clinic were considered eligible if they were between 18 and 70 years of age and had a BMI above 25 kg/m^2 at the initial examination. All patients were monitored in obesity clinic between 1 January 2014 and 31 December 2019. Registered dietitians instructed low-caloric diets and provided exercise recommendation for the patients. As attendance for body composition analysis was a voluntary aspect of the study, the authors excluded those who lost to follow-up earlier than three visits or three months. The present study was approved by the Center for Ethics in Human Research, Khon Kaen University (HE621166).

Data collection and body composition measures

This retrospective observational study was performed at the obesity clinic of Srinagarind Hospital, Khon Kaen University. Experienced nurses using standard methods obtained anthropometric measurements of weight, waist circumference (WC), hip circumference (HC), height, and BIA to estimate body composition. Weight was measured using a calibrated digital scale and was recorded to the nearest 100 grams. Height was measured in the participants standing without shoes and was recorded to the nearest 0.5 cm. WC and HC were measured regarding the WHO standard[18]. Data calculated from these measurements included BMI and waist-to-hip ratio (WHR). BIA was obtained using Tanita BC-418 Segmental Body Composition Analyzer (Tanita Corp., Itabashi-Ku, Tokyo, Japan). The method provided parameters including percent body fat (PBF), FM, and FFM. Same as a normalization of body weight for height through BMI calculation, the authors proposed the systematic normalization for a body height of FFM and FM to express the result of body composition. Fat mass index (FMI) was calculated as FM divided by height squared, and fat-free mass index (FFMI) was calculated as FFM divided by height squared.

Statistical analysis

Continuous data were presented as mean with standard deviation. Categorical data were presented as number and percentage. Changes in body weight as a percentile, FMI, and FFMI were also described. Significant changes of body composition after lifestyle therapy were determined by one-sample Student t-tests with the p-value less than 0.05. Between-group changes of continuous variables were assessed using Student t-tests. Univariate correlations between body composition and percent weight reduction were assessed using Pearson correlation coefficients. All analysis was performed using Stata/IC version 16.1 (Stata Corp., Lakeway, TX, USA).

Results

Baseline characteristics

Consecutive medical records of 121 patients who completed body composition measurement in at least three visits from January 2014 to December 2018 were reviewed. Seventy-three patients (60.33%) were women, and 48 (39.67%) were men. At the first visit to the obesity clinic, 54% of patients had BMI ≥40 kg/m^2. The prevalence of obesity-related metabolic complications was 49.2% for DM, 49.2% for hypertension, and 40% for dyslipidemia. Table 1 depicts the baseline characteristics and the body

Table 1. Baseline characteristics

	Mean	SD
Age (years)	38.1	14.14
Body weight (BW) (kg)	113.8	27.63
Body mass index (BMI) (kg/m^2)	42.3	8.70
Waist circumference (WC) (cm)	119.1	16.84
Hip circumference (HC) (cm)	127.9	16.53
Waist to hip ratio (WHR)	0.9	0.09
Percent body fat (PBF) (%)	48.2	9.92
Fat mass (FM) (kg)	55.6	19.23
Fat mass index (FMI) (kg/m^2)	20.9	7.66
Fat-free mass (FFM) (kg)	58.5	17.33
Fat-free mass index (FFMI) (kg/m^2)	21.5	4.35

composition variables of the participants.

The direction of body composition changes

At three-month follow-up, 49.6% of patients achieved 3% weight reduction. At six-month follow-up, 110 (90.9%) participants still attended the clinic, which 54.1% achieved 5% weight reduction. At twelve-month follow-up, 98 (81.0%) participants attended the clinic. The mean weight reduction was 9.40%, but only 30.6% of those achieved at least 10% weight reduction at 12-month. Moreover, 54.1% could achieve 5% weight reduction, and 64.1% of the participants could maintain weight at 12-month.

An evolution of mean weight reduction in total population (Figure 1A), together with a change of body composition (Figure 1B), showed a decrease in FMI while FFMI was maintained. Every point of the analysis showed a significant reduction of FMI comparing to baseline (p-value <0.05). There was a significant reduction in FMI afterward weight reduction at six-month (mean difference 4.03 kg/m^2; 95% CI 1.39 to 6.68) while FFMI had non-significant change (mean difference 0.50 kg/m^2; 95% CI -1.25 to 2.25).

Correlation of body composition and weight reduction at 3 and 6 months

FM and FMI at the first visit were positively correlated with the percentage of weight reduction (Table 2). Patients with higher FM had higher percentage of weight reduction at 3 and 6 months.

Figure 1A. Percentage of weight reduction in total population.

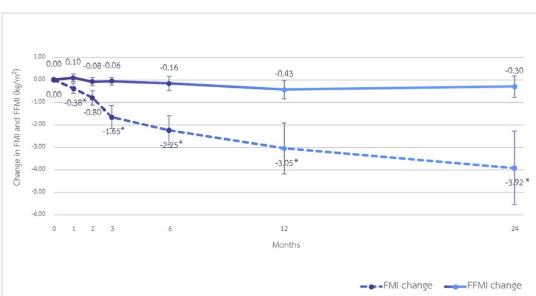

Figure 1B. Changes in FMI and FFMI of total population.

