

## **A Survey of Circadian Disruption of Sleep and Meal Timings in a Sample Population of Himachal Pradesh-India.**

**Bovinder Chand\***

Department of Zoology, Chaudhary Charan Singh University, Meerut-250004 (Uttar Pradesh), India.

**Neelu Jain Gupta**

Department of Zoology, Chaudhary Charan Singh University, Meerut-250004 (Uttar Pradesh), India.

\*Corresponding author. Email: bovinder\_katoch@yahoo.co.in

### **Abstract**

In recent times there are a lot of changes in sleeping and eating habits of the man due to 24X7 lifestyle. Entry of electricity and artificial light into our life has played a great role in changing our lifestyle. Television has also played an important role in developing the habit of sleeping late at night. Shift from agriculture profession to office jobs has occurred at a very rapid pace in recent times. Profession-related compulsions have resulted in circadian disruption to a great extent for example increasing night shift working culture is affecting sleeping patterns along with changes in eating routines and food preferences. In the last two decades, internet and social media addiction can be considered a major factor responsible for circadian disruption of sleep. At present, there is a trend of sleeping for a lesser duration along with frequent sleep disruption due to various factors. Similarly, meal timings have also become irregular. Instead of 3 meals a day we are taking caloric diets more than 3 times a day due to the easy availability of packed snacks and fast foods. It is now a well-known fact that circadian disruption is the cause of several health disorders. The present study is an attempt to find out the extent of circadian disruption of sleep and meal timings in a sample population of inhabitants of an Indian hill state Himachal Pradesh. We observed a significant sleep fragmentation, circadian disruption, reduction in sleep duration, unhealthy food preferences, and irregular routine of meal timings, which possibly may have direct or indirect adverse consequences on health.

**Keywords:** Circadian rhythms, Fast Food, Health, Lifestyle, Sleep

### **INTRODUCTION**

In the entire evolutionary history of human life, there have never been so rapid lifestyle changes as what has occurred in the last 3-to 4 decades with changes in many of our habits and routines especially related to sleeping and eating patterns. These changes have occurred so fast that our bodies may have not gotten sufficient time to adapt to these at a similar pace. This has been resulting in several lifestyle health disorders like cardiovascular disorders, obesity, type-2 diabetes, low immunity, various types of cancer, lower working efficiency along with mental health disorders.

From the scientific literature, it can be easily concluded that food and sleep are among the most important health determinants. The not only reduction in quality of these but their circadian misalignment also affect our health adversely. There is a strong link between circadian misalignment and many mental as well as physical health disorders. For example, a study in Chicago found out that in the students in the age group 11-14 years, the habit of sleeping for less duration was associated with lower grades and self-esteem along with higher initial levels of depressive symptoms (Fredriksen *et al.*, 2004). Circadian misalignment causes mental as well as behavioral health disorders (Sletten *et al.*, 2020). Disturbances in sleep rhythms result in mental health disorders, like sleep and mental health share overlapping neural mechanisms (Foster, *et al.*, 2013). The magnitude of autism, depression, and Parkinson's disease is increased by the circadian disruption of sleep (Logan and McClung, 2019). In people with altered circadian rhythms major depressive disorder (MDD), bipolar disorder (BD), anxiety, and schizophrenia (SZ) are commonly reported (Walker *et al.*, 2020). Along with mental health circadian

