

# A Review article on chrononutrition-Based Strategies for Enhancing Mental Well-Being in Adults: Current Evidence and Future Perspectives

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## Abstract

Mental health disorders, including stress-related conditions, depression, and anxiety, constitute a major global public health challenge. Although pharmacological and psychological interventions remain central to management, growing attention has been directed toward lifestyle-based approaches that complement conventional therapies. Chrononutrition, which examines the relationship between eating patterns and biological timing, has emerged as an important modifiable factor influencing psychological health. Disruption of circadian-aligned eating behaviors alters metabolic, hormonal, and neural processes involved in emotional regulation. This review critically evaluates the biological foundations of chrononutrition, summarizes current evidence linking meal timing with mental well-being in adults, and discusses chrononutrition-based interventions. In addition, emerging mechanistic pathways involving the gut–brain axis, inflammation, and cellular energetics are explored. Finally, future research priorities and clinical implications are outlined. Understanding the influence of dietary timing on mental health may facilitate the development of integrative and preventive mental healthcare strategies.

**Keywords:** Chrononutrition, circadian rhythm, mental well-being, depression, anxiety, stress, meal timing, gut–brain interaction

## 1. Introduction

Mental health conditions represent one of the leading contributors to disability worldwide. Depression, anxiety, and chronic stress significantly impair social functioning, work productivity, and overall quality of life. Rapid urbanization, irregular work schedules, disrupted sleep patterns, and unhealthy lifestyle practices have intensified the burden of psychological disorders among adults<sup>[1]</sup>. Despite advances in pharmacotherapy and psychotherapy, treatment response remains variable, and many individuals experience residual symptoms or adverse effects<sup>[1,2]</sup>.

In this context, interest has increased in non-pharmacological approaches that address modifiable lifestyle factors. Circadian biology has emerged as a crucial determinant of physical and psychological health<sup>[3]</sup>. The circadian system coordinates daily fluctuations in physiological processes, including sleep, hormone secretion, metabolism, and cognitive performance. Disturbance of this system is strongly associated with mood disorders<sup>[4]</sup>.

Chrononutrition represents an extension of circadian science into nutritional research. It focuses on the timing, frequency, and regularity of food intake in relation to endogenous biological rhythms<sup>[5]</sup>. Instead of emphasizing nutrient composition alone, chrononutrition highlights the importance of synchronizing eating

behavior with circadian physiology<sup>[5,6]</sup>. Increasing evidence suggests that inappropriate meal timing contributes to emotional dysregulation and psychiatric vulnerability<sup>[7]</sup>. However, comprehensive evaluations integrating biological mechanisms, clinical findings, and intervention strategies remain limited. This review aims to address this gap<sup>[8]</sup>.

## 2. Circadian Regulation and Nutritional Timing

### 2.1 Central and Peripheral Biological Clocks

The circadian system is organized around a central pacemaker located in the suprachiasmatic nucleus of the hypothalamus. This master clock coordinates peripheral clocks distributed across metabolic organs such as the liver, pancreas, intestine, and adipose tissue<sup>[8,9]</sup>. These clocks operate through transcriptional–translational feedback loops involving clock genes, including CLOCK, BMAL1, PER, and CRY<sup>[10]</sup>.

While light is the primary synchronizer of the central clock, feeding patterns serve as dominant cues for peripheral oscillators. Regular meal timing reinforces circadian alignment, whereas erratic eating behaviors induce internal desynchronization. This misalignment disrupts glucose metabolism, lipid regulation, and hormonal balance, indirectly influencing brain function and emotional stability<sup>[10, 11]</sup>.

### 2.2 Neuroendocrine Modulation

Chrononutrition affects several endocrine systems relevant to mental health:

HPA Axis: Irregular eating patterns alter cortisol rhythms, leading to prolonged stress responses<sup>[11, 12]</sup>.

Melatonin Regulation: Night-time food intake suppresses melatonin secretion, impairing sleep quality and mood regulation<sup>[12]</sup>.

Metabolic Hormones: Insulin, leptin, and ghrelin display circadian variation. Disruption of these rhythms affects appetite control and reward processing<sup>[13]</sup>.

### 2.3 Neurotransmitter Homeostasis

Neurotransmitters involved in mood regulation, such as serotonin and dopamine, exhibit daily oscillations. Tryptophan metabolism and monoamine synthesis are influenced by feeding schedules. Circadian misalignment may therefore compromise neurotransmitter availability, increasing susceptibility to depressive and anxious symptoms<sup>[12,13]</sup>.

## 3. Association Between Chrononutrition and Mental Health

### 3.1 Meal Timing and Depressive Symptoms

Several epidemiological studies indicate that late-evening energy intake and irregular eating schedules are associated with higher depressive scores<sup>[14]</sup>. Individuals with evening chronotypes frequently demonstrate inconsistent meal patterns and reduced psychological resilience. In contrast, regular breakfast consumption and earlier caloric distribution have been linked to improved mood and emotional stability<sup>[14,15]</sup>.