* Statistically significant (p-value <0.05). FMI=fat mass index; FFMI=fat-free mass index

Table 2. Correlation of body composition and weight reduction

	% weight reduction at 3 months		% weight reduction at 6 months	
	Correlation coefficient	p-value	Correlation coefficient	p-value
FM	0.33	0.002	0.29	0.004
FMI	0.34	0.001	0.27	0.007
FFM	0.04	0.713	0.09	0.391
FFMI	0.10	0.357	0.10	0.328
WHR	-0.06	0.570	-0.08	0.445

FM=fat mass; FMI=fat mass index; FFM=fat-free mass; FFMI=fat-free mass index; WHR=waist-to-hip ratio

Comparison between weight-reduction achievable group and non-achievable group

About ninety percent of the patients continued weight reduction and attended the clinic for six months. Weight reduction achievement was defined as at least five-percent reduction of body weight at six-month. Comparison between weight-reduction achievable group and non-achievable group showed that BW, FM and FMI at first visit were significantly different (Table 3). The analysis at three and six months showed a significant decrease in FMI between the groups as well. Weight-reduction achievable group have non-significant difference in FFMI after three and six months of weight reduction compared to the non-achievable group.

Discussion

Weight reduction can prevent and improve obesity-related complications. Excess in FM impairs insulin sensitivity and results in those long-term complications[19]. Assessment of body composition changes and weight changes may provide information to define expected weight-loss outcomes. The existing evidence suggested that lifestyle therapy could lose 0.5 to 1 kg per week[20]. Our study revealed that mean weight reduction of the authors' obese participants was 3.47 kg (3.05%) and 5.89 kg (5.18%) at three and six months, respectively. Patients with higher FM had higher percentage of weight reduction at 3 and 6 months. In the long-term, 10% weight-reduction can prevent obesity-related complications[21]. The authors observed mean weight reduction at twelve-month was 9.40%, however, only 30% of our patients achieved the goal of 10% weight reduction. Frisard et al. (2005) enrolled obese subjects in the weight loss program, and after six months, the average weight was decreased by 6.5±0.4 kg[19]. Franz et al. (2007) and found evidence from 80 clinical trials that weight reduction tended to reach a plateau, ranging between 5.0 and 8.5 kg (5% to 9% of starting weight) after six-month treatment with food and meal planning strategies. The review concluded that weight reduction tended to reach a plateau after six months[22]. Migual et al. (2021) compared

Table 3. Mean difference between weight-reduction achievable and non-achievable groups

	3% weight reduction in 3 months			5% weight reduction in 6 months		
	Achievable	Non-achievable	p-value	Achievable	Non-achievable	p-value
BW (kg)	118.98 (3.55)	108.70 (4.57)	0.040	120.15 (4.13)	109.32 (3.36)	0.021
FM (kg)	60.11 (3.10)	52.25 (2.67)	0.029	58.60 (2.61)	51.48 (2.54)	0.027
FMI (kg/m^2)	23.04 (1.24)	19.79 (1.09)	0.026	22.06 (1.01)	19.40 (1.04)	0.035
FFM (kg)	58.06 (2.60)	55.65 (2.31)	0.244	59.81 (2.57)	57.77 (2.21)	0.273
FFMI (kg/m^2)	21.70 (0.71)	20.58 (0.54)	0.104	21.92 (0.65)	21.22 (0.55)	0.201
FMI reduction from baseline (kg)	3.09 (0.37)	0.14 (0.16)	<0.001	4.12 (0.47)	0.42 (0.25)	<0.001
FFMI reduction from baseline (kg)	-0.18 (0.33)	0.02 (0.16)	1.000	0.27 (0.23)	0.05 (0.22)	0.852

Values are mean (SD), unpaired Student's t-test for between-group differences.

FMI=fat mass index; FFMI=fat-free mass index

weight changes from various lifestyle interventions and found that dietary intervention without supervised physical activities can reduce 7.8 kg after the six-month intervention period[23]. Initial weight reduction observed from studies mentioned above was greater than our results since our study observed from real-world practice, lifestyle therapy by dietary counseling could be less effective than supervised treatment with specific dietary pattern in previous controlled studies. Nevertheless, in the long-term, mainly those who intended to lose weight adhered to follow-up, our results showed that mean weight reduction continued to downslope and reached a plateau after twelve months. The present study investigated obese patients' body composition conducted in an obesity clinic in the Northeast region of Thailand for the first time. In this region, the dietary pattern is different from western countries. The cultural issue may be a barrier of caloric restriction because the regional food is rich in carbohydrates, particularly glutinous rice, and salt. Some studies showed geographic differences in fat mass and central fat distribution[29]. The difference could be influenced by ethnic or genetic characteristics, and possibly by culture.

