

# The Role of Chrononutrition in the Management of Hypertension: Synchronizing Meals with Circadian Rhythms

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## ABSTRACT

Both genetic and lifestyle factors, such as food and meal timing, affect hypertension, a significant risk factor for cardiovascular disease. The study of chrononutrition—the timing of meals to coincide with circadian rhythms—has attracted interest as a possible strategy for improving blood-pressure management. The effects of meal timing, frequency, and content on blood-pressure control and cardiovascular health are examined in this review. The significance of aligning dietary patterns with the body's internal clock is highlighted by the interaction of circadian rhythms, hormone variations, and nutrient metabolism. Meal timing strategies including intermittent fasting and early time-restricted feeding (eTRF) may lower blood-pressure and enhance metabolic health overall, according to data from epidemiological and clinical research. Knowing the mechanisms underlying the relationship between chrononutrition and hypertension can lead to new dietary strategies.

**Keywords:** Cardiovascular health, Chrononutrition, Circadian rhythms

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## INTRODUCTION

Nearly 1.3 billion persons worldwide suffer from hypertension, which continues to be a global public health concern.<sup>1</sup> Reducing salt intake, increasing potassium intake, and adhering to dietary patterns like the DASH diet are the main recommendations of dietary treatments, which are well-established in the management of hypertension.<sup>2</sup> On the other hand, recent studies indicate that the frequency and timing of meals are important for cardiovascular health. The study of chrononutrition, which combines the fields of nutrition and circadian biology, looks at how dietary intake affects metabolic and cardiovascular outcomes by interacting with the body's internal clock.<sup>3</sup> The hypothalamic Suprachiasmatic Nucleus (SCN) controls the circadian clock, which controls physiological functions like metabolism, hormone production, and blood pressure regulation.<sup>4,5</sup> Hypertension may result from circadian rhythm disruptions brought on by irregular eating habits, shift employment, or late-night meals.<sup>6,7</sup>

## Circadian Rhythms and Blood Pressure Regulation

There is a clear diurnal pattern to blood-pressure, with a morning spike and a nighttime fall. Endogenous clocks and external stimuli like light, sleep-wake cycles, and food intake control this pattern.<sup>8</sup> Non-dipping hypertension and an elevated risk of cardiovascular disease are linked to the dysregulation of these rhythms, which is frequently observed in people who work shifts or eat late at night.<sup>9</sup> Circadian regulation affects blood-pressure variations through the sympathetic nervous system, endothelial function, and the renin-angiotensin-aldosterone system (RAAS).<sup>10</sup> These processes may be interfered with by eating outside of the ideal circadian window, which could result in persistent hypertension.

## Chrononutrition and Hypertension: Key Concepts

### Meal Timing and Blood Pressure

Studies reveal that the timing of food consumption has a substantial effect on blood pressure control. Eating late at night is linked to poor glucose metabolism and elevated nocturnal blood pressure.<sup>11</sup> It has been demonstrated that early time-restricted feeding (eTRF), which limits food consumption to the early hours of the day (e.g., 8 AM–4 PM), improves lipid profiles, insulin sensitivity, and blood pressure.<sup>12</sup> Participants with pre-diabetes who adhered to eTRF showed notable

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decreases in both systolic and diastolic blood pressure when compared to those who had meals over an extended period of time, according to a study by Sutton et al. (2018).<sup>13</sup> According to these results, coordinating meals with the circadian rhythms of the body may improve cardiovascular health.

