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Effect of Exercise and Dietary Restraint on Energy Intake of Reduced-Obese Women

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Self-selected food intake of 15 reduced-obese women living in a metabolic ward was studied for 14 consecutive days to determine the effect of exercise and other metabolic and behavioral variables on energy intake. A choice of prepared food items were offered at breakfast, lunch and dinner, and a variety of additional food items were available continuously 24 h/day. Subjects performed either moderate intensity aerobic exercise (A-EX) ($n=8$) expending 354 ± 76 kcal/session or low intensity resistance weight training (R-EX) ($n=7$) expending 96 ± 4 kcal/session, 5 days/week. Mean energy intakes (kcal/day, $\pm SEM$) of the exercise groups were similar: 1867 ± 275 for A-EX, 1889 ± 294 for R-EX. Mean energy intakes of individuals ranged from 49 to 157% of the predetermined level required for weight maintenance. Resting metabolic rate per $kg^{0.75}$ and the Eating Inventory hunger score contributed significantly to the between subject variance in energy intake, whereas exercise energy expenditure did not. Regardless of exercise, eight women consistently restricted their energy intake (undereaters), and seven others consumed excess energy (overeaters). Overeaters were distinguished by higher Eating Inventory disinhibition ($p=0{\cdot}023$) and hunger ($p=0{\cdot}004$) scores. The overeaters' diet had a higher fat content, 34 ± 1 energy %, than that of undereaters, 27 ± 1 energy % ($p=0{\cdot}007$). Also, overeaters took a larger percentage of their daily energy intake in the evening, 13 ± 2%, compared to undereaters, 7 ± 1% ($p=0{\cdot}005$). We conclude that the Eating Inventory is useful for identifying reduced-obese women at risk of overeating, and these individuals may benefit from dietary counselling aimed at reducing fat intake and evening snacking.

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INTRODUCTION

Weight regain following weight loss is one of the most difficult challenges facing the treatment of obesity (Institute of Medicine, 1995). Precise statistics about relapse are not known. The few long-term studies suggest that most reduced-obese individuals regain nearly all their lost weight after 5 years (Wadden, 1992). Others have estimated that two-thirds of those who lose weight regain it in the first year (Wadden & Stunkard, 1986). Less than 3% maintain their reduced weight after 4 to 5 years (Kramer *et al.*, 1989). Weight regain is often followed by future attempts at weight loss, leading to a pattern of weight cycling that may make weight loss more difficult (Blackburn *et al.*, 1989) and increase the risk of chronic diseases independently of the risks due to obesity itself (Lissner *et al.*, 1991). Thus, reduced-obese individuals are an important population to study to learn more about the factors that can affect weight maintenance or regain.

A number of physiological factors are thought to contribute to weight regain in reduced-obese individuals, including decreased energy metabolism (Leibel & Hirsch, 1984; Geissler *et al.*, 1987; Elliot *et al.*, 1989), increased fat cell uptake of circulating triglycerides (Kern *et al.*, 1990), and reduced utilization and oxidation of body fat (Flatt, 1987). On the other hand, successful maintenance is associated with a host of psychological factors, such as greater internal motivation, self esteem, emotional control and the development of coping skills through behavior modification (Brownell *et al.*, 1986; Foreyt, 1992). Using detailed interviews, Kayman *et al.* (1990) found that, compared to obese women, formerly obese women who successfully maintained their weight loss for at least 2 years were more likely to be aware of their eating behaviors, confront problems directly, use social support and exercise regularly.

Exercise is one of the consistent and positive factors associated with successful maintenance (Katahn *et al.*, 1982; Graham *et al.*, 1983). It increases energy expenditure of activity and, possibly, of other energy compartments such as resting metabolism and thermic effect of food (Mole, 1990). However, studies suggest that energy balance is maintained primarily by modulating energy intake, not expenditure (Roberts *et al.*, 1990; Flatt, 1991). The food intake response to exercise is a key issue in weight maintenance.

A number of studies of food intake in free-living subjects suggest that obese individuals either consume less energy or at least do not compensate for the increased energy expenditure of exercise, thus prompting weight loss (Gwinup, 1975; Leon *et al.*, 1979; Neiman *et al.*, 1990). Obtaining accurate and reliable data on food intake in free-living subjects is difficult, particularly in obese individuals who are suspected of underreporting food intake (Schoeller, 1990) and may, in some cases, unconsciously conceal intake (Lichtman *et al.*, 1992).

The most accurate and reliable information on the effects of exercise on food intake has come from studies in which foods were carefully weighed and subjects lived under metabolic ward conditions. Results from such studies indicate that the effect of exercise on food intake in normal-weight women differs from that in obese women. Obese women did not increase food intake to compensate for increased physical activity whereas lean women did (Woo *et al.*, 1982a; Woo & Pi-Sunyer, 1985). Mildly obese women also did not increase food intake in response to exercise (Keim *et al.*, 1990). Some other studies suggest that exercise prompts increased consumption of carbohydrates and decreased intake of fat (Wood *et al.*, 1985), which in turn could lead to weight loss (Kendall *et al.*, 1989). Although these various