### 3.2 Eating Regularity and Anxiety

Irregular meal frequency and prolonged fasting periods may induce hypoglycemic episodes, autonomic activation, and irritability, thereby intensifying anxiety-related symptoms. Structured eating schedules help stabilize glucose availability and autonomic balance, potentially reducing anxiety severity<sup>[14, 15]</sup>.

### 3.3 Stress and Dysregulated Eating

Chronic psychological stress alters appetite rhythms and promotes nocturnal snacking and emotional eating. These behaviors further disrupt circadian organization, creating a self-perpetuating cycle. Chrononutrition-based interventions may interrupt this cycle by restoring predictable metabolic signaling<sup>[15]</sup>.

### 3.4 Shift Work and Circadian Disruption

Shift workers experience pronounced circadian misalignment due to inverted sleep–wake and feeding schedules. This population exhibits elevated rates of depression, insomnia, and burnout. Controlled feeding windows and scheduled meals have demonstrated potential in mitigating these adverse outcomes<sup>[16]</sup>.

## 4. Biological Pathways Linking Chrononutrition and Mental Well-Being

### 4.1 Gut–Brain Communication

The gut microbiome exhibits circadian oscillations influenced by dietary timing. Disrupted feeding rhythms alter microbial composition and metabolite production, including short-chain fatty acids and neurotransmitter precursors. These changes affect vagal signaling, neuroinflammation, and emotional behavior<sup>[16]</sup>.

### 4.2 Inflammatory and Immune Responses

Circadian disruption promotes chronic low-grade inflammation characterized by increased pro-inflammatory cytokines. Inflammatory mediators such as interleukin-6 and tumor necrosis factor- $\alpha$  play important roles in depression pathogenesis. Chrononutrition may attenuate these pathways by stabilizing metabolic rhythms<sup>[17]</sup>.

### 4.3 Mitochondrial and Energy Regulation

Cellular energy production follows circadian patterns. Irregular feeding impairs mitochondrial efficiency and increases oxidative stress within neural tissue, contributing to fatigue, cognitive dysfunction, and mood disturbances. Regularized eating supports cellular bioenergetics<sup>[17, 18]</sup>.

### 4.4 Epigenetic Regulation

Recent evidence suggests that feeding schedules influence epigenetic modification of clock and stress-related genes. These changes may mediate long-term effects of chrononutrition on mental health vulnerability and resilience<sup>[19, 20, 21]</sup>.

## 5. Chrononutrition-Based Interventions

### 5.1 Time-Restricted Eating

Time-restricted eating limits food intake to defined daily intervals, typically ranging from 8 to 10 hours. Early feeding windows appear to enhance circadian alignment, improve sleep quality, and reduce perceived stress<sup>[20, 21]</sup>.

### 5.2 Fixed Meal Scheduling

Consistent meal timing across weekdays and weekends stabilizes hormonal and metabolic rhythms. This low-cost intervention is feasible for large populations and may serve as a preventive strategy<sup>[21, 22]</sup>.

### 5.3 Morning-Focused Energy Intake

Diets emphasizing greater caloric intake in the morning support cortisol rhythm normalization and cognitive performance. Such patterns are associated with lower depressive symptomatology compared to evening-heavy diets<sup>[23]</sup>.

## 5.4 Chronotype-Oriented Nutrition

Individual chronotype influences metabolic and psychological responses to meal timing. Personalized approaches aligning feeding schedules with chronotype represent a promising area for intervention development<sup>[24]</sup>.

## 5.5 Multimodal Behavioral Integration

Combining chrononutrition with sleep hygiene, physical activity, and cognitive-behavioral therapy may enhance treatment outcomes in mood disorders<sup>[24,25]</sup>.

## 6. Clinical and Public Health Relevance

Chrononutrition represents an accessible, non-invasive strategy for mental health promotion. It may be particularly beneficial for:

Individuals with subclinical psychological distress

Patients with partial response to antidepressants

Shift workers and healthcare professionals

Young adults with irregular lifestyles

Incorporating chrononutrition counseling into primary care and mental health services may improve holistic patient management<sup>[26, 27, 28]</sup>.

## Limitations of Current Evidence

Most existing studies are observational, limiting causal inference. Dietary assessments rely heavily on self-reporting, introducing recall bias. Cultural, occupational, and socioeconomic influences remain underexplored. Addressing these limitations is necessary for effective clinical translation.

## 9. Conclusion

Chrononutrition represents a promising frontier in mental health research. Aligning eating behavior with endogenous circadian rhythms may influence neuroendocrine, inflammatory, and metabolic pathways involved in emotional regulation. Current evidence supports the potential benefits of structured meal timing, time-restricted eating, and personalized nutritional strategies. Although further high-quality research is required, integrating chrononutrition into preventive and therapeutic frameworks may substantially enhance mental healthcare delivery.

