

## Chrono-Nutrition against Metabolic Complexities: A Rising Science

Review Article

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### Abstract

This perspective review article aimed to review and elaborate on how meal timing (chrono-nutrition) impact on circadian rhythms and metabolic pathways involved in glucose metabolism. As technology advances and societies move toward industrialization, social activities, exercise, work schedule (i.e., shift work) and eating behavior (time, type and frequency) also change. For instance, people prefer to eat outside during suboptimal times misaligned with normal circadian rhythms. Growing body of evidence suggest that disruptions in normal physiological rhythms of glucose metabolism can lead to health problems. Obesity and diabetes mellitus (T2D) are among the most noted metabolic disorders throughout the world mainly occurring because of suboptimal eating habits and lifestyle. Eating less sugars, starch, or even fat overnight can help cope with the internal chronophysiology. Chrono-nutrition is a rising agro-human science that must be considered precisely in our routine life to help prevent or at the very least reduce and control obesity and T2D in the stressful modern era.

**Keywords:** Chrono-Nutrition; Circadian Rhythm; Diabetes; Obesity; Science.

### Philosophy and Discussion

In mammals including humans, a structure is located in the hypothalamus part of the brain called suprachiasmatic nucleus (SCN). This is a central clock accompanied by peripheral clocks in tissues like liver that are involved in the regulation of circadian rhythms of nutrient metabolism [1, 2]. For instance, it has been reported that glucose tolerance decreases in the evening and also at night because limited amounts of nutrients are needed overnight [3]. Therefore, having large meals or over-eating of high-sugar and starchy foods during evening and night hours should be avoided to reduce probability of obesity and T2D. Diurnal rhythms of glucose metabolism necessitate decreased insulin sensitivity and pancreatic  $\beta$ -cells function in the evening vs. morning, indicating that glucose metabolism follows physiological circadian rhythms [2]. However, in individuals with T2D in contrast to healthy ones, elevated levels of glucose or hyperglycemia occur overnight and early in the morning because hepatic glucose production is still active in these patients [2, 4]. Whole body insulin resistance is the first step in T2D development. However, hyperglycemia and related diabetes are more dependent on hepatic insulin resistance rather than muscle insulin resistance [4]. Moreover, muscle insulin resistance and caloric overload can lead to fat accumulation

in the liver, causing hepatic insulin resistance and failure in the suppressive effects of insulin on hepatic glucose production [4]. Consequently, glucose overflow during evening or night imposes insulin resistance and finally could result in increased risk obesity and T2D [5].

As mentioned above, glucose metabolism is closely synchronized with circadian systems; thus, altering eating time from early in the morning to later in the evening can lead to increased blood glucose and its associated complexities. According to nutritional habits so called 'chronotype', people are categorized into morning and evening chronotypes. The evening chronotype individuals are used to eat more intensely later in the evening. It is important to note that each chronotype affects chrono-nutrition. It has been demonstrated that night and shift workers possess lowered glucose tolerance and are at higher risks of obesity and diabetes because of their altered eating time and disruption in the normal circadian sleep-wake up cycle [6].

Furthermore, elevated levels of melatonin have been reported in those with later dinner timing, further indicating an impaired glucose metabolism by disruption in the circadian rhythms [2]. Conventionally, melatonin is known for its basic role in sleep-

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cycle and circadian rhythms regulation. However, discovery of MTNR1B, melatonin receptor 1b gene, has created an interest in investigating potential role of melatonin in glucose metabolism. Increased melatonin levels following food intake may impair glucose metabolism and decrease glucose tolerance. Melatonin reaches maximal level overnight which coincides with decreased glucose tolerance driven by the circadian rhythms [7]. Therefore, the increased risk of diabetes and obesity in shift-workers who are also night eaters can be attributed to the disruption in their circadian rhythms of glucose metabolism. The most accepted hypothesis about melatonin action is the inhibitory effect of melatonin on insulin secretion [7]. With regard to physiological impact of meal timing, chrono-nutrition implies that energy-dense nutrients should be taken early in the morning when physical activity and brain function are being started and intensified [5]. Eating breakfast is also encouraged in the literature whereas night eating is discouraged [8]. As such, greater postprandial glucose has been illustrated in males who skipped breakfast and had large lunch and dinner meals with more noticeable effect for dinner [9]. In addition to eating time, for improved nutrient and waste metabolism, food intake and daily physical exercise should be considered in a coordinated schedule needed for better cell function. Chrono-nutrition as an emerging science provides a simple and practical way to control glucose disturbance related disorders such as diabetes and obesity. As a result, chrono-nutrition and meal properties will play key roles in improving human life quality in the modern and postmodern eras.

## Conclusion

Glucose metabolism is influenced by circadian rhythms. Glucose tolerance decreases during evening and night times. Therefore, individuals who are night eaters exhibit higher blood glucose lev-

els or hyperglycemia overnight. The increased blood glucose concentrations alongside the greater insulin resistance are the major factors causing obesity and T2D. Chrono-nutrition is a mounting agro-human science that deserves growing attention in controlling and possibly preventing glucose metabolism related disorders in the stressful modern times.

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Contemplation in science gives rise to novel theories that warrant profound acknowledgment in practice.

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