disruptions of sleep affect our physical well-being also (Karatsoreos, 2012). Human performance is degraded by acute disruption of the 24-hr sleep-wakefulness cycle (Taub and Berger, 1976). Overweight and obese status can be linked to reduced amounts of sleep (Vorona *et al.*, 2005). Glucose metabolism is adversely affected by circadian disruption of sleep (Mason *et al.*, 2020). Sleep loss and disturbances are risk factors for the development of type-II diabetes (Tasali *et al.*, 2009). Cardiometabolic functioning is controlled by circadian systems (Rüger and Scheer, 2009). Sleep disturbances and disruption of the internal circadian timing system result in diabetes type -2 and cardiovascular health disorders (Kervezee *et al.*, 2020). Cardiovascular function is adversely affected by misalignment of the circadian timing system in association with behavioral and environmental cycles (Chellappa, *et al.*, 2019). Several hallmarks of cancer including DNA damage, repair, cell proliferation, and death are controlled by circadian clocks (Pariollaud and Lamia, 2020). Circadian disruption of sleep may result in cancer and other health disorders (Stevens *et al.*, 2007). Circadian disruptions of sleep can be associated with breast cancer (Stevens, 2005; Stevens *et al.*, 2014). Immune responses are impaired by sleep deprivation and restriction as a consequence of disrupted physiological and endocrine circadian rhythms (Bollinger *et al.*, 2010; Haspel *et al.*, 2020). In mice, chronic circadian misalignment accelerates immune senescence and results in weakened immunity (Inokawa *et al.*, 2020). Reduction in lifespan has also been reported in other organisms like *Drosophila* (Boomgarden *et al.*, 2019). For healthy life we need to keep our biological clocks synchronized with our activities, unfortunately, with today's busy life it seems difficult. Similar to sleep patterns circadian disruptions in meal patterns also affect health adversely. Prolonged alterations in meal timings and meal frequencies cause metabolic syndrome (Alkhulaifi and Darkoh, 2022). A study in Japan found that irregular meal timing was associated with lower physical activity levels, higher productivity loss, and higher neuroticism (Tahara *et al.*, 2021). Regularity of meal timings has many health benefits like lower LDL-cholesterol, lesser cardiometabolic risk factors, and optimum insulin secretions (Pot *et al.*, 2016). Irregular food timing may have an association with inflammatory bowel disease (Chakradeo *et al.*, 2018). Higher meal frequency, variations in meal timings, distribution of daily energy intake, and night-time eating, increase disease risk whereas regular meal patterns, reduced meal frequency (2–3 meals/day), and regular fasting periods have health benefits like modulation of the gut microbiota, increased autophagy and stress resistance, and reduced inflammation (Paoli., 2019). Irregularity in meal timings affects our gut microbiota for example prolonged variations in meal timings increase the symptomatic infection of *Helicobacter pylori* infection and may cause gastritis (Lim *et al.*, 2013). Variations in meal timings and disruptions in daily eating-fasting cycles are at present very common in Indian society and may have adverse health consequences (Gupta *et al.*, 2017; Gupta and Khare, 2020).

## **METHODS**

The survey was conducted online mode with the help of google forms. The 2965 subjects above the age of 18 years irrespective of gender from all districts of Himachal Pradesh were included in this study. They were contacted through social media apps like WhatsApp, Facebook, Instagram, or others and also through personal contacts. Duplicate entries were excluded and results were moderated accordingly. Participation in the survey was completely on a voluntary basis and all guidelines regarding ethics for research on human subjects were followed.

## RESULTS:

### A) SLEEP PATTERNS

Sleep is very important for normal brain function and systemic physiological mechanisms. Sleep disturbances can cause various health issues. Sleep disruption affects psychosocial health, performance, and risk-taking behaviors. Long-term circadian disruption of sleep leads to hypertension, dyslipidemia, cardiovascular disease, weight-related issues, metabolic syndrome, type 2 diabetes mellitus, and many types of cancer. Sleep disturbances have so much profound effect that they can increase the all-cause mortality in humans also (Medic et al., 2017); Baldwin *et al.*, 2010); Papadopoulos *et al.*, 2020; Muzet, 2007). In today's society, the sleep-wake routine is becoming irregular due to different factors.

In the present study, only 51.2% of respondents reported regularity in sleep-wake routines (difference of < 0.5 hours in routine sleep-wake timings), 42.8% with slightly irregular routines (difference of > 0.5 to <1.5 hours in routine sleep-wake timings), and 6.1% of participants reported very high irregularity in their sleep-wake timings (difference of > 1.5 hours in routine sleep-wake timings).

7.9% of the participants in our study reported that they experience very frequent sleep disturbances (at least once a week). 15.7% of respondents experience sleep disturbances often (< once in a week), 65.6 % rarely (< once in a month). Only 10.8% of respondents are able to take sound sleep without disturbances. The chief cause behind the sleep disturbances is sound pollution during the night.

