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Weight Reduction in Obese Correlates with Low Morning Cortisol Increase

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ABSTRACT

Foss B, Sæterdal LR, Dyrstad SM. Weight Reduction in Obese Correlates with Low Morning Cortisol Increase. **JEPonline** 2014;17(3):70-76. The purpose of this study was to characterize how the stress system (i.e., the morning cortisol increase) is related to weight reduction by exercise in obesity. Twelve subjects with a body mass index >35 participated in a 22-wk exercise intervention program. The exercise program consisted of physical activity supplemented with diet and cognitive therapy seminars. Saliva was collected on two consecutive days after the intervention program. Eight of the 12 subjects decreased their body weight by 4.4% (P=0.023). Their average “morning” cortisol increase was 2.8 ng/ml (± 3.7). Seven of the subjects decreased their adipose tissue mass by 9.3% (P=0.032). A negative relationship was found between morning cortisol increase and body weight reduction (p = -0.76, P = 0.028). Thus, our study shows that weight reduction by exercise in obese subjects correlates with low morning cortisol increase. The higher the stress response experienced, the less reduction in body weight was found.

Key Words: Exercise, Weight Reduction, Stress, Cortisol

INTRODUCTION

It is well recognized that physical activity and regular exercise are important in the prevention and treatment of obesity. The negative energy balance that occurs as a function of being physically active results in weight loss (2). Yet, other mechanisms behind the complexity of obesity and weight reduction are now also being considered including the role of the stress system (1,3-5,11). While the influence of the stress system on obesity is not fully understood, the morning rise of cortisol has been found to correlate positively with body mass index (16). This relationship highlights our recent hypothesis regarding the stress system and weight gain and how they may be linked via a positive feedback mechanism (3).

In regards to obesity, it is interesting that the stress system can also be triggered by physical activity (6,10). Recently, we found that obese subjects who participated in a 22-wk exercise program had higher morning cortisol levels after the exercise period compared to the non-exercising controls (4). In short, it seems evident that the stress system is affected by exercise in obese subjects. To further understand the role of the stress system and obesity, the purpose of this study was to characterize the relation between the morning cortisol increase and the weight reduction among exercising obese subjects.

METHODS

Subjects

Twelve subjects matched the inclusion criteria. They completed the exercise program and were included in this study. The inclusion criteria consisted of: (a) age 18 to 65 yrs; (b) BMI >35; (c) inactive but still able to move without help; and (d) holding a referral by a general practitioner.

The subjects followed a 22-wk exercise program that consisted of: (a) exercise sessions including circuit training, strength training, high intensity running, ball games, and aerobics; (b) outdoor walks; and (c) pool activities (4).

Fifty-seven workout sessions, each of ~60 min in duration was given during the exercise period. Detailed information on the intervention is presented by Lie et al (8). Once a week prior to exercise, the subjects joined a group seminar that consisted of: (a) four diet sessions with two additional food preparation lectures; (b) four cognitive therapy sessions; and (c) different sessions of “activity and health,” “how to sustain the new lifestyle,” and “peer exchanges.”

Each subject was required to execute a written informed consent. The study was approved by the Regional Ethics Committee for Medical Research (ref #: 2010/1270).

Adipose Tissue Analysis

Body composition was analyzed before and after the 22-wk exercise program by using an InBody 720 body composition analyzer (Biospace, Seoul, Korea).

Saliva Sampling and Cortisol Analysis

The morning rise of cortisol (in saliva) as a response to awakening is a well-documented method to assess the physiological stress response by the hypothalamic-pituitary-adrenal axis for different conditions (12,14) including obesity (7,16). Saliva was collected on two consecutive days after the 22-wk exercising program. Two samples per day were collected to characterize the morning rise of cortisol, that is, first, in the morning immediately when awakening (C1) and, then, 30 min after awakening (C2). Saliva sampling was performed as previously described (4,12,14,16,17). Saliva

was collected by Salivette® Cortisol swabs (Sarstedt AG & Co, Nümbrecht, Germany) that were carefully chewed on for 45 sec.

The subjects were instructed to not eat, drink, brush teeth or smoke the last 30 min prior to sampling. They were also instructed to not touch the swabs. The swab tubes were stored at 4°C until the day of transfer to the laboratory. They were then centrifuged and stored at -80°C until analysis. Saliva cortisol levels were analyzed using the enzyme immunoassay kit Parameter™ Cortisol assay (R&D Systems, Abingdon, UK) as previously described (4). Average cortisol values of parallel samples on consecutive days and parallel immunoassay samples were used for statistical analysis.

