Development of Obesity
Mechanisms and Physiology

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KEYWORDS

• Food intake control • Adiposity • Food reward • Satiation • Neutering • Exercise • Metabolic rate • Physical activity

KEY POINTS

- Although body condition and adiposity seem regulated in adult animals, they likely reflect a net sum of influences on food intake and energy expenditure.
- Dietary manipulations that affect a satiation modality are not likely to have lasting effects on energy balance.
- Diets that are varied, highly palatable, and high in fat favor mismatching of energy expenditure with energy intake.
- Food intake control is determined by neuronal inputs of central and peripheral origin; however, physical activity is alterable and changes in total energy expenditure can induce and exacerbate the obese phenotype.

CONSTANCY OF BODY WEIGHT

It has long been observed that mature healthy animals when given free access to a nutritionally adequate diet typically maintain their body weight with little change over time. This attribute is a result of a robust physiologic mechanism. After adult animals are force-fed to an extent that they gain weight, with time, they lose weight if allowed ad libitum consumption. In these animals, transient reduction in food intake restores body weight to the initial condition. Conversely, if adult animals are deprived of food, body weight is lost until free access to food is restored. Body weight in this case is regained as food intake is increased and energy expenditure reduced. Unfortunately, body weight seems well defended even in animals that are overweight. In cases of obesity, the mechanism that stabilizes body weight becomes an impediment to treatments intended to restore a healthy body condition.

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Fat mass is the greatest of body constituents affected in maintenance of stable body weight. With long-term changes in food availability, change in body fat accounts for 90% of resulting body weight change. In times of food excess or deprivation, the amount of fat stored as triacylglycerol within cells of adipose varies and accounts most for the mass of adipose. The number and size of adipocytes increases with accretion of triacylglycerol, whereas when body fat is lost, adipocyte size decreases while adipocyte number is little affected.

The physiologic mechanism that stabilizes body weight and apparently defends a constant proportion body fat body is complex and incompletely understood. Over the long-term, when animals are in a state of body weight maintenance, energy intake matches energy expenditure. This energy balance may not be perturbed even when diets widely different in nutrient proportions and energy densities are consumed. On a day-to-day basis, the amount and type of food ingested varies, as does energy expenditure in physical activity and thermoregulation. Stabilizing environmental conditions and food presence does not eliminate daily variation in amount of energy consumed by animals. Food intake of humans with unrestricted access to a variety of foods may oscillate by an average of about 25% from day to day.[1] As daily food intake varies, compensatory energy expenditure generally follows, increasing and decreasing in proportion to food excess and deprivation, respectively. Hence, the mechanism that regulates body weight is necessarily complex and requires conditional weighting and integration of many cues and signals about food that are of internal and external origin.

FOOD INTAKE CONTROL

It is intuitive and true that control of food intake is a key component of the mechanism that regulates body weight. Food intake is a simple "on" and "off" act during which a "meal" is consumed. The frequency of meals in a day and the duration and amount of food consumed during a meal changes with food availability, experience, and environmental conditions. Animals eat many meals of differing sizes within a day when they are given free access to food, as is observed in dogs and cats presented with diets that maintain their palatability throughout a day (**Fig. 1**). Although the act of food intake

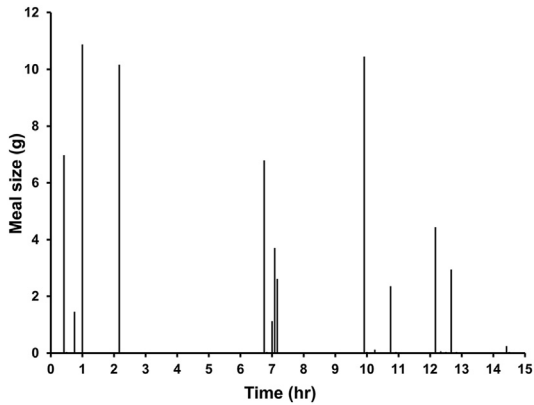

Fig. 1. Typical variation of meal size and periods of apparent satiety determined for an adult neutered male cat of stable body weight that is habituated to free access to a commercial dry feline diet during overnight (15 hour) periods. (*Courtesy of* Robert Backus, University of Missouri College of Veterinary Medicine, Columbia, MO.)