To promote good health the requisite duration of sleep per 24 hours varies for different age groups for example it should be 12 to 16 hours for infants of 4 to 12 months, 11 to 14 hours (including naps) for children 1 to 2 years of age, 10 to 13 hours for children 3 to 5 years of age, 9 to 12 hours for children 6 to 12 years of age, 8 to 10 hours for teenagers 13 to 18 years of age, 7-9 hours for adults above the age of 18 years (Ohayon *et al.*, 2017; Paruthi *et al.*, 2016; Ross, *et al.*, 2020). In our survey which had all participants above the age of 18 years, 7 or more than 7-hour average daily sleep is reported by only 19.6% of respondents, 6–7-hour sleep is reported by 65.3%, and 4–6 hours of sleep by 13.8% of respondents. Interestingly 1.3% of respondents said that they take sleep for about 4 hours only. So, almost 15.1% of people are taking sleep less than 6 hours per 24 hours. In the olden days before the entry of electricity and artificial lights, people were used to sleeping early at night and waking up early in the morning.

Indians had a tradition of sleeping early at night and waking up the next morning before sunrise i.e. at Brahma Muhurta (the time between 04:24 AM to 05:11 AM) and it is considered that the habit of waking up early in the morning makes us healthier (Harti and Kulkarni, 2020; Tripathi *et al.*, 2003; Radha, 2019; Chauhan *et al.*, 2019). A great shift has occurred in present times as seen in the present study. Only 34.2% of respondents reported that they usually sleep early at night and wake up early in the next morning (Sleep before 10:00 PM and wake up before 5:00 AM), 22.9% of respondents sleep late at night and in the next morning wake up late also (Sleep after midnight and wake up after 7:00 AM), 16.9% Sleep early at night but wake up late next morning (Sleep before 10:30 PM and wake up after 7:00 AM), 14.8% sleep late at night and wake up early next morning (Sleep after midnight and wake up before 6:00 AM). The rest of the people do not follow any of these above routines for sleep-wake cycles. The reasons reported for late sleeping by late sleepers include work-related compulsions including studies (43.5%), viewing television till late at night (5.1%), mobile and internet usage for social media or other entertainment purposes (38.3%), and any reason other than these (23.4%). So, we see that work-related compulsions and internet addiction are becoming a cause of developing a habit of sleeping late at night and getting exposed to artificial light for longer durations. Exposure to artificial light at night affects our melatonin secretion (McIntyre *et al.*, 1989), which is a chief regulator of the master circadian clock of the body (Pevet and Challet, 2011). Misalignment of

this clock may cause disturbances in all other circadian systems of the body resulting in health problems (Karatsoreos *et al.*, 2011).

### **B) EATING PATTERNS**

Adverse metabolic consequences are followed if there is a circadian misalignment in energy metabolism and appetite-regulating hormones (Boege *et al.*, 2021). Due to various factors including profession-related compulsions, meal timings have also become highly irregular in modern society similar to sleep patterns. It is found that only 23.5% of people at present take their meals at a routine time (difference of <1 hour), the rest of the respondents reported that at least one of their meal timings is irregular (difference of >1 hour). Irregularity in timings of dinner only is the least with 9.2% of respondents. In breakfast timings, 19.1% and lunch timings 28.8% irregularity is reported. A very high percentage (19.3%) said that there all meal timings are irregular. Snacking and consumption of caloric food in addition to regular 3 meals a day is also now a very common practice with very often 5% (once or more than once a week), often 20.5% (< once a week), rarely 57.1% (< once a month) and only 17.4% respondents are there who very rarely or never consume additional caloric diet except milk, tea, coffee or fruits.

Intermittent fasting has several health benefits. It optimizes physiological functions, enhances performance, and has been thought to slow aging and disease processes (Golbidi *et al.*, 2017; Anton *et al.*, 2018). 31.1% of the people reported that they never practice fasting, once in a week 22.9%, once in a month 10.7%, and rarely 35.1%. Skipping of meals is also very frequent in subjects. 5.9% of people skip their meals very often (more than once a week), often 14.7% (skipping frequency less than once a week), and rarely 54.9% (once in a month). 25% of people skip their meals never or rarely. Though intermittent fasting is considered good for metabolism, skipping breakfast can have adverse consequences (Huang *et al.*, 2010).