Statistical Analyses

Statistical analysis was performed using PASW Statistics 18 (SPSS Inc., Chicago, IL). Since the number of subjects was low, a normal distribution could not be expected. Comparisons were done by Wilcoxon Signed Rank test, and correlation analysis was performed using Spearman's rank correlation coefficient (ρ). Variable values are presented as mean ± standard deviation (SD). Statistical difference was set at $P<0.05$. A P-value between 0.05 and 0.1 indicated a tendency.

RESULTS

The average decrease in body weight after 22 wks of exercise was 118.5 ± 16.9 kg to 115.5 ± 16.9 kg. Although the weight reduction was not significant, it did demonstrate a tendency in support of the exercise program in reducing body weight ($P = 0.091$). Four of the 12 subjects did not reduce their body weight during the intervention. The remaining eight decreased their body weight from 121.8 ± 19 kg to 116.4 ± 19.8 kg, which was significant ($P = 0.012$). Body adipose tissue mass was also analyzed ($n = 7$) and found to decrease from 62.3 ± 5.1 kg to 56.5 ± 9.9 kg ($P = 0.028$) among the subjects losing weight.

The average morning rise of saliva cortisol after the 22-wk exercise period for the 12 subjects went from 5.5 $ng \cdot ml^{-1}$ (± 2.2) at awakening (C1) up to 7.7 $ng \cdot ml^{-1}$ (± 3.4) 30 min after awakening (C2). The morning cortisol increase for the 12 subjects (i.e., C2 - C1) was on average 2.2 $ng \cdot ml^{-1}$ ± 3.1. For the 8 subjects who had lost weight during the 22-wk exercise period, their average morning cortisol increase was 2.8 $ng \cdot ml^{-1}$ ± 3.7.

A clear negative relationship between body weight reduction and morning cortisol increase was found for the 8 subjects (i.e., the higher morning cortisol increase, the lower weight reduction by exercise was seen ($\rho = -0.76$, $P = 0.028$) (Figure 1). Similarly, there was also a clear negative relationship between adipose tissue reduction and morning cortisol increase ($n = 7$, $\rho = -0.93$, $P = 0.003$) among 7 of the 8 subjects who lost weight during the exercise period.