## References

1. Panda S. *The circadian code: lose weight, supercharge your energy, and transform your health from morning to midnight*. New York: Rodale; 2018.
2. Johnston JD. Physiological responses to food intake throughout the day. *Nutr Res Rev*. 2014;27(1):107–18.
3. Garaulet M, Gómez-Abellán P. Timing of food intake and obesity: a novel association. *Physiol Behav*. 2014;134:44–50.
4. Pot GK. Sleep and dietary habits in the urban environment: the role of chrono-nutrition. *Proc Nutr Soc*. 2018;77(3):189–98.
5. Logan RW, McClung CA. Circadian disruption and brain disorders. *Nat Rev Neurosci*. 2019;20(1):49–65.
6. McHill AW, Wright KP. Sleep and circadian disruption in metabolic health. *Obesity*. 2017;25(3):468–77.
7. Froy O. Metabolism and circadian rhythms. *Endocr Rev*. 2010;31(1):1–24.
8. Stenvers DJ, Scheer FAJL, Schrauwen P, et al. Circadian clocks and insulin resistance. *Nat Rev Endocrinol*. 2019;15(2):75–89.

9. Scheer FAJL, Hilton MF, Mantzoros CS, Shea SA. Circadian misalignment and metabolic consequences. *Proc Natl Acad Sci USA*. 2009;106(11):4453–8.
10. Zarrinpar A, Chaix A, Panda S. Daily eating patterns and gut microbiome. *Cell Metab*. 2016;23(6):1009–17.
11. Cryan JF, Dinan TG. Gut–brain axis. *Nat Rev Neurosci*. 2012;13(10):701–12.
12. Irwin MR, Slavich GM. Psychoneuroimmunology of depression. *Brain Behav Immun*. 2017;64:1–3.
13. Longo VD, Panda S. Fasting and time-restricted feeding. *Cell Metab*. 2016;23(6):1048–59.
14. Wilkinson MJ, Manoogian ENC, Zadourian A, et al. Time-restricted eating and metabolic health. *Cell Metab*. 2020;31(1):92–104.
15. Roenneberg T, Merrow M. Circadian clock and human health. *Curr Biol*. 2016;26(10):R432–43.
16. Hutchison AT, Regmi P, Manoogian ENC, Fleischer JG, Wittert GA, Panda S, et al. Time-restricted feeding improves glucose tolerance in men at risk for type 2 diabetes. *Cell Metab*. 2019;29(2):303–19.
17. Sutton EF, Beyl R, Early KS, Cefalu WT, Ravussin E, Peterson CM. Early time-restricted feeding improves insulin sensitivity and blood pressure. *Cell Metab*. 2018;27(6):1212–21.
18. Jakubowicz D, Barnea M, Wainstein J, Froy O. High caloric intake at breakfast vs dinner affects weight loss and hormonal regulation. *Obesity*. 2013;21(12):2504–12.
19. Wehrens SMT, Christou S, Isherwood C, Middleton B, Gibbs MA, Archer SN, et al. Meal timing regulates circadian rhythms in humans. *Curr Biol*. 2017;27(12):1768–75.
20. Vetter C, Devore EE, Ramin CA, Speizer FE, Willett WC, Schernhammer ES. Mismatch of sleep and meal timing and risk of depression. *JAMA Psychiatry*. 2018;75(2):152–60.
21. Baron KG, Reid KJ, Kern AS, Zee PC. Role of sleep timing in caloric intake and BMI. *Sleep*. 2011;34(5):593–9.
22. Lucassen EA, Zhao X, Rother KI, Mattingly MS, Courville AB, de Jonge L, et al. Evening chronotype associated with adverse metabolic and psychological profiles. *Appetite*. 2013;66:103–10.
23. Mendelson M, Borowik A, Michallet AS, Perrin C, Monneret D, Faure P, et al. Sleep quality and inflammation: a systematic review. *Sleep Med Rev*. 2018;40:42–53.
24. O’Mahony SM, Clarke G, Dinan TG, Cryan JF. Early-life stress alters gut microbiota and behavior. *Biol Psychiatry*. 2011;65(3):263–7.
25. Thaiss CA, Zeevi D, Levy M, Zilberman-Schapira G, Suez J, Tengeler AC, et al. Transkingdom control of microbiota diurnal oscillations. *Cell*. 2014;159(3):514–29.
26. Broussard JL, Van Cauter E. Disturbances of sleep and circadian rhythms: metabolic implications. *Endocr Rev*. 2016;37(6):593–617.
27. Potter GDM, Skene DJ, Arendt J, Cade JE, Grant PJ, Hardie LJ. Circadian rhythm and nutrition. *Proc Nutr Soc*. 2016;75(3):319–27.
28. Kalsbeek A, la Fleur S, Fliers E. Circadian control of glucose metabolism. *Mol Metab*. 2014;3(4):372–83.
29. Scheer FAJL, Morris CJ, Garcia JJ, Smales C, Kelly EE, Marks J, et al. Repeated circadian disruption and mood vulnerability. *PNAS*. 2021;118(6):e2023693118.
30. Dashti HS, Scheer FAJL, Jacques PF, Lamon-Fava S, Ordovás JM. Short sleep duration and dietary intake: epidemiologic evidence. *Obes Rev*. 2015;16(8):648–59.

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