### **SELF REPORTED HEALTH ASSESSMENT**

54% of participants assessed their health status as healthy. 42.5% of the participants said they are facing minor health problems. Health status with major health issues was reported by 3.4% of the participants. Health issues reported by the participants included high blood pressure (3.4%), low blood pressure (11.4%), other cardiovascular diseases (0.8%), obesity (3.9%), high blood urea (0.3%), high uric acid (1.7%), high cholesterol (1.2%), diabetes (1.2%), any other 9.5%.

### **CONCLUSIONS**

From the results of this study, it can be easily concluded that in the people of Himachal Pradesh there is a trend of reduction in sleep duration, sleep fragmentation, and irregularity of sleep-wake cycles. The habit of sleeping late at night is mainly due to work-related compulsions including studies and internet usage. Similar to sleep there is an irregularity in meal routines also. Meal timings are irregular along with frequent skipping of meals, more than 3 times a day calorific intake, and increased tendency of consuming unhealthy snacks and fast food. Almost half of the participants are facing some minor or major health problems. There is a need to make people about the importance of synchronized biological clocks and their activity schedules especially the sleep-wake cycles and the meal timings for good health.

**CONFLICT OF INTEREST:** Authors declare that there is no conflict of interest.

1. Alkhulaifi, F., & Darkoh, C. (2022). Meal Timing, Meal Frequency and Metabolic Syndrome. *Nutrients*, 14(9), 1719.
2. Anton, S. D., Moehl, K., Donahoo, W. T., Marosi, K., Lee, S. A., Mainous III, A. G., ... & Mattson, M. P. (2018). Flipping the metabolic switch: understanding and applying the health benefits of fasting. *Obesity*, 26(2), 254-268.
3. Baldwin, C. M., Ervin, A. M., Mays, M. Z., Robbins, J., Shafazand, S., Walsleben, J., & Weaver, T. (2010). Sleep disturbances, quality of life, and ethnicity: the Sleep Heart Health Study. *Journal of Clinical Sleep Medicine*, 6(2), 176-183.

4. Boege, H. L., Bhatti, M. Z., & St-Onge, M. P. (2021). Circadian rhythms and meal timing: impact on energy balance and body weight. *Current opinion in biotechnology*, 70, 1-6.
5. Bollinger, T., Bollinger, A., Oster, H., & Solbach, W. (2010). Sleep, immunity, and circadian clocks: a mechanistic model. *Gerontology*, 56(6), 574-580.
6. Boomgarden, A. C., Sagewalker, G. D., Shah, A. C., Haider, S. D., Patel, P., Wheeler, H. E., ... & Cavanaugh, D. J. (2019). Chronic circadian misalignment results in reduced longevity and large-scale changes in gene expression in *Drosophila*. *BMC genomics*, 20(1), 1-21.
7. Chakradeo, P. S., Keshavarzian, A., Singh, S., Dera, A. E., Esteban, J. P. G., Lee, A. A., ... & Swanson, G. R. (2018). Chronotype, social jet lag, sleep debt and food timing in inflammatory bowel disease. *Sleep medicine*, 52, 188-195.
8. Chauhan, V. V. J., Manche, V. Y., & Patrikar, V. V. G. (2019). Bramhamuhurta for Healthy Lifestyle-A Review Study. *World Journal of Pharmaceutical Research*, 8(6), 260-265.
9. Chellappa, S. L., Vujovic, N., Williams, J. S., & Scheer, F. A. (2019). Impact of circadian disruption on cardiovascular function and disease. *Trends in Endocrinology & Metabolism*, 30(10), 767-779.
10. Foster, R. G., Peirson, S. N., Wulff, K., Winnebeck, E., Vetter, C., & Roenneberg, T. (2013). Sleep and circadian rhythm disruption in social jetlag and mental illness. *Progress in molecular biology and translational science*, 119, 325-346.
11. Fredriksen, K., Rhodes, J., Reddy, R., & Way, N. (2004). Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years. *Child development*, 75(1), 84-95.
12. Golbidi, S., Daiber, A., Korac, B., Li, H., Essop, M. F., & Laher, I. (2017). Health benefits of fasting and caloric restriction. *Current diabetes reports*, 17(12), 1-11.
13. Gupta, N. J., Kumar, V., & Panda, S. (2017). A camera-phone based study reveals erratic eating pattern and disrupted daily eating-fasting cycle among adults in India. *PloS one*, 12(3), e0172852.
14. Gupta, N.J., & Khare, A. (2020). Disruption in daily eating-fasting and activity-rest cycles in Indian adolescents attending school. *Plos one*, 15(1), e0227002.
15. Harti, S. S., & Kulkarni, M. (2020). AN EPIDEMIOLOGICAL SURVEY STUDY TO KNOW THE SLEEPING AND WAKE UP TIME OF ELDERLY AND ITS RELATION TO HEALTH. *International Journal of Ayurveda and Pharma Research*, 63-66.
16. Haspel, J. A., Anafi, R., Brown, M. K., Cermakian, N., Depner, C., Desplats, P., ... & Solt, L. A. (2020). Perfect timing: circadian rhythms, sleep, and immunity—an NIH workshop summary. *JCI insight*, 5(1).
17. Huang, C. J., Hu, H. T., Fan, Y. C., Liao, Y. M., & Tsai, P. S. (2010). Associations of breakfast skipping with obesity and health-related quality of life: evidence from a national survey in Taiwan. *International journal of obesity*, 34(4), 720-725.
18. Inokawa, H., Umemura, Y., Shimba, A., Kawakami, E., Koike, N., Tsuchiya, Y., ... & Yagita, K. (2020). Chronic circadian misalignment accelerates immune senescence and abbreviates lifespan in mice. *Scientific reports*, 10(1), 1-13.
19. Karatsoreos, I. N. (2012). Effects of circadian disruption on mental and physical health. *Current neurology and neuroscience reports*, 12(2), 218-225.