Assessment of changes in body composition in the present study indicated that FM was primarily reduced (5.6% reduction of PBF and 11.6% reduction of FMI at six-month) toward weight reduction achieved by behavioral approaches while FFM was maintained. The results were in accordance with previous literature published by Miguel et al. (2021)[24]. They reported that lifestyle therapy focused on strength and endurance exercise resulting in significant loss of FM by 7.1% with nonsignificant change in FFM. Dao et al. (2004) also demonstrated maintenance of lean body mass (LBM) in intensive monitored patients[24]. Parks et al. (2014) observed that weight reduction in obese adolescents was predominantly accounted for the change in FM[25]. Hoie et al. (1993) also found reduction of FM in weight reduction by very-low-calorie diets and moderate-vigorous physical activity[26]. However, Frisard et al. (2005) revealed significant loss of FM (2.6 kg) and FFM (3 kg) after six months period of weight reduction[19] Gilbert et al. (1987) demonstrated a positive curvilinear correlation between body fat and LBM during weight gain. LBM tended to rise in correlation with the increasing degree of obesity, but the slope was lessened. Conversely, the fatter the subject was, the less would be the relative contribution of LBM to the total weight reduction following gastric stapling or intestinal bypass surgery[27]. This finding implied that patients with very high BMI might have weaker association between LBM and weight loss observed in the present study. The authors observed that FM and FMI at baseline positively correlated with percent weight reduction at three and six months. This correlation could be explained that they had limitless reduction potential in weight loss.

FM represents the accumulation of excessive caloric intakes, while FFM represents bone and muscle components. Caloric restriction results in weight loss that is mainly contributed by FFM reduction[28]. A healthy diet with adequate protein intake and an active lifestyle could maintain FFM while FM is reduced together with weight reduction. Exact amount of caloric intake as well as duration and intensity of physical activity could be assessed with difficulty in clinical practice. BMI and the percentage of weight reduction have limitation to indicate the respective contributions of FFM and FM in the body mass changes. Since body composition allows early and objective detection changed by lifestyle therapy and reflect nutritional intakes, losses, and expenses over time[15], measurement of FM could be beneficial in follow-up and may predict prognosis for weight reduction.

Maintaining 3% to 5% weight loss can significantly reduce the risk of cardiovascular disease or diabetes. In the short-term, the Korean Society for the Study of Obesity recommended 5% weight loss within six months of diagnosis[29]. In addition to answering the main question, the authors also performed subgroup analysis. The patients were categorized into 2 groups: achievable and non-achievable weight reduction groups. Weight reduction achievement was defined as at least five-percent reduction of body weight at six-month. At the beginning treatment, weight-reduction achievable group had significantly higher BW, FM, and FMI than non-achievable group. There was a significant difference in mean FMI reduction between groups. Unfortunately, the prevalence of obesity-related complications in the present study was rather low and heterogenous. Therefore, the authors could not demonstrate significant clinical outcomes from weight reduction.

Dual-energy X-ray absorptiometry (DXA) is the gold standard for body composition measurement. Other methods, such as computerized tomography (CT), 3-D body scanner, and BIA, have a wide range of validity, reproducibility, and feasibility. The validity of BIA can be influenced by age, sex, body structure, and hydration status and may be less reliable with increasing body fat. Although BIA is an indirect measurement, it has the advantages of being relatively simple, portable, inexpensive, and very limited inter-observer variations. Overall, the correlation coefficients between BIA for body composition changes compared with DXA were high. BIA is available in our obesity clinic and sensitive enough to detect body composition changes[19].

Strength of the present study is that the data represented real-world practice results in the Northeast region of Thailand. Patients in our clinic were adults with a mean age of 38-year which was close to the age group with the highest prevalence of obesity[3]. However, the study had some limitations. First, the study included only patients with fair to good compliance for follow-up resulting in continuous weight reduction in the long-term period. The trend of weight change may be different from patient-self weight control. Second, the use of BIA was not a gold standard to access body composition. Nonetheless, the present study reflected the applicability of this method in clinical practice. Unfortunately, the machine used in our study was not the modern one with impedance and/or phase angle determination[30]. Finally, the authors could not explore whether fat mass is associated with obesity-associated comorbidity and mortality due to the short-term follow-up period.

Conclusion

The present study showed that lifestyle therapy was effective for weight reduction and FFM maintenance. Body composition measurement determines quantitative assessment of tissue changes through time. Available body composition determination methods integrated into the routine of care allow sequential measurements for objective nutritional assessment. A longer time of follow-up may be needed to explore clinical outcomes in the aspect of obesity-related morbidity and mortality. Further study of body composition monitoring in obese subjects will provide information on the prevalence and improvement in obesity-related complications, particular in the condition with sarcopenic obesity.

What is already known on this topic?

Lifestyle modification is the main treatment for obese patients, resulting in weight reduction as well as improvement in co-morbidities.

What this study adds?

Lifestyle modification in real-world practice leads to weight reduction with significant loss of fat mass, while it could maintain fat-free mass. Body composition measurement by bioelectrical impedance analysis may provide value in obesity monitoring.

Acknowledgements

The authors thank the Department of Medicine, Faculty of Medicine, Khon Kaen University for publication support.

Funding statement

The study received funding support from the Faculty of Medicine, Khon Kaen University, Thailand.

Conflicts of interest

The authors declare no conflict of interest.

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