

## Review

### Kingly Breakfast Devours Diseases: Scientific Perspectives

S.K. Verma<sup>1\*</sup>, Riya Pareek<sup>1</sup> and Urvansh Mehta<sup>2</sup>

<sup>1</sup>Department of Medicine,  
Pacific Medical College and Hospital, Udaipur, Rajasthan, Bharat

<sup>2</sup>Department of Medicine,  
Community Health Centre, Koliyak, Bhavnagar, Gujarat, Bharat

**Corresponding Author Email:** skvermaster@gmail.com

#### ABSTRACT

*Emerging concept of chrononutrition proposes that meal timing per se could affect the circadian clock system or circadian rhythm and disruption of biological rhythm can negatively influence timing and food selection. Furthermore, research has come up with some suggestions that mealtime, energy distribution, nocturnal eating and frequency of food ingestion may affect nutrient metabolism which are associated with various metabolic diseases. Taking meal as per the biological circadian system invariably affect the human physiology and the long term health.*

**KEYWORDS:** Circadian rhythm, Nocturnal eating, Adiposity, Chrononutrition

#### INTRODUCTION

Recent scientific evidence has linked the circadian system to metabolic physiology and nutrition and generated new area of research nominated as 'Chrononutrition'. It proposes that nutrients or meal timing per se could affect the circadian clock system<sup>1</sup>. Research from this area has further shown that mealtimes, energy distribution, nocturnal eating and number of food episodes may influence nutrient metabolism and may be associated with metabolic and nutritional diseases<sup>2</sup>.

The individuals of the present society show long waking hours, they become more exposed to many food intake events over 24 hours, especially at times when they should be sleeping and the body is not metabolically prepared for digestion. In this regard, the daily dietary pattern has been seen as a potential new target for lifestyle intervention to reduce the risk of metabolic diseases<sup>3</sup>.

#### Food Intake and Circadian Synchronization

Eating behavior can synchronize the circadian timing. That has been exemplified by the phenomenon of "food anticipatory activity" which is responsible for inducing characteristics of anticipatory rhythms of feeding, locomotor activity and body temperature independent of the suprachiasmatic nuclei<sup>4</sup>. This anticipatory rhythmic activity leads to the release of many metabolic hormones and secretion of enzymes which are necessary for digestion.

Certain dietary components do influence circadian rhythms. Intake of caffeine, high- fat or high-sugar diets may change clock gene expression rhythms, especially for the peripheral clocks in the liver, as well as changing the locomotor activity rhythm and feeding behavior. Likewise, intake of a ketogenic diet (high fat and very low carbohydrate) also alters circadian locomotor activity rhythm<sup>5</sup>.

### Circadian Desynchronization and Metabolism

Circadian disruption in humans can negatively affect the metabolic homeostasis because humans are basically diurnal and show decreased levels of appetite and gastric emptying during night time<sup>6</sup>. Several biological markers which are involved in metabolism show circadian oscillations. Cortisol which is associated with glucose metabolism have a circadian rhythm with the lowest values during early rest phase and the peak in the activity phase<sup>7</sup>. Glucose tolerance being higher in the morning than in the afternoon and evening along with insulin levels which show less secretion and sensitivity in the evening<sup>8</sup>. Leptin, which is involved in satiety, is having levels high during the night but low during the day. Ghrelin, which is involved in stimulating appetite, plays a special role as it is a food-related entraining signal<sup>9</sup>.

In situations of circadian misalignment, an important proportion of meals may occur desynchronized with controls of hunger and appetite and during the time of suboptimal food metabolism, resulting in a relative impairment of these parameters. In addition, when the circadian misalignment becomes chronic, these effects may pave the way for the development of metabolic diseases<sup>10</sup>.

### Meal Timing and Metabolism

Several studies have pointed out that it is not only what and how much is eaten, but when it was eaten plays a significant role in weight regulation<sup>11,12</sup> and glucose and lipid metabolism<sup>13</sup>. In fact, skipping breakfast and/or overeating in the evening, play a significant role in weight gain and obesity<sup>11</sup>. Furthermore, Garaulet and associate have shown in their interventional study that the timing of lunch was predictive of weight loss during a 20-week period of dietary intervention conducted in obese and overweight persons<sup>14</sup>.

### Breakfast Consumption and Human Health

Several clinical studies have pointed out the importance of food consumption in the early hours of the day for successful change in body mass<sup>14,15</sup>. In this context, it is pertinent to discuss a study conducted on overweight and obese women with metabolic syndrome<sup>16</sup>. The selected women who had BMI of  $32.4 \pm 1.8$  Kg/m<sup>2</sup> were randomized into two isocaloric (1400Kcal) groups, a breakfast (BF) and a dinner (D) group. Breakfast group received 700 Kcal at breakfast, 500 Kcal at lunch and 200 Kcal at dinner, while dinner group received 200 Kcal at breakfast, 500 Kcal at lunch and 700 Kcal at dinner for a period of 12 weeks. It was found that the BF group had greater weight loss and waist circumference reduction. Triglyceride levels decreased by 33.6%, while it increased by 14.6% in dinner (D) group. The overall daily glucose, insulin, ghrelin and mean hunger scores were significantly lower, whereas mean satiety score was significantly higher in the BF group. The study concluded that a high-calorie breakfast with reduced intake at

dinner is beneficial and this approach might be useful as an alternative way for the management of obesity and metabolic syndrome<sup>16</sup>.