### Intermittent Fasting and Hypertension

The metabolic advantages of intermittent fasting (IF), which alternates between eating and fasting, have made IF more and more popular. According to studies, IF can improve autonomic regulation, decrease oxidative stress, and improve endothelial function, all of which can lower blood pressure.<sup>14</sup> According to a meta-analysis by Dutta et al. (2021), IF reduced blood pressure in those with metabolic syndrome in a modest but significant way.<sup>15</sup> Reduced calorie intake, increased insulin sensitivity, and improved circadian alignment are some of the benefits of intermittent fasting.<sup>16</sup>

### Meal Frequency and Cardiovascular Health

Recent research indicates that fewer, strategically planned meals may be more advantageous for blood-pressure regulation than the frequent, little meals that have traditionally been advocated for metabolic health. People who ate a substantial breakfast and a smaller dinner had better glycemic control and lower blood-pressure than those who ate a high-calorie meal, according to a study by Jakubowicz et al. (2019).<sup>17</sup> Changing energy intake earlier in the day supports cardiovascular health by lowering the postprandial metabolic burden and synchronizing with circadian rhythms.<sup>18</sup>

### Mechanistic Pathways Linking Chrononutrition and Hypertension

The positive benefits of chrononutrition on blood-pressure regulation are explained by a number of mechanisms:

#### Hormonal Regulation

Blood-pressure homeostasis is influenced by the circadian rhythms of cortisol, insulin, and melatonin. Eating late at night interferes with the release of melatonin, which may hinder the nocturnal drop in blood pressure and raise the risk of cardiovascular disease.<sup>19,20</sup>

#### Gut Microbiome and Circadian Rhythms

The gut microbiome, whose microbial composition varies according to meal timing, is essential for controlling blood-pressure. Endothelial function and inflammation are impacted by the variety of gut microbiota, which is influenced by chrononutrition.<sup>21</sup>

#### Oxidative Stress and Inflammation

Unusual eating habits enhance inflammation and oxidative stress, two major causes of hypertension. It has been demonstrated that time-restricted feeding improves vascular function and lowers oxidative damage.<sup>22,23</sup>

#### Practical Applications and Future Directions

Personalized dietary guidance is necessary for the implementation of chrononutrition-based interventions.

Early Time-Restricted Feeding (eTRF): Promoting meals earlier in the day to maximize circadian alignment is one of the main suggestions for hypertensive persons.<sup>24</sup>

**Intermittent fasting methods:** that fit different lifestyles and medical situations is known as intermittent fasting, or IF. Decreased Evening Caloric Intake: Giving breakfast and lunch precedence over eating late at night.

**Meal Timing Consistency:** To preserve circadian stability, steer clear of irregular eating habits.

Long-term clinical studies should be the main focus of future research<sup>24</sup> in order to determine the best meal timing plans for people with hypertension. Furthermore, investigating chronotype and genetic variants may aid in customizing dietary strategies for the control of hypertension.

## CONCLUSION

Chrononutrition is an underutilized yet promising strategy for managing hypertension. People may improve their overall cardiovascular health and blood-pressure regulation by coordinating their meal timing with their circadian cycles. Including chrononutrition concepts in dietary recommendations may improve methods for treating and preventing hypertension as this area of study develops. Chrononutrition is also helpful in reducing insulin resistance and different dimensions of metabolic syndrome.