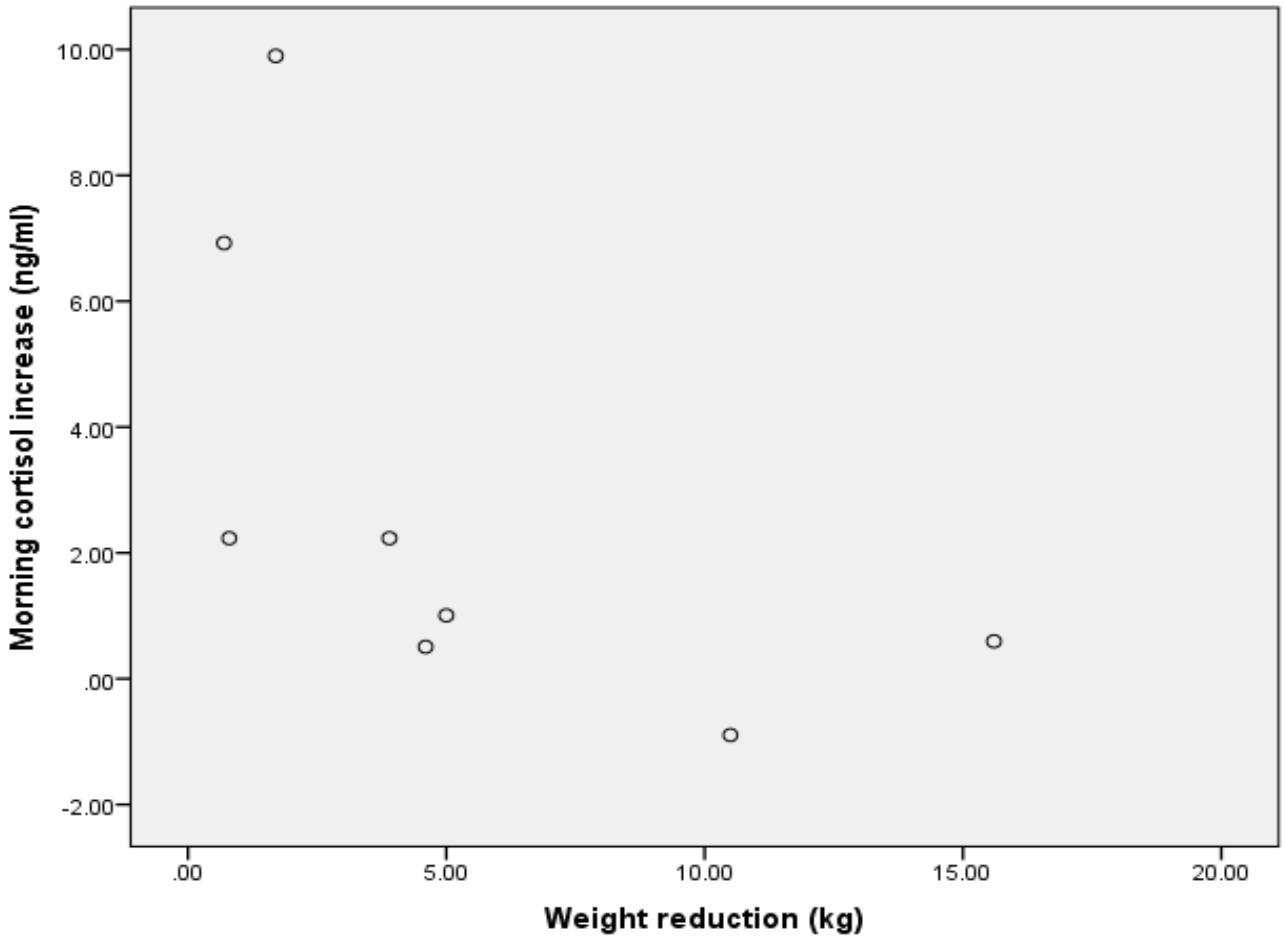

Figure 1. The Correlation between Weight Reduction and Morning Cortisol Increase for the Eight Subjects Losing Bodyweight during the 22-wk Intervention Period.

DISCUSSION

Our main finding in this study is that the 22-wk exercise program for obese subjects reduced body weight for 8 out of 12 of the subjects, and for the 8 subjects the weight reduction correlated negatively with the morning saliva cortisol increase. Thus, subjects with higher morning cortisol increase had lower weight reduction and vice versa. Similarly, we found that the adipose tissue decrease correlated also negatively with the morning saliva cortisol increase. These observations are not just interesting, but possibly important for at least two reasons. First, our results suggest that weight reduction in obese subjects by exercise may be affected by the body's stress reaction. The higher stress response experienced, the less reduction in body weight was found.

Due to the understanding that physical activity can increase the stress reaction (4,6,10), we speculate that an increased stress reaction, which is experienced among obese subjects, can oppose weight reduction by exercise. In this way, the hypothalamic-pituitary-adrenal axis may in fact contribute to explain why losing weight via regular exercise is difficult for obese people (4,15). Second, our results add value to the recent hypothesis that the stress system and weight gain may be linked via a positive feedback mechanism in obesity (3). The suggested consequence of this

hypothesis is that stress triggers adipose tissue accumulations, which triggers more stress. Therefore, to lose weight it is important to decrease the body's stress reaction. The results presented in this study support this hypothesis. Subjects with high stress levels, that is, high morning increase in cortisol, lose less weight.

Equally important is the fact that our findings agree and disagree with studies that characterize cortisol levels and weight reduction. In the study by Purnell et al. (13), obese subjects who lost weight by a diet-induced weight program over a 6-mth period showed an increase in cortisol production rate. Also, in a study by Manco et al. (9), massive weight loss by obese subjects was associated with an increase in free cortisol over a period of 2 yrs. The discrepancy between these two studies and our observations can be explained by the facts that these two studies did not include exercise as a major part of the weight loss program and that they did not study the morning rise in cortisol. Thus, these studies highlight the complexity of obesity, weight reduction, and the physiological stress system.

A consequence of our previous hypothesis (i.e., the stress system and weight gain may be linked via a positive feedback system in obesity) (3) is that dealing with weight reduction in obese subjects also requires dealing with the physiological stress system. Losing weight by physical activity seems to be a difficult task because the stress system may oppose weight loss mechanisms. Further research should therefore identify and remove possible stressors for obese subjects who participate in exercise intervention programs.

CONCLUSION

The findings indicate that there is a negative relationship between morning cortisol increase and weight loss in exercising obese subjects. This observation may help explain why losing weight by exercise is a difficult task among obese subjects.

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