The habit of eating proper breakfast is considered as an important indicator of health<sup>17</sup> while overweight/obesity is often commonly associated with individuals who skip the breakfast<sup>18</sup>. Interestingly, other studies have shown that skipping breakfast is associated with a higher risk of developing coronary heart disease<sup>19</sup>, stroke<sup>20</sup>, worse glycemic control and insulin resistance<sup>17</sup> as well as negative change in lipid profile<sup>21</sup>.

A meta-analysis of eight studies also concluded that breakfast skipping is associated with a significantly increased risk of type 2 diabetes<sup>22</sup>. Furthermore, the review of 19 studies on 19,270 overweight or obese participants found that the risk of being overweight or obese among those skipping breakfast compared to those consuming breakfast was 1.55<sup>23</sup>.

In this context, it is interesting to observe that how keenly observant our ancestors were who proverbially commented that “Eat breakfast yourself, share lunch with a friend and give dinner away to your enemy” or “Eat breakfast like a king, lunch like a prince and dinner like a pauper”<sup>24</sup>. In the light of present scientific observations, these proverbs seem to make sense<sup>2</sup>.

### Mechanisms behind Breakfast and Health Protection

1. Food intake in the morning is in rhythm with circadian system. After a time lag of 8 to 10 hours between breakfast and last night meal (window to eat), the body system is ready to accept and assimilate nutrients in a proper way. Morning food intake is particularly satiating and can reduce the total amount of energy ingested. This is in contrast to late night eating which has no satiating properties and may result in greater energy intake<sup>25</sup>. The above mentioned pattern is possible because of modulation of hormonal levels of ghrelin and leptin which are related to appetite control and satiety<sup>16,26</sup>.
2. Breakfast skipping has been consistently associated with lower micronutrient intakes in particular, calcium, folate, magnesium, vitamin C and vitamin A, when compared with regular breakfast eaters<sup>27-28</sup>.
3. It is important to re-emphasize that the chronotype is considered as an important determinant factor for consideration of meal timing preference in general and breakfast in particular. Eveningness which is associated with unhealthy behavior and metabolic diseases has also been associated with a tendency to skip breakfast<sup>29</sup>.
4. It is also observed that evening types seem to skip breakfast because their circadian rhythms are delayed. They do not consume breakfast due to lack of signaling by biological clocks for their time to take morning meal<sup>30</sup>.

5. Regularly eating breakfast may link positively to sleep health in persons with morning meal preference. This behavior is possibly due to the alterations in the release of orexigenic hormones and appetite suppressants<sup>31</sup>.

### Morning versus Nocturnal Eating

Having been analyzed the metabolic advantages of morning meal (breakfast), let us view scopically the disadvantages of late night eating. Nocturnal eating has resulted in metabolic dysfunctions<sup>32</sup>, obesity<sup>11</sup> and increased risk of diabetes<sup>33</sup>. The metabolic disadvantages are because fat oxidation is lower in the evening compared with that in the morning<sup>34-35</sup>. The energy metabolism is less efficient during the evening<sup>36</sup>. There is increased intake of food due to an insufficient satiety function<sup>37</sup> along with there is reduced nocturnal sensitivity and glucose tolerance<sup>8</sup>. Therefore, meal intake at night between 8pm and midnight, even it is comprised of low glycemic ingredients, contributes to higher glucose excursions and concomitantly greater insulin levels when compared with an equivalent meal in the morning<sup>13</sup>.

After considering the aforementioned evidences, eating late at night may have adverse metabolic effects, which are not favorable for healthful living. On the other hand, the morning eating is conducive for metabolic health and in some way or other mitigates or delay the development of chronic diseases linked to metabolic dysfunctions.

### CONCLUSION

In the pre-industrialization era, people were working in the day and sleeping in the night. The meals were basically two – first in the morning and second in the evening preferably before sunset. These meals were in perfect concordance with the circadian rhythm. People were healthy, physically and socially. The present scientific observations support this concept and substantiate the proverb that “Eat breakfast like a king.....”. The circadian disruption has paved the ways for metabolic disturbances and development of chronic diseases. There is therefore, an urgent need to think about the correlation of circadian rhythm and nutrition, what is labeled as chrononutrition. This might curtail the rising incidence of chronic metabolic diseases.

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