20. Karatsoreos, I. N., Bhagat, S., Bloss, E. B., Morrison, J. H., & McEwen, B. S. (2011). Disruption of circadian clocks has ramifications for metabolism, brain, and behavior. *Proceedings of the national Academy of Sciences*, *108*(4), 1657-1662.
21. Kervezee, L., Kosmadopoulos, A., & Boivin, D. B. (2020). Metabolic and cardiovascular consequences of shift work: The role of circadian disruption and sleep disturbances. *European Journal of Neuroscience*, *51*(1), 396-412.
22. Lim, S. L., Canavarro, C., Zaw, M. H., Zhu, F., Loke, W. C., Chan, Y. H., & Yeoh, K. G. (2013). Irregular meal timing is associated with helicobacter pylori infection and gastritis. *International Scholarly Research Notices*, *2013*.
23. Logan, R. W., & McClung, C. A. (2019). Rhythms of life: circadian disruption and brain disorders across the lifespan. *Nature Reviews Neuroscience*, *20*(1), 49-65.
24. Mason, I. C., Qian, J., Adler, G. K., & Scheer, F. A. (2020). Impact of circadian disruption on glucose metabolism: implications for type 2 diabetes. *Diabetologia*, *63*(3), 462-472.
25. McIntyre, I. M., Norman, T. R., Burrows, G. D., & Armstrong, S. M. (1989). Human melatonin suppression by light is intensity dependent. *Journal of pineal research*, *6*(2), 149-156.
26. Medic, G., Wille, M., & Hemels, M. E. (2017). Short-and long-term health consequences of sleep disruption. *Nature and science of sleep*, *9*, 151.
27. Muzet, A. (2007). Environmental noise, sleep and health. *Sleep medicine reviews*, *11*(2), 135-142.
28. Ohayon, M., Wickwire, E. M., Hirshkowitz, M., Albert, S. M., Avidan, A., Daly, F. J., ... & Vitiello, M. V. (2017). National Sleep Foundation's sleep quality recommendations: first report. *Sleep health*, *3*(1), 6-19.
29. Paoli, A., Tinsley, G., Bianco, A., & Moro, T. (2019). The influence of meal frequency and timing on health in humans: the role of fasting. *Nutrients*, *11*(4), 719.
30. Papadopoulos, D., Sosso, F. A., Khoury, T., & Surani, S. R. (2020). Sleep disturbances are mediators between socioeconomic status and health: a scoping review. *International Journal of Mental Health and Addiction*, 1-25.
31. Pariollaud, M., & Lamia, K. A. (2020). Cancer in the fourth dimension: What is the impact of circadian disruption?. *Cancer discovery*, *10*(10), 1455-1464.
32. Paruthi, S., Brooks, L. J., D'Ambrosio, C., Hall, W. A., Kotagal, S., Lloyd, R. M., ... & Wise, M. S. (2016). Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for healthy children: methodology and discussion. *Journal of clinical sleep medicine*, *12*(11), 1549-1561.
33. Pevet, P., & Challet, E. (2011). Melatonin: both master clock output and internal time-giver in the circadian clocks network. *Journal of Physiology-Paris*, *105*(4-6), 170-182.
34. Pot, G. K., Almoosawi, S., & Stephen, A. M. (2016). Meal irregularity and cardiometabolic consequences: results from observational and intervention studies. *Proceedings of the Nutrition Society*, *75*(4), 475-486.
35. Radha, P. (2019). Correlating Health-Oriented Human Traditions with Basic Science and Automating Health-Related Processes Using Modern Science. *Human Arenas*, *2*(4), 516-535.
36. Ross, R., Chaput, J. P., Giangregorio, L. M., Janssen, I., Saunders, T. J., Kho, M. E., ... & Tremblay, M. S. (2020). Canadian 24-Hour Movement Guidelines for Adults aged 18–64 years and Adults aged 65 years or older: an integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism*, *45*(10), S57-S102.

