WebLog Journal of Nutrition and Food Sciences

Mini Review
Published: 14 Nov, 2026

Emerging Roles of Chrono-Nutrition and Timing of Eating in Human Health: Toward Early and Small Night Meals

*Akbar Nikkhah**

Chief Highly Distinguished Professor and Scientist, National Elites Foundation, Iran

Abstract

An increasing attention is being paid to signifying eating timing for body weight management, reduced obesity and related metabolic issues, improved cardiovascular health, and enhanced life quality. The objective of this mini review was to underscore the significance of chrono-nutrition and in particular eating timing on human health and well-being in the post-modern era. Findings from animal and ruminant models have revealed that timing of eating affects nutrient metabolism and partitioning. The emerging insights suggest that chrono-eating matters and determines the fate of substrates in human body. The resulting developments in our understanding of human chronophysiology lead us to favor morning and early-day eating and to avoid night eating of large meals. Complementary long-term data are required before one can conclusively recommend particular eating strategies or circadian times of eating and fasting.

Keywords: Eating Timing; Chronophysiology; Human Health; Metabolic Disease; Circadian Rhythm



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Correspondence:
Akbar Nikkhah, Chief Highly Distinguished Professor and Scientist, National Elites Foundation, Iran, E-mail: anikkha@yahoo.com

Received Date: *27 Oct 2026*
Accepted Date: *12 Nov 2026*
Published Date: *14 Nov 2026*

Citation:
Akbar Nikkhah. Emerging Roles of Chrono-Nutrition and Timing of Eating in Human Health: Toward Early and Small Night Meals. WebLog J Nutr Food Sci. wjnfs.2026.k1405. https://doi.org/10.5281/zenodo.24281629

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Circadian or almost 24-h rhythms govern nutrient metabolism and partitioning in mammals [1]. Circadian rhythms are orchestrated by internal biological clocks and external cues such as light and eating and their schedules. Obesity, diabetes, and major metabolic disorders threat human health and welfare in today's machine times [2]. Timing of eating and the science of chrono-nutrition are contemplated to significantly influence circadian glucose and insulin rhythmicity and whereby to affect cardiovascular function and health. Recent findings using animal and ruminant models as well as human studies have uncovered the emerging science that when-to-eat and when-to-fast are of critical importance from human lifestyle and health perspectives [3-13]. For instance, timing of feeding has dramatically influenced diurnal and nocturnal rhythms of substrates in high-producing lactating dairy cows. Night or evening vs. morning eating has resulted in increased milk and body fat in dairy and beef ruminants [7-9]. Although ruminants host rumen fermentation and rely mostly on volatile fatty acids, these data suggest that chrono-nutrition matters when programming for improved human lifestyle and life quality [2].

Glucose metabolism in humans is highly dependent on eating [3]. Regardless of eating and its timing, circulating blood glucose concentrations possess circadian rhythms. Hence, as is evident, timing of eating would be expected to affect diurnal rhythms in glucose concentrations. Such changes in parallel with insulin rhythmicity would affect cellular glucose entrance and metabolism. Moreover, rates of glucose oxidation for energy release or tissue deposition may change. Altogether, these cascades could alter human metabolic status pertaining to obesity, insulin resistance, diabetes, metabolic abnormalities and liver-kidney related issues [1-3].

Evening instead of morning feeding in once-daily fed lactating Holstein cows increased rumen volume and fermentation, and resulted in elevated post-feeding levels of rumen volatile fatty acids and circulating beta-hydroxy butyrate [7]. Total digestive tract nutrient digestibility was increased as a result of evening vs. morning feeding and eating [14]. These results highlight the mediatory impacts of time of feeding on rumen and ruminant nutrient metabolism.

Shift-workers are known for increased nocturnal appetite since they are awake and active during night hours [10]. The human body has evolved to be active during day hours and stay passive and asleep overnight. As such, glucose and insulin have evolved to exhibit diminished metabolism and turnover overnight. As a consequence, night eating would be expected to interfere with normal and healthy glucose, insulin, and fat metabolism. Despite inadequate compelling long-term data to enable strong recommendations to avoid large night meals at present, the emerging science leads us toward such an advice. Complementary longitudinal data for various physiological states and ages

are required before definitive recommendation as for meal timing as well as eating and fasting strategies can be locally and globally formulated.

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