

Current Opinions in Chrononutrition and Health

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Nutritional sciences have traditionally prioritized what we eat, and the sentence “You are what you eat” has been used to describe the commitment between health and diets with low nutritional values. The “5 W’s and 1 H (5W1H) of meals” should be considered (i.e., what, *when*, where, who, why, and how). Furthermore, the way meals are eaten should be considered as well to better understand nutrition. The effects of foodstuffs eaten during the day may have positive or negative effects on many circadian rhythms depending on the time of the consumption [1]. This fact is not only a recent scientific revelation, but also popular knowledge which shows this nutritional paradigm as it can be observed through several proverbs such as “*have breakfast like a king, have lunch like a prince, and have dinner like a pauper*”, or “*orange is gold in the morning, silver at noon, and death at night*”. This last one issues the ability of the body to process some nutrients or, for example, in the case of oranges, the property of vitamin C to enhance awake during the day. Therefore, the recognition of the importance of the timing of meals has been present in society for centuries.

The field called Chronobiology studies those rhythmic phenomena that occur in living organisms, like migration in birds, hibernation in mammals, reproduction, etc. It also studies those rhythms which follow a 24 h pattern (circadian rhythms) like sleep/wake cycle, neurotransmitter and hormone rhythms, or ingest patterns among others. In this way, nutrients play a critical role to synchronize body functions with hours of the day, and this science is Chrononutrition which was defined by Alain Delabos in 1986 in France. Actually, Oike et al., [2] referred to it when he said: “food components regulate circadian clocks, and meal times affect metabolic homeostasis”.

The importance of the circadian rhythms in regulating food intake and metabolism plays a critical role for health. A wide array of physiological and metabolic functions are set and programmed by the hour of the day and many researches have shown that Chronodisruption (loss of circadian rhythmicity) leads to health impairments in living organisms [3]. A common example is eating late at night, which carries a high risk of developing obesity. The linkage between Chrononutrition and health is well-known from those experiments carried out in animals and humans with sleep disorders and their consequently linked-disorders when these alterations have been partially or totally reverted with diets designed to improve sleep [4]. These facts are the main cause

for the design of diets which have the aim to reinstate circadian rhythms in human populations. In this way, authors created the first milk formula, which emulated some circadian oscillations we found in breast milk. In particular, we analyzed the beneficial effects of tryptophan, nucleotides, and medium chain fatty acids, which improved the sleep/wake rhythm in newborns and infants with the adapted milk formula and cereals Day/Night (Ordesa®) [5]. This first step in chrononutrition based-diets was later applied to elderly humans or children who suffered from neurological disorders—with both serotonin or melatonin problems—and sleep disorders (like autism or palsy cerebral disorders) with positive results in sleep/wake circadian rhythm [6].

Chrononutrition is a field related to mood disorders improvements, mainly due to those diets which increase serotonin levels (through the essential amino acid tryptophan, its precursor ingest). The serotonergic system is implicated in mood and dysfunctions in the pathways where this neurotransmitter is involved. It can produce depression, anxiety disorders, bipolar disorders, and obsessive-compulsive disorders among other psychological alterations [1]. Moreover, the sensitivity of GABA

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receptors, may be modulated by ingest of hops or other plants. In some research carried out with non-alcohol beer in a moderated consumption at night it provokes beneficial changes in both anxiety and depression in stressed populations [7,8].

During the last two decades CLOCK genes have been investigated and they are present in all tissues and they enable the anticipation of daily events in living organisms. Lasts research has shown that our genetic clock is able to mirror ingested nutrients. Very often, body tissues use signaling molecules to synchronize genetic circadian clock, and these signaling molecules are very dependent on energy status of body. Therefore, many genes have been associated with glucose and lipid homeostasis and they are under circadian oscillations. In fact, glucose and lipid homeostasis are impaired in mutant rodents with genetic circadian alterations [9].

The linkage between nutrition and cognition is being more and more investigated in the last few years. In fact, the nutritional

cognitive neuroscience is an emerging interdisciplinary field of research focused on understanding nutrition's impact on cognition, learning, and brain health. The serotonin indol, is a neurotransmitter synthesized mainly during light hours, from tryptophan amino acid, and previous research have shown its effects on cognition. The firsts research performed about tryptophan and cognition were carried out through the tryptophan acute depletion which has shown several cognitive impairments [10].

Finally, we want to highlight that the future of chrononutrition is associated with the future of nutrition as a therapeutic tool against the endemic pathologies of our society such as obesity, metabolic syndrome and neurocognitive disorders where the management and design of the diet are associated with a circadian pattern of ingestion of certain nutrients that are health promoters. Without forgetting a correct teaching in healthy eating habits at community level.

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