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When to Eat: The Importance of Eating Patterns in Health and Disease

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It is well established that the quantity and quality of the food we consume can affect our health. Now it is becoming clear that *when we eat* also plays a key role in health and disease. Here, we discuss scientific discoveries that demonstrate meal timing could be an effective dietary strategy to combat obesity, type 2 diabetes (T2D), and cardiovascular disease (CVD).

THE BIOLOGICAL BASIS OF OPTIMAL MEAL TIMING

Circadian clocks are a biological timing system found in virtually every cell of the body that coordinate the timing of our daily behaviors (e.g., sleep/wake, feeding/fasting) and physiology (e.g., hormone release, heart function). These clocks also incorporate signals from the environment, such as light and food, to coordinate our internal biology with our surroundings.

When your biological clocks are out of sync with the environment, health can be negatively affected. For example, we know that the body expects to use certain kinds of fuel (i.e., fat, sugar) at specific times of the day. Your body is best at digesting food/drinks when you are active and light is present. Thus, eating/drinking when your body expects you to sleep/rest, and it is dark, can disrupt this system and compromise metabolism. In contrast, a consistent daily cycle of eating and fasting may nurture a healthy circadian clock and optimize metabolism. Indeed, in rodents, a regular daily schedule of eating and fasting keeps them healthy. The science of circadian biology is offering new clues on potential optimal meal-timing patterns.

Daily Eating Duration

Your daily eating duration is the number of hours between the first and last time that you consume any calories during the 24-h day. Dieting strategies, such as calorie restriction (CR) or intermittent fasting (IF) that emphasize calorie reduction unconsciously influence the

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daily eating duration. However, time-restricted feeding/eating (TRF/TRE; feeding in animals/eating in humans) specifically emphasizes a limited and consistent daily eating duration that does not need to involve CR.

Calorie Restriction (CR).—Classic CR studies in animals involve a reduction of daily calories. In rodents, this is typically achieved by providing a single meal with up to 40% reduction in calories compared with habitual intake and is usually consumed within a 2- to 4-h window, leaving ~20 h without food. In humans, CR is usually practiced by reducing daily calories by up to 25%, often with no specific attention paid to timing. The benefits of reduced calorie intake are well studied, whereas the influence of the short eating duration that can result from CR is not. Therefore, it is unclear if benefits of CR are in part due to the change in timing of calorie intake.

Intermittent Fasting (IF) involves reducing or refraining from calorie intake for various periods of time. There are several different types of IF, including the following:

1. Alternate-day fasting: complete fasting (water only) every other day.
2. Alternate-day modified fasting: modified fasting every other day, which typically involves eating roughly 75% fewer calories on the modified fasting days.
3. Periodic fasting: complete fasting days, typically once per week or a few days per month. Consuming a low-calorie diet (typically <1000 kcal) for 3 to 5 consecutive days in every 2 to 3 months is also considered periodic fasting. The 5:2 diet is a specific version of periodic fasting, typically including 5 days of no restriction (time or calorie) and 2 days of modified fasting each week.

While fasting, the body uses stored energy, including stored fat, which increases ketone levels, to meet your body's energy needs. Research suggests that fasting improves the health of many organs in your body, including your brain. Longer fasting periods may give the body more time for repair. Therefore, shorter eating durations and longer regular fasts may improve health.

Time-Restricted Feeding/Eating (TRF/TRE) is a new meal-timing strategy that involves eating and drinking all of your daily calories within a consistent 8- to 12-h, or shorter, daily interval. Evidence suggests that TRF may improve metabolism and cardiovascular health through optimization of circadian clock function. For example, in mice, TRF prevents and reverses obesity and diabetes, supports healthy bacteria in the gut, and reduces inflammation. In fruit flies, TRF prevents and reverses heart problems caused by an unhealthy diet and aging. In rodents, TRF also has other widespread benefits, such as reducing symptoms of Huntington's disease. Small studies in humans have tested daily eating durations of 4 to 11 h/day and found that TRE decreases blood pressure, improves blood sugar, and can help with weight, energy levels, sleep, and appetite. Some benefits of TRE occurred even when people did not lose weight, suggesting that a shorter daily eating duration may improve health independently of weight loss. In human studies, there is no explicit attempt to reduce calories, but some calorie reduction may occur, which could explain some health benefits.