37. Rüger, M., & Scheer, F. A. (2009). Effects of circadian disruption on the cardiometabolic system. *Reviews in Endocrine and Metabolic Disorders*, 10(4), 245-260.
38. Sletten, T. L., Cappuccio, F. P., Davidson, A. J., Van Cauter, E., Rajaratnam, S. M., & Scheer, F. A. (2020). Health consequences of circadian disruption. *Sleep*, 43(1), zsz194.
39. Stevens, R. G. (2005). Circadian disruption and breast cancer: from melatonin to clock genes. *Epidemiology*, 16(2), 254-258.
40. Stevens, R. G., Blask, D. E., Brainard, G. C., Hansen, J., Lockley, S. W., Provencio, I., ... & Reinlib, L. (2007). Meeting report: the role of environmental lighting and circadian disruption in cancer and other diseases. *Environmental health perspectives*, 115(9), 1357-1362.
41. Stevens, R. G., Brainard, G. C., Blask, D. E., Lockley, S. W., & Motta, M. E. (2014). Breast cancer and circadian disruption from electric lighting in the modern world. *CA: a cancer journal for clinicians*, 64(3), 207-218.
42. Tahara, Y., Makino, S., Suiko, T., Nagamori, Y., Iwai, T., Aono, M., & Shibata, S. (2021). Association between Irregular Meal Timing and the Mental Health of Japanese Workers. *Nutrients*, 13(8), 2775.
43. Tasali, E., Leproult, R., & Spiegel, K. (2009). Reduced sleep duration or quality: relationships with insulin resistance and type 2 diabetes. *Progress in cardiovascular diseases*, 51(5), 381-391.
44. Taub, J. M., & Berger, R. J. (1976). The effects of changing the phase and duration of sleep. *Journal of Experimental Psychology: Human Perception and Performance*, 2(1), 30.
45. Tripathi, D. B., Hridayam, A., & Commentry, N. H. (2003). Chaukhamba Sanskrit Pratishtan. *Delhi, Reprint*.
46. Vorona, R. D., Winn, M. P., Babineau, T. W., Eng, B. P., Feldman, H. R., & Ware, J. C. (2005). Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index. *Archives of internal medicine*, 165(1), 25-30.
47. Walker, W. H., Walton, J. C., DeVries, A. C., & Nelson, R. J. (2020). Circadian rhythm disruption and mental health. *Translational psychiatry*, 10(1), 1-13.