## REFERENCES

1. World Health Organization. Hypertension fact sheet. 2021.
2. Sacks FM, Svetkey LP, Vollmer WM, et al. The DASH diet and blood pressure control. *N Engl J Med.* 2001; 344(3):3-10.
3. Garaulet M, Gomez-Abellan P, Alburquerque-Béjar JJ, et al. Chrononutrition: role in obesity and metabolic syndrome. *Int J Obes.* 2019; 43(7):1230-1240.
4. Scheer FA, Hilton MF, Mantzoros CS, et al. Circadian rhythms and cardiovascular disease. *J Clin Invest.* 2009; 119(7):1809-1818.
5. Tiwari R, Singh S, Bajpai M, Verma N, Verma S. Impact of Osteocalcin on Glycemic Regulation and Insulin Sensitivity in Type 2 Diabetes Mellitus Patients. *Cureus.* 2024 Oct 17; 16(10):e71675. doi: 10.7759/cureus.71675. PMID: 39553160; PMCID: PMC11568420.
6. Reutrakul S, Kitjai P, Lertmaharit S, et al. Shift work and circadian disruption in hypertension. *Curr Hypertens Rep.* 2018; 20(9):69.
7. Tiwari R, Singh N, Singh S, Bajpai M, Verma S. Interplay of Adiponectin With Glycemic and Metabolic Risk Metrics in Patients With Diabetes. *Cureus.* 2024 Sep 30; 16(9):e70543. doi: 10.7759/cureus.70543. PMID: 39479098; PMCID: PMC11524515.
8. Smolensky MH, Blagrove RC, Shapiro G, et al. Circadian rhythms and blood pressure regulation. *Chronobiol Int.* 2016; 33(4):494-507.
9. Hermida RC, Ayala DE, Mojón A, et al. Chronotherapy and non-dipping hypertension. *Hypertension.* 2011; 57(1):98-105.
10. Takeda N, Maemura K. Molecular basis of circadian rhythm in the cardiovascular system. *Nat Rev Cardiol.* 2017; 14(7):451-462.
11. Lopez-Minguez J, García-González MA, Gómez-Abellán P, et al. Late eating and hypertension risk. *Nutrients.* 2018; 10(5):608.
12. Manoogian EN, Chow LS, Taub PR, et al. Time-restricted eating and cardiometabolic health. *Cell Metab.* 2022;34(1):12-25.
13. Sutton EF, Beyl R, Early KS, et al. Early time-restricted feeding and cardiometabolic health. *Cell Metab.* 2018; 27(6):1048-1055.
14. Longo VD, Panda S. Fasting and cardiovascular disease. *Circ Res.* 2019; 124(3):415-431.

15. Dutta M, Zaman S, Nair R, et al. Intermittent fasting and blood pressure reduction. *J Hypertens*. 2021; 39(4):823-832. doi: 10.4103/aam.aam\_40\_22. PMID: 38358165; PMCID: PMC10922179.
16. Verma S, Tiwari R, Verma N, Singh S, Sharma A. Anthropometry and blood biomarkers of diabetes and their possible association with obesity and metabolic syndrome. *J Diabetes Metab Disord*. 2023 Oct 11; 23(1):509-517. doi: 10.1007/s40200-023-01276-4. PMID: 38932840; PMCID: PMC11196461.
17. Jakubowicz D, Barnea M, Wainstein J, et al. Meal timing and metabolic outcomes. *Diabetes Care*. 2019; 42(4):565-572.
18. Potter GD, Cade JE, Grant PJ, et al. Circadian rhythm and metabolism. *Science*. 2016; 354(6315):1003-1009.
19. Chellappa SL, Morris CJ, Scheer FA. Melatonin and cardiovascular health. *Eur Heart J*. 2018; 39(24):2279-2286.
20. Thaiss CA, Zmora N, Levy M, et al. Gut microbiota and circadian rhythm. *Cell*. 2016;167(4):1089-1100.
21. Tiwari R, Verma S, Verma N, Verma D, Narayan J. Correlation of serum uric acid levels with certain anthropometric parameters in prediabetic and drug-naive diabetic subjects. *Ann Afr Med*. 2024 Jan-Mar; 23(1):13-18.
22. Chaix A, Lin T, Le HD, et al. Time-restricted feeding and oxidative stress. *Cell Metab*. 2019; 29(4):988-1000.
23. Singh R, Roy S, Ghildiyal A, Verma S. Association of Anthropometry With Nerve Conduction Parameters of Median Nerve: A Cross-Sectional Study in a North Indian Medical University Hospital. *Cureus*. 2024 Jul 6;16(7):e63946. doi: 10.7759/cureus.63946. PMID: 39105004; PMCID: PMC11299048.
24. Sharma A. Applications of Generative AI in Healthcare: Transforming Medical Research, Documentation, and Patient Engagement. *Global South Healthc J*. 2025;1(1):29-32

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