Chapter 9: Meal Frequency and Timing

Many people believe that eating more frequently than three meals per day will improve nutrition and the ability to achieve and maintain a healthy body weight. While there are clearly psychological factors that affect food intake, including food addictions discussed elsewhere, there are scientific studies supporting the idea that more frequent meals, as part of a structured diet, can help to maintain energy balance throughout the day.

In the 1960s, Fabry et al. (1) suggested a negative association between meal frequency and body weight, and many investigators have subsequently attempted a further evaluation of this association (2–7).

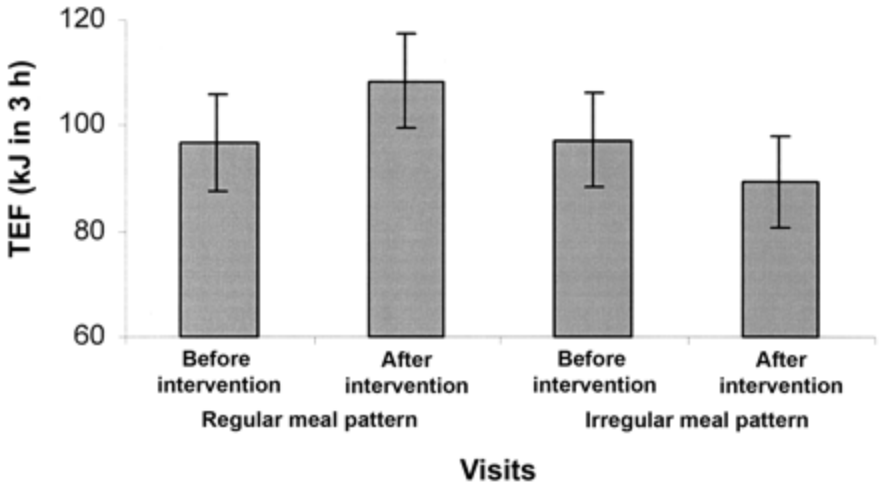
The results of studies evaluating the effect of meal frequency on energy intake (EI) are complex and require explanation (2, 4, 8–13). There appears to be no association between meal frequency and total energy expenditure (EE) (14–17), whereas the results of studies of the effect of meal frequency on the thermic effect of foods (TEF) after a meal (18–21) have provided interesting results when studies were appropriately designed.

Altered circulating total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides (22–24) and insulin resistance or metabolic syndrome (25) are recognized as risk factors for cardiovascular disease. Meal frequency may influence these factors, and an increased meal frequency is associated with lower fasting total and LDL cholesterol concentrations (26–28). However, studies of the response of glucose and insulin to variations in meal frequency are variable, as these responses are complex (1, 2).

It seems that Western populations increasingly are moving away from regular meals, perhaps because more meals are being eaten outside the home and because the tradition of families dining together has been eroded by hectic schedules. The prevalence of irregular meal patterns is greater among adolescents than it was during previous decades (29, 30). Japanese studies (31–33) also found

that irregular snacking has become more common in children and may have contributed to both the increasing prevalence of obesity in children and the elevated serum cholesterol concentrations in adolescents during the past few decades.

Irregular meal frequency disturbs energy metabolism in healthy lean women (34). This irregular meal frequency led to a lower postprandial EE than was seen with regular eating, whereas mean energy intake did not differ significantly. There was a higher degree of insulin resistance and higher fasting lipid profiles in these lean subjects after a period of irregular meal frequency, which may indicate a deleterious effect on these cardiovascular disease risk factors (35). As shown in the figure below, an irregular meal pattern has similar effects in obese subjects. Irregular meal frequency can affect metabolism in healthy obese women by leading to reduced thermic effects of food (TEF), which is the energy expended after a meal. The consequence of this reduce TEF is the increased storage of ingested energy as fat.



Mean (±SEM) thermic-effect of food (TEF) in 10 healthy obese women in the visits before and after the regular and irregular meal pattern interventions. There were significant differences between the two interventions (ANOVA; $P = 0.002$).

Irregular meal frequency led to a lower postprandial EE and impaired TEF, higher total and LDL cholesterol and lower postprandial insulin sensitivity than were seen with regular meal frequency in healthy obese women in agreement with earlier studies in lean women (34, 35). As expected, there were no significant differences in fasting metabolic rate (Resting Metabolic Rate – RMR) across the four visits in the figure above.

As explained earlier, many studies since the 1960s have evaluated the effect of meal frequency on EI and EE. The poor definition of key variables and the lack of the management of the intervention factors have weakened their interpretations. In the above experiments, a meal was clearly defined as providing some energy, and the interval between any two consecutive meals was to be greater than one hour. In this study, the known fluctuations in women's food intake (47) and RMR (48) through the menstrual cycle were also taken into account, since each subject began the interventions at the same point in her menstrual cycle.

Previous studies showed that impaired thermogenesis is associated with insulin resistance in obesity (49, 50), which is consistent with the finding of lower TEF and postprandial insulin insensitivity after the irregular meal pattern intervention.

In addition to the above study, Segal et al. (51) also found an independent effect of insulin resistance and obesity in producing a blunted TEF.

The peak postprandial insulin response and AUC of the insulin profile after the test meal in the obese subjects were significantly lower after the regular meal pattern intervention than after the irregular meal pattern intervention, which is consistent with findings of a study of lean women (35). This finding suggests that an irregular meal frequency may reduce insulin sensitivity and thus lead to a higher insulin response to a test meal, whereas a regular meal frequency may increase insulin sensitivity.

Plasma total and LDL cholesterol concentrations in obese healthy women are significantly higher after the irregular meal pattern intervention than after a regular meal pattern (52). Therefore, irregular eating may lead to unhealthy total and LDL cholesterol concentrations in both obese and nonobese women. Previous studies showed that a greater meal frequency is associated with lower fasting total and LDL cholesterol concentrations. An epidemiologic study (33) claimed that an irregular meal pattern may be associated with an elevated serum total cholesterol concentration in adolescents.

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