Timing (Phase) of the Daily Eating Interval

In addition to the daily eating duration, the time of day when we eat (aka phase) appears to affect our health. For example, metabolic research in mice often uses a high-fat diet to induce obesity and metabolic disorders, such as T2D, to study them and test therapeutic interventions. Interestingly, when on a high-fat diet, mice change their eating patterns and eat a significantly greater fraction of their food during their usual sleep/rest phase, compared with mice on a low-fat diet. Studies have revealed that calorie intake during the sleep/rest phase plays a role in metabolic diseases. As discussed, there is evidence that restricting food access to the active phase can prevent and treat metabolic diseases. Whereas restricting food access to the rest phase does not have the same health benefits, illustrating the importance of the timing of the daily eating interval.

Human studies in young adults found that eating close to when levels of the sleep hormone melatonin start to rise (i.e., close to bedtime), is associated with having more body fat. In a randomized weight-loss study, women with obesity who ate earlier in the day lost more weight. A small study in adults found that late-night eating increases blood sugar levels after the meal and the following day. Observational studies in people have also found that late-night eating is associated with obesity and greater risk of poor cardiometabolic health.

The circadian system prepares the body to be more efficient at digesting, absorbing, and metabolizing food earlier in the day (active phase). For instance, insulin sensitivity (needed to regulate blood sugar) is greater in the morning. Thus, larger meals are processed better when eaten in the first half of the day. Conversely, since melatonin (released at night) reduces insulin release, the body is not able to process glucose properly when you eat late at night or very early in the morning, when melatonin is high. Therefore, eating larger meals earlier in the day and avoiding food for a few hours prior to bedtime may have health benefits.

The effects of breakfast skipping on health are less clear. Studies on breakfast habits by surveys have found that never eating breakfast is associated with increased risk for T2D, obesity, and CVD. However, these studies also showed that breakfast skipping is associated with late-night eating, variable eating patterns, and poor food quality (i.e., increased high-fat/high-sugar snacking and reduced fruit and vegetable consumption). Although observational data have suggested that eating breakfast is associated with lower weight, a large randomized controlled trial found that breakfast skipping (for 4 months) was not associated with weight change in healthy and obese adults. The long-term health consequences of skipping breakfast are still unclear.

Calorie Distribution within the Eating Interval

There is scientific evidence also supporting the saying, “eat breakfast like a king, lunch like a prince, and dinner like a pauper,” which encourages eating the bulk of daily calories early in the day. For example, eating a large, high-protein breakfast has been shown to improve blood sugar control and weight loss in individuals with T2D. Another weight-loss study found that eating a larger breakfast and a smaller dinner improved weight loss and decreased

appetite in women. Thus, it may be beneficial to consume a majority of calories in the first half of the day.

Regularity of Eating

Since the circadian system is signaled, in part, by dietary intake, eating at consistent times is important for robust circadian rhythms. Thus, dramatically changing our mealtime from day to day may compromise physiology, similar to how sleep patterns are disturbed after an abrupt change in time zone (i.e., jet lag). Mobile apps that monitor peoples' eating habits have found that many people have erratic eating patterns, such as eating and sleeping at different times on workdays versus weekend (or nonwork) days. Irregular eating patterns have been associated with obesity, T2D, and CVD. Therefore, having a consistent daily eating time may be beneficial for health.

WHAT IS THE BEST EATING PATTERN?

There are almost no studies in humans comparing different meal-timing schedules to determine if one meal-timing strategy is better than the others. From what we know, our best available research suggests that 3 meal-timing habits are likely important for good health:

1. a consistent daily eating duration of fewer than 12 h per day,
2. eating most calories in the earlier part of the day, and
3. avoiding food intake close to bedtime, while sleeping, or very early morning, when melatonin levels are high.

CAUTIONS

There is insufficient research examining the consequences of IF and TRE on wide-ranging health outcomes in males and females (pregnant, and pre- and postmenopausal) or across age groups (teenage to centenarians). Although short-term studies have found no adverse effects of 8 h of TRE, the long-term effects of TRE are still unknown. It is also important to note that the response to a given dietary pattern may be different across different individuals; what may be optimal for one person may be different for another. Individuals should work with a health care provider knowledgeable in nutrition when considering new dieting strategies.

CONCLUSION

In addition to the quantity and quality of food that we eat, when we eat is an important aspect of healthy eating habits. Optimizing meal timing has significant health benefits and shows great promise for lifestyle interventions in the near future.

WHERE CAN I LEARN MORE?

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